SCALING UP CLIMATE SMART AGRICULTURE: INTEGRATING YOUTH, WOMEN AND THE DIGITAL REVOLUTION

PROCEEDINGS OF THE 2017 JOINT CONFERENCE

FOR THE

3RD AFAAS AFRICA-WIDE AGRICULTURAL EXTENSION WEEK

AND THE

51ST ANNUAL CONFERENCE OF THE SOUTH AFRICAN SOCIETY FOR AGRICULTURAL EXTENSION

30 October – 3 November 2017

Tsogo Sun Elangeni Hotel & Maharani Hotel

Durban, KwaZulu Natal

SOUTH AFRICAN SOCIETY FOR AGRICULTURAL EXTENSION (SASAE) & AFRICAN FORUM FOR AGRICULTURAL ADVISORY SERVICES (AFAAS)

PROCEEDINGS OF THE JOINT 3RD AFAAS AFRICA-WIDE AGRICULTURAL EXTENSION WEEK & 51ST ANNUAL CONFERENCE OF THE SOUTH AFRICAN SOCIETY FOR AGRICULTURAL EXTENSION

30 OCTOBER – 3 NOVEMBER 2017: ELANGENI & MAHARANI HOTELS, DURBAN, KWAZULU-NATAL PROVINCE, SOUTH AFRICA.

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FOREWORD

It is a great honour for me to present the proceedings report of the 3rd Africa-Wide Agricultural Extension Week. We salute the honourable Minister of Agriculture, Forestry and Fisheries, Mr Senzeni Zokwana for his vision and eagerness to establish and maintain effective linkages and partnerships with relevant stakeholders for the support and revitalisation of agricultural extension and advisory services. The honourable Minister made it possible for the Rainbow Nation, the Republic of South Africa to host the 3rd Africa-Wide Agricultural Extension Week (AEW). This is one of the key platforms and mechanisms used to promote lesson learning, sharing of information and increase professional interaction.

The 3rd AEW was organised in South Africa by the Department of Agriculture, Forestry and Fisheries (DAFF) in collaboration with the African Forum for Agricultural Advisory Services (AFAAS) and the South African Society for Agricultural Extension (SASAE). The conference focused on the theme of "Scaling up Climate Smart Agriculture (CSA): Integrating Youth, Women, and the Digital Revolution". This conference brought together Agricultural Extension and Advisory Services (AEAS) stakeholders from all over the world to focus on topical issues that need concerted actions from Agricultural Extension and Advisory Services in Africa.

The focus on this theme is a realisation that climate change is drastically affecting the production of food and other commodities in Africa. We therefore, seek to promote the scaling up of CSA technologies and innovations with a view of developing a robust system of support mechanisms to mitigate challenges of climate change across Africa. The strategic intent is to forge relationships with the economics and business faculties of academic institutions to undertake research and analysis on the business viability of new technologies, to develop marketing strategies for these technologies, and create commercialisation plans for useful, but technical, breakthrough in the climate smart agricultural research.

Such an approach will capacitate and empower the Extensionists to effectively deploy, support, and implement climate smart agriculture innovations. The vision of a leading, dynamic, prosperous and people-centred sector can be achieved with Extension and Advisory Services at the forefront. We believe that through learning networks, partnerships and sharing of information, Extension Practitioners will be empowered, and this will equally translate to the producers, more specifically women and youth. It is for such reasons that all delegates and stakeholders declared to provide an enabling environment for women and youth to develop and fully utilise their capacities and innovativeness to enhance climate smart agriculture for equitable development outcomes. The institutions also commit to mainstreaming of women and youth into their poverty eradication programmes.

In the 21st century, it is necessary to embrace accelerated engagement of tech-savvy youth in the development and use of ICTs for the benefit of and rejuvenating the aging farmers in our communities. The promotion for the development as well as up-scaling the use of ICTs to enhance innovative response and actions in climate adaptation, mitigation and resilience to climate change is fundamental.

Finally, I must thank all the members of the Local Organising Committee (LOC) for the outstanding work done in the successful organisation of the 3rd Africa-Wide Agricultural Extension Week, held in Durban at the Tsogo Sun, Elangeni and Maharani Hotels, KwaZulu-Natal Province, South Africa from the 30th October 2017 to 3rd of November 2017. Each one of you needs to remember that "tough times don't last but tough people do". Never ever say "I can't" but always say "I'll try". Stay strong, I really believe in you.

MR TOZAMILE LUKHALO

CHAIRPERSON: LOCAL ORGANISING COMMITTEE

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BACKGROUND TO AGRICULTURAL EXTENSION WEEK 2017, SOUTH AFRICA

The African Forum for Agricultural Advisory Services (AFAAS) is a continental body that brings National Agricultural Extension & Advisory Services (AEAS) actors under one umbrella. The AFAAS' goal is to enhance utilisation of improved knowledge, technologies and innovations by agricultural value chain actors for improving productivity oriented towards their individual and national development objectives. AEAS is a key component of the innovation system, playing a pivotal role in promoting productivity, increasing food security, strengthening rural communities, and underpinning agriculture as the engine for pro-poor economic growth. AEAS is one of the key pillars for transforming rural livelihoods and contributing to Africa's agenda 2063. AFAAS upholds the 2014 Malabo Declaration and the Comprehensive Africa Agriculture Development Programme (CAADP), whose Monitoring and Evaluation Framework is overarching for the CAADP institutions.

One of the main mechanisms that AFAAS has used for pursuing its mission is by promoting lesson learning, sharing of information and increased professional interaction through the "Agricultural Extension Week" (AEW) events. The AEW is a key mechanism for AFAAS to pursue its mission and capitalises on in order to reach its stakeholders and delivering results. This mechanism was demanded and identified by AEAS stakeholders in Africa as a tool to bring together AEAS stakeholders from all African countries to focus on topical issues that need concerted actions, including technology and innovation adaptation and scaling up and out, policy advocacy, promoting lesson learning, sharing information on good practices and increased professional interaction – especially to influence AEAS policies and programming in Africa. The AEW is held biennially, and so far, two AEWs have been held. The first AEW was held in August 2013 in Gaborone, Botswana, focusing on "Value chain approach in agricultural development: Coping with new demands for agricultural advisory services". The second one was held in Addis Ababa, Ethiopia, in October 2015 under the theme: "Reinvigorating extension services for market-led agriculture within the context of the Malabo Declaration". The third, and currently outlined, AEW was held in Durban, South Africa, from 30 October to 3 November 2017.

THEME OF THE WEEK

The AFAAS and the South African Society for Agricultural Extension (SASAE) together with the Department of Agriculture, Forestry and Fisheries (DAFF) were responsible for organising the 3rd AEW conference on the theme of:

"Scaling up climate smart agriculture (CSA): Integrating youth, women, and the digital revolution".

SUB-THEMES

1. Integrating youth and women in CSA
2. Scaling up ICT innovations for CSA
3. Scalable CSA technologies and innovations
4. Capacity development for scaling up CSA innovations
5. Knowledge management for CSA
6. Innovation for entrepreneurship

GOAL, OBJECTIVES AND EXPECTED OUTCOMES

Goal: Contribute to mainstreaming of CSA techniques in AEAS approaches to enhance environmental sustainability and climate resilience of most vulnerable farming populations, especially women and youth in Africa.

Objectives:

i. Facilitate networking and enhance information, knowledge and experience sharing on CSA among several stakeholders (including policy makers and technocrats);
ii. Promote mainstreaming of CSA in AEAS at local, national and continental level;
iii. Build consensus for scaling up and out CSA technologies, innovations and practices;
iv. Creating space for women and youth to be integral in finding solutions within the CSA knowledge platforms;
v. Take stock of available CSA technologies, innovations and practices and devise joint strategies for scaling up and out through partnerships;
vi. Build strong linkages of IFAD country programmes and other development partners' programmes/ projects within the continental AEAS knowledge and innovation networks.

Expected outcomes: Established and strengthened partnerships and improved knowledge and awareness of the importance of CSA to support the vulnerable rural farmers to demand for better access to and utilisation of technologies, innovations, management practices created and shared amongst AEAS actors.

Expected outputs:

i. Knowledge on scaling up CSA in AEAS for multiple actors to support farmers, especially youth and women to increase and add value to their agricultural productivity, production and marketing shared;
ii. Best fit practices on CSA for reducing vulnerability profiled and a framework developed for sharing amongst AEAS actors;
iii. Strong linkages of IFAD country programmes and other development partners' programmes/ projects within the continental AEAS knowledge and innovation networks developed;
iv. Two follow up operational meetings held for internal reflection and lesson learning;
v. Reporting from AEW proceedings generated and shared with participants.

CONFERENCE PROGRAMME

SUNDAY, 29th OCTOBER 2017	
09:00 – 13:00	AFAAS Board Meeting / LOC Meeting
12:00 – 18:00	**REGISTRATION**
16:00 – 19:00	SASAE Board Meeting
20:00 – 21:00	KZN Branch of SASAE AGM
	DINNER OWN ARRANGEMENTS

MONDAY, 30th OCTOBER 2017	
OPENING SESSION – CHAIRPERSON: ACTING DG DAFF	
08:00 – 09:00	**LATE REGISTRATION**
09:00 – 09:10	Singing of the National Anthems (South Africa & African Union)
09:10 – 09:30	Welcome to the eThekwini Metro: Executive Mayor
09:30 – 09:45	Message by Hon. Prof. R. Oniang'o (AFAAS Patron)
09:45 – 10:05	Message by president of SASAE
10:05 – 10:20	Introduction of the Premier of KwaZulu-Natal by the MEC of Agriculture and Rural Development
10:20 – 10:40	Remarks and message of support by the Premier of KwaZulu-Natal
10:40 – 10:55	Introduction of Minister by the Hon. Deputy Minister: General Bheki Cele, Agriculture, Forestry & Fisheries
10:55 – 11:25	Official Opening of AEW by Hon. Mr. Senzeni Zokwana, (MP) Minister of Agriculture, Forestry and Fisheries
11:30 – 11:45	Group Photo
11:45 – 12:15	**TEA BREAK**

12:15 – 12:45	**Key Note Speaker – Reposition Agricultural Extension to contribute effectively to inclusive CSA and Resilient Africa** Associate Prof. M Mangheni, Makerere University, Uganda
12:45 – 13:30	**SA best practices**: **Reaching the plate: Success stories of South African Agriculture by means of Extension** Dr J. A. Van Niekerk (University of Free State, FAO, University of Ghent)
13:30 – 14:30	**LUNCH BREAK**
SECOND SESSION - Chairperson: Prof. E M Zwane	
14:30 – 15:00	**Climate Smart Agriculture Strategic Framework** Dr I. B. Kgakatsi (DAFF)
15:00 – 15:30	**Sector specific drought indicators and drought monitoring in South Africa** Prof. A. Jordaan
15:30 – 16:00	**Panel Discussion:** Dr J. Mutimba; Dr P. Djamen; Prof. T. Arokoyo,
16:00 – 16:30	**TEA BREAK**
18:30 – 22:00	**GALA DINNER AND NATIONAL EXTENSION AND ADVISORY SERVICES AWARDS, SOUTH AFRICA Amphitheatre opposite Elangeni Hotel**

TUESDAY, 31st OCTOBER 2017				
THIRD SESSION: Chairperson: Ms. L Botsheleng				
08:30 – 10:00	**Korean - KAFACI Experience in agricultural extension and Advisory services** Dr Cho Rae, KAFACI **Sub-theme 1: Integrating youth and women in CSA** – Ms S. Mwamakamba (FANRPAN) **Sub-theme 2: Scaling up ICT innovations for CSA** – Mr A. Rasoanindrainy (AFAAS)			
10:00 – 10:30	**TEA BREAK**			
	Chairperson: **Mr R. H. Khwidzhili**	**Chairperson;** **Ms M. L. Mbongo**	**Chairperson:** **Mr T. T. Mabuza**	**Chairperson:** **Ms C. Levendal**
10:30 – 11:00	**Sub-theme 1 paper 1** Adoption Choice of Climate Smart Agriculture Practices by	**Sub-theme 1 paper 2** Behavioural approaches of rural women farmers to mitigation and adaptation measures of	**Sub-theme 2 paper 1** The Potential of Innovation Platforms and ICTs in Enhancing Adoption of CSA	**Sub-theme 2 paper 2** Mapping and monitoring the “footprint” of

	Rural Women in Southern Nigeria. **<u>Etim Nsikak-Abasi A.</u> & Etim NseAbasi N.**	climate change in Abia State, Nigeria. **<u>Umeh, O.J.</u> & Nwachukwu, I.**	Innovations in Smallholder Dairying: Evidence from Zimbabwe. **<u>Hanyani-Mlambo, B.</u>; Mudhara, M.; Mafongoya, P. & Nyikahadzoi, K.**	agriculture in the Western Cape. **<u>Wallace, M.G.</u>**
11:10 – 11:40	**Sub-theme 1 paper 3** **P**erceived effects of climate change on vegetable production among women farmers in Kwara State, Nigeria. **<u>Olooto F.M.</u>, Yusuf O.J., Ayanda I.F. & Salawudeen O.L.**	**Sub-theme 1 paper 4** The role of Operation Sukuma Sakhe (OSS) on Climate Smart Agriculture awareness in Youth and its impact on food security in KwaZulu Natal. **<u>Khali, G.</u>, Tembe, S. & Hlatshwayo, P.**	**Sub-theme 2 paper 3** Access and training needs in telephone applications among extension workers in Edo state: Implications for climate smart agriculture in Nigeria. **<u>Koyenikan, M.J.,</u> Ohiomoba, I.S. & Abdusalam-Saghir, P.**	**Sub-theme 2 paper 4** Socio-Economic determinants of mobile phone adoption as ICT tool for agricultural marketing among smallholder irrigation farmers in South Africa. **<u>Akinyemi B.E</u> & Mushunje, A.**
11:50 – 12:20	**Sub-theme 1 paper 5** Participation of the youth in agricultural extension programmes of the Manzini region, Swaziland. **<u>Jibowo, A.A.</u> & Sihlongoyane, M.N.**	**Sub-theme 1 paper 6** Gender Involvement in Climate Smart Aquaculture Value Chain of South West States, Nigeria. **<u>Akinyemi A.O.</u>, <u>Fregene, B.T.</u>, & Omonona BB.T.**	**Sub-theme 2 paper 5** Scaling up climate smart agriculture from the Koup pilot project of 80 000ha to 500 000ha. Doing it the LandCare way**.** **<u>Steyn, F.</u>**	**Sub-theme 2 paper 6** Developing farmer capacity to practice conservation agriculture (CA) at farm level. **Pierre, A., <u>Du Toit, P.N.</u> & Nemadodzi, E.A.**
12:20 – 12:50	**Sub-theme 1 paper 7** Integrating agricultural videos in rural extension as tools to enhance climate smart agriculture in Cameroon. **Labu, N.B. & Ngouambe, N.**	**Sub-theme 1 paper 8** Outcomes of Assessment of the Nutritional Status of Children from Historically Disadvantaged Agri-business Families, South Africa. (*A challenge for a responsive agricultural extension function*) **<u>Sonandi, A.,</u> Zwane, E.M. & Van Niekerk, J.A.**	**Sub-theme 2 paper 7** Extension workers perceptions regarding the Digital mobile technology services in addressing climate change issues: A case study of Botswana. **<u>Hulela, K.</u>, Moremedi, G.**	**Sub-theme 2 paper 8** Development of a 'Planting App' for Maize across South Africa. **<u>Walker, S.</u>, Kaempffer, L.C., Newby, T., Ferguson, J. & Van der Burgt, F.**
13:00 –14:00	**LUNCH**			

FOURTH SESSION - CHAIRPERSON: Dr. K Davis				
14:00 –15:30	**Sub-theme 3: Scalable CSA Technologies and Innovations:** Dr I. Trautmann (Department of Agriculture, Western Cape) **Sub-theme 4: Capacity development for scaling up CSA innovations:** Dr M. Akeredolu (AFAAS) **Respondent:** Prof. M. Zinnah			
15:30 – 16:00	**TEA BREAK**			
	Chairperson; Ms M. E. Bornman	**Chairperson: Dr A. Sonandi**	**Chairperson: Ms J. Mtungwa**	**Chairperson: Ms L. Matthews**
16:00 – 16:30	**Sub-theme 3 paper 1** FRUITLOOK: A spatial approach to assess and improve water use efficiency of vineyards and deciduous fruit orchards in South Africa. **Roux, A., Jarmain, C. & Goudriaan, R.**	**Sub-theme 3 paper 2** Introduction of biogas-digester technology as a climate change mitigation measure in small-scale farming communities of Amatole District Municipality (Eastern Cape). **Ndzimande, N., Dumani, A., Moeketsi, M. & Nape, M.**	**Sub-theme 4 paper 1** Capacity development for scaling up Climate Smart Agriculture: The Sasakawa Africa Fund for Extension Model of experiential learning. **Naibakelao, D., Akeredolu, M. & Oladele, O.I.**	**Sub-theme 4 paper 2** Rainwater Harvesting: Climate Smart Techniques for increased Smallholder Productivity. **Botha, J.J.; Anderson, J.J. & Koatla, T.A.B.**
16:40 – 17:10	**Sub-theme 3 paper 3** Crossbreeding in beef cattle for increased efficiency in response to environmental conditions. **Theunissen, A., Scholtz, M.M., Mokolobate, M.C. Ntwaeagae, O. & Ferreira, M.**	**Sub-theme 3 paper 4** Solar powered irrigation technology helping to integrate women and youth into Climate Smart Agriculture (CSA) in Gwanda, Zimbabwe. **Zheke, H.G.**	**Sub-theme 4 paper 3** Building capacity of agricultural extension services in southern Africa for scaling up climate smart agriculture innovations. **Förch, W., Podisi, B. & Beerhalter, S.**	**Sub-theme 4 paper 4** Capacity development for scaling up CSA innovations. **Zwane, E.M.**
17:20 – 17:50	**Sub-theme 3 paper 5** A farmer-centred Innovation Systems Approach to scale up Conservation Agriculture (CA) in South Africa. **Smith, H.**	**Sub-theme 3 paper 6** Potential and farmer-based dissemination of conservation agriculture in semi-arid West Africa. **Djamen, P.**	**Sub-theme 4 paper 5** Best Technology for Addressing Climate Change in Sudan. **Bereir, A.M.A.R.**	**Sub-theme 4 paper 6** The role of a Virtual Irrigation Academy (VIA) to improve water productivity in Malawi, Tanzania and South Africa. **Stevens, J. B.**
17:50 – 18:20	**Sub-theme 3 paper 7** Delivery of climate smart agricultural extension in Uganda;		**Sub-theme 4 paper 7** The first twenty years - the development and adoption of a climate smart grain production system for the	**Sub-theme 4 paper 8** Project CSA Bateké: Building Community Resilience. **Kazika, A.**

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<tr><td></td><td>Incorporating gender & nutrition, ICT and youth in agriculture.
Luzobe, B.</td><td></td><td>Swartland region of the Western Cape Province.
Strauss, J.A. & Swanepoel, A.</td><td></td></tr>
<tr><td>**19:00 – 22:00**</td><td colspan="4">**Cultural Evening – Braai style menu at Amphitheatre - opposite Elangeni Hotel.**</td></tr>
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<tr><td>08:30 – 09:30</td><td>**Plenary** – Discussion of projects to be visited</td></tr>
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Congela Room</td><td>**Side Event - The New Extensionist and Professionalisation of Rural Advisory Services.** Ms. H Ngwenya, GFRAS</td></tr>
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Sub-theme 6: Innovation for entrepreneurship: Dr J. Mutimba (AFAAS)
Respondent: IFAD / FANRPAN Dr T. Takavarasha</td></tr>
<tr><td>**10:00 – 10:30**</td><td colspan="4">**TEA BREAK**</td></tr>
<tr><td></td><td>**Chairperson:
Ms H. J. Ngwenya**</td><td>**Chairperson:
Dr Y. Pakela-Jezile**</td><td>**Chairperson:
Mr T. Sedumedi**</td><td>**Chairperson:
Mr G. Shole**</td></tr>
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The relevance of smallholder farmers' adoption decision-making behaviours in the adoption of climate smart agricultural (CSA) practices in South</td><td>**Sub-theme 5 paper 2**
Maize farmers' perception of the effects of climate change and coping strategies in Nassarawa innovation platform, Nigeria.</td><td>**Sub-theme 6 paper 1**
Farmer Perspective on the role of Conservation Agriculture on Food Security and Land Restoration in the Maize Triangle, Vanderbijlpark,</td><td>**Sub-theme 6 paper 2**
Promoting entrepreneurship and SMME's through extension: Case of the Mngcunube mentorship program amongst small scale livestock farmers.</td></tr>
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	Africa: the case of soil conservation at Qamata Irrigation Scheme, Eastern Cape. **Ighodaro, I.D., & Mushunje, A.**	**Tologbonse, E.B., Arokoyo, T. & Akeredolu, M.**	Sedibeng District, Gauteng Province. **Mokoka, S.J.**	**Jordaan, A.J., Kew, L. & Blaker, J.**
11:10 – 11:40	**Sub-theme 5 paper 3** Farmers' knowledge of alternate wet and dry techniques in lowland rice production in Ndop, Cameroon. **Chimewah, A.N. & Oladele, I.O.**	**Sub-theme 5 paper 4** Determinants of farmers' adoption alternate wet and dry techniques in lowland rice production in Ghana and Uganda for climate smart agriculture. **Oladele, O.I.**	**Sub-theme 6 paper 3** Developing Agripreneurship Behaviour of Innovative Youth Farmers in Ethiopia **Teklehaimanot, A.**	**Sub-theme 6 paper 4** Cultivated pastures by smallholder farmers to transform and reorient agricultural systems and promote entrepreneurship in communal areas. **Dlamini, S.S., Khali, W.G., Hlatshwayo, P.P., Luthuli, C.F. & Mfusi, M.J.**
11:50 – 12:20	**Sub-theme 5 paper 5** Adoption of agro-weather information sources for climate-smart agriculture among farmers in Embu and Ada'a Districts of Kenya and Ethiopia. **Oladele O.I., Shimeles A., Mamo G., Aregawi, F., Gitika M.P., Ngari F. & Braimoh A.K.**	**Sub-theme 5 paper 6** Perceived Impacts and Adaptation Responses to Climate Change: An Assessment of Livestock Smallholder Farmers in Amathole District Municipality, Eastern Cape Province, South Africa. **Sopein, O., Monde, N. & Yusuf, S.F.G.**	**Sub-theme 6 paper 5** Analysing urban household food security in the Cape Town Metropole of South Africa, with reference to the role of urban agriculture. **Swanepoel, J.W., Van Niekerk, J.A. & D'Haese, L.**	**Sub-theme 6 paper 6** Performance Levels of Agri-SMMEs in Entrepreneurial Leadership: A Call for Effective TQM-empowered Agricultural Extension Services. **Sonandi, A., Neuland, E. & Ladzani, W.**
12:20 – 12:50	**Sub-theme 5 paper 7** Strengthening Systems for Regional Knowledge Management and Sharing for CSA. **Zengenene, D., Förch, W. & Podisi, B.**		**Sub-theme 6 paper 7** Collaborative research project: Climate smart and sustainable viticulture in the Western Cape, South Africa. **Ponstein, H. Presented by Steyn, F.**	
13:00 – 14:00	**LUNCH**			
SEVENTH SESSION - CHAIRPERSON: Dr S. Franzel				
14:00 –17:00	Poster/ Share Fair/ Network and Workshop sessions			

14:00 –17:00 Suite 4 -5	**Side Event** - **Global Forum for Rural Advisory Services Nutrition Working Group Launch.** Ms E. Kuyper University of California, Davis, USA
14:00 –17:00 Tugela	**Side Event - Business models and dissemination techniques for sustaining promotion of postharvest management.** Mr J. Egessa, AFAAS
14:00 –17:00 Congela	**Side Event - Farmers teaching farmers: Optimizing use of the farmer-to-farmer extension approach for promoting Climate Smart Agriculture.** Dr S. Franzel, World Agroforestry Centre, USA
14:00 – 17:00 Great Elanga	**Side Event - Field Schools and Climate Change adaptation.** Mr E. Adenya, FAO, Kenya
17:15 – 18:30	**51st SASAE Annual General Meeting**

	FRIDAY, 3rd NOVEMBER 2017	
	EIGHTH SESSION - CHAIRPERSON: Dr. M Simon	
	Breakaway Session: **To commence at 09:00 ***	**Breakaway Session**
08:30 – 11:00		Poster/ Exhibition/ and Side Event session
08:30 – 11:00 Tugela Room		**Side Event - Farmer-to-farmer videos as an effective tool for extension and advisory services.** Dr N Ojijo, Access Agriculture, Kenya.
09:00 – 09:45 Great Elanga	***Presentation of Science Agenda for Agriculture in Africa and its implications for Agricultural Extension and Advisory Services:** Dr Yemi Akinbamijo: Executive Director: Forum for Agricultural Research in Africa (FARA)	
09:45 – 11:00 Great Elanga	**Panel discussion:** Highlights of the week	
11:00 – 11:30	**TEA BREAK**	

11:30 – 13:00	**FORMAL CLOSING SESSION**
	Declaration / AFAAS
	Official Closing *Hon. Deputy Minister: General Bheki Cele, Agriculture, Forestry & Fisheries* *SA National Anthem*
13:00 – 14:00	**LUNCH**
	Conference concludes: Delegates Depart at own leisure
14:00 – 17:00	**AFAAS General Assembly Meeting**
18:30	**DINNER OWN ARRANGEMENTS**

SATURDAY, 04th NOVEMBER 2017	
08:30 – 17:00 Suite 5	**Side Event - Strengthening Extension and Rural Advisory Services Systems in Africa.** Ms N. Ernst, GFRAS
09:00 – 13:00	**Local Organising Committee** (LOC) Aftermath discussion: AEW 2017

DAY 1: MONDAY, 30TH OCTOBER 2017

OPENING SESSION

WELCOME TO THE ETHEKWINI METRO

THIS ADDRESS BY THE EXECUTIVE MAYOR WAS NOT AVAILABLE AT THE TIME THE PROCEEDINGS DOCUMENT WAS PRODUCED.

MESSAGE BY HON. PROF. R. ONIANG'O (AFAAS PATRON)

THIS ADDRESS BY THE AFAAS PATRON WAS NOT AVAILABLE AT THE TIME THE PROCEEDINGS DOCUMENT WAS PRODUCED.

MESSAGE BY THE PRESIDENT OF SASAE

Mr Kuben, L Moodley[1]

The Programme Director, Mr Mooketsa Ramasodi, Sanibonani nonke, I greet you all in true South African tradition and hospitality.

May I acknowledge and recognise our honoured dignitaries, political principals of national, provincial, local and international governments. Our strategic partners, international delegates, national delegates and officials of the agricultural extension fraternity.

PREMIER

Hon. Mr Willies Mchunu, Premier of KwaZulu Natal Province

NATIONAL MINISTERS IN ATTENDANCE

Hon. Mr Senzeni Zokwana, (MP) Minister of Agriculture, Forestry and Fisheries

Hon. Gen. Bheki Cele, (MP) Deputy Minister of Agriculture, Forestry and Fisheries

Hon. Mr David van Rooyen, (MP) Minister of Cooperative Governance & Traditional Affairs

Hon. Mr Nathi Nhleko, (MP) Minister of Public Works

PROVINCIAL MINISTERS IN ATTENDANCE

Hon. Mr Themba Mthembu, (MP) KZN MEC for Agriculture and Rural Development

Hon. Mr Sihle Zikalala, (MP) KZN MEC for Economic Development, Tourism and Environmental Affairs

Hon. Ms Manketsi Tlhape, (MP) North West MEC for Rural, Environmental and Agricultural Development

Mr Norman Shushu, (MP) Northern Cape MEC for Agriculture, Land Reform and Rural Development

Her Worship, Ms Zandile Gumede, Mayor of eThekwini Metro Municipality

PROVINCIAL / NATIONAL HEADS OF DEPARTMENT

Mr Mooketsa Ramasodi, Acting Director General of Agriculture, Forestry and Fisheries

Mr Jerry Mfusi, KZN Department of Agriculture and Rural Development

Mr Nhlakanipho Nkontwana, Gauteng Agriculture and Rural Development

Dr Poncho Mokaila, North West Rural, Environmental and Agricultural Development

[1] President of SASAE. Email: Kuben.Moodley@kzndard.gov.za or kubenlm@gmail.com

EXTENSION DIGNITARIES (INTERNATIONAL AND NATIONAL)

Prof. Ruth Oniango, Patron of African Forum for Agricultural Advisory Services (AFAAS)

Mrs Mary Kamau, Board Chairperson AFAAS

Mr Silim Mohammed Nahdy, Executive Director of African Forum for Agricultural Advisory Services (AFAAS)

Prof. Moses Zinnah, Executive Director of the Centre for Coordination of Agricultural Research and Development for Southern Africa (CCARDESA)

Prof. Elliot Zwane, Chairman of the Southern African Regional Forum for Agricultural Advisory Services (SARFAAS)

May I take this opportunity of welcoming the delegates as the host institution to the 3rd Africa Agricultural Extension Week, 2017.

My appreciation to the Global Forum for Rural Advisory Services and the African Forum for Agricultural Advisory Services in choosing (SASAE) South Africa, Durban to host the 3rd Africa Agricultural Extension Week 2017, a strategic and highly relevant conference. This was indeed a rigorous bid that was made in Limbé, Cameroon in October 2016. The bid was made with other African countries and South Africa hosting this event today bears testimony to our success in both winning and hosting this conference.

This is a joint conference held and sponsored by the National Department of Agriculture, Forestry and Fisheries (DAFF), African Forum for Agricultural Advisory Services (AFAAS), and South African Society for Agricultural Extension (SASAE).

The local organising committee would like to thank all three organisations for their financial contributions and more importantly, the resources that went into a year of planning for this milestone event.

A special appreciation to the Hon. Mr Senzeni Zokwana, Minister of Agriculture, Forestry and Fisheries for mandating SASAE to bid for the conference, providing the major funding towards the conference, and releasing high level staff to assist in the operations. The operations consisted of:

- National Organising Steering Committee
- DAFF / SASAE / AFAAS Joint Committee
  - Local Organising Committee
  - Content Committee
  - Promotions and Awards Committee
  - Security and Protocol Committee
  - International Government Relations Committee
  - Stakeholder Management Committee
  - Finance Committee
  - Communications Media Committee
  - The National Extension Awards Committee

The South African Society for Agricultural Extension was established on 23 August 1966 in Pretoria, and we are now celebrating our 51st year. Some 150 extensionists attended the founding meeting, of which 119 members joined the society that day as founder members and today we stand in excess of 1000 members, both internationally and nationally.

In the beginning, membership was restricted to graduates and was racially exclusive. This was later opened up to individuals with relevant extension training and/ or experience in extension across all racial divides.

Our mission is to act as a scientific society, which holds high the interests of its members on the promotion of the Science and Vocation of Agricultural Extension.

THE OBJECTIVES OF OUR SOCIETY ARE AS FOLLOWS:

a. To advance and apply the SCIENCE AND PRACTICE OF AGRICULTURAL EXTENSION within rural development as a scientific discipline by stimulating thought, study, research, discussion and the publication and exchange of knowledge, both nationally and internationally.

b. To promote the professionalism, status and dignity of the AGRICULTURAL EXTENSION PROFESSION amongst members, the scientific fraternity, agricultural extension practitioners, the general public, and with the studying youth.

c. To practise the natural, economic and managerial sciences responsibly and in public interest.

d. To act as representatives for the extension profession in agriculture.

The first fully elected democratic National Government commenced in 1994. Prior to 1994, the agricultural extension landscape in South Africa consisted primarily of four extension services run on racial lines. These included:

1. The House of Assembly: The White Agriculturalist
2. The House of Representatives: The Coloured Agriculturalist
3. The House of Delegates: The Indian Agriculturalist
4. Transkei, Venda, Bophutaswana, Ciskei, KwaZulu Natal: The African Homelands

This caused significant hardship, fragmented development and built the extension cadre in an unequitable manner. Agriculture declined and resources were poorly utilised.

Post 1994 saw the unification of South Africa in a non-racial and unsegregated government. Today we have a National Government with a National Minister and nine provinces with Provincial Ministers of Agriculture and Rural Development. This is indeed the transformation as envisioned by the father of our nation, Madiba, Nelson Mandela.

Agriculture has taken centre stage in the National Development Plan (NDP) of vision 2030 in the country. The NDP provides the founding strategic plan of Government to promote an “integrated and inclusive rural economy”. The NDP states that since 1994, the main challenge for rural development has been the marginalisation of the poor, with many rural areas and households trapped in a vicious cycle of poverty. Rural areas and communities require greater social, economic and political opportunities to overcome these challenges.

The Extension Recovery Plan was a special conditional grant that started in 2008 to revitalise the extension services of South Africa. We acknowledge the amount of more than R1,911 billion that has been spent by Government in the last seven years. This has provided much needed attention and financial support to professionalising, equipping, skilling and reskilling extension practitioners to help them do their work more effectively. This has also helped to make extension services more available to farmers and improve the quality of advice. The key deliverables that have transformed our extension landscape include:

- Digital Pen - Information management and monitoring tool
- Farmers Green Book - Farmer record keeping tool
- Management diary - Diarise meetings and activities
- Vehicles - Enabling extension staff to make field visits
- Uniforms - Enhancing visibility and professional look of practitioners
- Affiliate with Professional Council - Practitioners comply with professional standards
- Affiliate with Professional Associations - Build the professional image of the extension industry
- Extension Conferences - Build the professional image of the extension industry
- Extension Awards - Recognise and award excellence
- Recruitment of practitioners - Increase the number of practitioners in service
- Qualification upgrading - Align qualification with extension expertise required
- Curriculum development - Incorporate unit stand qualification for extension in curricula
- Targeted skills development - Obtain ITC and soft skills; continued improvement in technical skills
- ICT packages - Provide ICT working tools
- Extension Suite Online (ESO) - Offer easy access to agricultural information during farmer contacts
- Other technical field equipment - Provide technical field equipment

In conclusion, the next step of SASAE is to work together with our global and national partners to achieve and ignite economic growth and employment and thereby reduce poverty, inequality and employment, not only in South Africa but within the continent of Africa.

SASAE has the mandate, the will, and the passion to drive decent work, sustainable livelihoods, rural development, food security and land reform to achieve “vibrant, sustainable, rural communities and food security for all”.

Rural Advisory Services has become the mantra for transformation in an environment that is hungry for pro development. Our Conference will indeed steer us in this direction.

I leave you with this quote by Steve Jobs, “The only way to do great work is to love what you do”.

I thank you.

INTRODUCTION OF HON. MINISTER BY THE MEC OF AGRICULTURE AND RURAL DEVELOPMENT, KZN

Hon. Mr Themba Mthembu[2]

Programme Director

The Honourable Premier of KwaZulu-Natal, Willies Mchunu

Amakhosi Asendlunkulu

Minister of the Department of Agriculture, Forestry & Fisheries, Senzeni Zokwana

The Deputy Minister of the Department of Agriculture, Forestry & Fisheries, Bheki Cele

The Mayor of eThekwini Cllr. Zandile Gumede

All councillors present

Chairperson of AFAAS

President of SASAE

All officials present

Distinguished guests

Ladies and Gentlemen

And a special welcome to all the extension officers present.

Extension support is at the coalface of service delivery. This service is the lifeblood of agriculture, it is in the core of our day-to-day functioning of the Department. Extension Officers have direct excess and interface with farmers on a regular and intimate level.

Making them a crucial aspect in promoting agricultural productivity, increasing food and nutrition security, improving rural livelihoods and promoting agriculture as an engine for pro-poor economic growth.

Therefore, I cannot begin to stress the importance of ensuring that the extension programme is built on sound principles and good practice.

I am proud that as a Province, we have been granted the privilege of hosting such a crucial session of dialogue, interaction and engagement which I trust will culminate in the strengthening of the skills and knowledge base of our extension officers, ensuring improved and better service delivery to farmers across the country and the Province of KwaZulu-Natal.

Last year as a Department tasked with Agriculture and Rural Development in the Province, we embarked on an extensive strategy review process to ensure that we are able to focus and respond to the shifting political, environmental, technological and socio-economic terrain in which we operate. Even more pressing, was

[2] MEC Department of Agriculture and Rural Development, KZN.

ensuring that we are able to respond to the crisis levels of unemployment, poverty and inequality which persist 23 years after the dawn of democracy.

To ensure agriculture is strategically positioned to play a meaningful and leadership role in changing this reality for the millions of poor people in the Province, we located Food and Nutrition Security at the core of our agricultural agenda. This would be buttressed by the promotion of small-holder farming and massive developmental programmes targeted at the youth, women and people with disabilities as these groups remain the face of poverty, particularly in rural areas.

I am therefore pleased that this year's conference is themed: **Scaling Up Climate Smart Agriculture: Integrating Youth, Women, and the Digital Revolution"** as it speaks to the agenda of ensuring that as a Department we are better placed to make fundamental changes to the lives of our people.

I am even more impressed that climate smart agriculture has become a critical aspect of our agricultural and rural development mandate. As seen over the past two years, natural disasters such as droughts and floods have become a reality that requires us to adjust and adapt our methods of farming to ensure we remain food secure with the focus of changing the lives of the farmers at grassroots level.

Distinguished guests, I look forward to the outcomes and recommendations of this week-long engagement that I trust will contribute vastly in improving the effectiveness of the extension programme within the agricultural sector.

With that, allow me to introduce Honarable Mr. Senzeni Zokwana, (MP) Minister of Agriculture, Forestry and Fisheries.

I thank you

OFFICIAL OPENING OF AEW BY HON. MR. SENZENI ZOKWANA, (MP) MINISTER OF AGRICULTURE, FORESTRY AND FISHERIES

Hon. Mr. Senzeni Zokwana (MP)

The Minister of Cooperative Governance & Traditional Affairs
Minister of Public Works
The Premier of the KwaZulu-Natal Province
MEC for Agriculture and Rural Development in KwaZulu-Natal
MEC for Agriculture, Land Reform and Rural Development in Northern Cape
MEC for Rural, Environmental and Agricultural Development in North West
MEC for Economic Development, Tourism and Environmental Affairs
Chairperson Portfolio Committee on Agriculture, Forestry and Fisheries in absentia
The Executive Mayor of eThekwini Metro Municipality
Members of the Traditional Leadership
The Chairperson of the African Forum for Agricultural Advisory services (AFAAS)
The President of the South African Society for Agricultural Extension (SASAE)
Distinguished guests
Ladies and gentlemen

This is the year for commemorating the late freedom stalwart, Oliver Reginald Tambo, who led the African National Congress Liberation Movement as its longest serving President during its exile supported in your countries by you brothers and sisters gathered here.

The people and the Government of the Republic of South Africa at large are pleased and humbled to be chosen as the host country for the 3rd African Forum for Agricultural Advisory Services (AFAAS) Africa-Wide Extension Week which is combined with the 51st Annual Conference of the South African Society of Agricultural Extension (SASAE). This Continental Multi-Stakeholder Forum could not have come at a better time; when most countries of our Continent are ravaged by challenges of severe drought and climate change. This is a very opportune time indeed when South African Department of Agriculture, Forestry and Fisheries is the co-host of this key milestone under the theme: "**Scaling up Climate Smart Agriculture: Integrating youth, women, and the digital revolution**".

The Paris Agreement defines a universal, legal framework to strengthen the global response to the threat of climate change. It establishes the obligation of parties to contribute to climate change mitigation and adaptation. All countries are expected to develop plans on how to contribute to climate change mitigation.

The 17th Conference of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC) hosted by South Africa in 2011 in Durban achieved an unprecedented outcome that not only significantly advanced the global effort needed urgently to address the immediate global climate change crisis; but also set a new long-term pathway for the development of a fair, ambitious and legally binding future multi-lateral and rules-based global climate change system which can balance climate and development imperatives.

According to BioWatch (South Africa), the concept was developed by the Food and Agriculture Organization of the United Nations (FAO). BioWatch (SA) has further noted some developments at Continental level and in South Africa.

The New Partnership for Africa's Development (NEPAD) has convened an Africa Climate Smart Agriculture Alliance under its Comprehensive Africa Agriculture Development Programme (CAADP). It was launched at the June 2014 AU Summit in Malabo, Equatorial Guinea. The African Alliance aims at scaling up Climate Smart

Agriculture to at least six million smallholder farmers in Sub-Saharan Africa by 2021. At the moment, the scaling up programmes is focusing on Nigeria, Ethiopia and Zambia. South Africa is included in the next batch of selected countries as from this year.

The African Union Heads of State and Government have endorsed the NEPAD's programme on agriculture and climate change. The programme puts emphasis on gender and nutrition, Climate Smart Agriculture, and support to – smallholder farmers and the setting up of an African Climate Smart Agriculture Coordination Platform. This supports the African vision articulated in Agenda 2063, **"The Africa we want"** where there is no hunger by 2063 and the target of increasing farming households practising Climate Smart Agriculture by 25 million by 2025.

Ladies and gentlemen, the African Climate Smart Agriculture Alliance programmes seek to influence national country policies to create an evidence base of resources, especially online, conservation agriculture, training of scientists, and facilitate a co-ordinated African position on Climate Smart Agriculture in climate negotiations post COP 21.

In South Africa, the Department of Environmental Affairs (DEA) led National Climate Change Response White Paper which highlights the need to invest in and increase research in water, nutrient and soil conservation technologies and techniques. This means the development of climate resistant crops, livestock and the financing models to promote the development of CSA. This is consistent with the CAADP objectives in addressing some of the challenges posed by climate change. There are also well-developed approaches to agriculture through different Climate Smart Agriculture approaches noted in the Agricultural Policy Action Plan (APAP) 2014. To implement the Paris Agreement of which South Africa is signatory, the Department of Agriculture, Forestry and Fisheries (DAFF) has been identified Climate Smart Agriculture to form part of our national flagship programmes and Nationally Determined Contributions (NDC) to assist in reducing greenhouse gas (GHG) emissions. To this end, DAFF has, since 2015, initiated a process on the development of the national Climate Smart Agriculture strategic framework to guide the upscaling and implementation of climate smart agriculture programme within the sector.

In South Africa, we can proudly say that we have long put in place progressive, innovative and proactive policies and plans to deal with an ever-changing climate. These policies are guided by the overarching principle of sustainable development, which is the cornerstone of Vision 2030 contained in the National Development Plan (NDP).

We have a National Strategy for Sustainable Development, a National Climate Change Response Policy, Green Economy Strategy, and Integrated Resource Plan (IRP) – which outlines our country's energy mix. This is in addition to our Industrial Policy and Action Plan that recognizes that energy efficiency and less-carbon intensive production are central tenets of a green economy. A National Adaptation Strategy has been developed to guide South Africa's efforts to plan for and adapt to the impacts of climate change. Our approach balances our contribution as a responsible global citizen to the international effort to curb emissions, with the need to address economic growth, job creation, and poverty alleviation.

In 2015 the United Nations adopted 17 Sustainable Development Goals (SDGs), including a goal on climate change, as part of the 2030 Agenda for Sustainable Development as a plan of action for people, planet and prosperity. It also seeks to strengthen universal peace, recognising that eradicating poverty in all its forms and dimensions, including extreme poverty, is the greatest global challenge and an indispensable requirement for sustainable development. South Africa contributes to several of these Sustainable Development Goals 1, 2, 5, 12, 13, 14, and 17 through its National Policy on Food and Nutrition Security.

Ladies and gentlemen, the African Forum for Agricultural Advisory Services (AFAAS) is a continental platform for mutual learning and innovation among agricultural extension and advisory services providers across Africa. The AFAAS' goal is to enhance utilisation of improved knowledge systems and innovations for increasing productivity towards individual and national development objectives. AFAAS operates through multi-stakeholder country fora that embrace public and private actors in the national agricultural innovation systems.

Talking about multi-stakeholder fora, I wish to mention that the Department of Agriculture, Forestry and Fisheries has facilitated the development of a National Policy on Extension and Advisory Services which was approved by Cabinet in October 2016. This policy will guide and regulate the provision of Extension and Advisory Services and is currently being implemented in the country. The policy advocates for a pluralistic approach in the provision of Extension and Advisory Services. I am pleased to announce that my Department (DAFF) have established Provincial Extension Co-ordinating Forums (PECF) as institutional implementation mechanisms in all nine (9) Provinces. A similar structure will be established at a national level to ensure linkages on topical issues affecting extension and advisory services at various levels (national, provincial and local level). The purpose of the PECF is to:

(i) Articulate priorities,

(ii) Outline the co-ordination of planning and action with regard to the provision of extension and advisory services in the designated geographic area, and

(iii) Help local interest groups secure advice and support from higher levels.

The PECF is comprised of Extension Practitioners that act as facilitators in building partnerships with private sector, researchers, Farmer Organisations (such as Grain SA, Citrus Growers Association, South African Sugar Association, markets (inputs and outputs) and credit institutions to address producer problems.

The latest development is the Draft Policy on Comprehensive Producer Development Support (PCPDS) which provides a framework on the support models for the three (3) producer categories (Vulnerable Households, Smallholder and Commercial).

Ladies and gentlemen, climate change has become a threat to the productivity and long-term sustainability of the agricultural, forestry and fisheries sector, particularly the household and smallholder producers. The adoption of climate-smart agricultural practices is therefore of great importance. This makes it critical that, more than before, the curriculum for the training of Extension Practitioners and Advisors of the future at tertiary institutions should incorporate climate smart agriculture and sustainability related issues. Gone are the days of a primary production-oriented only extension and advisory services. A full value chain approach should be the model for training that improves the value-add of extension and advisory services and promotes sustainability in the long term. DAFF is also making a concerted effort to capacitate producers and farmers on Climate Smart Agriculture programme through the development of the training programme on Extension and Advisory Services.

Similarly, the participation of vulnerable groups (i.e. youth, women and persons with disabilities) is critical. Indigenous knowledge systems should be recognised and be at the centre of climate-smart debates. Therefore, this should form part of the extension and advisory services package, not just be an appendage or an afterthought.

Programme Director, the recently launched United Nations (UN) report titled *"World Population Prospects: the 2017 Revision"* projects that the current world population of 7.6 billion will reach 8.6 billion by 2030 and 9.8 billion by 2050. More than half of the global population growth between now and 2050 is expected to occur in Africa, particularly in the Sub-Saharan Africa. The impact of climate change together with the envisaged population growth will indeed have considerable challenge to governments in implementing the developmental objectives, particularly the 2030 Agenda for Sustainable Development.

Ladies and gentlemen, the conference would not have lived up to its expectation if it does not come up with pragmatic and innovative means of addressing the threat posed by climate change and the expected growth in population especially in developing regions.

As you will be visiting about five (5) projects on Wednesday the 1st of November 2017, AFAAS in collaboration with the Government of South Africa and other relevant stakeholders gathered here today are expected to identify legacy projects on Climate Smart Agriculture. These projects, (which will be implemented in South Africa) should integrate climate change adaptation within existing development planning and implementation processes, by including key approaches that enhance adaptive capacity, enhance livelihoods, and reduce the risk of and adverse effects from climate-related disasters. These include ecosystem-based adaptation, sound catchment management, community-based adaptation, conservation agriculture and climate smart agriculture (including forestry and fisheries), among others.

We also expect AFAAS to support and strengthen the National Extension and Advisory Services Forum (NAEASF) which will be launched this evening.

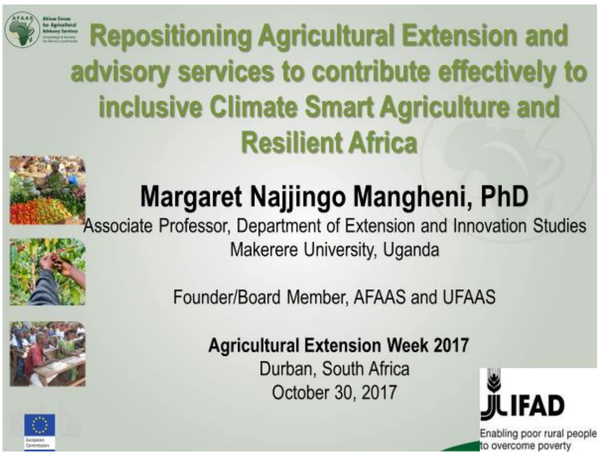
I wish you all a successful conference and I am looking forward to receiving the recommendations and resolutions of this conference on which the Honourable Deputy Minister will be presiding during the closing ceremony. This shows that the Government of the Republic of South Africa’s (RSA) commitment is not only limited to financial support and planning but have a political commitment too.

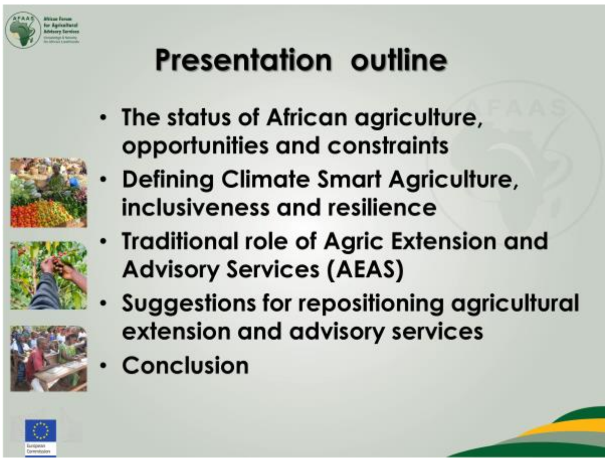
Thank you for choosing our country to host the 3rd Agricultural Extension Week and I hope you will not go home without visiting our warm waters and boost local economy of the province.

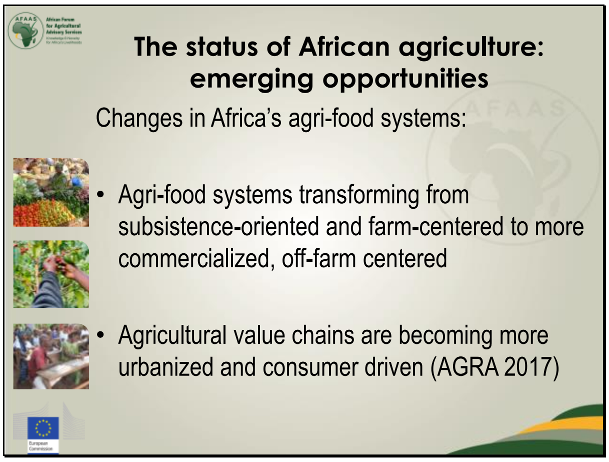
I thank you!

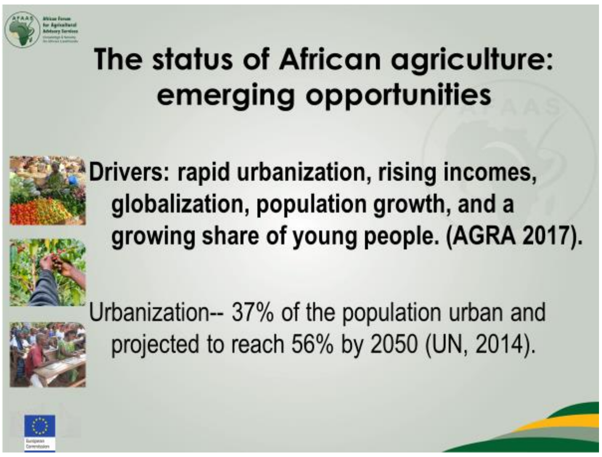
KEYNOTE SPEAKER – REPOSITION AGRICULTURAL EXTENSION TO CONTRIBUTE EFFECTIVELY TO INCLUSIVE CSA AND RESILIENT AFRICA

Associate Prof. M. Mangheni[3]









[3] Makerere University, Uganda

The status of African agriculture emerging opportunities

This dynamic is creating many new growth and employment opportunities in agricultural value chains including:

*i) **Value addition by small and medium enterprises (SMEs)*** in agricultural trade, farm servicing, agro-processing, urban retailing and food services.

*ii) **Large agribusinesses*** like seed companies, agro-processors, and supermarkets

*iii) **Smallholder farmers*** to finally transition their enterprises into thriving businesses.

The status of African agriculture: emerging opportunities

Governments through new extension systems have the opportunity to leverage these spontaneous dynamics to create even more growth in productive employment and income, and **in ways that benefit young people, women and the poor.**

The status of African agriculture: emerging opportunities

Africa's agricultural transformation focus:

- A market driven, business agenda that encompasses the entire food system, not just agricultural production.
- Improvement in nutrition outcomes
- Inclusiveness

Defining Inclusive Growth

Better life for **ALL** as laid out in the Malabo Declaration, in the Sustainable Development Goals (SDGs), and in Africa's Agenda 2063 including:

- Africa's smallholder farmers (men, women, youth)

-Small and medium enterprises (SMEs) in the agri-food system.

-Large agribusinesses.

The Climate Change Challenge!!!

Need to make farming and value chains more resilient to shocks from climate change through:

•Climate Smart practices that sustainably increasing agricultural productivity and incomes

•Adapting and building resilience to climate shocks

•Reducing and/or removing greenhouse gas emissions, where possible.

The Climate Change Challenge!!!

- Human capital is the single most important resource that Africa has. The human capital manages all other capitals.
- Agricultural extension and advisory services have a key role –providing Information, knowledge, skills, technologies, institutions, partnerships and networks, services.

Role of Agricultural Extension and Advisory Services

Originally extension conceived as service to "**extend**" research-based knowledge to rural sector to improve their livelihoods;

Traditional focus on increasing production, improving yields, training farmers, and transferring technology

TRADITIONAL EXTENSION SEVERELY CHALLANGED

Repositioning agricultural extension

New focus areas:

- Clientele
- Government extension organizations
- Capacities
- Expertise
- Methods and approaches
- Policies and institutions

Repositioning: (1) New type of clientele

Type of clientele is changing:

- Beyond farmers to include other actors in the agri-food innovation system/value chains
- Beyond subsistence farmers to commercial farmers and other SME investors
- Private sector clients who are profit motivated, dynamic, time conscious

Repositioning: (1) New type of clientele

The 'new' type of farmer served:

- Business oriented
- Well networked locally, regionally, and even internationally
- Empowered—can demand for services, hold government and service providers accountable, negotiate favorable terms with other actors

Repositioning: (1) New type of clientele –the youth

The youth bulge opportunity—youth are over 60% in the continent; over 35% in many countries and form the majority of the unemployed.

They are many, strong, have time, tech-savvy……with unique needs e.g may have a negative attitude to agriculture, less access to resources, unique enterprise preferences etc…

Repositioning: (1) New type of clientele--youth

Have immense potential to activate the transformation of increased production, productivity, quality adherence and access to global markets.

"Africa's youth bulge is the secret to a cool, profitable agriculture" (Gabriel Rugalema and Joy Mulema, The East African newspaper Sept 16-22, 2017)

Repositioning: ...refocusing the AEAS

The emerging farmer:

- Has Mobile phone, internet, radio, etc.
- Networking, active participation etc.
- Access to multiple information sources
- Women

A farmer in Kibirichia, Kenya. Photo by Neil

Repositioning: (2) Government extension organizations

The traditional Ministries of Agriculture structures not suited to new set up because:

- Bureaucratic, not result oriented, rigid,
- Inappropriate reward/incentive systems-low pay not linked to performance, weak supervision and accountability systems
- Limited opportunities for continuous skills updating
- Under resourced

Repositioning: (2) Government extension organizations

- Organizational structures don't have clear/operational linkages with other services and actors that support climate smart market oriented agriculture (research, markets, financing, processing and value addition, food quality standards, environment and natural resources management, meteorology and weather forecasting……)

Repositioning: (2) Government extension organizations

- Extension workers isolated in the countryside with no link to headquarters.
- Impact of extension not easy to demonstrate; therefore local governments spend on visible projects like roads which win votes and less on extension.

Repositioning: (2) Government extension organizations

- **Structures not suited to pluralism-- Many actors/service providers who are not coordinated and regulated**

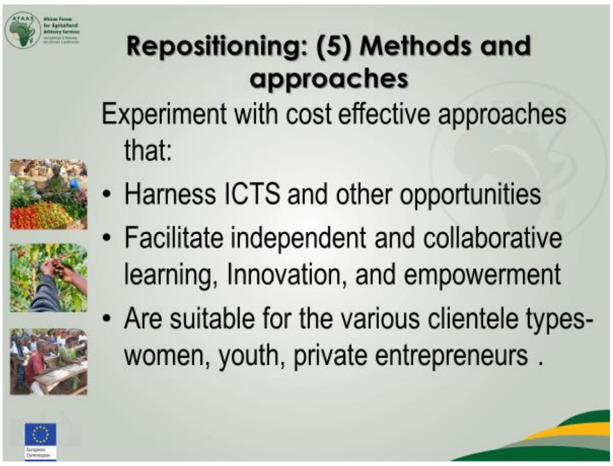
Government taking a back seat

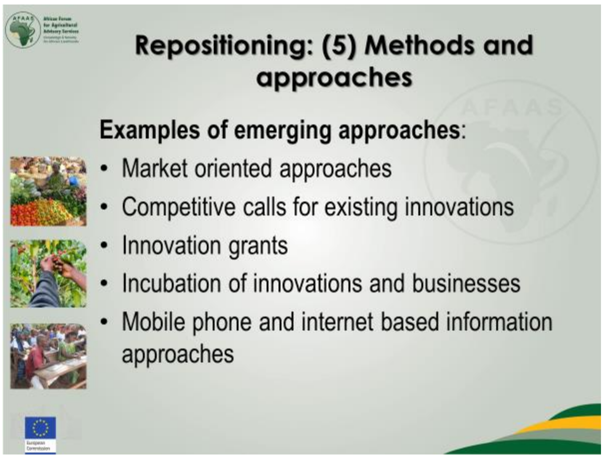
Repositioning: (2) Government extension organizations

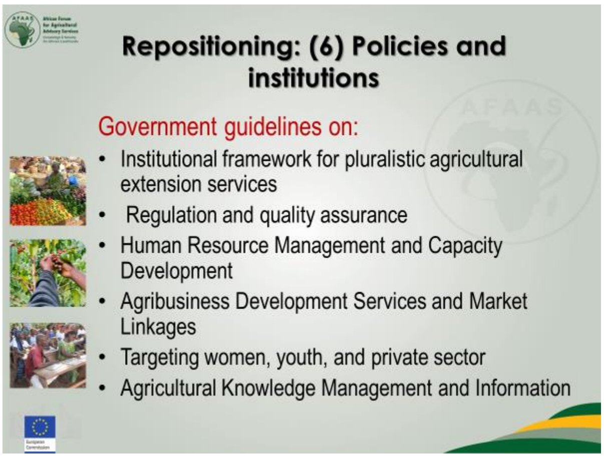
- Private services are important but not sufficient
- Strong public sector still needed
  - ➢Coordination and Financing
  - ➢Setting direction
  - ➢Regulation and quality assurance
  - ➢Championing public interests
  - ➢Equipping and facilitating a new Extension worker—well networked, skilled, business mindset, knowledgeable etc.…


Repositioning: (3) Developing capacities for new roles
Beyond technology transfer to:
Facilitation of innovation;
Assisting farmer groups to form and organize,
Dealing with marketing and financial issues, insurance and risk management
Partnering with a broad range of service providers and other agencies
This calls for new demands and capacities on AEAS


Repositioning: (4) New expertise
Extension organizations to recruit staff with qualifications and diversity of disciplines e.g Social sciences, ICT, business management, economics, statistics and data/information management, natural resource management and environment, nutrition, gender etc..and not just agriculture.


Repositioning: (5) Methods and approaches
Experiment with cost effective approaches that:
Harness ICTS and other opportunities
Facilitate independent and collaborative learning, Innovation, and empowerment
Are suitable for the various clientele types- women, youth, private entrepreneurs .


Repositioning: (5) Methods and approaches
Examples of emerging approaches:
Market oriented approaches
Competitive calls for existing innovations
Innovation grants
Incubation of innovations and businesses
Mobile phone and internet based information approaches


Repositioning: (6) Policies and institutions
Government guidelines on:
Institutional framework for pluralistic agricultural extension services
Regulation and quality assurance
Human Resource Management and Capacity Development
Agribusiness Development Services and Market Linkages
Targeting women, youth, and private sector
Agricultural Knowledge Management and Information


Repositioning: (6) Policies and institutions
Need for agricultural extension actors to be networked & organized at national, regional and continental levels e.g AFAAS, Sub Regional Fora, national Country Fora, SASAE


What national and continental networks Offer?
• Information and experience sharing through different platforms (face to face, virtual social networking etc)
• Mobilize a pool of experts to backstop and catalyse country-level AEAS
• Capacity strengthening for AAS stakeholders
• Scaling up and out of innovations
• Network with and create continental and global level partnerships
• Championing Knowledge Management in AEAS
• Policy and advocacy for AEAS

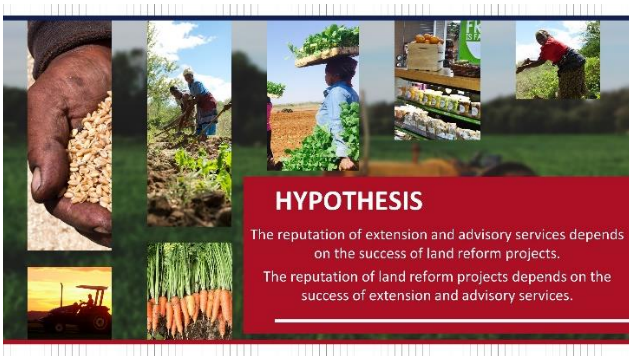

Conclusion
• Need for critical reflection to determine what needs to change to suit the changed context—climate change, emerging clientele of extension—private sector, youth, women etc.
• Hope this conference will provide a platform/space for such reflection and crafting of new more effective approaches to position Africa as a global food basket.

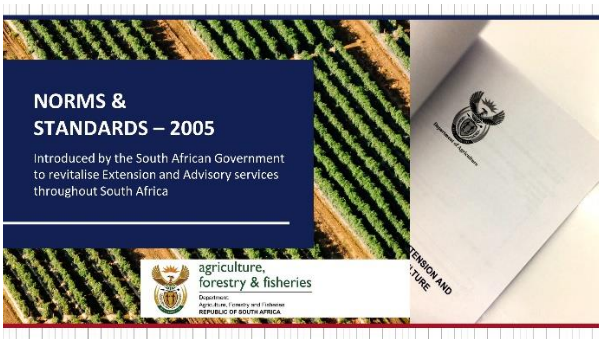

Appreciation
agriculture, forestry & fisheries
European Commission
IFAD
Enabling poor rural people to overcome poverty
WORLD BANK
Rural Development Administration
SASAE
http://www.afaas-africa.org
http://networking.afaas-africa.org

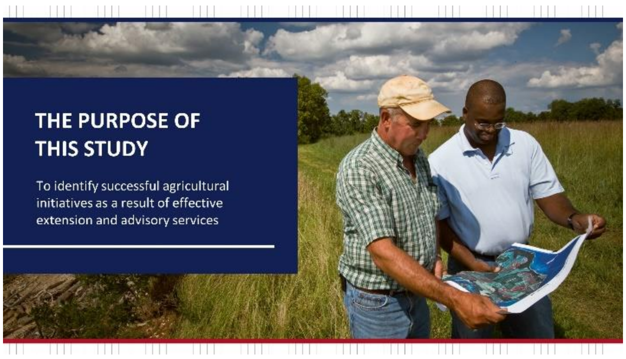

Thank you for your kind attention

SA BEST PRACTICES: REACHING THE PLATE: SUCCESS STORIES OF SOUTH AFRICAN AGRICULTURE BY MEANS OF EXTENSION

Dr J. A. Van Niekerk[4], Dr J. W. Swanepoel[5], H. Ngwenya[6] & Dr M Blum[7].







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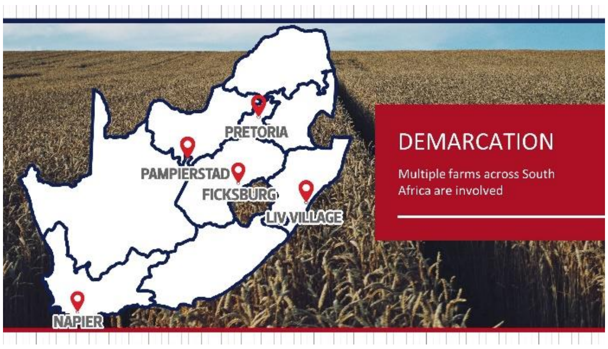
[5] Centre for Sustainable Agriculture: Universtity of the Freestate: Faculty: Natural and Agricultural Sciences: PO Box / 339, Bloemfontein 9300, Republic of South Africa

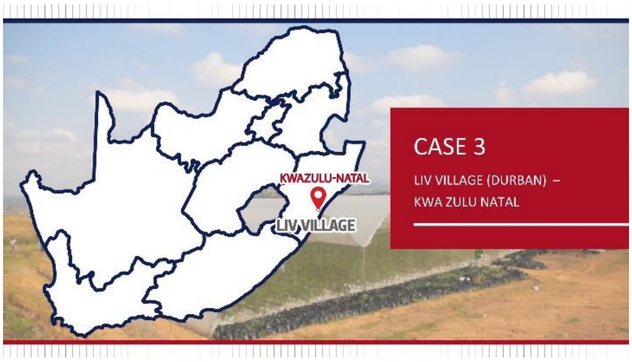
[6] Centre for Sustainable Agriculture: Universtity of the Freestate: Faculty: Natural and Agricultural Sciences: PO Box / 339, Bloemfontein 9300, Republic of South Africa

[7] Food Agricultural Organisation, PO Box 13782/Pretoria/ Republic of South Africa



A Video of the project was shown.

A video of the project was show.



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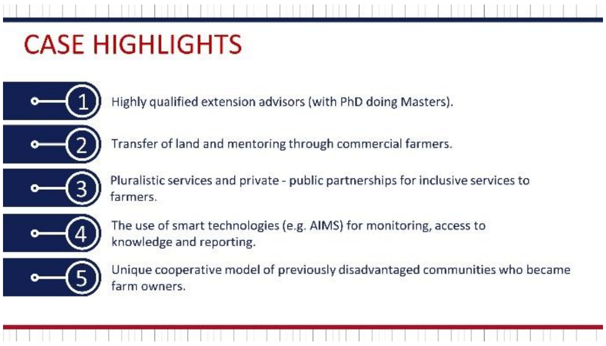

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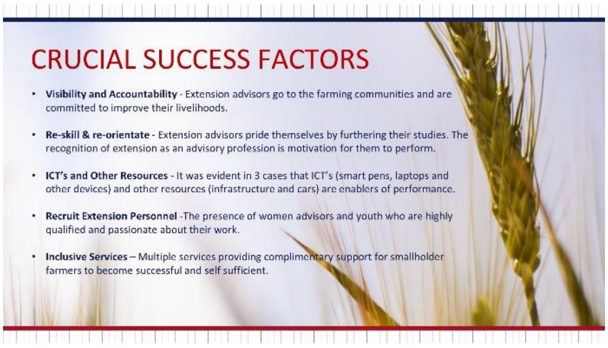

A closing video was played.

REACHING THE PLATE

Success stories of South African Agriculture through Extension and Advisory services

Dr J.W. Swanepoel[1];

Dr J.A. Van Niekerk[1];

Ms H.J. Ngwenya[1];

Prof L. D'Haese[2];

Dr M.L. Blum[3];

Mr M. Ebersohn[4]

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Summary

The Centre for Sustainable Agriculture, Rural Development and Extension under the leadership of Drs Jan Swanepoel and Johan van Niekerk commenced in a study on the good management practices that resulted in successful land reform initiatives where agricultural extension played a pivotal role.

In collaboration with the Food and Agricultural Organization (FAO), the University of Ghent in Belgium and Space Africa ™, successful land reform projects were identified in five provinces in South Africa. These projects were documented as case studies, and feedback was provided in a keynote presentation at the National Extension Week in a joint conference: 3rd AFAAS Africa-wide Agricultural Extension Week and the 51st Annual Conference of the South African Society for Agricultural Extension in October in Durban, Kwazulu Natal. The national minister of agriculture, minister Zokwane, the acting director general of agriculture, numerous MEC's and 700 delegates from the agricultural sector all over Africa attended this presentation. The presenters included Ms Hlami Ngwenya (UFS), Dr Jan Swanepoel (UFS), Dr Magdalena Blum (FAO) and Dr Johan van Niekerk (UFS).

Agricultural extensionists in South Africa play a pivotal role in service delivery to commercial farmers and new farmers that enter agriculture. The reputation of extension and advisory services depends on the success of land reform projects, while the reputation of land reform projects depends on the success of extension and advisory services.

The key indicators that resulted from the study were the following:

- Visibility and Accountability - Extension advisors go to the farming communities and are committed to improve their livelihoods.
- Re-skill & re-orientate - Extension advisors pride themselves by furthering their studies. The recognition of extension as an advisory profession is motivation for them to perform.
- ICT's and Other Resources - It was evident in three cases that ICT's (smart pens, laptops and other devices) and other resources (infrastructure and cars) are enablers of performance.
- Recruit Extension Personnel -The presence of women advisors and youth who are highly qualified and passionate about their work.
- Inclusive Services – Multiple services providing complimentary support for smallholder farmers to become successful and self-sufficient.

From left to right: Dr Johan van Niekerk (UFS); Mr Mooketsa Ramasodi (Acting Director General of Department of Agriculture, Fisheries and Forestry (DAFF)); Dr Jan Swanepoel (UFS).

SECOND SESSION

CLIMATE SMART AGRICULTURE STRATEGIC FRAMEWORK

Dr I. B. Kgakatsi[8]

CLIMATE SMART AGRICULTURE STRATEGIC FRAMEWORK

3rd AFAAS AFRICA-WIDE AGRICULTURAL EXTENSION WEEK

51st ANNUAL CONFERENCE OF THE SOUTH AFRICAN SOCIETY FOR AGRICULTURAL EXTENSION

Dr Ikalafeng Kgakatsi

30 October 2017

agriculture, forestry & fisheries
Department: Agriculture, Forestry and Fisheries
REPUBLIC OF SOUTH AFRICA

1

Outline

1. **INTRODUCTION AND BACKGROUND**
2. **SA CSA STRATEGIC FRAMEWORK: OVERVIEW**
3. **AIMS AND OBJECTIVES OF SA CSA FRAMEWORK**
4. **KEY OUTPUTS OF SA CSA STRATEGIC FRAMEWORK**
5. **MONITORING AND EVALUATION**
6. **IMPLEMENTATION OF CSA IN SA**
7. **IMPLEMENTATION COORDINATING FRAMEWORK**
8. **CONCLUSION**

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INTRODUCTION AND BACKGROUND

- Climate Smart Agriculture (CSA) as defined by the Food and Agriculture Organization of the United Nations (FAO) is an approach that addresses specific elements: **Adaptation**, **Mitigation** and **Food Security** to the adverse impacts of climate change and achieves sustainable development goals.
- Impacts of climate change is already felt in agriculture, food security, water resources and eco-system, public health and infrastructure climate related disasters.
- Adaptation to CC won't stop but will reduce the impacts
- The process of developing the national CSA Strategic Framework by DAFF started in 2015.
- The framework will guide the implementation and upscaling of best CSA practices throughout South Africa (including extension and farmers).

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INTRODUCTION AND BACKGROUND cont…….

- South Africa's CSA Strategic Framework highlights the importance of CSA mainstreaming w.r.t gender, youth and rural communities, etc
- The idea is to change behaviours and address concerns, empower communities for effective decision making through adoption of good principles and practices
- It is critical to involve all role players in decision-making processes, policies and laws, institutions, technologies, standards, planning frameworks and actions, and this **Framework** ensure that these continue to be part of the agenda in subsequent decision-making processes, implementation and revision.
- The framework is also aligned to Climate Change Response Strategy, CCSP, CCAMP and relevant DAFF policies

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[8] Department of Agriculture, Forestry and Fisheries (DAFF), Pretoria.

SA CSA STRATEGIC FRAMEWORK: OVERVIEW

- Wider consultations was conducted through meetings, National and Provincial Workshops to solicit inputs and to discuss the situational analysis report which informed the development of the CSA Strategic Framework.
- These consolidated inputs into the CSA Strategic Framework included inputs from the agriculture, forestry and fisheries sector stakeholders as well as government departments, PDAs, research and academic institutions, organised labour, SOEs,NGOs, etc.

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AIM AND OBJECTIVES OF CSA FRAMEWORK

Aim

- The main Aim is to create a socially inclusive and sustainable agricultural, forestry, fisheries and natural resource management underpinned by increased productivity for national food security and nutrition

Objectives

- To guide actions for the Agriculture, Forestry and Fisheries sector, all levels of government, investors and development partners on mainstreaming CSA into agriculture, forestry and fisheries plans, programmes and projects.
- Contribute to increasing productivity and growth of agricultural, forestry and fisheries related value chains with nutrition and gender considerations.

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AIM AND OBJECTIVES continue……..

- Enhance resilience to climatic and weather shocks on the social, environmental, and economic aspects of agriculture, forestry and fisheries production and food systems.
- Contribute to low carbon development through efficient use of agricultural, agribusiness, forestry and fisheries resources to reduce national emission intensity in the DAFF production and food systems.
- Strengthen governance and institutional coordination for effective implementation of the Climate Smart Agriculture Framework Programme at the national, provincial and local levels.

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KEY OUTPUTS OF THE CSA STRATEGIC FRAMEWORK

Key outputs

Output 1: An enabling and coordinated policy environment

Output 2: A strong climate smart AFF sectors anchored by coordinated, capacitated institutions and partnerships

Output 3: Increased investment in research and an expanded CSA Knowledge Base

Outcome 4: A resource efficient and resilient value - chain based on technology innovation

KEY OUTPUTS OF CSA STRATEGIC FRAMEWORK

Key outputs conti……

Output 5: A CSA Communication and Awareness Building Strategy that enhances the understanding of CSA, builds consensus on issues, and stimulates stakeholder action

Output 6: A diverse funding base to build a climate resilient investment programme

Output 7: An incentivised and driven CSA system characterised by strong stakeholder commitment

MONITORING AND EVALUATION(M&E)

- M&E will be key drivers of CSA mainstreaming into the Agriculture, Forestry and Fisheries Sectors.
- M&E systems are critical for results-oriented and suitable for internal and external reporting on progress made in CSA integration, including identification of relevant indicators that contain consistent information for all the main subthemes.
- A more comprehensive and comparable CSA in the Agriculture, Forestry and Fisheries Programme reporting system should contain consistent information for all the main sub-themes and that goes beyond mere funding allocation and expenditure data.
- It is critical to involve ALL stakeholders in the development of the M&E system with a view to agreeing on a reporting system to be applied by all stakeholder.

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IMPLEMENTATION OF CSA

- It is critical to involve all stakeholders & role players from the onset and ensure CSA mainstreaming at all levels.
- This is to ensure successful implementation nationally, provisionally and locally.
- It is also important to learn from others and encourage partnership and collaboration at various levels including regional and international.
- Strong partnerships between governments and private sectors need to be encouraged.

IMPLEMENTATION COORDINATING FRAMEWORK

National Steering Committee - CSA
policy guidance and inter/intra-sectoral coordination

↓

Provincial CSA Steering Committees and Coordination Units - to coordinate and implement the CSA programmes at provincial and local level.

↓

The CSA Provincial and CSA District Coordination Units - the implementing CSA activities at the Provincial and District levels (local government)

↓

CSA Technical Working Group -to provide scientific advise to the National Steering Committee

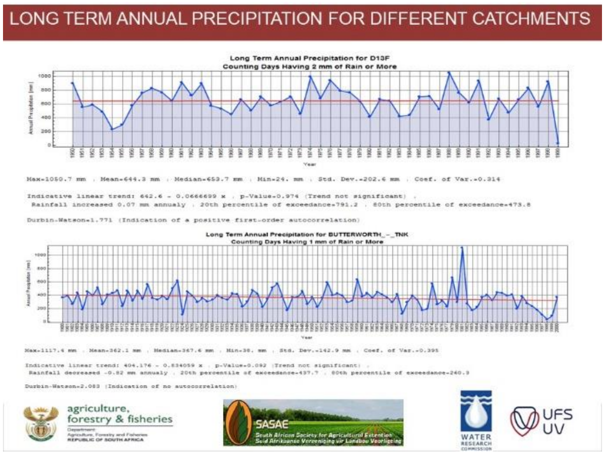
CONCLUSION

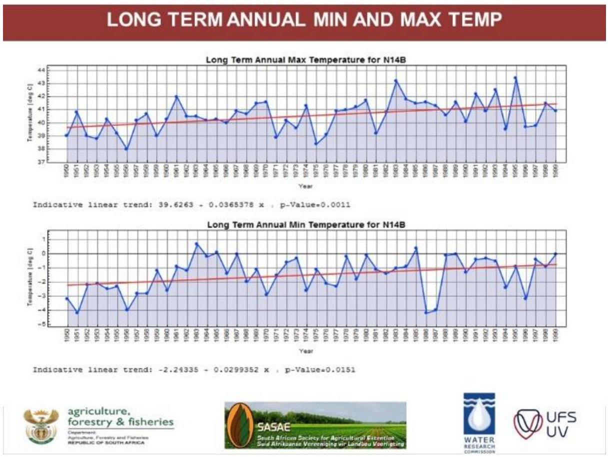
- Climate change is a cross-cutting issue and affects us ALL.
- It is the responsibility of all of us to ensure that we tackle climate change by adopting climate-smart practices and approaches that will promote sustainable agriculture and assist us as a country to achieve sustainable development and ensure food security.
- The development of CSA strategic frameworks should enable us to achieve this objective.
- CSA mainstreaming is critical to change behaviours and perceptions, and should integrate indigenous knowledge systems
- In general the framework emphasis that the goal of promoting effective adaptive responses and increasing adaptive capacity to reduce vulnerability and increase overall resillience of agricultural and food systems.

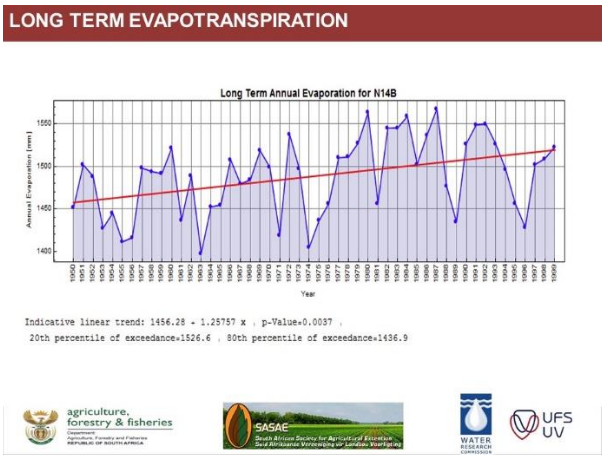
thank you,

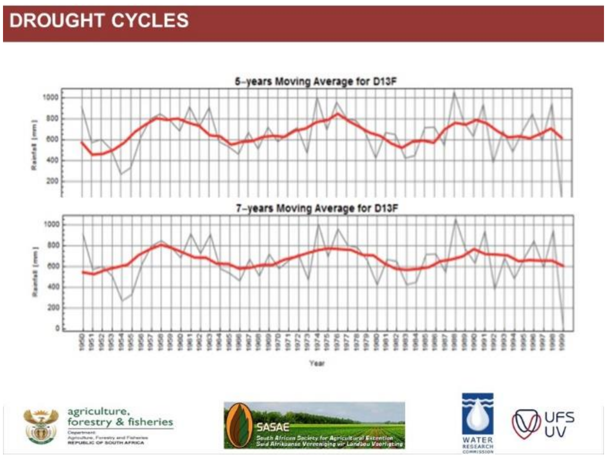
SECTOR SPECIFIC DROUGHT INDICATORS AND DROUGHT MONITORING IN SOUTH AFRICA

Prof. A. Jordaan







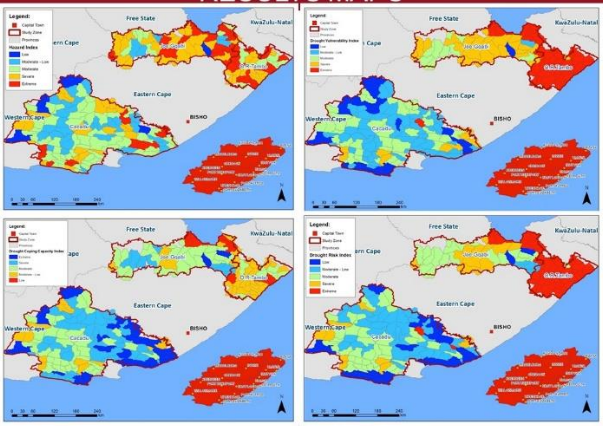


DIFFERENCE IS IN DROUGHT RESILIENCE / VULNERABILITY: USE OF CAPITALS FOR RISK ASSESSMENT

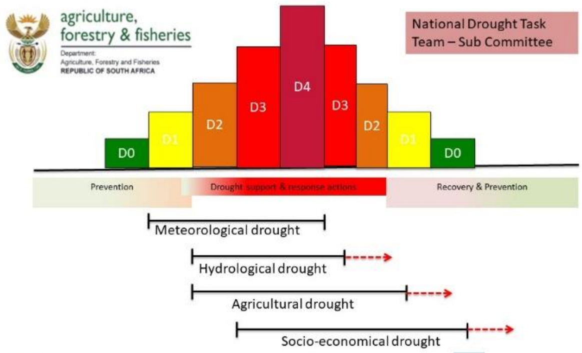
1. Human capital
2. Social capital
3. Cultural capital
4. Economic/financial capital
5. Natural resource capital
6. Infrastructure capital
7. Institutional capital
8. Political capital

Resilience to drought hazard

RESULTS MAPS



DIFFERENT TYPES OF DROUGHT AND STAGES OF DROUGHT



DROUGHT INDICATORS PROPOSED FOR SA

- Meteorological (SAWS – Met data)
  - SPI
  - SPEI
  - % of normal precipitation
- Hydrological (DWAS – gauging real time)
  - Dam levels
  - Stream flow
  - Groundwater levels
- Agricultural (SANSA & other - Remote sensing)
  - Soil moisture content
  - NDVI
  - %VCI
  - PSAG

GUIDELINES FOR DROUGHT CLASSIFICATION IN SA

				Meteorological		Agricultural/Vegetation					Hydrological		
Cat	Description	Possible impacts & actions	Freq	Pecent of normal precip	SPI	CPC Soil moisture module %	NDVI	1 month VCI	PASG	Satellite vegetation health index	Ground water levels %	Weekly stream flow %	Dam levels %
D 0	Dry	Dry period: Short term dryness slowing plant growth of crops and pastures; fire risk above average: some lingering water deficiencies: pastures and crops not fully recovered	1/3 yr	<75% for 30 days	-0,5 to -0,7	21-30		<90%	3 month <90%	36-45	60-100	50-70	80-100 Mod low
D 1	Moderate drought	Some damage to crops & pastures: fire risk is high: Levels of streams, reservoirs or wells are low: Some water shortages are imminent and developing: voluntary water restrictions requested: Early warning	1/5 yr	<70% for 30 days	-0,8 tp -1,2	11-20		<80%	6 month <90%	26-35	40-60	31-50	60-80 Low
	Severe drought	Crop and pasture losses likely: Fire risk very high: Water shortages common: Water restrictions imposed: drought warning messages: Institutions to prepare for response mechanisms.	1/10 yr	<65% for 180 days	-1,3 to -1,5	6-10		<70%	12 month <90%	16-25	30-40	21-30	40-60 Very low
	Extreme drought	Major crop and pasture losses: Extreme fire danger: Widespread water shortages and restrictions compulsory: Extended duration with critical impact: Warning messages must be adhered to: disaster drought declaration: Institutions to implement active response actions	1/20 yr	<60% for 180 days	-1,6 to -1,9	3-5		<60%	12-24 month 80%-90%	6-15	15-30	10-20	20-40 Below absolut minimum
D 4	Exceptional drought	Exceptional and widespread crop & pasture losses: Exceptional high fire risk: shortages of water in reservoirs, streams and wells: creating water emergencies. Potential food insecurity. Water restrictions compulsory: Warning messages must be adhered to: Active response mechanisms: Impacts critical to larger economy	1/30 yr	<65% for 360 days	-2 or less	0-2		<50%	12-24 month <80%	1-5	00-15	0-10	0-20 Dam dry

SECONDARY INDICATORS

- Farm level indicators
  - Grazing conditions
  - Water availability
  - Actual soil moisture
  - Crop and planting conditions
- Socio-economic indicators
  - Financial impact
  - Economic impact
  - Social impact
  - Food security
  - Markets

REFERENCE FARMS

- At least one RF per quaternary catchment
- Criteria – Good agricultural practices?
- Data
  - Meteorological
  - Veld condition
  - Plant conditions
  - Crop yield expectations
  - Soil moisture
  - Condition of animals
  - Carrying capacity – animal #
  - Sales, progeny, mortality
  - Etc. etc.
- Must be simple to complete
- Data must be used
- No nice to have features – pratcitical
- Data translated into useful products such as early warning – decision support

	N-50%	N-30%	N-15%	Normal	N+ 15%	N+25%
Rainfall	X					
Temp/evapotransp.		X				
Veld condition			X			
Animal condition			X			
Dam & stream levels		X				
Groundwater levels				X		
Planting conditions	X					
Crop condition		X				
Yield potential			X			
Sales animals						X
Progeny				X		
Disease outbreaks	???					

SOCIO ECONOMIC INDICATORS

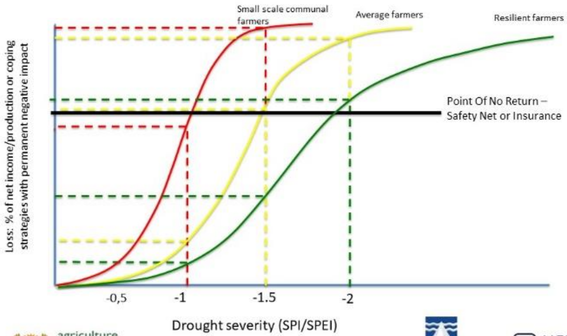
- Regional economic impact – rural business and towns affected
- Financial impact on farmers - % of farmers not able to continue with production
- Impact on specific sector as such that it harm sustainability
- Impact on market, eg. loss in export contracts
- Official crop estimates
- Food security index (regional, national)
- Macro-economic impacts

DIFFERENT FARMING SYSTEMS

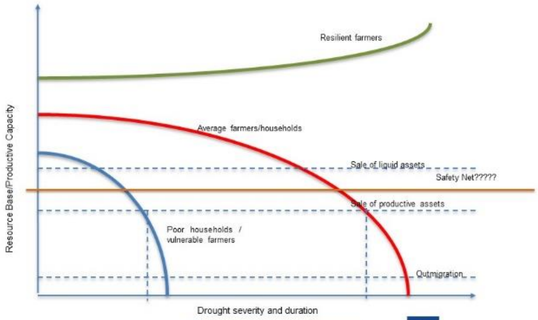
- Commercial farming
- Communal farming
- Dryland crop production
- Irrigation
- Extensive livestock
- Crop production
- Horticulture

Dry period for one sector might be an extreme drought for another

USE OF LOSS FUNCTIONS TO DETERMINE DROUGHT IMPACT – NOT THE SAME FOR ALL FARMERS/SYTEMS

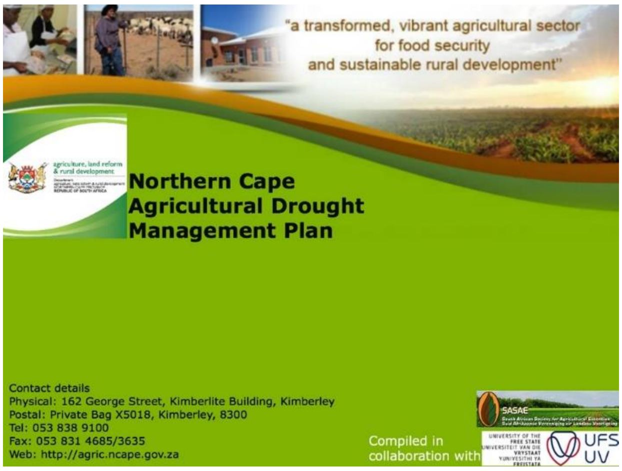


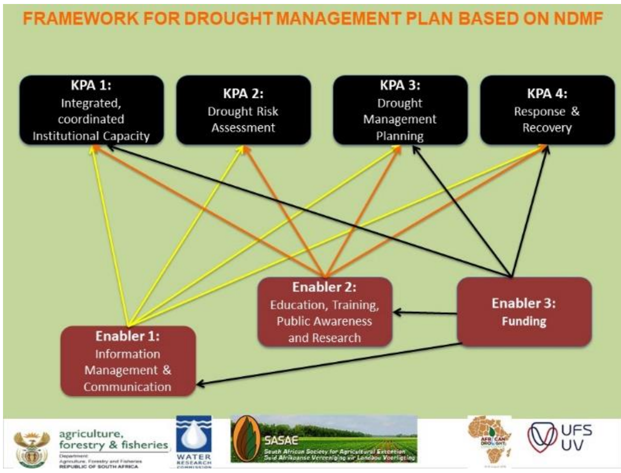
Comparison of livelihoods with assets to no assets…Exogenous shocks have different impacts and disaster safety nets must distinguish.

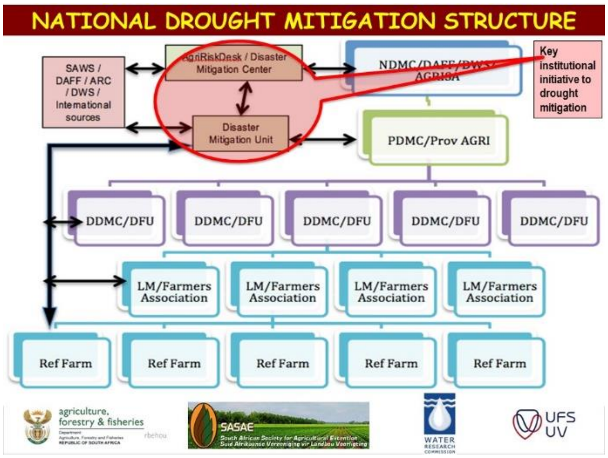


STRATEGY BASED AT THREE LEVELS

National	Policy and Institutionalization
Regional	Institutionalization, coordination
Local/Farm	Implementation of adaptation/prevention/mitigation/coping strategies


"a transformed, vibrant agricultural sector
for food security
and sustainable rural development"
Northern Cape
Agricultural Drought
Management Plan
Contact details
Physical: 162 George Street, Kimberlite Building, Kimberley
Postal: Private Bag X5018, Kimberley, 8300
Tel: 053 838 9100
Fax: 053 831 4685/3635
Web: http://agric.ncape.gov.za
Compiled in
collaboration with


FRAMEWORK FOR DROUGHT MANAGEMENT PLAN BASED ON NDMF
KPA 1: Integrated, coordinated Institutional Capacity
KPA 2: Drought Risk Assessment
KPA 3: Drought Management Planning
KPA 4: Response & Recovery
Enabler 1: Information Management & Communication
Enabler 2: Education, Training, Public Awareness and Research
Enabler 3: Funding


NATIONAL DROUGHT MITIGATION STRUCTURE
SAWS / DAFF / ARC / DWS / International sources
AgriRiskDesk / Disaster Mitigation Center
Disaster Mitigation Unit
Key institutional initiative to drought mitigation
PDMC/Prov AGRI
DDMC/DFU
LM/Farmers Association
Ref Farm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AWARDS CEREMONIES DURING THE JOINT AEW 2017

1. REPORT ON THE PROCEEDINGS OF THE 1ST NATIONAL EXTENSION AND ADVISORY SERVICES AWARDS

1.1 Purpose

The Minister for Agriculture, Forestry and Fisheries (DAFF) hosted the 1st National Extension and Advisory Services Awards (NEASA). This award system is a new initiative by the Department of Agriculture, Forestry and Fisheries (DAFF) aimed at acknowledging and rewarding the excellent performance in public Extension and Advisory Services. It is guided by the National Framework for the award system in recognition of excellent performance in public Extension and Advisory Services. Its objectives are to:

- Recognise outstanding performance in Extension and Advisory Services;
- Motivate public Extension and Advisory Services Practitioners to further promote innovation and best practices in Extension and Advisory Services;
- Encourage the Extension and Advisory Services Practitioners to contribute towards sustainable food and nutrition security goals and to job creation;
- Improve image and promote professionalism of the Extension Services through showcasing the successes achieved through effective Extension and Advisory Services; and
- Attract strategic partners, sponsorship and investment in the service.

1.2 Date and venue of the event

The NEASA event was held on the 30th of October 2017 in Durban at the Amphitheater opposite Tsogo Sun Elangeni & Maharani Hotels.

1.3 Attendance of the event

The event was graced by the presence of over 600 participants. The participants included the Minister for Agriculture, Forestry and Fisheries the Members of the Executive Council (MECs) for Agriculture from Northern Cape and KwaZulu-Natal, Heads of Departments (HoDs) from Mpumalanga, KwaZulu-Natal and North West Provinces, the delegates from over 35 African countries, the representatives from various government departments, office of the Premier of KwaZulu-Natal, office of the eThekwini Metro and various stakeholders (academia, farmer and commodity organizations, research institutions, NGOs, financial institutions, inputs suppliers etc).

1.4 Outcome of the event

The programme directors for the evening were Dr Maanda Dagada from the Mpumalanga Department of Agriculture, Rural Development and Land Administration and Mr Steve Galane from DAFF. The artists which rendered entertainment were Ms Naledi Brown, Ladymsith Black Mambazo and Mr Thabo Hume provided Dick Jockey services. The eminent role players for the evening were; the MEC for Agriculture and Rural Development in KwaZulu-Natal, Mr Themba Mthembu who delivered the speech introducing the Minister. The Minister for Agriculture, Forestry and Fisheries Hon. Senzeni Zokwana gave a keynote address and launched the National Forum for Extension and Advisory Services (NFEAS), the President of South African Society for Agricultural Extension (SASAE), Mr Kuben Moodley who received the certificate and Memorandum of Understanding (MoU) as a host organization for the NFEAS. The Chairperson of the Board of African Forum for Agricultural Advisory Services (AFAAS), Ms Mary Kamau shared the message of support. Mr Ismael Thiame from Grain Farmer Development Association (GFADA) delivered a report on the adjudication process. The MEC for Agriculture from Northern Cape, Mr Norman Shushu, rendered the vote of thanks. All dignitaries who were present as well as HoDs and Sponsors participated in handing over of awards to Extension Practitioners. The awards conferral was according to the following categories:

The recognition awards

CATEGORIES WHERE PRODUCERS WON	EXTENSION PRACTITIONERS	PROVINCE	AWARD
FEA Top: Entrepreneur Agri-processing	Vela Gedze	Western Cape	Trophy and certificate
FEA Entrepreneur: Export Markets	Malebogo Phetlhu	Western Cape	Trophy and certificate
FEA-Best Entrepreneur: in the sector-Commercial	Bokang Senatla	North West	Trophy and certificate
FEA: Best subsistence producer in the sector	Taoana E.	Free State	Trophy and certificate
#YAFF: Fisheries Large-scale	Pumeza Pamela Blow	Eastern Cape	Trophy and certificate
#YAFF: graduate entrepreneur	Lulamile Gede	Eastern Cape	Trophy and certificate
#YAFF: Forestry Small-scale	Vuyo Qwabe	Eastern Cape	Trophy and certificate
#YAFF: forestry commercial	Thembokwakhe Vivian Ncwane	KwaZulu-Natal	Trophy and certificate
#YAFF: agriculture small scale	Phogole SR	Limpopo	Trophy and certificate
#YAFF: agriculture commercial	Mokoena N.	Free State	Trophy and certificate

The NEASA winners per category

CATEGORIES	WINNERS	PROVINCE	PRIZE
Top performer: Agricultural Advisors	Mr Matlala William Mankga	Mpumalanga	R50 000.00
Top performer: Senior Agricultural Advisors	Mr Phumudzo Ratshidzea	Mpumalanga	R50 000.00

Top performer: Supervisor	Mr Ntau Anton Maswikaneng	Gauteng	R50 000.00
Top performer: Subject Matter Specialist	Mr Hermanus Johannes Fourie Grobler	Western Cape	R50 000.00
Top performer: Support Services	Ms Murhandiwani Shivambu	Mpumalanga	R50 000.00
Overall winner	Ms Murhandiwani Shivambu	Mpumalanga	R70 000.00

- All winners further received a trophy and a certificate

Ms. Zanele Mkhize

NEAS Awards Committee

2. SASAE AWARDS COMMITTEE REPORT FOR THE JOINT AGRICULTURAL EXTENSION WEEK (AEW) HOSTED BY DAFF, SASAE AND AFAAS AT THE ELANGENI HOTEL, DURBAN, KWAZULU-NATAL, 29 OCTOBER TO 03 NOVEMBER 2017

Due to the nature of the Joint AEW Conference and the National Extension Awards that was awarded for the first time, SASAE had only the Loubie Loubser Award for the most active Branch and the awards for the Most Popular Paper, Most Scientific Paper and Best Poster at the Joint AEW. The awards were as follows:

LOUBIE LOUBSER FLOATING TROPHY

The trophy may be awarded annually to the most active Branch of the Society.

The Committee recommended the Award go the **KwaZulu-Natal Branch.** It was handed over to them during the Closing Ceremony of the Joint AEW.

MOST POPULAR PAPER

During the Joint AEW, the participants were asked to evaluate all the papers that were presented at the Conference according to certain criteria and to nominate the **"Most Popular Paper".**

This year the winner was **Mr. F Steyn, from the Western Cape Branch,** for the paper: *"Scaling up climate smart agriculture from the Koup pilot project of 80 000ha to 500 000ha. Doing it the LandCare way."*

MOST SCIENTIFIC PAPER

During the Joint AEW, the Editorial Committee evaluated all the papers presented at the Conference according to a set of criteria to determine the **"Most Scientific Paper"**.

The winner was **Mr. A Roux, from the Western Cape Branch.** The title of his paper was: *"FRUITLOOK: A spatial approach to assess and improve water use efficiency of vineyards and deciduous fruit orchards in South Africa".*

BEST POSTER

During the Joint AEW we had a Poster Session where more than 30 posters were displayed. There was a panel who adjudicated the posters to determine the **"Best Poster"**.

The winner was J. B. Booysen, R Meeske, & H J F Grobler, **from the Western Cape Branch.** The title of their Poster was: *Investigation to determine beef production potential of beef jersey crosses in an intensive rearing system.*

Ms. Sibongile Makola

SASAE AWARDS COMMITTEE

3. AFAAS AWARDS

Hon. Prof. Ruth Oniang'o, AFAAS patron was recognised during AFAAS extension week for the exemplary role in advancing for a food secure Africa. Furthermore, Professor Ruth Oniang'o is an outstanding African woman. She is a leading academic expert in Food Security and Nutrition with a record of influencing government policies and training numerous young professionals in this field. As a leading academic she founded and edited the African Journal of Food, Agriculture, Nutrition and Development (AJFAND). It is the premier peer-reviewed journal on agricultural development in Africa. She is a strong believer the forefront of debate when it comes to matters of agricultural research, food and nutrition security and in restoring Africa's dignity by ensuring a Green Revolution for Africa.She is a committed activist, the founder and first Executive Director of Rural Outreach Program (ROP), a not- for- profit community development organization with the goal was of harnessing the intellectual resource of the university, connect it with the various capacities within communities to try and improve rural poor people's livelihoods. She has literally transformed the lives of many rural poor families in the Butere-Mumias district of western Kenya and the environs. As a leading politician in Parliament, she found herself in a better position to address policy issues related to food security and poverty. For example, she supported a Bill to professionalize Nutritionists and Dieticians, brought in a Bill to address drought and famine and supported the exploitation of modern technologies including biotechnology by African scientists and policy makers.

The Local Organising Committee and Mr. Tozamile Lukhalo – Chair of the LOC were awarded/ recognised - through a token of appreciation for the great work done in organising the Joint AEW 2017, coordinating all the local actors and resource mobilisation.

Mr. Max Olupot

AFAAS SECRETARIAT.

MINISTER'S SPEECH ON NATIONAL EXTENSION AWARDS AND LAUNCH OF THE NATIONAL FORUM FOR EXTENSION AND ADVISORY SERVICES.

Hon. Mr. Senzeni Zokwana (MP)

The Minister of Cooperative Governance & Traditional Affairs, Mr. David van Rooyen
Minister of Public Works, Mr Nathi Nhleko
The Premier of the KwaZulu-Natal Province, Mr Willies Mchunu
MEC for Agriculture and Rural Development in KwaZulu-Natal, Mr Themba Mthembu
MEC for Agriculture, Land Reform and Rural Development in Northern Cape, Mr Norman Shushu
MEC for Rural, Environmental and Agricultural Development in North West, Ms Manketsi Tlhape
MEC for Economic Development, Tourism and Environmental Affairs in KwaZulu-Natal, Mr Sihle Zikalala
Chairperson Portfolio Committee on Agriculture, Forestry and Fisheries in absentia, Ms Rosina Semenya
The Executive Mayor of eThekwini Metro Municipality, Ms Zandile Gumede
Members of the Traditional Leadership
The Executive Director of the African Forum for Agricultural Advisory services (AFAAS), Dr. Silim M. Nahdy
The President of the South African Society for Agricultural Extension, Mr Kuben Moodley
Distinguished guests
Ladies and gentlemen;

It gives me a great pleasure to be with you in this prestigious night. I'm particularly grateful to those of you who have travelled from outside South Africa to attend this ceremony. It's good to have you here.

I am truly pleased to be part of this historic evening whereby greatest milestones for the agriculture, forestry and fisheries sector are recorded. I am referring to the very first National Extension and Advisory Services Awards ceremony and the launch of the South African Forum for Extension and Advisory Services.

It is indeed a confirmation of the historic and continuous dedication from the people of South Africa in addressing the triple challenges facing our country today, namely; poverty, inequality and unemployment. This event is specifically relevant as a response to ensure sector transformation through food security, job creation, and increased contribution of the sector to the GDP.

Ladies and Gentlemen, the level of unemployment was at 27.7% in the second quarter of 2017. What strikes home mostly is the number of individuals that are still vulnerable to hunger which is standing at 13, 4 % or 7, 3 million people according to the General Household Survey (GHS) 2016. While this is still alarming, it is an improvement from 29,3% of the population that was vulnerable to hunger in 2002.

This is still a fight our Government is tirelessly tackling by putting in place necessary policies such as National Policy on Food and Nutrition Security, the National Policy on Extension and Advisory Services and many more, which seek to enhance partnerships with relevant stakeholders and to prioritise available funds for producer support and development (e.g. Comprehensive Agricultural Support Programme - CASP).

Through the Policy on Comprehensive Producer Development Support which is still under consideration, my department endeavours to achieve the national development objectives of poverty alleviation, economic development and job creation as stipulated in the National Development Plan (NDP) Vision 2030. The NDP has identified agriculture and agro-processing as primary drivers of growth in the economy. The NDP is a national development framework that is aligned to deliver on the aspiration of the Agenda 2063 particularly relating to Pillar 1 "A prosperous Africa based on inclusive growth and sustainable development".

The Global Food Security Index (GFSI) developed by the Economist Intelligence Unit measures food security in terms of affordability, availability, quality and safety. According to this classification, South Africa's food security ranking has improved three places to 44th out of 113 countries, and the country ranks first on the African continent. "Asilele, siyasebenza!" [loosely translated to "We are not sleeping, we are working"].

Programme Director, the role of Extension and Advisory Services in Food and Nutrition Security cannot be overemphasised. We are grateful also for the technical support of the African Forum for Agricultural Advisory Services (AFAAS) which is the umbrella organisation for agricultural extension and advisory services in Africa. AFAAS supports the establishment and provides technical (and sometimes financial) support to Country Forum across the continent.

Equally, South Africa has the responsibility to establish a National Forum that will spearhead the delivery of Extension and Advisory Services to producers in the country. The Forum will serve as a coordinating structure at a national level to enhance effective implementation as well as monitoring and evaluation of Extension and Advisory Services in the sector. The forum comprises of representatives from government, academia, producer organisation, Provincial Departments of Agriculture (PDAs), commodity organisation, state owned enterprises, professional associations, civil society organisations, farmers union, research institutions among others.

South Africa is one of the few countries that have the National Policy on Extension and Advisory Services and the first country to professionalise the extension service to be regarded as a field of practice. The Policy commits South Africa to delivering and maintaining a pluralistic, harmonised, co-ordinated extension and advisory services for agriculture, forestry and fisheries sector that operates on a common set of principles and values, and which responds to the needs, aspirations, opportunities and other circumstances of the many actors in the respective value chains.

The National Forum for Extension and Advisory Services is established within the mandate of the National Policy for Extension and Advisory Services which advocates for the establishment of institutional mechanisms to strengthen relationships between extension agents, research, and producers, as well as at provincial and district and local levels.

One of the key outputs of the Agricultural Policy Action Plan (APAP) is the development of knowledge sharing platform for best practices. The main purpose of the Forum is to provide strategic guidance and coordination to ensure effective implementation and monitoring of Extension and Advisory Services.

The South African Society for Agricultural Extension (SASAE) has been nominated as the host institution for the Forum. They will perform the secretariat function and report to the DAFF.

You can count on our continued support for this newly formed National Forum for Extension and Advisory Services. We will use our policies and regulatory framework to support the smooth functioning of the Forum.

Ladies and gentlemen, I am pleased to announce to you this evening that the National Forum for Extension and Advisory Services in South Africa is officially launched.

Programme Director, it gives me a great pleasure yet again to recognise our Extension Practitioners who have gone beyond the call of duty, to ensure that agricultural development is a reality in this country. These are our front liners who have not only contributed to ensuring food security but also have seen through the development of / small holder producers, sometimes in the most unfavourable conditions. It is therefore an accolade of monumental achievement for us as Africans to celebrate this day in a fashionable and revolutionary style.

In August we have just celebrated the Female Entrepreneur Awards (FEA) wherein we acknowledged female producers who have risen against all odds and are even exporting beyond our borders. We are honoured tonight to recognise the Extension Practitioners who contributed into the success of the FEA and the Youth in Agriculture, Forestry and Fisheries (#YAFF) winners.

Since last year, our Government started to acknowledge our young producers who will ensure that the food basket for this region overflows from generation to generation.

In one way or the other, Extension Practitioners from both government and out of government played a significant role in ushering their positive changes that we are able to attest today. This bears reference to our newly Cabinet approved National Policy on Extension and Advisory Services which talks to the pluralistic nature of Extension and Advisory Services delivery model.

DAFF has introduced the Extension Recovery Plan (ERP) in order to revitalize Extension and Advisory Services in the country. The plan has made a significant mark in improving service delivery to our clients. It has ensured that our Extension Practitioners receive all necessary tools to competently perform their duties; they are now skilled and most of them have upgraded their qualifications. Up to 68% holds a minimum of 4-year qualifications in Agriculture. The number of Extension Practitioners on the ground has also increased by 38% since the introduction of the ERP in 2007/08 financial year (i.e. from 2 210 in 2007 to 3 050 currently). This has improved the overall extension to farmer ratio from 1: 1200 to 1: 870. The Norms and Standard for Extension and Advisory Services in Agriculture (2005) are still guiding most of the interventions that are happening in Extension and Advisory Services. Towards this end, we equally acknowledge that we are not there yet, there is still long way to go.

I am honoured and privileged to crown our foot soldiers today and to invite all our Extension Practitioners to embrace this initiative going forward.

Allow me Programme Director to also convey my humble gratitude to all our sponsors who contributed generously in making this event a success, namely: Agricultural Research Council (ARC), BBF Safety Group, Land Bank, Manstrat, Gauflora Group and XCallibre. Lastly but not least, I would like to thank the team that organised this event. I know that it takes a huge amount of work behind the scenes to make these events a success. I also want to recognise and thank the panel of adjudicators for their dedication and support. This event would have been void without their contribution. I want to thank again the panel of adjudicators from the following organisations: Agricultural Research Council (ARC), Grain Farmer Development Association (GFADA), Land Bank, Manstrat, National African Farmers Union (NAFU) and University of Pretoria.

I thank you

(At this point, I request the President of the South African Society for Agricultural Extension (SASAE) to ascend the stage to receive the Memorandum of Understanding signed between the DAFF and SASAE).

SUB-THEME 1: INTEGRATING YOUTH AND WOMEN IN CSA

ADOPTION CHOICE OF CLIMATE SMART AGRICULTURE PRACTICES BY RURAL WOMEN IN SOUTHERN NIGERIA

Etim Nsikak-Abasi, A.[9] & Etim NseAbasi, N.[10]

ABSTRACT

An empirical study was conducted to investigate the adoption choice of Climate Smart Agriculture (CSA) practices by rural women in Akwa Ibom State of Southern Nigeria. Specifically, factors influencing rural women's choice of CSA practices, the impact of these practices on their income and food security status, and constraints to adoption of CSA practices were evaluated. Through the multistage sampling procedure, 280 rural women in Akwa Ibom State, Southern Nigeria, were selected as representative farmers. Using focus group discussions (FGDs) and with the aid of fixed response and open-ended questionnaires, cross sectional data were obtained and analysed. A Multinomial Logit Model was employed to analyse the data. Results of analysis revealed that the most critical factors influencing rural women's choice of adopting CSA practices were age, education, frequency of extension contact, membership of cooperative, land tenural status, farm size, household size, and terrain of land. Findings showed that age of women farmers significantly influenced the probability of choosing to adopt crop residue mulching and improved high yielding varieties (p<0.01). Results also revealed that the educational level of women had a positive and significant (p<0.05) influence on choice of efficient use of fertilizer. Results of the study further revealed that the choice of non-adoption, cover-cropping and crop residue mulching was significantly influenced by the size of farmland. Women's decision to choose agroforestry was significantly (p<0.05) influenced by the terrain of farmland as farmers with steeper and sloppy lands had a higher probability of choosing agroforestry. Furthermore, membership of cooperatives positively influenced women's choice of improved high yielding varieties. With rigorous extension services to many rural communities, awareness on climate smart agriculture practices will be created and rapid adoption of these practices in different farming systems will be enhanced.

Keywords: Adoption, CSA practices, Women, Nigeria

1. INTRODUCTION

Climate smart agriculture (CSA) is an integrative approach to address the inter linked challenges of food security and climate change which explicitly aims for three objectives of sustainably, namely increasing agricultural productivity to support equitable increases in farm income, food security and development;

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adopting and building resilience of agricultural and food security systems to climate change at multiple levels; and reducing greenhouse gas emissions from agriculture. Climate change is a serious challenge to sustainable crop and livestock production, as well as food security. According to Mutoko (2014), climate change poses new challenges to fight against poverty and sustainability of agrarian livelihood in sub-Saharan Africa. Changes in rainfall patterns and increasing temperatures have negatively impacted agricultural production. Studies by Kurukulasuriya et al (2006) and Kurukulasuriya and Rosenthal (2003) suggest that climate will adversely affect agricultural production in sub-Saharan Africa through declining crop yields and livestock productivity caused by rainfall variability, rising temperatures and increased pest/disease incidences. An empirical study by Lobell et al (2011) corroborates that losses in crop yields arising from climate change may have a negative impact and may threaten the survival of small holder farmers in sub-Saharan Africa. A recent empirical study by Teklewold (2016) confirmed that small holder farmers in sub-Saharan African countries (SSA) are confronted with changing patterns of temperature, and precipitation and increased occurrences of extreme events like drought and floods, and these changes will not only distort agricultural production but reduce crop yields. Earlier studies by Ngige (2009) and Lasco et al (2014) agreed that changes in temperature and precipitation patterns exposes farming systems to heavy risk resulting in greater short-term and long-term crop failures and output reduction. Farmers in the rural communities are precarious since their production is rainfall dependent. As noted by Al-Hassan and Poulton (2009) and Athula and Scarborough (2011), climate change introduces uncertainties in the livelihoods of countries depending heavily on weather and climate as well as threatening global communities through increasing temperatures, reduced precipitation, frequent droughts and paucity of water (Adger et al., 2003; IPCC, 2007). If they do not adapt in the face of system-wide heat and water stresses that will negatively impact plants, livestock and people, they will be dealing with reduced production prospects (Challinor et al., 2014).

Though the effects of climate change are expected to vary geographically (Jost et al., 2016), the poor and vulnerable small holder farmers, particularly rural women, are reported to be at higher risk of negative impacts from climate change (Goh, 2012; Kakota et al., 2011; Jost et al., 2016). This may not be unconnected to the fact that household responsibilities such as child care and the collection of firewood and water makes women particularly climate sensitive since they take on more agricultural work as men migrate for labour even in the face of less access to agricultural resources such as land extension services and input (Doss, 2011; FAO, 2011; Kakota et al., 2011; Petermann et al., 2010; Wright and Chandan, 2014). However, the increasing role of rural women in small holder agricultural production provides an important opportunity to positively impact food production and security in a changing climate (Carvajal-Escobar et al., 2008). It is estimated that if rural women had equal access to agricultural resources as men, output could be increased by 20-30% and the total number of hungry people globally could be reduced by 12-17% (FAO, 2011). Several farm level studies also suggest that adoption of CSA technologies can improve crop yields, increase input use efficiency, increase net income and reduce GHG emissions (Ghathala et al., 2011; Sapkota et al., 2014; Khatrichhetri et al., 2011).

Despite the various benefits of CSA techniques, the current rate of adoption by farmers is fairly low (Palaanisam et al., 2015). With a population of 150 million, Nigeria's agriculture must undergo a significant transformation to meet the challenges of over population, climate change, poverty, and food insecurity. Climate smart agriculture can offer a solution to this problem. Therefore, focusing attention and practices for CSA practices on women is an important strategy for effective decision on the choice of adoption of these practices. Given the role of rural women in agricultural production, and the challenges of climate change, it becomes imperative to study the factors influencing rural women's choice of CSA practices. This study was conducted to estimate the determinants of adoption choice of climate smart agriculture practices by rural women in southern Nigeria.

2. METHODOLOGY

The study was conducted in Akwa Ibom State, Southern Nigeria. The state is in the rainforest belt and lies between latitude 4033' and 5053' North and longitude 7025' and 8025' East. The total land area in the state is 7,249 square kilometres and it has an estimated population of 3.9 million (National Population Commission, 2006). The state has 31 local government areas. There are six Agricultural Project Development (ADP) zones in the state, namely Uyo, Abak, Oron, Etinan, Eket and Ikot Ekpene. The state is edged to the North, East, West and South by Abia, Cross River, Rivers State and Atlantic Ocean respectively. Akwa Ibom State is characterised by heavy rains and the annual precipitation ranges between 2000-3000mm. The area is typically agrarian, and the predominant occupation of most rural inhabitants is farming. There are two seasons – the rainy season (March to October) and a short dry season (November to February). A multi stage sampling technique was used to select a total of 280 rural women farmers used for the study. Firstly, two of the six ADP zones were randomly selected. Secondly, two villages were randomly selected per ADP zone to make a total of four villages. Thirdly, 70 women were selected per village to provide a sample of 280 rural women. Primary data were obtained from a cross section of the rural women using questionnaires and focus group discussions.

2.1. Model specification

To model the determinants of adoption choice of Climate Smart Agriculture (CSA), a Multinomial Logit Model (MNL) was used. The model was used to analyse the factors influencing choice of CSA practices among rural women in Akwa Ibom State, Nigeria. The model was preferred because it permits the analysis of decisions across more than two categories in the dependent variable, hence, it becomes possible to determine choice probabilities for the different CSA practices. On the contrary, the binary probit or logit models are limited to a maximum of two choice categories (Maddala, 1983). The MNL was preferred for this study because it is simpler to compute than its counterpart, the multinomial probit model (Hassan and Nhemachena, 2008). This MNL model was used by Ayuya et al (2011).

The MNL model is expressed as follows:

P(y-/j/x) - /exp(Xβj)/[1+$\sum_{n=}^{j} \exp(x\beta_n)$j/1, 2, j]………..(1)

Where y denotes a random variable taking on the values (1,2, ….j) for a positive integer J and x denote a set of conditioning variables. X is a 1 x K vector with first element unity and β_j is a KX1 vector with j = 2, ….j. In this case, y denotes Climate Smart Agriculture practices or categories while x denotes specific household and farm characteristics of the rural women. The inherent is how changes in the household and farm specific characteristics affect the response probabilities P(y=j/x), j = 1,2,….,j. Since the probabilities must sum to unity, p(y=j/x) is determined once the probabilities for j=1,2,…., J are known. For this study, the CSA used in the study area were characterised, after which the most adopted material by farmers (or decision categories) were identified. These materials, comprised the decision categories for the multinomial logit model.

In order for the parameter estimates of the MNL model in Equation (1) to be unbiased and consistent, the Independence of Irrelevant Alternatives (IIA) is assumed to hold (Deressa et al., 2008). The IIA assumption requires that the probability of using one CSA by a given rural farmer must be independent of the probability of choosing another CSA (that is P_j/P_K is independent of the remaining probabilities). The basis of this assumption is the independent and homoscedastic disturbance terms of the basic model in equation 1. The parameter estimates of the MNL model only provide the direction of the effect of the explanatory variables on the dependent (choice) variable, thus the estimates represent neither the actual magnitude of change nor the probabilities. Instead, the marginal effects are used to measure the expected change in probability of a particular technique being chosen with respect to a unit change in an independent variable from the mean (Greene, 2000). To obtain the marginal effects for the model, equation 1 is differentiated with respect to the independent as shown in equation 2.

$\frac{\delta P_j}{\delta X_k} = P_j(\beta_{jk} - \sum_{J=1}^{J-1} P_j\beta_{jk})$…………(2)

It has also been observed that the marginal effects and respective coefficients may be different (Hassan and Nhemachena, 2008) since the former depends on the sign and magnitude of all the other coefficients.

The empirical specification for examining the influence of explanatory variables which are described in Table 1 on the choice of CSA (Y) is given as follows:

$Y = 1….j -/\beta_0 + \beta_1$ (Sex) + β_2 (Age) + β_3 (Edu) + β_4 (Farm Size) + β_5(Farming Exp) +β_6 (Extension) +β_7 (Land Tenure) +β_8 Terrian + β_9 (Membership) +β_{11} (Household Size) + μ………..(3).

Where y denotes a random variable taking on the values (0,1,2,3,4) for no-negative integer J.

Y_0 = Choice of no Climate Smart Agriculture Practice

Y_1 =Choice of Crop Residue mulching

Y_2 =Choice of Improved high yielding varieties

Y_3 =Choice of cover cropping

Y_4 =Choice of Efficient use of fertilizer

Y_5 = Choice of Agro forestry

Table 1: Variables Used in the Multinomial Logit Model and their Expected Signs

Variables	Definition and Measurement of Variables Used	Expected Sign
CAS	Choice of Climate Smart Agriculture practice	
Age	Age in years of the farmer (continuous)	$\pm$
Education	Number of years of formal education (continuous)	$\pm$
Farm size	Size of farmland available in hectares (continuous)	$\pm$
Farming Exp.	Number of years of experience in farming (continuous)	$\pm$
Extension contact	Number of visits by extension agent (continuous)	$\pm$
Land Tenure	Land ownership by title deed (1=owned by title deed, 0 =otherwise)	$\pm$
Terrain	Topography of the land (1=sloppy & steep, 0 if otherwise)	$\pm$
Membership	If a farmer belongs to agricultural related group (1=belong to a group, 0 = otherwise)	$\pm$
Household size	Number of household members (continuous)	$\pm$

3. RESULTS AND DISCUSSION

3.1. Result of Marginal Effects of Multinomial Logit Model

Table 2 presents the result of the marginal effects of the multinomial logit model. The results showed that age of the household head significantly influenced the probability of choosing crop residue mulching and improved high yielding varieties by 3.88% and 1.18% respectively. The results imply that younger female farmers are more interested in trying out new ideas because of their risk-taking behaviour.

Educational level of the women farmers was significant and had a direct effect on choice of efficient use of fertilizer. Raising the level of education by 10 years increased the probability of choosing to use fertilizer efficiently by 1.35%. This finiding is in conformity with earlier empirical findings by Feder et al (1985), Udoh and Etim (2006, 2008), Etim and Okon (2013), Etim and Edet (2013), Etim (2015) and Etim et al (2017) who found that education empowers farmers to interpret and respond to new ideas faster than their counterparts with lower levels of education. The hypothesis that human capital plays a direct role in the acquisition and evaluation of innovations is supported by this result. Bacha et al (2001) and Zegeye (2001) in Ethiopia, Chirwa (2005) in Malawi, Chianu and Tsujii (2004), Etim (2015) and Etim et al (2017) in Nigeria all obtained similar results. Furthermore, Chander et al (2003) and Maddison (2006) agree that education may increase an individual's ability to acquire and absorb information on climate change and various farm management practices.

Table 2: Marginal effects from the Multinomial Logit on the Choice of climate smart Agriculture Practice

Explanatory Variables	No Adoption	Crop Residue Mulching	Improved High Yielding varieties	Cover Cropping	Efficient use of Fertilizer	Agro Forestry
Sex	0.7604 (0.5100)	0.0070 (0.2010)	0.3888 (0.0010)	0.7990 (0.0107	0.3306 (0.0089)	0.2097 (0.0076)
Age	0.0078 (0.0016)	0.0388 (0.0027)	0.01802 (0.0221)	0.0100 (0.0500)	0.5106 (0.0700)	0.031 (0.1803)
Education	0.1062 (0.0911)	0.1102 (0.0187)	0.0051 (0.0138	0.6010 (0.0302)	0.0135 (0.0017)	0.2108 (0.3030)
Farming Experience	0.0830 (0.0160)	0.2106 (0.0133)	0.8100 (0.0156)	0.2302 (0.0241)	0.0800 (0.0011	0.1755 (0.0020)
Extension Contact	-0.02810* (0.0091)	0.1662 (0.0810)	0.1720** (0.0810)	0.0970 (0.0200)	0.0109 (0.0088)	0.1907 (0.0333)
Household Size	0.1102 (0.2818)	0.4473 (0.0251)	0.3021 (0.0117)	0.5507 (0.0111)	0.0607 (0.1001)	0.3939 (0.0310)
Membership of cooperative	0.5006 (0.3003)	0.5220 (0.0707)	0.0818** (0.1010)	0.7108 (0.00011)	0.0800 (0.3010)	0.0309 (0.5000)
Land Tenure	0.2771 (0.1130)	0.6331 (0.0068)	0.1799 (0.0031)	0.6500 (0.0224)	0.0903 (0.0610)	0.8001 (0.0014)
Farm Size	0.0311 (0.1500)	0.3103 (0.0708)	0.8007 (0.0038)	0.0833 * (0.0108)	0.0308* (0.0011)	0.3088 (0.1010)
Terrain	0.0200 (0.6133)	0.1709 (0.0113)	0.0085 (0.0004)	0.0908 (0.0025)	0.0818 (0.0010)	0.1576** (0.0405)

Note: Figures in parenthesis are p-values.

Membership of social organisations positively influenced by the choice of improved high yielding varieties at 10% level of significance. Women farmers who were members of agriculturally related social organisations had a higher probability of choosing improved high yielding varieties by 8.18%. This is not unconnected to the fact that with socialisation, women farmers are exposed to a wide range of ideas, knowledge and information. In an earlier study, Nkamleu (2007) reported that membership in social groups exposed farmers to a broad range of innovations and improved their access to information through training and regular contact which eventually positively changed their attitude to innovation. This result, however, conforms to earlier empirical findings by Nchinda et al (2010), Ayuya et al (2012) and Etim et al (2017).

The choice of agro forestry was influenced by the terrain. Women farmers who cropped on steeper sloppy lands had a higher probability of choosing agro forestry by 15.16%. The adoption of agro forestry as a CSA practice is not unconnected to the fact that agro forestry improves the quality of farms and is a very important practice in food supply of small holder farmers (Van Asten et al 2011).

The choice of efficient use of fertilizer was positively and significantly influenced by the size of farms. Increasing the farm size by one hectare raises the probability of choosing efficient use of fertilizer and cover cropping by 3.08% and 8.33% respectively. Results suggest that smaller farm holdings discourage technology use. Larger farms often give room for the experimentation on a small plot of land (Small Plot Adoption Technique) without compromising family food supply and security. Zepeda (1994) reported that the benefits desirable form large scale adoption of innovations is higher for larger farms. Similar empirical findings on the positive effect of increasing from size on technology adoption were reported by Abara and Singh (1993), Fernandez-Cornejo (1996), Adesina (1996), Onyenweak et al (2010), Etim and Edet (2014), Etim (2015) and Etim et al (2017).

Furthermore, frequency of extension contact influenced women's choice of non-adoption. This suggests that an increase in extension contact by one visit decreased the probability of choosing not to adopt any CSA practice by 28.10%. Increasing the visits by extension personnel raised the probability of using improved high yielding varieties by 17.20%. Findings by Adesina et al (2000), Abdulai and Huffman (2005), Tixale (2007), Yirga (2007), Menale et al (2009) and Etim et al (2017) agree that frequency of extension contacts being a proxy for farmer's access to agricultural information positively affected adoption of innovations.

4. CONCLUSION

One of the most effective ways of reducing poverty and increasing food and nutrition security is by ensuring that there is agricultural growth. Investing in climate smart agriculture is an effective means of achieving agricultural growth. The current study examined the adoption choice of climate smart agriculture practice in southern Nigeria. The adoption choice of CSA practices identified by rural women were crops residue mulching, improved high yielding varieties, cover cropping, efficient use of fertilizer, and agro forestry. The most critical factors identified as influencing the rural women's choice of adopting CAS practices included age, education, frequency of extension contact, membership of social organisation, farm size, and terrain of land. Polices to encourage the education of rural women and increase their access to land should be pursued.

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BEHAVIOURAL APPROACHES OF RURAL WOMEN FARMERS TO MITIGATION AND ADAPTATION MEASURES OF CLIMATE CHANGE IN ABIA STATE NIGERIA

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ABSTRACT

*Farmers' behavioural attitudes towards climate change are complex and poorly understood, making the development of mitigation and adaptation policies that would be accepted and implemented difficult. This paper assessed behavioural approaches of rural women farmers to adaptation measures of climate change in Abia State Nigeria. Specifically, the paper ascertains perceived effects of climate change in the study area, adaptation measures practiced by the women in the study area, identified farmers behavioural responses to adaptation measures to climate change and factors that influence farmers' behavioural responses. Multistage sampling techniques were used in selecting 180 respondents for the study. Descriptive statistics was used for data analysis while Tobit regression model and Pearson Correlation was used to test the hypotheses. Results shows that high sunshine intensity, increased drought, inadequate access to water and crop losses are major perceived changes to climate change, while change of planting time ($\bar{x}$ = 4.79), enterprise diversification ($\bar{x}$ = 4.51) and crop rotation ($\bar{x}$ = 4.22) are major adaptation measures practiced by women in the study area. Seeking information based on observed changes ($\bar{x}$ = 5.00), reverting to indigenous or self-help methods, and change of cropping style and time ($\bar{x}$ = 3.41) were identified as major behavioural responses of the women to climate change while Tobit regression results indicated that age (-2.795**), household size (2.705**), level of education (3.389***) and income (2.505**) were major factors that influence the women farmers' behavioural responses. This study could provide a valuable contribution to policy makers for modelling a framework for the adoption of sustainable climate change adaptation and mitigation practices and therefore recommend, among others, that targeted and timely information be provided to the women through agricultural extension and mass media. The most effective and sustainable indigenous technologies used by the farming communities could be incubated with a view to upscale and out scale them in order to enhance adaptation to climate change and variability by the resource-poor farmers.*

Keywords: Behavioural responses, rural women, adaptation, climate change

1. INTRODUCTION

Climate change is perhaps the most serious environmental threat to the fight against hunger, malnutrition, disease and poverty in Africa. This is mainly through its impact on agricultural productivity. Climate change, which is attributable to the natural climate cycle and human activities, has adversely affected agricultural productivity in Africa (Ziervogel *et al.,* 2006). Available evidence shows that climate change is global, likewise its impacts; but the most adverse effects will be felt mainly by developing countries, especially those in Africa, due to their low level of coping capabilities (Anselm et al, 2010). Nigeria is one of those developing countries.

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The Intergovernmental Panel on Climate Change (IPCC, 2010) defines climate change as statistically significant variations in weather elements (rainfall, temperature, sunlight) that persist for an extended period, typically decades or longer. It includes shifts in the frequency and magnitude of sporadic weather events as well as the slow continuous rise in global mean surface temperature. As the planet warms, rainfall patterns shift, and extreme events such as droughts, floods, and forest fires become more frequent, which result in poor and unpredictable yields, thereby making farmers more vulnerable, particularly in Africa (NOAA, 2016). Farmers (who constitute the bulk of the poor in Africa) face prospects of tragic crop failures, reduced agricultural productivity, increased hunger, malnutrition and diseases. It is projected that crop yield in Africa may decrease by 10-20% in 2050 or even up to 50% due to climate change (Jones and Thornton, 2003). This is because African agriculture and Nigeria in particular is predominantly rain-fed and hence fundamentally dependent on the vagaries of weather. As the people of Africa strive to overcome poverty and advance economic growth, this phenomenon threatens to deepen vulnerabilities, erode hard-won gains and seriously undermine prospects for development. There is therefore the need for concerted efforts toward tackling this menace.

Much of climate change agricultural research has tended to concentrate on assessing the sensitivity of various attributes of crop systems (e.g. crop/livestock yields, pest, diseases, weeds, etc.) – the biophysical aspects of food production. These studies have identified and recommended many mitigation and adaptation strategies with little or no regard to the aspect of level of conformity, and responses of the affected farmers to utilisation of these strategies. These partial assessments most often consider climate change effects in isolation of the actions of the vulnerable, providing little insight into how and what the farmers are actually doing to cope with climate change.

Studies have shown that women are more potent agents of environmental degradation management. This is because they constitute the majority (80%) of the farmers (Mgbada, 2013; Umeh, 2015). Through continuous cultivation and tendering of the soil, they are in a continuous battle contending with vagaries of weather to achieve a bumper harvest. They play decisive roles in managing and preserving all-natural resources including biodiversity, water, land and other natural resources and thus environmental sustainability (UN W, 2013). It is important to remember, however, that women are not only vulnerable to climate change, but they are also effective actors or agents of change in relation to both mitigation and adaptation. Women often have a strong body of knowledge and expertise that can be used in climate change mitigation, disaster reduction and adaptation strategies. Furthermore, women's responsibilities in households and communities, as stewards of natural and household resources, position them well to contribute to livelihood strategies adapted to changing environmental realities (CSW, 2008). Thus, it is implied that women in Nigeria are not only the worst hit by climate change but are a major factor for due consideration in key decision taking processes concerning climate change issues.

Research has shown that behavioural factors influence the outcome of policy incentives in that they can either complement or constrain the effects of policies. The Theory of Reasoned Action (TORA) originally proposed by Ajzen (2005), both provide the conceptual framework for exploring farmers' attitudes and intentions. Thus, it is important to consider farmers behaviour when seeking to access or improve the effectiveness of policies. As devastative effects of climate change continue to replete our environment and the world over, what is the level of conformity, utilisation and behavioural attitude or approach of the women farmers to these mitigation and adaptation measures? Hence, this paper was set to assess and evaluate the behavioural approaches of rural women farmers to mitigation and adaptation measures of climate change in Abia State Nigeria. Specifically, the paper ascertains perceived effects of climate change in the study area, adaptation measures practiced by the women in the study area, identified farmers behavioural responses to adaptation measures to climate change and factors that influence farmers' behavioural responses.

1.2. Hypotheses

$H_0 1$ = age, household size, level of education, years of farming experience, scale of production, level of income, contact with extension are not significant and do not influence farmers behavioural approach to climate change adaptation measures in the study area.

$H_0 2$ = There is no significant relationship between the adaptation measures practiced by the women and the women's behavioural responses to adaptation measures to climate change in the study area.

2. METHODOLOGY

The study was conducted in Abia State, Nigeria. Abia State lies between Longitudes $7^0 23^1$ and $8^0 2^1$ East of the Equator and Latitudes $4^0 47^1$ and $6^0 12^1$ north of the Greenwich Meridian. It covers a land area of 6,320 square kilometres (2,440 sq mi) at the density of 450/km^2 (1,200/sq mi). The climate is tropical with dry and rainy seasons. A large proportion of the people are engaged in agriculture and they produce mostly yam, maize, cocoyam, rice, cassava, plantain and cashew (NPC, 2009). Abia State is made up 17 local government areas (LGAs), which are grouped into three agricultural zones. The agricultural zones are Aba, Ohafia and Umuahia agricultural zone.

Multi-stage sampling procedure was used in selecting 180 respondents for the study. In the first stage, all three agricultural zones that make up Abia State were selected in order to cover the state effectively. They are Umuahia, Ohafia and Aba agricultural zones. In the second stage, two ADP blocks were randomly selected in each of the zones making it six blocks. Thirdly, two ADP circles each were randomly selected from each of the blocks making it twelve circles, while in the fourth stage, 15 women farmers were randomly selected from each of the circles. This brought the sample size to 180 rural women farmers.

Data for this study were generated from primary sources. The primary sources included well-structured questionnaires, interview schedules and direct tours and observation of ecological disaster sites in the study areas to observe the adaptation/mitigation practices adopted by the rural women in coping with these challenges.

2.1. Data analysis

To accomplish objective one, descriptive statistics such as frequencies, percentages and mean will be employed to analyse the socio-economic characteristics of the women farmers. The socio-economic factors to be considered are age, educational level, marital status, household size, primary occupation, farming experience, membership of cooperative societies, extension contact, number of extension trainings on environmental management, level of technology and access to credit facilities.

A 5-point Likert rating scale was used to achieve objectives two, three and four. They are to ascertain perceived effects of climate change in the study area, ascertain adaptation measures practiced by the women and identify farmers behavioural responses to adaptation measures to climate change in the study area. The 5-point Likert rating scale was divided into very high (5), high (4), moderate (3), low (2), and very low (1). Variables with mean scores of 3.0 (which is the average mean score of the likert level) and above imply that they are positive and affirmative to the objective being measured while factors with mean scores of less than 3.0 are negative and rarely have influence on the objective being measured. To determine the mean likert level = $\sum X/N$. mean of each item was computed by multiplying the frequency of each response pattern with its appropriate nominal value and dividing the sum with the number of respondents to the items. This can be summarised with the equation below.

Mean = ∑fn/N

Where mean = likert mean score

∑ = summation

F = frequency

n= likert nominal scale

N = number of respondents

mean = 1+2+3+4+5/ 5 = 15/5 = 3

2.2. Hypotheses

Hypothesis one which is identifying factors that influence farmers' behavioural approach to adaptation measures to climate change in the study area was tested using Tobit regression analysis Y/Y* = f (X1, X2, X3, X4, X5, x6,x7,x8,μ).

The latent variable Y= 1 and Y*= 0.

1 = influence

0 = non – non- influence

Where:

X1 = Age (years)

X2 = Household size (Number of persons in the household)

X3 = Level of Education in years (years)

X4= Farming experience (years)

X5= Income (amount in Naira)

X6= Farming status (full time=1)

X8 = Farm size (Ha)

X9 = Extension contact (yes = 1)

X10 = Membership of cooperative societies (number of cooperative)

X11 = Access to credit (access = 1)

X12 = Access to land (access = 1)

Pearson Correlation analysis was used to test hypothesis two which entails the relationship between the adaptation measures practiced by the women and the women's behavioural responses to adaptation measures to climate change in the study area.

PPMCC (r) = $\frac{n\sum XY-(\sum X)(\sum Y)}{\sqrt{((n\sum X)^2-(\sum X^2)\,(n\sum Y^2)-(n\sum Y)^2}}$

Where,

r = correlation coefficient

Y = dependent variable

X = independent variable

n = sample size

T- test of significance on the correlation coefficient was equally carried out with model given as;

$t = \frac{r\ x\ \sqrt{n-2}}{1-r^2}$

where,

t = t-test of significance

r = correlation coefficient

n = sample size

3. RESULTS AND DISCUSSION

3.1. Socio-economic characteristics of the women farmers

The socio-economic profiles of the women were examined and presented in Table 1. The results show that the mean age of the women is 44.5 years indicating that the women are in their prime productive age, able to embark into their agricultural production activities, given favourable working conditions. The majority (86.67%) of them are also married with a household size of 6.5. There is an appreciable level of literacy among the women as 55.5% have attained secondary school and mean farming experience of 15.5 years. Level of literacy could have a significant influence on their sourcing and access to information as well as input for their farming operations. These findings are in agreement with Gordon and Craig (2011) as they opined that education increases level of skill and fosters access to information on improved agricultural practices. The results also indicate that the women have a mean farm size of 1.5ha, and a mean monthly income of N37,550. This indicates that the women are smallholder low income earning farmers, therefore, they need to protect the available farm land against vagaries of weather and other adverse working conditions in order to maintain their farming production and sustain themselves and their family. An impressive 61.11% of the women have contact with extension agents fortnightly while most (54.44%) of them belong to 3 to 4 cooperative societies. Access to extension and membership to cooperatives enhances their access and exchange of information on production innovations, weather forecasts, adaptation /mitigation strategies and other important updates concerning their farming operations. This is in agreement with Nwaobiala and Ubor (2016) that Nigerian farmers are small scaled and such interventions such as extension and input services are necessary, as it can help improve the status of the farmers, guaranteeing timely access to information, fertilizer, seeds and other essential agricultural inputs. Table 1 also shows that most (78.33%) of the women do not have access to government credit facilities while 60.56% do not own their farm land as they are on a lease implying that they are self-sponsored farmers. This indicates that they may not have enough funds to upscale their production or adopt new innovations but may resort to indigenous practices and other labour and money saving strategies for sustainable farming operations.

Table 1: Percentage distribution of the socio-economic characteristics of the women farmers engaged in climate adaptation measures in Abia State

Socio-economic variables	Percentage	Mean
Age	59.44	44.5
Marital Status	86.67 (married)	
Educational Level	55.55 (SSCE/WAEC/GCE)	
Household Size	68.89	6.5
Income (N)	53.89	37,550
Farming Status	65.56 (Full time)	
Farming Experience (Years)	52.22	15.5
Farm Size (HA)	55.67	1.5
Contact with extension	61.11 (Fortnightly)	
Membership of cooperative societies	54.44	3.5
Access to government credit	78.33 (none)	
Access to land	60.56 (lease)	

Field survey 2016

3.2. Perceived effects of climate change in the study area

Perceived effects of climate change by the women in the study area were accessed and presented in Table 2. Results show that high sunshine intensity ($\bar{x}$ = 4.88), increased rate of erosion ($\bar{x}$ = 4.67), increased drought ($\bar{x}$ = 4.46) and crop losses ($\bar{x}$ = 4.52), and inadequate access to water ($\bar{x}$ = 4.47) are major perceived changes to climate change in the study area. This result is in agreement with (CSW, 2013) that inadequate access to water and poor water quality does not only affect women, their responsibilities as primary givers, and the health of their families, but it also impacts agricultural production and the care of livestock and increases the overall amount of labour that is expended to collect, store, protect and distribute water.

Table 2: Mean distribution of perceived effects of climate change in the study area

Variables	Total	SD	Mean
High sunshine intensity	879	1.78334	4.88
Poor soil fertility	800	1.72012	4.44
Crop losses	814	1.73127	4.52

Excessive storm/lightening	538	0.56311	2.99
Increased rate of erosion	841	1.75001	4.67
Decrease in agric. Output	778	1.68815	4.32
Increased drought	804	1.74667	4.46
Change in harmattan period	841	1.75001	4.67
Poor health condition of farmers	681	1.20342	3.78
Inadequate access to water	807	1.74687	4.47

Field survey 2016

3.3. Adaptation measures practiced by the women in the study area

Adaptation measures are required to enable farmers to mitigate the harmful effects of unavoidable climate change by maximising field opportunities and supporting sustainable agricultural and human development. The study indicated from Table 3 that change of planting time ($\bar{x}$ = 4.79), enterprise diversification ($\bar{x}$ = 4.51), crop rotation ($\bar{x}$ = 4.22), planting of resistant varieties ($\bar{x}$ = 4.10) and seeking for expert advice ($\bar{x}$ = 4.03) are major adaptation measures practiced by the women in the study area. Women are not only vulnerable to climate change, but they are also effective actors or agents of change in relation to both mitigation and adaptation. The findings are in line with (CSW, 2013) that women often have a strong body of knowledge and expertise that can be used in climate change mitigation, disaster reduction, and adaptation strategies. Furthermore, women's responsibilities in households and communities, as stewards of natural and household resources, positions them well to contribute to livelihood strategies adapted to changing environmental realities.

Table 3: Mean distribution of adaptation measures practiced by the women in the study area

Variables	**Total**	**SD**	**Mean**
Adoption of agricultural innovation	579	1.44126	3.22
Good cropping system	771	1.78821	4.28
Enterprise diversification	812	1.99761	4.51
Early planting of crops	845	1.99882	4.69
Mixed cropping	802	1.97288	4.45
Use of organic manure	553	1.39984	3.10
Crop rotation	759	1.87766	4.22
Land rotation	500	1.00344	2.78

Use of cover crops	638	1.22209	3.54
Minimum soil tillage	480	1.00777	2.67
Mulching	753	1.77670	4.18
Change of planting time	863	1.99907	4.79
Planting of resistant varieties	737	1.76555	4.10
Adoption of irrigation techniques	495	1.06791	2.75
Expert advice	725	1.78889	4.03
Communal effort	701	1.58819	3.89
Government assistance	462	1.06791	2.57

Field survey 2016

3.4. Farmers' behavioural responses to adaptation measures to climate change

Studies of behavioural response pattern to adaptation measures to climate change address the interaction between individuals and their environments. Data in Table 4 shows that the women farmers in the study area respond differently to the adoption and practice of adaptation measures. Major responses exhibited by the women are: seeking information based on observed changes ($\overline{X}$ = 4.79), change of cropping time ($\overline{X}$ = 4.03), reverting to indigenous or self-help methods ($\overline{X}$ = 3.67), consulting fellow farmers for advice ($\overline{X}$ = 3.33), and playing ignorant of the situation at hand ($\overline{X}$ = 3.67). The result indicates that most of the women try to obtain more information and education to be well equipped to make informed decisions on the adaptation measures to apply in such situations. Some in their bid to seek for information consult fellow farmers either to be educated before taking up a particular strategy or to compare their situation and take the same decision as their neighbours. However, some of the women play ignorant of the existence of these adaptation measures thereby falling deep into the dangers and challenges of climate change menace. Timely dissemination of information and education of farmers on mitigation and adaptation strategies, weather forecast and other weather-related information is very important and a necessary prerequisite for farmers informed decision making. Agricultural extension services delivery outfit, agricultural advisory services agencies and other related NGOs should as a matter of urgency provide required education and information on climate change issues at the grassroots level.

Table 4: Mean distribution of farmers' behavioural responses to adaptation measures to climate change in the study area

Variables	**Total**	**SD**	**Mean**
Change of cropping style and time	614	1.41128	3.41
Change of cropping time	725	1.70012	4.03

Seek for information based on observed changes	974	1.98822	5.41
Revert to indigenous or self-help methods	660	1.42215	3.67
Consulting fellow farmers for advice,	564	1.41141	3.33
Value addition and storage of remaining crops	473	0.89921	2.63
Play ignorant of the situation at hand	519	0.92134	2.88
Abandonment of farming enterprise due to loss of crop	493	0.91007	2.72

Field survey 2016

3.5. Factors that influence farmers' behavioural approach to adaptation measures to climate change in the study area

Influences that act on individual decision-makers on their responses to adaptation strategies were measured and the results presented in Table 5. Results show that eight out of eleven factors have influences at different significant levels on the women's responses to adaptation strategies in the study area.

Household size (2.705):** In the absence of well-functioning labour markets, smaller households face higher labour bottlenecks at critical points in their family farming enterprise (Osondu and Ibezim, 2013). The coefficient of household size shows significant positive influence on the women's response to adoption of adaptation measures. This has implications on labour supply may justify the need to augment family labour with hired labour in disaster management situations. Therefore, household size which also represents labour supply need to be duly considered.

Level of education (3.389*):** The coefficient of level of education has a strong influence at 1% significant level on the women's choice of adaptation measures. This is in agreement with Imonikhe (2010) that education enhances farmer's ability to make accurate and meaningful management decisions. Farmer's level of education is an important factor in determining his/her ability to understand policies or programmes that affect farming, to accept and adopt agricultural innovations. Nwaru (2007) further added that education and training help to unlock the natural talents and inherent enterprising qualities of farmers and enhance their abilities to understand and evaluate new production techniques.

Income (2.505):** The result indicates that the women's ability to adapt to the demands of climate change is influenced by the extent of their access and control over economic resources. In agreement to this finding, Nwibo and Okorie (2013) noted that income level of an individual plays a great role in shaping the type of production enterprise to venture into and subsequent decisions taken in course of the enterprise. Significant resources are needed to cover the cost of the goods, services and technologies required in the implementation of climate change adaptation measures in developing and developed countries.

Farm Size (Ha) (5.646*):** The coefficient of farm size shows a high influence at 1% significant level. Socio-economic analysis of the women indicated that the mean farm size of the respondents was 1.64 hectares. This is a clear indication that the women farmers in the area are mostly small-scale farmers. This result, which is quite a popular finding among previous studies (Bedemo *et al*., 2013), confirms that rural households with small landholding and farm output, which is the case among majority of women in the study area, depend on targeted interventions from government and related agencies to escape the vagaries and adverse effect of climate change.

Membership of cooperative societies (5.027*):** Coefficient of membership of cooperative societies has shown high influence on the decision process of the women. The involvement of more women in cooperative activities may be attributed to their being more gregarious in nature as well as their ability to organise themselves much more easily than males. In agreement to this finding, Badiru *et al*, (2016) observed that cooperative members gain new skills and training, access to agricultural information, credit, higher quality raw materials, thereby enabling members to engage in multiple activities through which women can make informed decisions and get out of poverty.

Access to credit (2.952*):** Inadequate capital is a major problem confronting small-scale farmers in Nigeria. Meanwhile, access to credit is regarded as one of the key elements in raising productivity (Anyiro and Oriaku, 2011). There is generally observed low government support for women farm business. They cannot qualify for loans because they lack the collateral or because their farm business is small. Lack of assistance still keeps the women at the subsistence level of operation. At this level, the rate and prompt adoption of adaptation measures against climate change menace is often times greatly reduced.

Table 5: Tobit regression result of the determinants of behavioural responses to climate change adaptation measures in the study area.

Parameter	Estimate	Std. Error	t-value
Age	-0.012	0.007	-2.795**
Household size	0.040	0.023	2.705**
Level of education	0.023	0.058	3.389***
Farming experience	0.001	0.006	0.221
Income	0.000	0.000	2.505**
Farming status	0.007	0.043	0.172
Farm Size (Ha)	0.024	0.038	5.646***
Contact with extension	0.009	0.007	1.265
Membership of cooperative societies	0.000	0.000	5.027***
Access to credit	0.137	0.048	2.952***
Access to land	0.000	0.000	3.626***
Pseudo R^2	56.879		
Log-likelihood	221.198		
Pearson Goodness-of-Fit Test	323.271		

3.6. Relationship between the adaptation measures practiced by the women and the women's behavioural responses to adaptation measures to climate change in the study area

The 2-tailed Pearson correlation analysis for the study is positive (.094) at 10% level of significance. This implies that the women's behavioural inclination to adaptation measures to climate change actually influences their adoption and practice of these adaptation measures. Thus, it is important to consider the women farmers' behaviour when seeking to access or improve the effectiveness of policies. This will enhance levels of conformity, and responses of the affected farmers to utilisation of these strategies.

Table 6: Pearson Correlation result of the relationship between adaptation measures and behavioural responses of the respondents to climate change

Correlations			
		ADAPTATION MEASURES	**BEHAVIOURAL RESPONSES**
ADAPTATION MEASURES	Pearson Correlation	1	.630
	Sig. (2-tailed)		.094
	N	160	160
BEHAVIOURAL RESPONSES	Pearson Correlation	.630	1
	Sig. (2-tailed)	.094	
	N	160	160

2-tail correlation significant at 10%

4. CONCLUSION AND RECOMMENDATIONS

The study revealed that change of planting time ($\bar{x}$ = 4.79), enterprise diversification ($\bar{x}$ = 4.51) and crop rotation ($\bar{x}$ = 4.22) are major adaptation measures practiced by the women in the study area. Moreover, seeking for information based on observed changes ($\bar{x}$ = 5.00), reverting to indigenous or self-help methods and change of cropping style and time ($\bar{x}$ = 3.41) were identified as major behavioural responses of the women to adoption of climate change adaptation measures. Factors such as age (-2.795**), household size (2.705**), level of education (3.389***) and income (2.505**) were major factors that influence the women farmers' behavioural approach to adaptation measures to climate change in the study area.

Increasing women's participation in climate change action would result in more environmental and productivity gains and would create mutual benefits and greater returns across the farming household. The study therefore recommends that targeted and timely information be provided to the women through agricultural extension and mass media approaches. Again, the most effective and sustainable indigenous technologies used by the farming communities could be incubated with a view to upscale and out scale them in order to enhance adaptation to climate change and variability by the resource-poor farmers.

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PERCEIVED EFFECTS OF CLIMATE CHANGE ON VEGETABLE PRODUCTION AMONG WOMEN FARMERS IN KWARA STATE, NIGERIA

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ABSTRACT

Women are key players in the agricultural sector of most developing countries of the world. A significant change in climate on a global scale will impact vegetable cultivation and agriculture as a whole. Vegetables are the best resource for overcoming micronutrient deficiencies and providing smallholder farmers with much higher income and more jobs per hectare than staple crops. Women in Asa Local Government of Kwara State are known predominantly for vegetable production. A structured interview schedule was used to obtain information from 156 women on their experiences of climate change impacts on vegetable production. The study revealed that the women are involved in the production of various vegetables such as amaranth, cochorus, celosia, bitter leaf, water leaf, tomatoes, pepper, pumpkin, and okro. Over the years, there have been noticeable changes in the rainfall pattern which has resulted in the women adopting various strategies to cope with the situation. Planting at the on-set of rain, mulching, irrigation, and fadama (wetland farming) were some of the coping strategies the women engaged in on their vegetable farms. The large majority (95%) of the women perceived climate change as a huge challenge and opportunity to learn more about their environment. Furthermore, they were also able to discover some vegetables that are resilient which they cultivate during harsh weather when other crops do not survive.

Keywords: Coping strategies, smallholder farmers, environment, vegetable farms

1. INTRODUCTION

Agriculture is an important sector in Nigeria as it provides employment for over 60% of the entire population. This population operates subsistence agriculture which is almost entirely weather dependent (Sofoluwe et al., 2011). Women play an important role in food production, producing between 60 and 80% of the food in most low-income countries. Women often engage in vegetable production amongst other crops to make ends meet. Moreover, the worsening condition of climate change adversely affects the vegetable production yield. The declining productivity of agricultural crops and food wastes had been traced to adverse climatic change and variability.

Climate change is one of the most serious environmental threats facing mankind worldwide. It affects agriculture in several ways, including its direct impact on food production. Climate change, which is attributable to the natural climate cycle and human activities, has adversely affected agricultural productivity in Africa (Ziervogel et al., 2006). Available evidence shows that climate change is global, likewise its impacts; but the most adverse effects will be felt mainly by developing countries, especially those in Africa, due to their low level of coping capabilities among which Nigeria belong (Nwafor, 2007; Jagtap, 2007; Odjugo, 2010). As the planet warms, rainfall patterns shift, and extreme events such as droughts, floods and forest fires become more frequent (Zoellick, 2009), which results in poor and unpredictable yields, thereby making farmers more vulnerable, particularly in Africa (UNFCCC, 2007). Farmers, who constitute the bulk of the poor in Africa, face

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challenges of tragic crop failures, reduced agricultural productivity, increased hunger, malnutrition and diseases (Zoellick, 2009). It is projected that crop yield in Africa may fall by 10-20% by 2050 or even up to 50% due to climate change (Jones and Thornton, 2003), particularly because African agriculture is predominantly rain-fed and hence fundamentally dependent on the vagaries of weather. As the people of Africa strive to overcome poverty and advance economic growth, this phenomenon threatens to deepen vulnerabilities, erode hard-won gains and seriously undermine prospects for development (Zoellick, 2009). There is therefore the need for concerted efforts toward tackling this menace.

Agricultural interventions that are considered to be 'climate smart' should be harnessed to address problems of exacerbating climate change. It is important to understand the gender dimensions of climate change when considering appropriate climate smart agriculture. Climate-smart agricultural practices have the potential to increase farmers' productivity and resilience, reduce or remove greenhouse gases, and enhance the achievement of food security and development goals. The best technological innovations, management practices and interventions contribute both to climate change adaptation and mitigation (Jost et al., 2013).

Mubaya et al (2010) noted that the impact of climate change is two-fold, namely bio-physical and socio-economic. Bio-physical impacts include rising sea waters, more frequent and intense storms, extinction of species, worsening drought, crop failure, as well as changes in cloud cover and precipitation, melting of polar ice caps and glaciers, and reduced snow cover (Mendelsohn and Dinah, 2005; UNDP, 2004; UNFCCC, 2007). The environmental degradation caused by bio-physical impacts creates socio-economic impacts. This is mainly on the agricultural sector where areas suitable for agriculture, the length of growing seasons and yield potential, particularly along the margins of semi-arid and arid areas are expected to decrease (Mubaya et al., 2010). This consequently affects small-scale subsistence farmers in terms of productivity, food security and family income. Climate change is therefore expected to have a significant impact on the livelihoods of the rural poor in developing countries.

According to the World Bank (2015), women are key players in the agricultural sector, yet compared to men, they own fewer assets and have access to less land, fewer inputs, and fewer financial and extension services and are more prone to adverse effects of worsening climate change. Assessing whether the women vegetable farmers consider change in climate as a threat to their vegetable production, that is, their perception about the effect of climate change on their vegetable production, is crucial to understanding intervention approaches to addressing the problem of low yield, incidence of pests and diseases, heat and cold stress associated with vegetable production. Understanding coping strategies that they employ to survive this critical condition is of vital importance. The study therefore aimed to assess the perceived effects of climate on vegetable production among women farmers in Kwara state.

1.1. Objectives of the study

The main objective of the study was to investigate the perception of women farmers on the effects of climate change on vegetable production in Kwara State, Nigeria.

The specific objectives were to:

1. Describe the socioeconomic characteristics of women vegetable farmers in the study area.
2. Identify coping strategies employed by women vegetables farmers on climate change effects.
3. Determine the perception of women about the effect of climate change on vegetable production.

1.2. Research hypotheses

1. There is no significant relationship between socioeconomic characteristics of women farmers and perceived effects of climate change on vegetable production.
2. There is no significant relationship between coping strategies employed by women farmers and perceived effects of climate change on vegetable production.

2. METHODOLOGY

2.1. Study area

The study was conducted in Kwara State, Nigeria. Kwara State is located in the North Central Geographical Zone of Nigeria within latitudes 70 45'N and 90 30'E and 6o 25'E. It covers a total land area of about 36,825 square kilometers. The state comprises of 16 Local Governments Areas (LGA's) which are further grouped by Kwara State Agricultural Development Project (KWADP) into four zones. The topography is mainly plain to slightly gentle rolling lands. The annual rainfall ranges between 1000mm and 1500mm. Average temperature ranges between 300C and 350C. It also has an estimated figure of 203,833 farm families with the majority living in rural areas.

2.2. Population and study sample

The population for this study comprises of all women vegetable farmers in Kwara State. A multi-stage sampling technique was used to select the respondents in the study area. Firstly, Zone C, which fell within Kwara Central Senatorial District and made up of five local government areas, namely Ilorin West, Ilorin East, Ilorin South, Moro and Asa, was purposively selected for the study due to the predominance of women farmers who grow vegetable crops in abundance in Kwara State. Secondly, Asa LGA which has the largest women vegetable farmers in the zone was selected. Thirdly, five communities were randomly selected from Asa local government area, namely Otte, Lasoju, Idi-Emi, Ogele and Bala. According to information obtained from the extension agents working in the area, the population of women vegetable farmers in the various communities is shown in Table 1. At the final stage, 50% of women vegetable farmers were randomly selected from each community to give a total sample size of 156 respondents. Data were collected with the use of a structured interview schedule between March and April, 2017.

Table 1: Study population and sample

Community	Population of women vegetable farmers	Sample (50%)
Otte	63	31
Lasoju	74	37
Idi-Emi	55	28
Ogele	54	27
Bala	66	33
Total	312	156

3. RESULTS AND DISCUSSION

The socioeconomic characteristics of women farmers are presented in Table 2. A high percentage of them (69.2%) are in their productive years (31-50 years), although some are younger (12.8%) and a few of them are old (3.3%). This shows that women of various age categories are involved in vegetable production. Most of the women are married (64.1%), some are widows while a few of them are single. Marriage is seen as a stage of responsibility whereby women are expected to have a means of livelihood to cater for their households. Vegetable production is a major source of livelihood for women in Asa local government area. More than half (51.9%) of the women farmers had no formal education while some of them had primary (31.34%) and secondary (12.2%) education. Many of the women had large families of 4-6 children (43.6%) and 7-9 children (20.5%). This requires that they should have a source of income to support their families, and the children also assist their parents on the farm or to market vegetable products. Most of the women (66.1%) have been involved in vegetable production for more than seven years, 25.6% have been engaged in vegetable production for 4-6 years while 8.3% have been engaged in vegetable production for 1-3 years. This is an indication that these women had a wealth of experience in vegetable production practices and adaptation strategies to weather and climate fluctuations in the area.

Table 2: Socioeconomic characteristics of respondents (n=156)

Variables	Frequency	Percentage
Age (years)		
Below 30	20	12.8
31-40	41	26.3
41-50	67	42.9
51-60	23	14.7
61-70	5	3.3
Marital status		
Single	11	7.1
Married	100	64.1
Widow	45	28.8
Education background		
No formal education	81	51.9
Primary education	49	31.4
Secondary education	19	12.2
Adult education	3	1.9
Quranic education	4	2.6
Number of children		
1-3	56	35.9
4-6	68	43.6
7-9	32	20.5
Years of vegetable production		
1-3 years	13	8.3
4-6 years	40	25.6
7-9 years	61	39.1
10 years and above	42	27.0

Source: Field Survey 2017

Table 3 shows the various types of vegetable grown by women in Asa local government and the number of times each were produced annually. It can be observed that the majority of the women (about 80%) produced Amaranthus, Celosia and Chorcorus (leafy vegetables) more than three times in a year. Fruit vegetables such as Okro, Tomatoes, Rodo pepper and Tatase were grown at least twice or three times a year. Other vegetables grown by the women included water leaf and bitter leaf which are also produced all year round depending on the prevailing situation and individual woman's experience in vegetable production.

Table 3: Types and frequency of vegetable production by respondents per growing season (n=156)

Variable	Once F (%)	Twice F (%)	Three times F (%)	More than thrice F (%)
Amarantus	7 (4.5)	22 (14.1)	5 (3.2)	122 (78.2)
Celosia	16 (10.3)	11 (7.0)	3 (1.9)	126 (80.8)
Chocorus	9 (5.8)	14 (9.0)	11 (7.0)	122 (78.2)
Okro	5 (3.2)	42 (26.9)	88 (56.4)	21 (13.5)
Tomatoes	3 (1.9)	48 (30.8)	77 (49.4)	28 (17.9)
Bitter leaf	27 (17.3)	29 (18.6)	62 (39.7)	38 (24.4)
Water leaf	15 (9.6)	36 (23.1)	45 (28.8)	60 (38.5)
Rodo pepper	3 (1.9)	43 (27.6)	68 (43.6)	42 (26.9)
Tatase	10 (6.4)	30 (19.2)	72 (46.2)	44 (28.2)

Source: Field Survey 2017

Table 4 shows the result on noticeable changes over the years as observed by women in Asa local government area in the last 10-15 years. Most of the women (70.5%) indicated that every year there is lateness in the onset of rain. This could have a negative influence on vegetable production since Nigeria agriculture is mostly rain fed. Another change in weather condition as observed by the women is that the rain is not enough. This happens every year (34.0%) or once every two years (58.9%) which may also affect their level of vegetable production because it is dependent on availability of rain. More than half of the women (53.9%) also observed that once in every two years the rain is more than what is expected. This could result in flooding, weed problems and incidence of diseases and pests on their vegetable farms. Some of the women also indicated extreme heat/high temperature in the area every year (41.7%) and once every three years (44.2%). This could affect the production of crops that suffer heat stress such as tomatoes.

Other noticeable changes as indicated by the women include too much cold (57.7%), long dryness (53.8%), strong wind (53.2%), heavy storms (46.8%), and flooding (60.9%). All these have their various effects on the women's productivity and vegetable production generally because vegetables are sensitive crops that react to the slightest change in weather conditions.

Table 4: Noticeable changes and how often the changes occur (n=156)

Noticeable changes in weather	Every year F (%)	Once in 2 years F (%)	Once in 3 years F (%)
Late in the onset of the rain	110 (70.5)	40 (25.6)	6 (3.9)
Not enough rain	53 (34.0)	92 (58.9)	11 (7.1)
Too much rain	52 (33.3)	84 (53.9)	20 (12.8)
Too much heat/high temperature	65 (41.7)	22 (14.1)	69 (44.2)
Too much cold	25 (16.0)	90 (57.7)	41 (26.3)
Long dryness	26 (16.7)	84 (53.8)	46 (29.5)
Strong wind	83 (53.2)	42 (26.9)	31 (19.9)
Heavy storm	38 (24.4)	73 (46.8)	45 (28.8)
Flooding	30 (19.2)	95 (60.9)	31 (19.9)

Source: Field Survey 2017

The effects of changes in weather condition and their level of severity on vegetable production are presented in Table 5. More than half of the women (66.0%) indicated low production as severe, while 28.9% said it is very severe. This means that climate has resulted in low production for the women vegetable farmers. This would have affected their income and livelihoods which is in line with Mubaya et al (2010) who noted that climate change has both biophysical and socioeconomic implications that affect small-scale subsistence farmers in terms of productivity, food security and family income. Many of the women (62.8%) also indicated an inability to grow vegetables at the right time as a severe effect of climate change in the area. As displayed earlier in Table 4, lateness in the onset of rain is one of the observable changes reported by the women. This would affect their time of planting and it would also shorten the length of growing season thereby reducing the women's productivity. Inability to produce around the year as before (61.5%) is another severe effect of climate change as indicated by the women. This could be as a result of dry spells and heat/high temperatures that are sometimes experienced in the area. Another severe effect of climate change as indicated by most of the women (69.2%) is scarcity or non-availability of water. This is also a resultant effect of inconsistent/ insufficient rainfall, droughts and dry spells. A high percentage of the women (62.8%) also reported the incidence of insect pests as a severe effect of climate change, while 40.4% of them reported diseases as severe. Excessive much rain leads to high humidity which favours the breeding of many insect pests and diseases. This can lead to severe losses to vegetable and other crop farmers in the area.

Table 5: Effects of changes on vegetable production (n=156)

Effects of climate change	Very severe F (%)	Severe F (%)	Not severe F (%)
Low production	45 (28.9)	103 (66.0)	8 (5.1)
Unable to grow at the right time	35 (22.5)	98 (62.8)	23 (14.7)
Unable to produce round the year as before	34 (21.8)	96 (61.5)	26 (16.7)
Non-availability of water	32 (20.5)	108 (69.2)	16 (10.3)
Insect pests	32 (20.5)	98 (62.8)	26 (16.7)
Diseases	16 (10.3)	63 (40.4)	77 (49.3)

Source: Field Survey 2017

Results from Table 6 show that 28.8% of the women engaged in early planting to minimise the effect of climate change. This could mean that they begin their planting operations immediately after the first rain without waiting for the rains to be fully established. This will enable them to take advantage of the early rains to plant in case there is a dry spell, they will water the crops through irrigation. More than half of the respondents (50.6%) employed irrigation processes to minimise the effect of climate change. This involves artificial supply of water to their crops either from wells, boreholes or nearby streams and rivers. Due to inconsistent rainfall, scarcity of water is a major problem indicated by the women in the study area. Other coping strategies employed by the women include mulching (1.3 %), planting at the onset of rain (3.2 %), and planting many vegetables instead of only one (16.0%). Mulching helps to maintain soil moisture by reducing evaporation thereby keeping the soil moist and making nutrients available to the crops. It also prevents direct contact of sunshine and rain drops to the soil keeping out excess heat and reducing runoff that can cause erosion. Planting different types of vegetables enables the women to identify which ones adapt better to the prevailing weather condition. It also prevents too much loss in case some crops did not do well.

Table 6: Women farmers coping strategies for climate change (n=156)

Variables	Frequency	Percentage
Early planting	45	28.8
Irrigation	79	50.6
Mulching	2	1.3
Planting at the onset of rain	5	3.3
Planting many vegetables instead of only one	25	16.0

Source: Field Survey 2017

3.1. Perception of women farmers on climate change effects

Result presented in Table 7 reveal that the majority of the women (96.2%) were of the opinion that climate change has reduced vegetable production in the study area. This is an indication that climate change has a negative impact on vegetable production for the women farmers. The vast majority of the women (97.4%) also agreed to the fact that some vegetables are not doing well as a result of climate change. This shows that the women were able to identify crops that are not doing well and those that adapt to prevailing weather conditions. Most of the women (69.8%) were in support of the statement that climate change has enabled them to identify other crops that can grow in this area. As previously shown in Table 6, women decided to plant many vegetables in a bid to minimise the effect of climate change and this has enabled them to identify which of these vegetables perform better in the area. Furthermore, most of the women (93.0%) were of the opinion that they earn more income as a result of growing many types of vegetables. Growing many vegetables prevent the women from losing too much as a result of crop failure thereby maintaining/improving their source of income. Most of the women (87.9%) also agreed to the fact that climate change has resulted in a high incidence of pests on the vegetable farms. Moreover, a high percentage of the women (77.5%) were of the opinion that there is an increase in disease attacks on vegetable farms as a result of climate change. High rainfall and increased temperature. which are common features of climate change, are favourable conditions for the build-up of pests and diseases. Almost half of the women (42.3%) were uncertain about the fact that climate change is favourable to the practices of organic agriculture, while 11.5% disagreed. This could mean that women in the area have not been exposed to the practices of organic agriculture. However, the majority of the women (91.7%) agreed to the fact that climate change has resulted in the reduction of chemical use on the farm in the study area. Most of the women (89.1%) also supported the statement that they gained more knowledge as a result of climate change. The women were able to learn more about their environment and the crops they can grow that will do well. Therefore, more than half of the women (56.4%) were of the opinion that climate change has made vegetable production more interesting/enjoyable to the farmers. This could be due to the fact that they were able to experiment with many vegetable crops and observe them, thus learning more about their farming practices.

Table 7: Perception of women farmers on climate change effects (n=156)

Statement	SA	A	U	D	SD
1. Climate change has reduced my vegetable production	53 (34.0)	97 (62.2)	5 (3.2)	1 (0.6)	
2. Some vegetables are not doing well as a result of climate change	45 (28.8)	107 (68.6)	3 (2.0)	1 (0.6)	
3. Climate change has enabled me to identify other crops that can be grown in this area	35 (22.4)	74 (47.4)	38 (24.4)	7 (4.5)	2 (1.3)
4. My income has increased as a result of growing many types of vegetables	52 (33.4)	93 (59.6)	9 (5.8)	1 (0.6)	1(0.6)
5. Climate change results in high incidence of pests on the vegetables farms	28 (18.0)	109 (69.9)	13 (8.3)	5 (3.2)	1 (0.6)
6. Diseases attack on the vegetables farms has increased as a result of climate change	23 (14.7)	98 (62.8)	25 (16.1)	5 (3.2)	5 (3.2)
7. Climate change is favorable to the practice of organic agriculture	31 (19.9)	41 (26.3)	66 (42.3)	18 (11.5)	
8. Climate change has resulted in the reduction of chemical use on the farm	16 (10.3)	127 (81.4)	10 (6.4)	3 (1.9)	
9. I gained more knowledge on vegetable production as a result of climate change	48 (30.8)	91 (58.3)	11 (7.1)	5 (3.2)	1 (0.6)
10. Climate change has made vegetable production more interesting/enjoyable to farmers	44 (28.2)	44 (28.2)	15 (9.6)	37 (23.7)	16 (10.3)

Source: Field Survey 2017

3.2. Research hypothesis 1

There is no significant relationship between socioeconomic characteristics of women farmers and perceived effects of climate change on vegetable production.

A Chi-square analysis of the relationship between women farmers' selected socio-economic characteristics and perceived effects of climate change on vegetable production is shown in Table 8. From the table, it can be seen that women farmers' marital status was significantly related to their perceived effects of climate change on vegetable production, while religion was not significantly related.

Table 8: Chi-square analysis of relationship between women farmers' selected socio-economic characteristics and perceived effects of climate change on vegetable production.

Variables	Chi-square value	Df	P	Contingency Coefficient	Decision
Marital status	16.227	6	0.013*	0.38	S
Religion	3.017	6	0.807	1.167	NS

*Significant at p<0.05

Table 9 shows the Pearson Product Moment Correlation analysis of the relationship between women farmers' other socio-economic characteristics and perceived effects of climate change on vegetable production. It can be seen from the table that academic qualification and farming experience are significantly related to perceived effects of climate change among women vegetable farmers in Kwara State, Nigeria.

Table 9: PPMC table showing analysis of relationship between women farmers' other socio-economic characteristics and perceived effects of climate change on vegetable production.

Variables	r-value	p-value	Decision
Age			
Academic qualification	-0.179	0.026*	S
Farming experience	0.384	0.000*	S

*Significant at p<0.05

3.3. Research hypothesis 2

There is no significant relationship between coping strategies employed by women farmers and perceived effects of climate change on vegetable production.

A Chi-square analysis of the relationship between women farmers' coping strategies and perceived effects of climate change on vegetable production is shown in Table 10. The table reveals a significant relationship between women farmers' coping strategies and perceived effects of climate change on vegetable production.

Table 10: Chi-square analysis of the relationship between coping strategies employed by women farmers and perceived effects of climate change on vegetable production.

Variables	Chi-square value	Df	P	Contingency Coefficient	Decision
Coping strategies	80.739	10	0.000*	1.439	S

*Significant at p<0.05

4. CONCLUSION AND RECOMMENDATIONS

It can be concluded from the findings of this study that women farmers in Kwara State were conscious of climatic changes in their environment. They have also noticed its impact on their vegetable production and have designed ways of coping with the adverse effects of climate change. The following recommendations are therefore suggested:

1. Women farmers should be assisted in the procurement of inputs such as improved seeds (pest and diseases resistant varieties, early maturing and climate resilient varieties), irrigation facilities and more reliable credit sources.
2. The women also need more enlightenment on climate smart agricultural practices to enable them to cope better with worsening climate change effects.

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THE ROLE OF OPERATION SUKUMA SAKHE (OSS) ON CLIMATE SMART AGRICULTURE AWARENESS IN YOUTH AND ITS IMPACT ON FOOD SECURITY IN KWAZULU NATAL

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ABSTRACT

This paper attempts to establish the role of Operation Sukuma Sakhe (OSS) on Climate Smart Agriculture awareness on youth and its impact on food security in KwaZulu Natal (KZN). OSS is a service delivery model operating at ward level throughout the province with the aim of poverty eradication, located in the office of the Premier in KZN. Results are based on the rapid appraisal conducted from the Provincial Task Team (PTT) and the fieldworkers on the ground level on their knowledge of Climate Smart Agriculture (CSA) where questionnaires were administered. It was observed that 28.5% of PTT members are highly knowledgeable on climate change while 60% of fieldworkers indicated high knowledge. Results indicated that over 70% of both levels showed great concern regarding climate change. Results also indicated that 100% and 90% of participants respectively responded that youth awareness on climate smart agriculture can improve their living ethics towards caring for the environment, henceforth improving food security among communities. The study concludes that involvement of OSS in youth awareness and involvement in climate smart agriculture can greatly assist to ensure community food security through proper production strategies.

1. INTRODUCTION

Operation Sukuma Sakhe is a service delivery model located in the nerve of KwaZulu Natal Provincial Government, the Office of the Premier (OTP). Sukuma Sakhe is an IsiZulu language phrase which can be translated to "arise and build". It is an important model as all government departments in the province, national departments present in the province, as well as local and district municipalities report about their participation in poverty eradication on a monthly basis.

Figure 1 shows the desired outcomes which are sustainable livelihood that might be created through the provision of integrated services to communities, encouraging a better life for all. Figure 2 indicates that the most important stakeholders or beneficiaries of OSS are poor and vulnerable groups (women, youth, elderly and disabled). Traditional leaders are also an important component of OSS.

According to Ngidi and Kubheka (2012), OSS was a re-launch of 'War in Poverty' that was a flagship programme launched in 2008 in uMsinga. It was re-launched in 2009 as 'Operation Sukuma Sakhe' and it integrates all departments, non-government organisations (NGOs) and traditional leaders for appropriate service delivery. OSS methodology is interventions on poverty with the aim of eradicating it and all forms of social ills associated with poverty. These interventions are informed by profiling of households in the ward by field workers.

Identified issues can be categorised into immediate, medium term and long term. These issues are referred to relevant stakeholder (departments) for their proper categorisation, assessment and interventions and

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reporting back to the bottom structure upward. The stakeholder integration enhances appropriate service delivery to communities through this service delivery model.

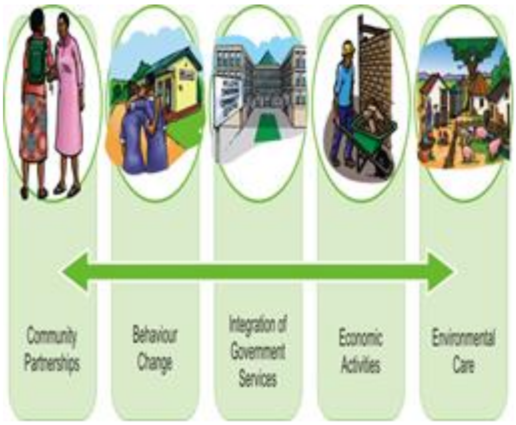

Figure 1: Sustainable livelihood

Figure 2: OSS beneficiaries

Structurally, OSS operates in the ward, which is called ward war room (WWR) where ward councillors are political champions, members of WWR are government officials working in that ward, non-government organisations (NGO's) and traditional leaders in that ward as well as other people with interest. Second tier is Local Task Team (LTT) which is made up of WWR representatives as well as government officials and NGO's working in the municipality. Municipal Mayor is the political champion of the LTT. Like in WWR members of LTT choose office bearers of LTT. District Task Team (DTT) is the next structure, each Member of Executive Council (MEC) and Premier is allocated a district to champion together with a Head of Provincial Department (HOD). Election of PTT office bearers follows a similar process to that of LTT.

The Department of Agriculture and Rural Development in KwaZulu Natal (KZNDARD) has an Extension Officers (EO) as part of all war rooms. As all departments are part of OSS, the aim of the study was to unpack, understand and make suggestions as to how climate smart agriculture (CSA) is understood and can be incorporated; youth made aware of climate change and improve food security using this transversal provincial structure.

1.1. Objectives

The main objectives of this study were to determine knowledge of OSS leaders at a top level (Provincial Task Team-PTT) and on ground level (fieldworkers) on climate smart agriculture (CSA). In addition, to identify the role of OSS in improving CSA awareness in youth within communities for improved food security.

2. LITERATURE REVIEW

According to Texas Food Bank (TFBN, 2014), food insecurity is the restricted access to adequate food due to lack of funds and other resources. However, food insecurity may be comprised of inadequate access to available food and an unsustainable food supply aggravated by poverty. Stats SA (2016) indicated that KZN is one of the provinces with the highest population distribution which is at 11.1million people. However, the province is said to have experienced a significant population decline due to outwards migration (job search), low fertility and high mortality rates. With only 36.7% (stats SA, 2016) of youth being economically active and climate change, food production has drastically declined while the population is at its uppermost. Globally, climate change has brought drastic decline on food production which has negatively impacted the global economy. This climate change syndrome has increased food insecurity among the most deprived communities of KZN. This has also affected the household food security of our communities as there are erratic seasonal changes experienced during the production seasons resulting in extreme pest devastation and low yields. Climate change has become enormous that it requires technological interventions and natural resource conservation techniques for improved yields in every production aspect including sustainable use of available resources.

2.1. Food security

du Toit, Ramonyai, Lubbe and Ntushelo (2011) outlined that Food and Agriculture Organization of the United Nations (FAO, 2004) report highlighted that in many parts of the world agriculture is a key to food security. Therefore, war room meetings have an EO to attend to agricultural issues in the meetings for relevant food security interventions. Association for Rural Advancement (AFRA, 2009) reported that one of the strategies used to meet food security attentions for the households is One Home One Garden (OHOG), introduced by the Premier in KZN where households receive basic training and basic equipment for vegetable production. This OHOG campaign was aimed at promoting vegetable production at household level to enhance food security and improving livelihoods.

Having all stakeholders' interventions in place, climate change and altered land use patterns exacerbate food production challenges, henceforth efficient, resilient and adaptive strategies need to be acquired. Stabilising and improving food security entails agricultural production systems to change in the direction of higher productivity and also, essentially, lower output variability in the face of climate risk and risks of an agro-ecological and socio-economic nature (FAO, 2010). Therefore, production synergies should be transformed towards climate smart systems through sustainable production (natural resources management and less emissions to the environment).

2.2. Engaging youth in CSA

According to Food Agriculture and Natural Resources Policy Analysis Network (FANRPAN, 2012), young Africans are a vital tool to African agricultural development, even in the smallholder agriculture sector, which currently offers few opportunities for today's youth. It has been realised that the average age of the African farmer is above 50 years and farming is alleged by the youth as old-fashioned and offering little opportunity for a productive future, so they pursue well-paid jobs in urban areas. There is an urgent need, not only for local agricultural production and food security enhancement but it requires strengthened systems (innovative solutions) to withstand adverse climatic challenges. Youth, being the future of the country and the communities, are more likely to understand and adopt new technologies to improve food production than elders and to respond to climate change encounters. Therefore, youth awareness on climate-smart agriculture is an urgent necessity so as to effectively improve the livelihoods through sustainable agricultural production.

3. METHODOLOGY

KwaZulu Natal Department of Agriculture and Rural Development (KZNDARD) have Food Security programmes in place for the alleviation of food insecurity especially in the rural communities since 2008. However, climate change and the level of youth involvement in agriculture threatens production's stability and productivity.

A survey was conducted to the basic unit members or fieldworkers (n=20) of Nquthu LTT, Nquthu has 17 wards so on average each ward was represented by at least a fieldworker, that made the representation acceptable. A self-administered survey was also conducted to a top technical structure of OSS which is PTT (n=7), the province with its 11 districts, the sample was over 50% which was a good representation.

The second part of the study was to examine the reporting form and the elements that the Department of Agriculture and Rural Development on and determine if those elements address issues of youth awareness to climate change and food security. The intention was to propose improvement on reporting template by KZNDARD, so that issues of CSA, awareness of youth and food security are properly captured. This is because climate change and the level of youth involvement in agriculture threatens production's stability and productivity.

The survey questionnaire was used for data collection with similar questionnaires administered for both participants.

4. RESULTS AND DISCUSSION

Results indicated that only 28.5% of PTT members have high knowledge of climate change and felt that more should be done to curb climate change by promoting CSA principles. This situation where not even half of policy makers have very limited of this highly reported phenomenon. It also raised concerned as if such dire situation is taken seriously and will ever be addressed at policy and political level.

Furthermore, 60% of fieldworkers indicated high knowledge by observing heat over a period of time. Fieldworkers also indicated that climate change is negatively affecting farmers livelihoods in the wards and villages there are working on.

Over 90% of both levels indicated that youth are not being made aware or they don't notice programs targeting youth on issues of climate change and food security, yet they see great need for awareness in youth. Both sets further stated that youth awareness on climate smart agriculture can improve their living ethics towards caring for the environment, henceforth stable and improved food security among communities through their understanding of new technologies.

Moreover, 71.4% of fieldworkers and 70% of PTT members responded that indeed food security is highly being threatened by climate change impact and there is great need for any action that will minimise or reverse climate change. Therefore, extension methods should focus on sustainable production initiatives that reduce evaporation and improve productivity in their daily extension work. These principles should be compulsory in all state funded projects, to mitigate impact of climate change and livelihood disruptions.

5. CONCLUSION AND EXTENSION IMPLICATIONS

Both important structures of OSS indicated a need for climate smart agriculture principles in planning and execution. It was further indicated that youth should be influenced so that they can be involved in reducing climate change or improving adoption of CSA.

DARD in OSS PTT that formulated reported template should be represented by someone knowledgeable or skilled in agricultural extension so that agricultural interventions be captured, reported and analyzed properly. OSS is an important structure that agricultural extension at all levels should participate fully. So that issues that can reduce or eliminate poverty be addressed at all levels. Food security, CSA principles and youth awareness can be improved if are all part of agenda all the time including at cabinet level.

Climate change is of great concern however if the relevant information is available, adequate caution taken towards effective production strategies, sustainable natural resource utilization and management and reduction of emissions to the environment, food and economy may be stabilised thereby stabilising food security.

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PARTICIPATION OF THE YOUTH IN AGRICULTURAL EXTENSION PROGRAMMES OF THE MANZINI REGION, SWAZILAND

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ABSTRACT

The extent of youth participation in Swaziland Agricultural Extension has not been adequately documented. The purpose of this study was to determine the degree of youth involvement in Agricultural Extension in the Manzini Region of Swaziland. Eleven organisations involved in Agricultural Extension for the youth were included in the study. A sample of 63 youths taking part in Agricultural Extension who were reached by the organisations were randomly selected for the study. A validated questionnaire with a reliability coefficient of 0.91 was used to collect data from the youths. Results showed that the organisations (Mean = 3.17) and the youths (Mean = 2.97) were not actively participating in Agricultural Extension. The youth programmes were faced with many challenges including economic (Mean = 4.37), technological (Mean = 4.03), and institutional (Mean = 3.93) challenges. Participation had a negligible association (r = -.082) with years of formal education, negative and low association with age (r = -.199), and moderate association with experience in farming (r = .341). In conclusion, youth participation in Agricultural Extension programmes was very low, except in vegetable production and broiler management. To increase youth participation, adequate and subsidised farm inputs, greater access to farm credit, and an increased number of visits by extension agents should be provided for the youth.

1. INTRODUCTION

1.1. Background and setting

As a result of the industrial revolution, around the 1870's, there were more people in the USA finding employment in non-farm jobs than on the land. Rural families felt they were losing their children to the cities and subsequently, deep emotional attachment to the land increased. The 4-H movement grew out of this concern for the future of a generation of rural youth. Parents wanted to instill in their children the idea that agriculture was not just for those who could not get a job in the cities, but that farming and rural life were human aspects to be valued (Seiders, 2015).

In the United States, the 4 – H clubs are youth clubs designed to train the head, heart, hands and contribute to good health. The 4 – H means the following:

Head – to think clearly and carry out responsibilities

Heart – to understand and appreciate things in life

Hands – to work willingly and well

Health – to build strong bodies

In several countries, including the United States of America, Jamaica, and Nigeria, the 4 – H clubs are simply referred to as Young Farmers' Clubs or rural youth clubs. In Kenya, they are called 4 – K clubs. In Guatemala they are called 4 – S clubs and in the Republic of Benin they are called 4 – D clubs. The 4 – S when translated

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from Spanish meant Knowledge, Service, Health and Feelings. The 4– D club meant people have taken their *Decision* to do their *Duties* for a real *Development* of their dear *Dahomey*. Masina (1987) reported that, in 1982, a youth programme was established, which led to the formation of the 4-S club as a youth organisation in Swaziland. Its membership was open to rural youths both in and out of school. The youths involved were in the age group of 9-21 years. The organisation's name, 4-S, was derived from the following:

SivesemaSwati – The Swazi nation

Siyasebenta - Is working

Siyatfutfuka – Is developing

Sihlangene – In unity

1.2. Objectives of the 4-S Club

The objectives of the 4-S Club in Swaziland are to:

1. Teach the youth improved methods in agriculture.
2. Teach the youth to appreciate and respect agriculture as a profession.
3. Help the youth produce food for their families and the extra for sale.
4. Develop leadership among the youth.
5. Positively change farmers' attitudes and practices.

1.3. Other youth development programmes

The JFFLS (Junior Farmer Field and Life School) was officially implemented in Swaziland as a pilot programme supported by the UN Agencies in 2006. The Children and Youth Development Programme (CYDP) was built upon the success of the Junior Farmer and Field Life Schools and the 4-S programmes, which are targeting children and youth in agri-based activities in Swaziland. The programme provides agricultural skills and life skills as well as some take-home food to the participating children and youth. Emphasis is also placed on sensitising the adolescents to sexual reproductive health, HIV and AIDS (Dlamini, 2014).

1.4. The problem

Although the youth constitutes about 40% of Swaziland's total population (UNESCO, 2010), they are often not given adequate attention by government policy makers and development strategists (Brixiová and Kangoye, 2014). In Swaziland, the participation of the youth in agricultural extension programmes has been scarcely researched (FAO, 2014). Youths have the potential to overcome some of the major constraints to expanding food production in developing countries such as Swaziland in pest control, feeding, genetic improvement and protection against other hazards, because they are often more open to new ideas and practices than adult farmers. They play an important role in awareness creation on different subjects (Ijere, 1992). The various organisations involved in youth agricultural extension programmes, types of programmes, the challenges encountered in the programmes, sources of funding, are some of the areas that have been scarcely researched in youth extension programmes.

1.5. Purpose of the study

The purpose of the study was to assess the participation of the youth in agricultural extension in Swaziland as carried out by government as well as non-government organisations.

1.6. Objectives of the study

The objectives of the study were to:

1. Identify organisations which are participating in agricultural extension for the youth.

2. Identify agricultural extension programmes in which youth are participating in Swaziland, through the various organisations.

3. Determine the frequencies of meeting the youth Agricultural Extension Agents by the youth to take part in agricultural extension programmes.

4. Describe challenges encountered by the youth in agricultural extension programmes.

5. Describe the association between demographic characteristics of the youth and their participation in agricultural extension programmes.

2. METHODOLOGY

2.1. Target population and sample size

The target population of the study was all the youth aged 15 to 35 years (UNESCO, 2010) who participate in agricultural extension programmes in the Manzini region of Swaziland. There were 33 youth agricultural extension organisation**s** with 303 members participating in agricultural extension youth programmes in the Manzini Region. About 20 of these organisations were active. Ten organisations were systematically selected, from which 63 respondents were randomly selected to constitute the sample size for the study.

2.2. Instrumentation

A six-point Likert-type scale was used to measure the domains of the instrument consisting of nominal and ordinal variables. To identify the organisations which were involved in agricultural extension for the youth, and how actively the youths participated in the programmes of each organisation, respondents were asked to indicate 1= very inactive participation; 2= inactive participation; 3= slightly inactive participation; 4= slightly active participation; 5= active participation; 6= very active participation.

To identify agricultural extension programmes in which youths participated through various organisations and how active the youth were, respondents were required to indicate: 1=very inactive participation; 2=inactive participation; 3=slightly inactive participation; 4=slightly active participation; 5=active participation; 6=very active participation. How frequently the youth met with the extension agents, and agreement with what constituted challenges to the youth, were similarly measured on six-point Likert-type scales. The other variables were measured with direct questions.

2.3. Validity

The validity of the instrument was ascertained by giving the questionnaire to two lecturers in the University of Swaziland, Department of Agricultural Education and Extension, one youth coordinator in the Ministry of Agriculture in the Manzini region, and two youths who were members of youth organisations in agriculture to read and suggest improvements. Comments from the judges were used to improve the instrument.

2.4. Reliability

Reliability was established after testing the instrument with 30 youths who participated in agricultural extension programmes through the government and non-government organisations. These youths were not included as respondents for the study. The relevant reliability coefficient was calculated, using Cronbach's alpha and was found to be 0.91 (Cronbach, 1970).

2.5. Data collection

Data were collected from a sample of 63 young people from the organisations, who completed the questionnaire. Sampling was stratified according to communities. Data were collected from five out-of-school youth organisations and five in-school youth organisations. The organisations were systematically selected from the clubs of Children and Youth Development Programmes and Non-Governmental Organisations available in the Manzini region.

2.6. Ethical consideration

Assurance of confidentiality was highly emphasised. Names of respondents were not required in the questionnaire. Permission was sought from relevant authorities to collect the data. Participation in the study was not compulsory.

2.7. Data analysis

To analyse data from respondents, the Statistical Package of Social Science programme version 20.0 was used where the means, standard deviations, frequencies, percentages and correlation tools were used to analyse the data. Davis scale was used to interpret the correlation analysis of objective 5.

Table 1: Davis scale for interpreting correlation coefficients

Coefficient	Description
1.0	Perfect association
0.70 to 0.99	Very high association
0.50 to 0.69	Substantial association
0.30 to 0.49	Moderate association
0.10 to 0.29	Low association
0.01 to 0.09	Negligible association

3. RESULTS AND DISCUSSION

3.1. Organisation which actively participated in youth agricultural extension programmes

Data in Table 2 show active participation of Children and Youth Development Programme (CYDP), and Junior Achievement (M > 3.50) in youth agricultural extension programmes. All the other organisations did not actively participate. The domain mean of 3.17 shows that the organidations did not actively participate in youth extension programmes.

Table 2: Organisational participation in agricultural extension programmes for the youth in the Manzini region (n=63)

Organisations	M	SD
1. Children and Youth Development Programme (CYDP)	4.59	2.10
2. Junior achievement	3.62	1.96
3. World Vision	3.41	1.96
4. Micro Finance	3.08	1.85
5. Inhlanyelo Fund	3.08	2.01
6. Swaziland National Youth Council	2.97	1.85
7. African Cooperative Action Trust (ACAT)	2.95	1.83
8. Financial Banks	2.84	1.92
9. Council of Churches	2.68	1.86
10. FINCORP	2.63	1.92
Domain	**3.17**	**1.92**

Rating scale: **1**=Very inactively participate, **2**=Inactively participate, **3**=Slightly inactively participate, **4**=Slightly actively participate, **5**=Actively participate, **6**=Very actively participate. Mean (M) ≥ 3.50=Actively participate; Mean (M) < 3.50=Not actively participate.

3.2. Agricultural extension programmes in which youth participated

Data in Table 3 show that the respondents indicated active participation of the youth in vegetable production and broiler management (M ≥ 3.50). The youth inactively participated in other programmes, including crop production, and production of floor polish, fabric softer, beekeeping and egg production, cooperative movement, pig production, indigenous chicken production, marketing, food processing, skin ointment, goat production and fish farming, dairy production and beef production (M < 3.50). The domain mean of 2.97 suggested that the respondents inactively participated in youth agricultural extension and other youth development programmes. The standard deviation which was above 1 shows that there was large variation in the way the youth responded to the rated statements. The government of Swaziland, through its Children and Youth Development Programmes, provides farming inputs to youth and extension services to communities to facilitate the programmes. The Non-Government Organisations assist the government in providing training, farm credits and farm inputs. These programmes are also provided in schools, both at primary and secondary levels. However, there is lack of active participation of the youth in many of these programmes. Some of the programmes are non-agricultural.

Table 3: Agricultural extension programmes in which youth participate in Swaziland, carried by the different organizations (n=63)

Extension programmes	M	SD
1. Vegetable production	3.59	2.01
2. Broiler management	3.51	1.94
3. Indigenous chicken rearing	3.48	1.86
4. Production of floor polish	3.33	1.99
5. Crop production	3.21	1.99
6. Fabric softener	3.19	1.86
7. Fish farming	3.08	1.98
8. Egg production	3.03	1.75
9. Youth cooperative movement	2.95	1.73
10. Pig production	2.89	1.81
11. Food processing	2.86	1.79
12. Marketing	2.86	1.74
13. Skin ointment	2.68	1.66
14. Fish farming	2.54	1.84
15. Beef production	2.52	1.71
16. Dairy production	2.43	1.58
17. Goat rearing	2.30	1.53
Domain	**2.97**	**1.81**

Rating scale: **1**=Very inactively participate, **2**=Inactively participate, **3**=Slightly inactively participate, **4**=Slightly actively participate, **5**=Actively participate, **6**=Very actively participate. Mean (M) ≥ 3.50=Actively participate; Mean (M) < 3.50=Not actively participate.

3.3. Frequencies of meeting with agricultural extension agents by the youth

Data in Table 4 show that the respondents met frequently with the agricultural extension agents to learn about, and carry out vegetable production (M = 3.90). The respondents indicated infrequent meeting with agricultural extension agents on crop production, marketing, pig production, broiler management, egg production and other agricultural extension programmes.

The respondents also stated infrequent meetings with the agricultural extension agents on youth in cooperative movement, indigenous chickens rearing, bee-keeping, goat rearing, beef production, fish farming, production of floor polish and fabric softer as well as skin ointment, dairy production and food processing, some of which are non-agricultural programmes. The domain mean of 2.86, suggested that the agricultural extension agents were infrequent in meeting the youth on agricultural extension and other youth programmes.

Table 4: Frequencies of meeting agricultural extension agents by the youth to take part in agricultural extension and other youth development programmes (n=63)

Extension programmes	M	SD
1. Vegetable production	3.90	1.85
2. Crop production	3.48	1.84
3. Marketing	3.33	1.68

4. Pig production	3.14	1.74
5. Broiler management	3.03	1.71
6. Egg production	3.00	1.68
7. Production of floor polish	2.95	1.81
8. Youth cooperative movement	2.94	1.74
9. Goat rearing	2.84	1.90
10. Indigenous chickens rearing	2.84	1.84
11. Bee keeping	2.79	1.91
12. Beef production	2.75	1.81
13. Fish farming	2.57	1.75
14. Fabric softener	2.51	1.70
15. Food processing	2.30	1.58
16. Dairy production	2.13	1.31
17. Skin ointment	2.06	1.31
Domain	**2.86**	**1.72**

Rating scale: 1=Very Infrequently, 2=Infrequently, 3=Slightly Infrequently 4= Slightly Frequently, 5= Frequently, 6=Very Frequently. Mean ≥ 3.50 =Frequently, Mean ≤ 3.50 = Infrequently

3.4. Challenges encountered by the youth

Data in Tables 5, 6, 7 and 8 show that the youth encountered many economic, technological, institutional and socio-cultural challenges during participation in the youth programmes.

3.4.1. Economic challenges

Data in Table 5 show that respondents encountered many economic challenges including high costs of livestock feed, fertilizers, vaccines, insecticides and transport, and seeds; lack of farm credit, unavailability of market for farm products, and transport facilities (M ≥3.50).

Table 5: Economic challenges faced by youth in agricultural extension programmes (n=63)

Economic challenges	**M**	**SD**
1. High cost of livestock of feed	5.06	1.09
2. No farm credits	4.89	1.25
3. High cost of fertilizers	4.56	1.53
4. Lack of market for produce	4.52	1.46
5. High cost of vaccination	4.46	1.44
6. Lack of transport	4.32	1.31
7.labour shortage for farm work	4.29	1.44
8. High cost insecticides	4.25	1.36
9. Shortage of financial capital	3.67	2.06
10. High cost of seeds	3.65	1.90
Domain	**4.37**	**1.47**

Rating scale: 1=Strongly Disagree, 2=Disagree, 3=Slightly Disagree, 4=Slightly Agree, 5=Agree, 6=Strongly Agree; Mean ≥ 3.50 = Challenge; Mean < 3.50 = Not a challenge.

3.4.2. Technological challenges

Data in Table 6 show that respondents encountered many technological challenges (M ≥ 3.50) including pests, diseases, weeds, infertile soil, lack of production knowledge, farm inputs, tractors, and unfavourable weather.

Table 6: Technological challenges faced by youth in agricultural extension programmes (n=63)

Technological challenges	M	SD
1. Pests are abundant during crop growing season	4.59	1.33
2. Soil fertility	4.48	1.39
3. Lack of knowledge on agricultural technology	4.37	1.44
4. Unfavourable weather conditions	4.17	1.55
5. Rains disturb field operations	4.17	1.47
6. Diseases are many during crop production	3.90	1.16
7. Lack of farming inputs	3.81	1.63
8. There is too much weeds	3.79	1.59
9. Unusual rainfall distribution	3.73	1.66
10. Lack of tractors	3.73	1.64
11. Diseases of animals	3.54	1.53
Domain	4.03	1.49

Rating scale: 1=Strongly disagree, 2=Disagree, 3=Slightly disagree, 4=Slightly agree, 5=Agree, 6 = Strongly agree. Mean (M) ≥ 3.50 = Challenge; Mean (M) < 3.50 = Not a challenge

3.4.3. Institutional challenges

Data in Table 7 show that the youth encountered many institutional challenges. The challenges include unavailability of extension and research support, and inappropriate government policies.

Table 7: Institutional challenges (n=63)

Institutional challenges	**M**	**SD**
1. Unavailability of extension support	4.19	1.45
2. Unavailability of research	4.17	1.26
3. Lack of information about youth programmes in my area	4.02	1.60
4. Inappropriate government policies	3.78	1.54
5. Inadequate agricultural extension information	3.51	1.62
Domain	**3.93**	**1.54**

Rating scale: 1=Strongly disagree, 2=Disagree, 3=Slightly disagree, 4=Slightly agree, 5=Agree, 6=Strongly agree. Mean (M) ≥ 3.50 = Challenge; Mean (M) < 3.50 = Not a challenge

3.4.4. Socio-cultural challenges

Data in Table 8 show that the youth encountered some socio-cultural challenges (M ≥ 3.50). The challenges include negative influence by the community, theft of produce, disturbance by sports in schools, and culture's negative influence. The domain mean of 3.23 show that the challenges are few, and hence should not constitute a serious bottleneck in youth participation. However, they should still be addressed.

Table 8: Socio-cultural challenges (n=63)

Socio-cultural challenges	M	SD
1. Community's negative influence	4.19	1.40
2. Theft of products is a problem	3.60	1.74
3. Disturbance by sports	3.60	1.54
4. Culture's negative influence	3.56	1.60
5. Incwala ceremony	3.17	1.72
6. Community conflicts	3.16	1.94
7. Family conflicts	3.16	1.42
9. Reed dance	3.14	1.83
10. Funerals	2.94	1.51
11. I cannot change the farming practices that I am used to	2.90	1.48
12. Disturbance by marriage ceremonies	2.86	1.42
13. Religious ceremonies	2.78	1.37
14. Lusekwane ceremony	2.62	1.36
Domain	**3.23**	**1.57**

Rating scale: 1=Strongly disagree, 2=Disagree, 3=Slightly disagree, 4=Slightly agree, 5=Agree, 6 = Strongly agree. Mean (M) ≥ 3.50 = Challenge; Mean (M) < 3.50 = Not a challenge

3.5 Association between demographic characteristics of the youth and their participation in agricultural extension programmes

Davis' (1971) scale (Table 1) was used to interpret the findings. Data in Table 9 show that there was a negative and moderate association between sex and participation (r= - .384). The more respondents were females, the less the participation. A higher percentage of males (55.6%) than females (44.4%) actually participated in the programmes. A positive and moderate association (r=.341) was found between size of household and participation. The larger the size of household, the greater the participation of youth in the programme. This is understandable because a large household could have enough members to release for participation so as to meet the needs of members. Status of respondents and age had low associations with participation. This is because majority of respondents were not heads of household (85%) and were in the youth years of age of 15-25 years (73%). The remaining independent variables had negligible associations with participation.

Table 9: Association between demographic characteristics and youth participation in agricultural extension programmes (n=63)

	Y	X^1	X^2	X^3	X^4	X^5	X^6	X^7	X^8	X^9
Y	1.00									
X^1	-.103	1.00								
X^2	-.384	-.311	1.00							
X^3	-.199	.137	-.159	1.00						

X^4	-.092	-.236	.256	-.036	1.00					
X^5	.082	-.053	.006	.145	-.084	1.00				
X^6	-.031	.141	-.073	-.264	.128	-.307	1.00			
X^7	-.047	.287	.119	-.120	-.099	-.120	.117	1.00		
X^8	.341	-.149	.413	-.345	.123	-.016	-.203	.359	1.00	
X^9	.006	-.068	-.032	-.015	.217	.029	.197	.238	.133	1.00

Dependent variable: Y= Agricultural extension programmes in which youth are involved in: Production of floor polish, Fabric softener, Skin ointment, Food processing, Dairy production, Broiler management, Egg production, Indigenous chicken rearing, Pig Production, Marketing, Youth Cooperative Movement, Goat Rearing, Beef Production, Crop production, Vegetable production, Fish Farming, Bee keeping. Rating scale: **1**=Very inactively participate, **2**=Inactively participate, **3**=Slightly inactively participate, **4**=Slightly actively participate, **5**=Actively participate, **6**=Very actively participate.

Independent variable: x^1=Status of respondent; x^2=sex; x^3=age; $x^{4=}$marital status; $x^{5=}$education level; x^6=member in an organization; x^7=occupational status; x^8=experience in farming; x^9=size of household.

4. CONCLUSION

The following conclusions were derived from the findings:

1. The level of involvement in agricultural extension programmes by government and Non-Government Organisations was low. Only two organisations, namely, Children and Youth Development Programme (CYDP) and Junior Achievement were the organisations which were actively participating.

2. The level of participation by the youths in agricultural extension programmes was very low. The youths were participating notably in vegetable production and broiler management. Their participation in other programmes was minimal.

3. The frequency of extension agents' meeting youth on agricultural extension programmes was very low. The youth met frequently with extension agents only on vegetable production. The extension agents did not meet the youth frequently on agricultural and other youth development programmes.

4. Economic, technological and institutional challenges were the main challenges faced by youth in agricultural extension programmes. Socio-cultural challenges faced by the youth were few.

5. There was a positive and moderate association between experience in farming and participation. Youth participation increased with their years of experience in farming. The association was moderate but negative with sex. Males participated more than females. Associations of status in terms of being heads of households or not, and age with participation were negative and low.

5. RECOMMENDATIONS

The following recommendations emanate from the conclusions:

1. Government and Non-Governmental Organizations should actively participate in youth agricultural extension and other youth development programmes.

2. There should be increased effort to mobilise the youth for active participation in various agricultural extension and other youth development programmes. Their participation should cover a wide spectrum of agricultural extension and other programmes that are relevant to the youth.

3. Youth extension agents should increase their frequencies of meeting the youth in all areas of agricultural extension and youth development programmes. They should not focus on vegetable production only.

4. The economic challenges facing the youth should be properly addressed, including provision of livestock feeds and vaccines, farm credit, transportation and market for agricultural products. Technological challenges such as lack of tractor services, pest and disease attack, weed infestation of farms, should also be properly addressed. Institutional problems such as inadequate extension, research and government policies on youth programmes should be addressed. Socio-cultural challenges such as community's negative influence, and theft should be eliminated.

5. Both male and female youths should be encouraged to participate actively in agricultural extension. Special attention should be focused on the youth who are less experienced in farming.

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GENDER INVOLVEMENT IN CLIMATE SMART AQUACULTURE VALUE CHAIN OF SOUTH WEST STATES, NIGERIA

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ABSTRACT

Climate change is predicted to significantly impact aquaculture production systems through an increase in mean temperature and changes in rain patterns. However, there is inadequate information on gender involvement in climate smart aquaculture production for most states in Nigeria. The study identified problems caused by climate change and assessed the extent of gender involvement in the climate smart aquaculture value chain of South West Nigeria. A multistage sampling method was used to select actors in the value chain of Catfish Farmers Association of Nigeria in Oyo and Lagos States. Producers and processors were sampled. Data analysis included descriptive statistics, t-test and multinomial logit regression. Results showed that men produced fish and women were more involved in processing. Climate smart aquaculture was recorded more by male fish farmers. There were significant differences in climate smart aquaculture between both states (p<0.05). Information on the pattern of climate smart technology on aquaculture value chain and gender roles in aquaculture would help integrate gender in the design, implementation and interventions of agriculture advisory services. Extension policies that fail to incorporate gender advisory services will negatively impact livelihoods and food security in the long run. Climate smart agriculture and extension advisory services that benefit women will enhance equal access to gender sensitive technologies.

1. INTRODUCTION

Nigeria is a country with tremendous aquatic and fisheries resources that makes significant contributions to livelihood, food security and the overall economy of the nation (Ipinjolu, 2014). In order to achieve sustainable development goals of eradicating extreme poverty and hunger and to ensure environmental sustainability, food security and fisheries development goal through climate smart aquaculture an adaptation to climate change will be necessary. This study discusses gender involvement in climate smart aquaculture as a veritable approach to increasing fish production in the face of climate change trends in Nigeria. Gender equality and equity are prerequisites to poverty eradication and sustainable development (Garside, 2006).

Change in climate over time is attributed directly or indirectly to human activities that alter the composition of the global atmosphere and which are due to natural variability observed over comparable time periods (IPCC, 2014). Climate change is predicted to significantly impact aquaculture production systems through an increase in mean temperature and changes in rainfall patterns. It has become a global issue in recent times manifesting in variations of different climate parameters such as cloud cover, precipitation, temperature ranges, sea levels and vapour pressure which have impacted on the environment and socio-economic systems of fish farmers (Fregene and Ogunnika, 2013).

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The elevated water temperatures affect fish physiological processes, thereby affecting spawning, survival of juveniles' "recruit into the exploitable phase of population", population size, production and yield (Tubiello, 2007). Due to reduction in fish yield, climate change can also reduce income at both the household and national levels (FAO, 2016). Climate change has been documented to threaten the livelihoods of approximately 200 million people and their families worldwide who live by fishing and aquaculture (FAO, 2016).

Climate smart adaptation and mitigation strategies aim to achieve the goals of increased productivity/food security, adaptation/resilience, and mitigation (CGIAR, 2016). Gender-responsive approaches to Climate Smart Aquaculture (CSA) means that the particular needs, priorities, and realities of males and females are recognised and adequately addressed in the design and application of CSA so that both men and women can equally benefit (Nelson, 2016). The gender gap in agriculture is a pattern, documented worldwide, in which women in aquaculture have less access to productive resources, financial capital and advisory services as compared to men (FAO, 2011).

1.1. Concept of gender and definition of terms

The concept of gender is used by sociologists to describe all the socially given attributes, roles, activities, and responsibilities connected to being a male or a female in a given society (March *et al.,* 2010). Gender identity determines how we are perceived, and how we are expected to think and act as women and men, because of the way society is organised. Gender relations are concerned with how power is distributed between the sexes. They create and reproduce systemic differences in men and women's positions in a given society. Gender relations define the way in which responsibilities and claims are allocated and the way in which each is given a value. It also varies according to time, place and between different groups of people.

Production in this study refers to the production of fish, fish products and services (pond construction) for income or subsistence. Both men and women perform productive works, but not all of these are valued or reward equally (March, 2010). Access to a resource refers to the opportunity to make use of a resource. Control over a resource is the power to decide how a resource is used, and who has access to it. The way in which resources are allocated between women and men often results in women having access but no control (March, 2010). Gender equality is a state in which women and men enjoy equal rights, opportunities and entitlements in civil and political life. It implies equal participation of women and men in decision making, equal ability to exercise their human rights, equal access to and control over resources, and the benefits of development, equal opportunities in employment and in all other aspects of their livelihoods (FAO, 2009).

1.2. Climate change in aquaculture

Climate change and its impacts in Nigeria have attracted the attention of the local scientists and international bodies. Some of the reports and publications which focus on the country include those of Okali (2004), Gwary (2005, 2010), Ajani (2009), DFID (2008) and FAO (2007). The World Meteorological Organisation (2014) reviewed the predicted changes in temperature and precipitation in the country from 2010-2014. It has become a global issue in recent times manifesting in variations of different climate parameters such as cloud cover, precipitation, temperature ranges, sea levels and vapour pressure. These have produced impact on the environment and socio-economic systems. They now constitute one of the most important environmental problems in fish farming (Fregene & Ogunnika, 2013).

Climate smart aquaculture is an approach to developing the technical, policy and investment conditions to achieve sustainable aquaculture development for food security under climate change. It integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing climate change challenges in aquaculture. It is composed of three main pillars; sustainably increasing aquacultural productivity and incomes, adapting and building resilience to climate change, and reducing and or removing greenhouse gas emissions where possible (Nelson, 2016).

Male and female aquaculture actors (fish farmers and processors) pursue separate but interrelated livelihoods and do incorporate different technology and production. Social norms and intra-household decision-making, may affect male and female participation in more sustainable aquaculture (Joet *et al*., 2015). The impact of climate change and related adaptive strategies are not gender neutral because vulnerability is often determined by socio-economic factors, livelihoods, people's capacity and access to knowledge, information, services and support.

2. METHODOLOGY

The study was carried out in southwest Nigeria. Southwest is one of the six geopolitical zones in Nigeria. It falls on latitude 6^o to the North and latitude 4^o to the South. It is marked by longitude 4^o to the West and 6^o to the East. It is bounded in the North by Kogi and Kwara States, in the East by Edo and Delta States, in the South by Atlantic Ocean, and in the West by Republic of Benin. The climate is tropical with distinct wet (rainy) and dry seasons with relatively high humidity. The dry season lasts from November to March while the wet season begins in April and ends in October. The mean annual rainfall is 1480 mm with a mean monthly temperature range of $18\text{-}24^o$ C during the rainy season and from $30\text{-}35^o$ C during the dry season. Southwest Nigeria covers an area of approximately 114, 271 km^2 that is, approximately 12% of Nigeria's total land mass and the vegetation is typically rainforest. The total population is 27, 581, 992 as it stood in 2006 and they are mainly farmers. The climate in the zone favours the cultivation of crops like maize, yam, cassava, millet, rice, plantains, cocoa, kola nut, coffee, palm produce, cashew and fish production (Oni, Oladele and Oyewole, 2005).

A multistage sampling method (States, Agricultural Development Project Zones and Local Government Authorities) were used to select fish farmers in Oyo and Lagos States from South West Nigeria. Proportionate stratified sampling was used to select 303 fish farmers from membership lists of Lagos State Catfish Farmers Associations (LACAFA) and Oyo State Catfish Farmers Association of Nigeria (CAFAN) and 101 processors. Primary data were collected through in-depth interviews, focus group discussions and questionnaire. Climate smart aquaculture involvement was computed using a transformed score of 7 items on the interval scale of measurement. Data were analysed using SPSS version 20.0. Statistical analyses conducted include descriptive statistics, t-test and multinomial logit analysis.

3. RESULTS AND DISCUSSION

This section presents the overall outcomes of the data analysed on gender involvement in climate smart aquaculture among fish farmers and processors. Presented in Table 1, are the perceptions of climate change by fish farmers and processors. This shows that 22.7% of males perceived climate change as long duration of hot season than compared to 21.0% of females. This may be as a result of more involvement of males in fish farming activities compared to females. Females (29.3%) perceived it as change in time of rainfall. Incidences of flooding was also perceived by 21.0% of females. Other variables of climate change indicated that males had more perception compared to females. This gender differences in te perceived variables of climate change could be attributed to less access to climate information experienced by female respondents, which is in line with the findings of Twyman *et.al.* (2014).

Table 1: Perception of climate change among fish farmers and processors

Variables	Gender			
N=404	Male (n=247)	Percent (%)	Female (n=157)	Percent (%)
High temperature	25	10.1	6	3.8
Long duration of hot season	56	22.7	33	21.0
Change in time of rainfall	64	25.9	46	29.3
High velocity wind	36	14.6	10	6.4
Increased incidence of flooding	36	14.6	33	21.0
High intensity of sunlight	30	12.1	29	18.5
Total	**247**	**100**	**157**	**100**

Table 2 indicated that 98.0% and 93.6% of the male and female population respectively were of the opinion that adopting improved aquaculture management and reducing post-harvest losses will help to reduce the effect of climate change on aquaculture sector as indicated by 90.7% and 88.5% of male and female respondents. Results show that replanting mangroves in aquaculture areas in Lagos and Oyo States will mitigate against climate change.

Table 2: Mitigation factors

Variables	Gender		
N=404	Male Freq (%)	Female Freq (%)	Total (%)
Reducing emission	156 63.2	95 60.5	62.1
Adopting improved aquaculture management	242 98.0	147 93.6	96.3
Avoiding or displacing emission	188 76.1	105 66.9	72.5
Reducing post-harvest losses	224 90.7	139 88.5	89.9
Use of fishing practices that adhere to principles of the code of conduct for responsible fisheries	206 83.4	142 90.4	86.1
Replanting mangroves in aquaculture area	189 76.5	107 68.2	73.3
Use of an innovative risk financing instruments and insurance schemes to reduce climate-related risks	222 89.8	133 84.7	87.9

Table 3 revealed that there were gender differences in the level of involvement in climate smart aquaculture. Males were generally more involved than their female counterparts. According to the study, male fish farmers and processors (60.0%) perceived that sustainably increasing aquaculture productivity to support equitable increases in incomes, food security and development are approaches to climate change while 40.0% of females agreed with the findings. Reintroduction of social protection initiatives was perceived as an effective climate smart aquaculture involvement by 58.9% of men and 41.1% of women. In a study by Adelekan and Fregene (2014), only 37% and 45% of men and women respectively belong to livelihood groups, while 49% and 41% of men and women respectively belong to social groups. Males (59.4%) and females (41.6%) adapted and built resilience to climate change from the farm as effective practices to support climate smart aquaculture production in the South-West Nigeria. It corroborates the findings of Ayoade (2014). Further, 58.7% and 41.3% of males and females respectively are of the opinion that managing climate risk policy with agencies will enhance sustainable aquaculture production which is in line with Birkmann (2015) and Green (2015).

Table 4 shows that participants in Lagos State reported significantly (p<01) higher involvement in climate smart aquaculture involvement compared to Oyo State. This finding was in line with the observational report by Nelson and Huyer (2016) that discovered differences in responsive approaches to climate smart agriculture due to temperature and precipitation data showed significant difference between Lagos and Oyo States.

Table 3: Climate smart aquaculture involvement

Variables	Gender	
N=404	Male Freq (%)	Female Freq (%)
Building response capacity and effective conservation of genetic resources	194 59.0	135 41.0
Managing climate risk policy with agencies	202 58.7	142 41.3
Disaster risk assessment and management	163 58.6	115 41.4
Sustainably increasing aquaculture productivity to support equitable increases in incomes, food security and development;	204 60.0	136 40.0
Reintroduction of social protection initiatives	188 58.9	131 41.1
Adapting and building resilience to climate change from the farm to national level	196 59.4	134 40.6
Use of an innovative risk financing instruments and insurance schemes to reduce climate-related risks	191 59.1	132 40.9

Table 4: T-test for state difference in climate smart aquaculture

State	N	**Mean**	**SD**	**SEM**	**df**	**T**	**P**
Oyo	198	.34	.476	.034	402	3.555	<.001
Lagos	206	.93	.393	.027			

(*** Mean difference is significant at 0.001)

Results in Table 5 indicate the model design for predicting climate smart aquaculture involvement by gender and state. State was significant (P<.001), while significant gender differences in climate smart aquaculture

(P<.05) exist among fish farmers and fish processors in South-West Nigeria. Females were not as involved in climate smart aquaculture as compared to males. This implies that fish farmers' involvement in climate smart aquaculture differs by gender and state. This finding is supported by the report of Gwary (2010) and gender differences in aquaculture business and climate change adaptation activities as found in Ipinjolu, Magawata and Shinkafi (2014).

Table 5: Summary of Multinomial Logit showing gender and state as predictors of climate smart aquaculture involvement in South-West Nigeria

Effect	Reduced Model	Chi-Square	Df	B	SE	Sig
Intercept	19.018[a]	.000	0	1.230	213	
Gender	22.332	3.314	1	.460	.256	.023*
State	27.359	8.341	1	-.689	.241	.004**
Profit	384.605	168.41	147	37.07	.324	.009*
Income	218.022	1.826	2	.180	.446	.401

** P<.001	, * P<.05	

Logit Model Specification:

$Y = B_0+X_1B_1+X_2B_2+X_3B_3+X_4B_4$

Y= Climate Smart Involvement

B_0= Intercept

X_1=Gender

X_2=State

X_3=Profit

X_4=Income

4. CONCLUSION AND RECOMMENDATIONS

This study found gender differences in the climate smart aquaculture involvement and practices which confirmed that males mostly engage in climate smart aquaculture particularly in fish farming while fish processing is predominant among females within South-West, Nigeria. Fish farmers and processors in Lagos State practiced climate smart aquaculture adaptation strategies more than those in Oyo State. However, the rationale for the observed differences could be linked to geographical and economic justifications.

If fish farmers were to achieve optimum climate smart aquaculture advantages, certain conditions must be put in place. These include adoption of improved aquaculture management practices, reducing post-harvest losses and replanting mangroves in aquaculture areas. In order to support female and male equity in uptake and benefit derived from climate smart aquaculture, equal participation and engagement of male and females are important actions to be taken at the outset of any climate smart aquaculture intervention. The transition to CSA will need to take place at all levels (individual, business, community, national and regional) and time scales. Furthermore, awareness programmes on climate smart aquaculture practices should be created and regularly reinforced to increase sustainability of aquaculture production in Nigeria. Thus, a gender involvement approach will achieve more effective and equitable outcomes, reduce project risks, and reduce the gender gap in outcomes.

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INTEGRATING AGRICULTURAL VIDEOS IN RURAL EXTENSION AS TOOLS TO ENHANCE CLIMATE SMART AGRICULTURE IN CAMEROON

Labu, N. B.[19] & Ngouambe, N.

1. INTRODUCTION

The agricultural sector plays a fundamental role in the economy and society of most African countries in the Sub Saharan Africa, with the government placing a lot of importance on the sector (Dewbre and Borot de Battisti, 2008). More than in any other sector, improvements in agricultural performance have the potential to increase rural incomes and purchasing power for large numbers of people to lift them out of poverty (Ludi, 2009).

Agriculture in developing countries must undergo a significant transformation in order to meet the related challenges of achieving food security and responding to climate change (FAO, 2010). A lot has been done in the improvement of the agricultural sector through various innovations and technologies in order to cope with the growing population and the changing climate (Dana, 1969). However, most estimates indicate that climate change is likely to reduce agricultural productivity, production stability and incomes in some areas that already have high levels of food insecurity. Developing climate smart agriculture is thus crucial to achieving future food security and climate change goals (FAO, 2010).

A lot has been done to improve on the strategies for extension over the years in order to cope with the changing climate and increasing population. But in these efforts women who are a fundamental part of this struggle to feed the growing population in most cases are often left out, meanwhile their contributions to the well-being of the family cannot be overemphasised. In this regard, new extension strategies need to properly involve the women and youths for better enhancement of climate smart agriculture especially through the use of agricultural videos.

1.1. The purpose of this paper

Due to the major role women in Cameroon and youths play in the development of the agricultural sector, teaching them to integrate climate smart agricultural practices in order to cope with feeding the growing population is primordial. This will help preserve the environment especially the soils for future generations and improving yields on the available farmlands knowing that agriculture is the key to food security. This paper is therefore aimed at bringing a plus to rural extension in Cameroon through the use of agricultural videos in order to tell the experiences and success stories of others in a changing climate to the women and youths who generally have very limited means to cope with the exigencies.

2. METHODOLOGY

Data used for this study was mainly through focused group discussions on the perceptions of women and youths on climate smart agriculture. These group discussions that gave us this information was carried out through an ongoing project that is aimed at bringing solutions to the agricultural problems of women and

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youths through the use of agricultural videos. However, some videos on climate smart agriculture and other success stories of other farmers were projected to the farmers. Some of the videos watched included, 'Sustainable management of soils in Sub-Sahara Africa', 'How to make money', and 'How to fight against striga in order to improve soil fertility'.

3. RESULTS

About 104 women and youths were reached in group discussions and even individual discussions. The different videos mentioned in the methodology were visualised by this population. By the end of the video projections, approximately 95% of the sample were very impressed as the different methods to cope with climate smart agriculture and improve yields were clearly seen by the women and youths who were very excited and desired to have more of such video projection sessions. A good number of them promised to inform their friends to see successes of agriculture. This will enhance production, environmental protection and measures to fight against environmental pollution.

4. CONCLUSIONS AND EXTENSION IMPLICATION

Many women are reached through different topics aimed at solving their problems within a very short period of time at a lesser cost than when an extension agent has to move from one region to the other for the same topic. Different varieties of crops were projected to solve cultivation problems, different post-harvest management technologies and proper marketing of farm produce, soil management and rational use of farm inputs and fertilizers.

The extension implication of this paper is that agricultural videos can be integrated in the extension approach of Cameroon in order to enhance climate smart agriculture and consequently better yields and better environmental and soil management.

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OUTCOMES OF ASSESSMENT OF THE NUTRITIONAL STATUS OF CHILDREN FROM HISTORICALLY DISADVANTAGED AGRI-BUSINESS FAMILIES, SOUTH AFRICA (*A challenge for a responsive agricultural extension function*)

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ABSTRACT

Introduction: *In the South African context, little is known of the nutritional status of children of historically disadvantaged agri-business smallholders. Instead, they are presumed of having elevated nutritional status by virtue of being dependants of food producers. The narrow scope of agricultural extension services that support food security initiatives echoes this presumption.* ***Objective:*** *This study sought to evaluate the nutritional status of children from historically disadvantaged agri-business families.* ***Methods:*** *The study's purposeful sample comprised of 263 agri-business households that generated an annual turnover of \$11 811 - \$39 370, and 327 children aged 5-14 years. A 3-day 24h dietary recall method was administered, and questionnaires were used to assess the households' socio-economic status, and the caregivers' nutritional knowledge, and practices. Food models and Foodfinder III nutritional software were used to improve the accuracy of recorded food quantities. The Statistical Package for Social Sciences, version 20, was used to perform descriptive, inferential and non-parametric statistical analyses.* ***Results:*** *Generally, the caregivers had good nutritional knowledge, but their households' feeding practices were modest. The majority of their households had a monthly non-farm income of \$78.82 - \$118.11 (32.9%), and monthly food expenditure of \$55.20 - \$70.87 (23.2%). The average annual farm income payable to each agri-business smallholder was \$2 903. The mean food variety score (FVS) was low at 23.431±7.89, while the mean dietary diversity score (DDS) was debatably high at 7.82±4.53. The households' non-farm income was positively highly correlated to food expenditure (p<0.01). In turn, food expenditure had a significant influence on FVS (p<0.01) and DDS (p<0.05). The majority of children had normal weight-to-age (80.14%), normal height-to-age (90.7%) and normal body mass index-for-age Z-scores (56.57%). However, the risk of overweight, the actual overweight and obesity were a concern as they were evident among 36.39%, 6% and 8% of the children, respectively.* ***Conclusion:*** *Notwithstanding their good nutritional knowledge, the agri-business families consumed meals that were predominantly carbohydrates-based and had low FVS and debatably high DDS. The majority of children had normal anthropometric dimensions that were indicative of good nutritional status. However, overweight / obesity appeared a creeping problem than is stunting and wasting. The responsibilities of extension practitioners in advancing food and nutrition security should include nutrition education.*

Keywords: Nutritional Knowledge, FVS, DDS, Anthropometric parameters, Nutritional Status, Children.

1. BACKGROUND

Since the dawn of the democratic South Africa in 1994, the subject of food security has received serious attention in many civil society, academic and government circles. This attention which led to the formulation of South Africa's Integrated Food Security Strategy (IFSS) [1] was prompted by the dire need to address food

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insecurity concerns of many previously disadvantaged families, particularly those who reside in poverty-stricken rural areas of South Africa. Accordingly, the Extension Recovery Plan of 2008 was hatched by South Africa's Department of Agriculture in order to strengthen the capacity of the country's agricultural extension practitioners with a view to providing effective support to the implementation of IFSS, among many pressing imperatives.

Subsequent to the inception of the IFSS, the country introduced a number of food security-based agricultural programmes that sought to benefit mainly the previously disadvantaged smallholder agri-business families. A number of local food security studies were conducted on these smallholder families. However, many of them tended to put either little emphasis or none on the nutrition facet of food security [2, 3, 4, 5,6]. Instead, children of smallholder farmers are presumed having an elevated nutritional status by virtue of being dependants of food producers. Indeed, the narrow scope of agricultural extension services that are rendered in order to advance the South African inhabitants' food security status bears testimony to the presumption referred to above. One's food security status is no guarantee to achieving good nutritional status. Nevertheless, in other parts of the world, the nutrition dimension of food security receives due attention [7] Research in the nutrition facet covers indicators of nutritional status such as food variety and dietary diversity [8, 9], and anthropometric parameters [10, 11]. These indicators formed part of the investigation in the current study.

In the light of the above gaps, this study sought to make an investigation into, namely; the nutritional status of children from historically disadvantaged agri-business families, and key socio-economic attributes that influence the children's nutritional status.

2. METHODS

2.1. Study population and sampling

The study population was agri-business families who operate and reside in Umzimvubu and Ntabankulu Local Municipalities of Alfred Nzo District Municipality in the Eastern Cape Province, South Africa. Specifically, it targeted previously disadvantaged smallholder agri-business families whose individual or collective annual turnover is between $11 811 and $39 370. All families who met this criterion were purposefully selected from a farmer database that was made available by local agricultural extension officers. Subsequent to the exclusion of survivalist farming families (annual turnover less than $11 811), this study included the whole remaining purposeful research sample of 263 agri-business families, and 327 children aged 5-14 years. From each of the 263 farming households, questions that relate to nutritional knowledge, attitudes and feeding and general care of children were directed to caregivers who lived in these households.

2.2. Research methods

2.2.1. Socio-economic and nutrition questionnaires

Questionnaires were used to assess the caregivers' socio-economic status and feeding practices. A 24h dietary recall questionnaire was administered twice in weekdays and once in weekends. Food models and the internationally acclaimed Foodfinder III nutritional software of the Medical Research Council of South Africa were used to improve the accuracy of recorded food quantities.

2.2.2. Anthropometric measurements

The researcher and fieldworkers received training from public health workers on measurement of weight and height of the caregivers' children in order to determine anthropometric measurements. Accordingly, a calibrated electronic scale was used to measure weight. All the children were weighed with their shoes and socks being removed, and with their light clothes put on. Two weight readings were taken within the nearest 0.1kg, and the average of the two readings was recorded if the two readings were different. Height was measured with a stadiometer, with vertical scale of metres and a sliding headpiece, to the nearest 0.1cm. Children had to put their legs and knees straight together with arms aside, and feet and heels touching together. As with weight, two measurements were taken, and the average recorded if the two measurements were different.

Weight and height recordings were captured on Excel, and the following anthropometric measurements determined on WHO Anthro V3.2.2 and AnthroPlus V1.0.4 softwares, namely; weight-for-age Z-scores (WAZ), height-for-age Z-scores (HAZ) and body mass index-for-age Z-scores (BMIZ). WAZ, which is measured in children that are younger than nine years**Error! Bookmark not defined.** was confined to 146 children aged 5-8 years in this study. MBIZ was calculated as, weight/height^2. The classification of the children's Z-scores of WAZ, HAZ and BMIZ was done in accordance with WHO [12].

2.3. Data analysis

Data was cleaned and statistically analysed using Statistical Package for Social Sciences (SPSS), Version 20. Descriptive statistics was performed to establish central tendencies. Non-parametric Kruskal-Wallis H test was conducted in order to elucidate the outcomes of the parametric tests, and a bivariate correlation analysis was conducted to describe relationships between variables.

2.4. Ethical considerations

The researcher obtained consent from the caregivers to conduct the study. Their right to anonymity, confidentiality and fair treatment was respected. This study also upheld scientific integrity.

3. RESULTS

3.1. Socio-economic information

3.1.1. Demographic characteristics

Most of the caregivers who participated in this study were women (n=250, 94.95%), the majority of which were aged 36-40 years (n=54, 20.5%), followed by those aged 46-50 years (n=36, 13.7%). Their children were aged 5-14 years, the majority of which were male (n=177, 45.13%). The caregivers' level of education was low; the majority having acquired Grade 8-11 (n=66, 25.1%), while some never had any formal education (n=41, 15.6%). Most caregivers permanently lived with 4-6 persons (n=109, 41.4%), while the majority (n=143, 55.4%) had no employed family members among those that they permanently live with.

3.1.2. Economic characteristics

The main sources of non-farm income of households were wages / salaries of employed family members, government social grants and remittances. The households had a modest monthly non-farm income; the majority earning \$78.82 - \$118.11 (n=85, 32.9%). A minimum monthly non-farm income of \$39.37 - \$78.74 was earned by 21.3% of the households, while a maximum of more than \$196.85 (19.8%) was earned by 19.8%. Monthly non-farm income was positively strongly correlated to food expenditure (r=0.55, p<0.01).

The farming activities of the agri-business smallholders were not intense, often characterized by low yields and productivity due to use of out dated farming methods and poor infrastructure base. The majority of the smallholders (n=236, 89.73%) co-owned and / or co-managed their agri-business units in groups; the average size of a group being four people. The average annual farm income payable to each agri-business smallholder was \$2 903. However, in their homesteads the agribusiness smallholders kept some livestock and grew crops which were used for home consumption, mainly.

3.2. Nutritional knowledge

In the current study, the caregivers' nutritional knowledge was assessed on areas of namely; breakfast patterns, frequency and variety of meals consumed per day, and ability to judge their children's basic anthropometric conditions.

3.2.1. Breakfast eating patterns

In this study, caregivers were asked some opinion seeking questions on breakfast eating patterns, the responses of which are captured in Table 1. When asked for an opinion on whether it is a good nutritional practice to provide breakfast to their children before they go to school or church, the majority of the caregivers responded in the `affirmative' (n=227, 86.3%), while a few (n=8, 3.%) said such practice was not good.

Subsequently, the caregivers were asked if it is economically difficult to provide breakfast to their children before they go to school or church. Most caregivers acknowledged such economic difficulty (n=153, 58.2%), while 106 (40.3%) said it was not difficult. Commonly mentioned sources of economic difficulties in providing breakfast included; expensive electricity, and expensive food materials that make a nutritious breakfast.

With respect to the frequency of providing breakfast to their children, about half of the caregivers (n=132, 50.2%) said the provision of breakfast is made every day of the week, followed by those who reportedly provided breakfast four to six times a week (n=82, 31.2%).

Table 1: Caregivers' opinion in providing children with breakfast

Characteristics	Frequency (n=263)	Percentage (%)
IS PROVISION OF BREAKFAST A GOOD PRACTICE?		
Good	227	86.3
Not good	8	3.0
Do not know	28	10.6
IS IT DIFFICULT TO PROVIDE BREAKFAST?		
Difficult	153	58.2
Not difficult	106	40.3
Do not know	4	1.5
FREQUENCY OF PROVISION OF BREAKFAST		
Every day	132	50.2
4-6 times per week	82	31.2
1-3 times per week	26	9.9
Never	23	8.7

3.2.2. Frequency and diversity of meals

A similar line of questions was posed to the caregivers regarding their opinion on the practice of providing their children with three meals a day and a snack in between. To this end, many said this was a good practice (n=222, 84.4%), while the rest reported either `not good' (n=10, 3.8%) or `do not know' (n=31, 11.8%). Those who responded in the affirmative felt that this nutritional practice would make their children; grow fast and perform well at school. In reality, a smaller number of caregivers (n=104, 39%) said they are affording to provide their children with three meals a day and snacks in between, while the rest (n=159, 60.5%) indicated that they are not affording.

This study also sought to make a brief assessment of nutritional knowledge and attitudes of the caregivers on the importance of providing their children with different types of meals. When asked to share their opinion on this nutritional practice, the overwhelming majority said this practice was good (n=244, 92.8%), followed by those who said they `do not know' (n=10, 3.8%) [Table 2]. The commonly cited reasons given for providing different types of meals were; children do get tired of eating the same food all the time, and different meals provide a wide range of nutrients that are needed by the body Notwithstanding the above responses on the diversity of meals, more than half of the caregivers (n=139, 52.9%) said in reality it was difficult to provide their children with different types of foods (Table 2). Cited causes of this difficulty were; expensive prices of food, and unavailability of some foodstuffs in the local shops.

Table 2: Caregivers' opinion on the practiceof providing children with three meals per day, and a snack in between.

Characteristics	Frequency (n=263)	Percentage (%)
IS IT A GOOD PRACTICE?		
Good	222	84.4
Not good	10	3.8
Do not know	31	11.8
IS IT A DIFFICULT PRACTICE?		
Difficult	138	52.5
Not difficult	125	47.5
IS PROVISION OF VARIETY IN MEALS A GOOD PRACTICE?		
Good	244	92.8
Not good	10	3.8
Do not know	9	3.4
IS PROVISION OF VARIETY IN MEALS A DIFFICULT PRACTICE?		
Difficult	139	52.9
Not difficult	124	47.1
Do not know	0	0

3.3. Food intake, food variety and dietary diversity

Table 3: Top 20 most consumed food items

Rank	**Food item**	**Mean food intake (g/person/day)**
1	Maize meal soft porridge	99.23±74.56
2	Instant tea	182.14±131.38
3	White sugar	19.99±7.05
4	Maize meal stiff *pap*	123.49±72.79
5	Brown bread/rolls	27.58±30.81
6	Amarhewu	176.78±174.66
7	Crumbed maize meal (*uphuthu*)	107.67±105.07
8	Fresh milk	21.85±26.34
9	Potatoes	21.38±14.34
10	Samp	156.63±139.91
11	Rice	64.86±36.03
12	Sour milk	128.57±118.77
13	Carrot	14.28±10.94
14	Baked bread, homemade	49.16±50.43
15	Cabbage	10.64±12.47
16	Spinach	10.17±14.89
17	Onion	8.78±11.74
18	Sunflower oil	23.85±32.99
19	Canned fish	13.66±17.56
20	Chicken	33.81±39.95

3.3.1. Food intake

Table 3 presents a summary of top 20 most consumed food items by the caregivers' children during the 3-day 24h dietary recall. Noticeably, the carbohydrates-rich food items from the `cereal, roots and tubers' group dominated the top 10 most consumed foods. From the `flesh' and `dairy products' groups, only canned fish and chickens, and fresh milk and sour milk, respectively, appeared in the list of top 20 most consumed foods items. Only carrots and spinach from the `vitamin A-rich vegetables and fruits' group, and cabbage and onion from the `other vegetables' group appeared in the list presented in Table 3, while sunflower oil represented the `fats and oils' group. Food groups whose food items did not feature in the list in question were `eggs', `legumes and nuts', and `other fruits and juices' groups.

This study also found that consumed quantities of food items varied widely within and between households, largely due to the varying socio-economic profiles of the caregivers' households. Consumed quantities of food items from other food groups were rather low (e.g. dairy products, vegetables, and flesh foods). Again, this appeared a function of socio-economic properties of the caregivers' households, which have been discussed earlier in this paper.

3.3.2. Food variety and dietary diversity

The average FVS for the 263 investigated households was low at 23.43 (see Table 4). Most of the caregivers' households (n = 215; 81.7%) had a low FVS, followed by those with a medium FVS (n = 48; 18.3%). None of the households had a high FVS category (see Fig. 1).

Regarding dietary diversity, most of the caregivers' households (n = 88; 33.5%) consumed foods from eight food groups, followed by those (n = 71; 27.0%) who consumed foods from all nine foods groups. Three food groups were the lowest number consumed (n = 5; 1.9%). The mean dietary diversity score (DDS) was 7.82, which is indicative of a high DDS. The majority of the caregivers' households (n = 184; 70%) had high DDS (see Fig. 2), followed by those with medium DDS (37.2%) and low DDS (8.2%).

Table 4: Food variety scores within food groups

Food Group	**Mean**	**SD**[21]	**Range**
Cereal, roots and tubers	5.05	0.89	3-7
Fleshy foods	3.22	1.08	1-5
Dairy products	1.97	1.14	0-6
Legumes and nuts	1.00	0.58	0-3
Eggs	0.38	0.49	0-1
Vitamin A-rich vegetables and fruits	3.06	1.20	0-5
Other fruits and juices	2.85	1.93	0-8
Other vegetables	4.03	2.48	0-11
Fats and oils	1.86	0.86	0-4
Total Food Items	**23.43**		

[21] SD: Standard Deviation

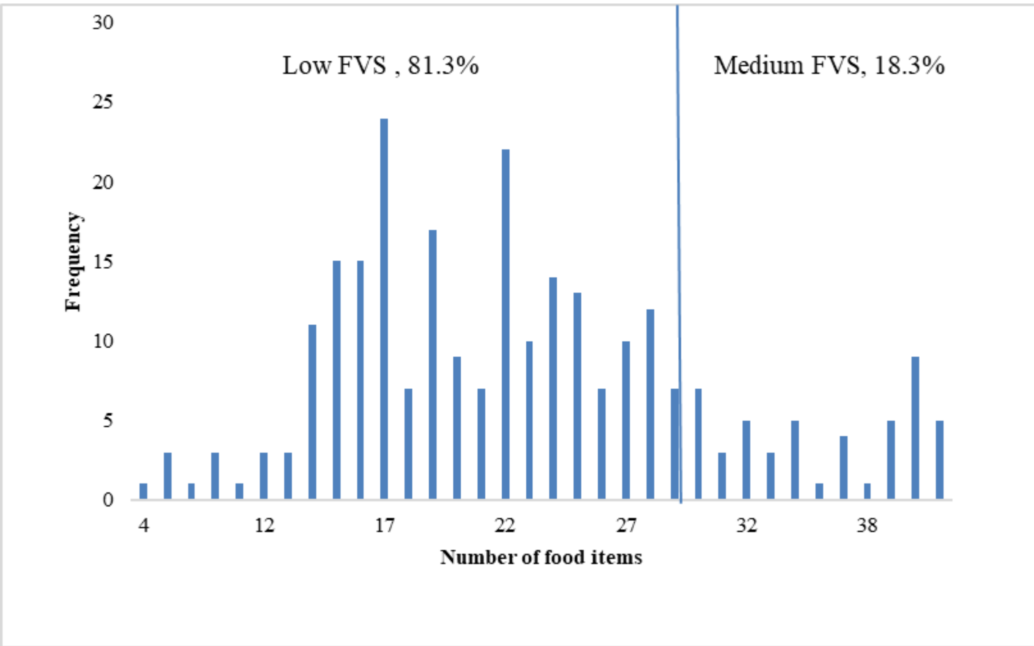

Figure 1: Distribution of food variety scores (FVS) from the caregivers' households

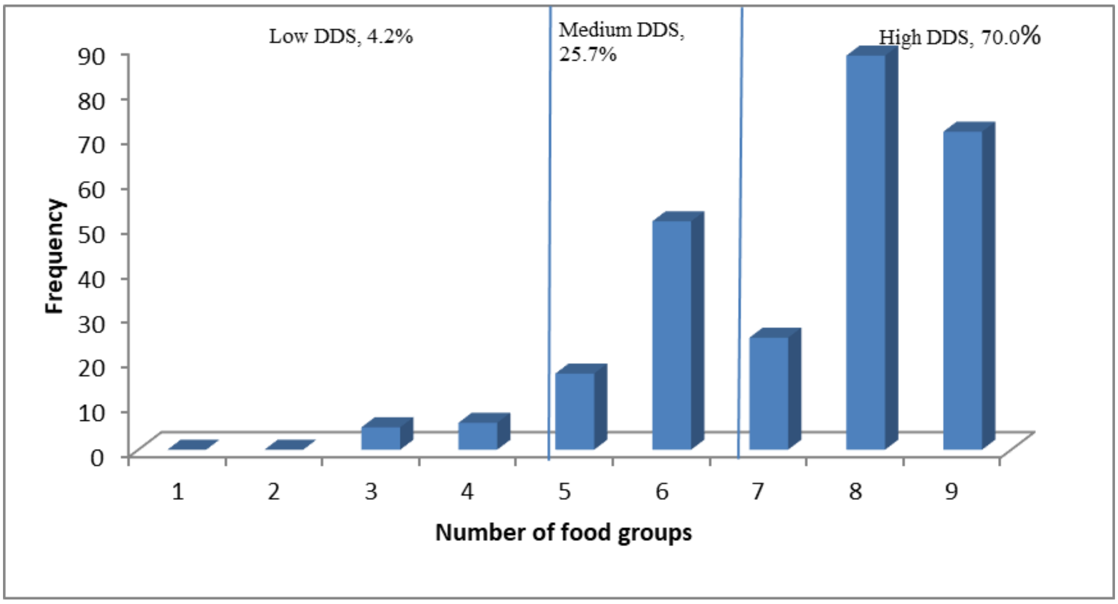

Figure 2: Distribution of dietary diversity scores (DDS) from the caregivers' households

3.4. Anthropometric parameters

3.4.1. WAZ, HAZ and BMIZ

As indicated earlier, the measurement of WAZ was limited only to 146 children of 5-8 years of age. Of these children, the majority (80.14%) had normal WAZ (<-1SD to <0SD), while the remaining minority (19.86%) were underweight (≥-3SD to <-2SD) [Table 5]. The prevalence of underweight was higher among male children than in their female counterparts (p≤0.05).

Of the 327 children who were subjected to the HAZ measurement, the overwhelming majority (90.70%) had normal HAZ (>-1SD to +3SD). The rest who were stunting (<-2SD), particularly female children ($p \geq 0.05$).

The measurement of BMIZ was also extended to all 327 children. Over half (56.57%) of the children included in this study had normal BMIZ (>-2SD to <+1SD), and a very small proportion (0.92%) was wasting (<-2SD to >-3SD). Of concern was a creeping problem of over-nutrition. To this end, 36.39% of children were at risk of overweight (>+1SD to <+2SD), while 6% and 8% were overweight (>+2SD to <+3SD) and obese (>+3SD), respectively. Noticeably, female children were heavier than their male counterparts of the same age ($p \geq 0.05$).

The caregivers were given an opportunity to visually appraise the body condition of their children in a scale of underweight, normal weight, overweight and obese. In their responses, most of the caregivers rated the weight of their children as normal (n=221, 84%), followed by those who rated them underweight (n=29, 11%), overweight (n=1, 0.4%) and obese (n=12, 4.6%).

Table 5: Summary of anthropometric characteristics of the children under study

Classification	**Z-score**	**Gender**		**Total**
		Male	**Female**	
WAZ[22] (n=146)				
Severely underweight	<-3SD	0	0	0
Underweight	≥-3SD to <-2SD	17 (17.71%)	12 (24.00%)	29 (19.86%)
Normal WAZ	<-1SD to <0SD	79 (82.29%)	38 (76.00%)	117 (80.14%)
HAZ[23] (n=327)				
Severely stunting	<-3SD	0	0	0
Stunting	<-2SD	13 (7.34%)	17 (11.33%)	30 (9.30%)
Normal HAZ	<-1SD to +3SD	164 (92.66%)	133 (88.67%)	297 (90.7%)
BMIZ[24] (n=327)				
Severely wasting	<-3SD	0	0	0
Wasting	<-2SD to >-3SD	2 (1.13%)	1 (0.67%)	3 (0.92%)

[22] WAZ: Weight-for-age
[23] HAZ: Height-for-age
[24] BMIZ: Body mass index-for-age Z score

Normal BMIZ	>-2SD to <+1SD	117 (66.10%)	68 (45.33%)	185 (56.57%)
Risk of overweight	>+1SD to <+2SD	52 (29.38%)	67 (44.67%)	119 (36.39%)
Overweight	>+2SD to <+3SD	2 (1.13%)	6 (4.00%)	8 (2.45%)
Obese	>+3SD	4 (2.26%)	8 (5.33%)	12 (3.67%)

3.4.2. Factors affecting nutritional status

Hypothetical tests were conducted on key factors that were deemed influential in the children's anthropometric parameters, namely; WAZ, HAZ and BMIZ. These key factors were monthly non-farm income, monthly food expenditure, farm income, and the caregivers' level of education and breakfast patterns. As shown in Table 6, all these key factors, with the exception of breakfast patterns, had an influence ($p \leq 0.01$) on the children's WAZ, HAZ and BMIZ. The influence of breakfast patterns on the children's anthropometric parameters was rather non-significant ($p \geq 0.05$).

4. DISCUSSION

The size of the caregivers' households was investigated, because of its potential effect on the nutritional status of habitants of the households. It was found comparable with the average size of households of 3.7 and 3.9 at Alfred Nzo District and Eastern Cape Province, respectively **Error! Bookmark not defined.**. Also comparable w as the unemployment rate among adult habitants of the studied households. Nutritional knowledge can play a pivotal role in determining one's feeding behaviour and nutritional status [13]. Generally, the caregivers were found to have good knowledge and attitudes towards various aspects of human nutrition such as the importance of eating breakfast, the ideal number of meals a child should have a day, and the importance of food variety. However, Shakkour [14] cautioned that good nutritional knowledge and attitudes do not automatically lead to good nutritional practices. In many instances good nutritional practices are hindered by socio-economic constraints such as employment, poverty, and a large number of dependents [15]. Indeed, in this study, the caregivers' feeding practices were not as good as their nutritional knowledge and attitudes. This observation was clear right from their provision of the first meal of the day – breakfast. Half of the caregivers could not provide their children with breakfast before they go to school or church. Skipping breakfast is not a good nutritional practice, because of its association with poor performance of children at school and numerous health risks [16, 17, 18]. In order to narrow the identified gap between nutritional knowledge and nutritional practices, the scope of rendered extension services in advancing food security should be reviewed accordingly. Such a scope should be responsive and nutrition-sensitive.

Table 6: Summary of results of Kruskal-Wallis H tests on the effect of various factors on anthropometric parameters

Nutritional status – WAZ, HAZ and BMIZ	**Monthly non-farm income**			**Monthly food expenditure**		
	df	**Chi-square**	**Asymp. Sig.**	**df**	**Chi-square**	**Asymp. Sig.**
WAZ	4	44.23	0.000**	8	40.12	0.000**
HAZ	4	43.18	0.000**	8	43.91	0.000**
BMIZ	4	42.82	0.000**	8	46.08	0.000**
	Monthly farm income			**Level of education**		
	df	**Chi-square**	**Asymp. Sig.**	**df**	**Chi-square**	**Asymp. Sig.**
WAZ	7	74.83	0.027*	5	14.27	0.010*
HAZ	7	71.21	0.038*	5	13.42	0.015*
BMIZ	7	69.82	0.045*	5	12.18	0.021*
	Breakfast feeding patterns					
	df	**Chi-square**	**Asymp. Sig.**			
WAZ	1	1.93	0.32			
HAZ	1	2.4	0.43			
BMIZ	1	1.60	0.20			

Consumption of breakfast makes an important contribution to a day's nutrient intake, yet skipping breakfast is a common practice among adolescents [19]. Parents have an important role to play in influencing their children's breakfast eating patterns [20]. Breakfast is one of many meals that were skipped by the caregivers' children understudy. Ideally, children aged 5-14 should have at least three meals a day and a snack in between [21]. However, in this study, only 39.5% of the caregivers' households could afford the above prescribed number of meals. Equally of concern is the quality of consumed meals in the face of the revelation that over half of the caregivers' households found it difficult to provide a variety of meals to their children. A wide variety of meals is likely to provide a wide range of nutrients that are necessary for a child's good nutritional status, health and performance at school. This view is widely held by many in the literature [22, 23, 24].

The caregivers' inabilities in providing a variety of meals to their children is reflected on their households' low FVS. Most the caregivers' households provided meals that were dominated by carbohydrates-rich maize products such as stiff *pap*, crumbed maize meal, samp and *amarhewu*, and wheat-based products such as steamed bread and baked bread. It was, therefore, not surprising that in this study the `cereal, roots and tubers' food group had the highest FVS. On the other hand, it is commendable that most of the caregivers' households had a conservatively high DDS. This high DDS came as a result of consumption of few food items on a wide range of the nine food groups. This eating pattern is unlikely to lead to adequate nutrient intake and good nutritional status due to exclusion of critically important nutrients in the feeding menu. A wide range of fruit, which provide a good source of minerals and vitamins, was either rarely consumed or not consumed in many households. Apples and citrus were two most consumed fruits, but their consumption was limited to approximately half of the 263 households that were included in this study. Consumption of bananas was expected to be high by virtue of the proximity of the studied population and local retail shops to banana plantations of the province of KwaZulu-Natal. Banana consumption was reported in only 28.57% of the caregivers' households. It appears that physical availability of this food item was not a problem, but its financial accessibility [25].

FVS and DDS which are indicative of the farming households' nutritional status, were influenced by a number of socio-economic factors. First and foremost, the caregivers' level of education had a significant influence on FVS ($p \leq 0.05$) than on DDS ($p \geq 0.05$). Probably, higher level of education of caregivers played a critical role in exposing them to good nutritional and caring practices for their children. Similar observations were also made by some authors [26, 27], while others could not find a relationship between parents' level of education and their children's nutritional status [28]. Further analysis of results showed that the caregivers' level of education had a significant effect ($p \leq 0.05$) on their households' monthly non-farm income and expenditure on food. The monthly non-farm income was positively strongly correlated to food expenditure ($r=0.55$, $p<0.01$). In turn, food expenditure had a significant influence on FVS ($r=0.672$; $p<0.01$) and DDS ($r=0.322$; $p<0.01$). These economic variables also had a significant influence on the anthropometric parameters of WAZ, HAZ and BMIZ which are also indicative of nutritional status. These findings on the economic variables (income and food expenditure) are similar to those reported in a survey that was conducted by ECSECC at Alfred Nzo District [29]. The survey found that most of the monthly expenditure is used to acquire non-durable goods like food, while very little is used to buy either durable or semi-durable goods. For example, in 2013 from a total household income of $811 million, $724 million was used in household expenditure. ECSECC concluded that this elevated household expenditure is symptomatic of poverty in the district, as high expenditure on non-durable goods does very little contribution to wealth creation.

With respect to anthropometric nutritional status, South African communities are reportedly sandwiched between malnutrition, and overweight / obesity [30]. In the current study, majority of children had good nutritional status, because they had normal WAZ, HAZ and BMIZ. Very few had low nutritional status through being wasted and stunted. However, among children aged 5-8 years, the prevalence of underweight was 20%, which is indicative of low nutritional status. In terms of the prevalence of various anthropometric conditions, this study found risk of overweight / overweight / obesity a more threatening problem than malnutrition is. Possibly, the high prevalence of these anthropometric conditions was caused by high consumption of carbohydrates-rich food items from the `cereal, roots and tubers' food group and lack of physical activity.

5. CONCLUSION

Whilst the caregivers were found to have good nutritional knowledge, in reality they followed modest feeding practices for their children. Their feeding practices were characterised by high consumption of carbohydrates-rich food items, low FVS and debatably high DDS which are indicative of low to moderate nutritional status. On the anthropometric scale, the majority of children had normal body weight which translated to a good nutritional status. Staple food production-based food security programmes need to be reviewed in favour of the nutrition dimension.

This study recommends diversification of food production and nutrition education as means to improving nutrition security / nutritional status of children from agri-business families. Furthermore, standard procedures and methods into assessing nutrition security / nutritional status should be used. Currently, many previously disadvantaged agri-business families are presumed food and nutrition insecure, and the awarding of government food production subsidies is based solely on this historical misfortune. This situation necessitates that agricultural extension practitioners take lead in providing nutrition education and awareness among farming communities. This should be done in collaboration with other sister state departments such as the Department of Health, and non-governmental organisations. There is also a need to evaluate nutrition security / nutritional status of families of relatively bigger and well-established agri-business owners / managers.

In recognition of this study's limitations, it is advisable that caution be exercised when generalising its findings to children from previously disadvantaged agri-business families outside the Eastern Cape Province as agricultural performance of agri-business units in other provinces may differ. Eating behaviour is also expected to vary, subject to socio-economic conditions.

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THE POTENTIAL OF INNOVATION PLATFORMS AND ICTs IN ENHANCING ADOPTION OF CSA INNOVATIONS IN SMALLHOLDER DAIRYING: EVIDENCE FROM ZIMBABWE

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ABSTRACT

Climate change models forecast an increase in temperature and drought conditions in Zimbabwe, with negative ramifications on smallholder dairying. Climate Smart Agriculture (CSA), which is designed to sustain increases in agricultural productivity and incomes, can enable farmers to adapt and build resilience to climate change. Based on a cross-sectional survey of 227 households in Rusitu and Gokwe dairy sites in Zimbabwe, this paper investigates the potential of innovation platforms and ICTs in enhancing the adoption of CSA innovations in smallholder dairying. Collected data were analysed using Multinomial Logit (MNL) regression. Survey results identified dairy herd size, the number of lactating dairy cows, stock type, participation in innovation platforms and ICT use as the statistically significant factors determining the adoption of CSA innovations such as artificial insemination and fodder production ($p < 0.01$). The results indicate a great potential for innovation platforms and ICTs in enhancing the adoption of CSA innovations in smallholder dairying. This provides valuable insights and lessons for extension and advisory services vis à vis approaches and strategies for scaling up CSA innovations.

Keywords: Innovation platforms, ICTs, climate smart agriculture, smallholder dairying, technology adoption, Zimbabwe.

1. INTRODUCTION

Climate change poses a severe threat to the attainment of sustainable food security, agricultural growth and development in Sub-Saharan Africa (FAO, 2010). In Zimbabwe, it threatens the country's inclusive growth agenda and poverty reduction efforts as poor and marginalized groups will incur the greatest burden (UNICEF, 2014; CRS, 2016). Climate change models forecast an increase in temperature, and a significant probability of drying conditions in Zimbabwe (Brown et al., 2012), with negative ramifications on key livelihood enterprises such as commercial smallholder dairying. Unlike other sectors, dairy farming both significantly contributes to and is affected by climate change. The sector is a major factor in greenhouse gas emissions, particularly methane, which contributes to climate change (Siemes, 2008; FAO, 2010). Climate change and variability also affects the availability and quality of water resources and pastures, and increases the prevalence of diseases, intensity of the heat load, as well as temperature and humidity-related discomfort in dairy animals (Kasulo et al., 2012; Zewdu et al., 2014; Kirui et al., 2015). These changes impact directly on feed intake, herd productivity, reproduction, net revenues, and dairy enterprise viability (Kirui et al., 2015; IFAD, 2017).

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Climate Smart Agriculture (CSA) innovations, which are designed to offset negative impacts of climate change and sustainably increase productivity and incomes, can also enable farmers to adapt and build resilience to climate change (Zougmore et al., 2016). However, despite the multiplicity of efforts underway to scale-up/out CSA innovations, constraints such as the lack of labour, capital and information on suitable fodders (Mutoko, 2014), the lack of access to adequate land, basic tools and equipment, skills, labour-saving technologies, rural energy, and transport have been acting as barriers (Barnard et al., 2015; Murray et al., 2016). This paradox creates immense demand for greater innovation. Literature reviews indicate that the adoption of CSA innovations can be enhanced by innovation platforms (Tefera et al., 2010; Makini et al., 2013; Duncan et al., 2015) and Information and Communication Technologies (ICTs) (Masuka et al., 2016; Tata & McNamara, 2016; Mutunga & Waema, 2016). However, grassroots evidence for this remains inadequate.

Literature also notes that, the smallholder dairy sector plays a critical role in sustaining the livelihoods of rural and often resource-poor Zimbabweans, as a source of food, income and employment (Hanyani-Mlambo et al, 1998). However, most of the existing literature on adoption of CSA innovations in smallholder dairying has been limited in both its conceptual and geographical focus. Very few studies have delved into the nexus between innovation platforms, ICTs and the adoption of CSA practices in Southern Africa (Kasulo et al., 2012; Tata & McNamara, 2016). Most other related studies have been restricted to Asia, Latin America, West and East Africa (Wambugu et al., 2014; Duncan et al., 2015; Tadesse & Bahiigwa, 2015; Zougmore et al., 2016; Khatri-Chhetri et al., 2017; Shikuku et al., 2017). This thus presents both a conceptual and practical knowledge gap.

This paper undertakes to explore the potential of innovation platforms and ICTs in enhancing the adoption of CSA innovations in smallholder dairying. Artificial Insemination (AI) and fodder production rank as some of the CSA innovations with the greatest potential of sustaining increases in dairy productivity and incomes, thereby enabling smallholder dairy producers to adapt and build resilience to climate change (Gauly et al., 2012; Zewdu et al., 2014; Wambugu et al 2014), hence the decision to focus on these two CSA innovations. The specific contributions of this paper are: (i) assessing socio-economic variables that are key for multinomial logit regression modelling, (ii) investigating the extent to which innovation platforms and ICTs contribute to the adoption of AI and fodder production in smallholder dairying.

2. RESEARCH METHODOLOGY

2.1. Study area description

In order to explore the nexus between innovation platforms, ICTs and the adoption of CSA practices the study targeted two smallholder dairy production project sites in Rusitu and Gokwe. The Rusitu smallholder dairy project is located about 440 kilometres east of Harare in Manicaland Province and falls within latitude 20^0 02’ S and longitude 33^0 48’ E. The scheme is located in agro-ecological region I, characterised by high rainfall, low temperatures, well-drained soils and provides a perfect environment for dairying. The Gokwe smallholder dairy scheme, on the other hand, is located 338 kilometres west of Harare in the Midlands Province and falls within latitude 18^0 13’ S and longitude 28^0 56’ E. The scheme is located in agro-ecological regions III and IV characterised by low rainfall, fairly severe mid-season dry spells and is, therefore, marginal for dairying.

2.2. Sampling procedure and sample size

Multistage sampling, a complex form of cluster sampling, was adopted to guide sampling for the household questionnaire survey. Rusitu and Gokwe were purposively selected as the two research sites given their contrasting characteristics and representativeness of the generality of smallholder dairy schemes in Zimbabwe. At the second stage, smallholder dairy farmers in both Rusitu and Gokwe were stratified on the basis of their level of participation in dairy innovation platforms. The household was then used as the unit of sampling during the third and final stage of sampling. At this stage and within the strata, a probability sampling method was used as the basis for selecting households included in the survey. A total of 227 households were sampled for the study. Of these, 100 households (44.1%) actively participated in smallholder dairy innovation platforms, while the remaining 127 households (55.9%) were not.

2.3. Field data collection

Primary data were collected through the use of desk studies, key informant interviews, focus group discussions, and a structured household questionnaire survey. The use of numerous data collection methods was deliberate since this is a way of triangulating collected data for purposes of verification, validation and improving the reliability of collected data (Babbie et al., 2001; Wagner et al., 2012). The formal household questionnaire survey collected data on household demographics, participation in innovation platforms, use of ICTs, asset ownership, livestock numbers and dynamics, dairy production and marketing, as well as access to livestock technology, inputs and support services. The questionnaire was pre-tested before use for purposes of ensuring that the study generates accurate, consistent, dependable and reliable data.

2.4. Analytical model: Multinomial Logit Regression Analysis

The decision on the methodological framework and econometric model used in this study depended on the research objectives and the hypotheses to be tested. Given that adoption decisions involve multiple options (*1=full adoption, 2=partial adoption,* and *3=non-adoption*), multinomial regression techniques were adopted to evaluate choice decisions. The precise methodology applied was the Multinomial Logit (MNL) regression with the objective of analyzing the determinants of farmers' choice decisions since this approach has been widely adopted for use in adoption studies involving multiple options (Hassan and Nhemachena, 2008; Joshi and Bauer, 2006; van Edig and Schwarze, 2012) and is usually simpler and produces more accurate results than other possible options such as Multinomial Probit (MNP) (Tse, 1987; Kropko, 2008). The main limitation of the MNL model is the independence of irrelevant alternatives (IIA) property, which postulates that the ratio of the probabilities of choosing any two alternatives is independent of the attributes of any other alternative in the choice set (Tse, 1987). Despite this weakness, as argued above, the model is still very useful and acceptable in analyzing decisions involving multiple choices.

The MNL model was applied as follows; let A_i be a random variable representing the adaptation measure chosen by any farming household. The researchers assume that each farmer faces a set of discrete, mutually exclusive choices of adaptation measures. These measures are assumed to depend on a number of climate attributes, socioeconomic characteristics and other factors X . The MNL model for adaptation choice specifies the following relationship between the probability of choosing option A_i and the set of explanatory variables X (Greene, 2003).

$$\Pr ob(A_i = j) = \frac{e^{\beta_j' x_i}}{\sum_{k=0}^{j} e^{\beta_k' x_i}}, \; j = 0,1.......J \qquad (1)$$

where β_j is a vector of coefficients on each of the independent variables X . Equation (1) can be normalized to remove indeterminacy in the model by assuming that $\beta_0 = 0$ and the probabilities can be estimated as:

$$\Pr ob(A_i = j | x_i) = \frac{e^{\beta_j' x_i}}{1 + \sum_{k=1}^{j} e^{\beta_k' x_i}}, \; j = 0,1,2......J, \beta_0 = 0 \qquad (2)$$

Estimating equation (2) yields the J log-odds ratios

$$\ln\left(\frac{P_{ij}}{P_{ik}}\right) = x_i'(\beta_j - \beta_k) = x_i'\beta_j, \text{if } \mathrm{k} = 0 \qquad (3)$$

The dependent variable is, therefore, the log of any one alternative (adaptation strategy) relative to the base alternative (no adaptation). The MNL coefficients are difficult to interpret, while associating the β_j with the j^{th} outcome is tempting and misleading. To interpret the effects of explanatory variables on the probabilities, marginal effects are usually derived (Greene, 2003):

$$\delta_j = \frac{\delta P_j}{\delta x_i} = P_j\left[\beta_j - \sum_{k=0}^{j} P_k \beta_k\right] = P_j\left(\beta_j - \overline{\beta}\right) \qquad (4)$$

The marginal effects measure the expected change in the probability of a particular choice being made with respect to a unit change in an explanatory variable (Greene, 2003). The signs of the marginal effects and respective coefficients may be different, as the former depend on the sign and magnitude of all other coefficients.

2.5. Model variables, expected signs and data sources

The dependent variables in the empirical estimation for this study is the level of adoption of the CSA practices in dairy production (AI and fodder production) and falls into three different categories (*1=full adoption, 2=partial adoption,* and *3=non-adoption*). Non-adoption was taken as a reference category, while the choice of explanatory variables and expected sign of influence is largely guided by empirical literature that includes studies by Hassan and Nhemachena (2008) and Ahmed (2016). The same model was used for both AI and fodder production since the two dependent variables are affected by almost the same variables. Table 1 summarizes the explanatory variables used for empirical estimation, together with their expected influence on farm level adaptations.

Table 1: **Description of explanatory variables and expected signs**		
Explanatory variable	**Description**	**Expected sign for CSA adoption**
Age	Age of household head (years)	+
Gender	Gender of household head (1 if male, 0 otherwise)	+/-
Educ	Number of years of formal education of household head	+
Agrictraining	Household head completed agricultural training (1=yes, 0=no)	+
Stocktype	Dominant herd stock type (1=indigenous, 0=otherwise)	-
Herdsize	Size of the dairy herd	+
Lactcows	Total number of lactating cows	+
Dairyincome	Estimated annual income from dairy activities ($)	+
ICTuse	Use of ICTs in dairy activities (1=yes, 0=no)	+
Innovation	Farmer participation in innovation platforms (1=yes, 0=no)	+

3. RESULTS

3.1. Descriptive statistics

The average smallholder dairy herd size was four animals, with on average one lactating cow and generating an estimated income of US$1,346 per annum. Most surveyed households (65%) keep pure or crossbreds, with the rest relying on indigenous cattle. The bulk of smallholder dairy producing households (79%) were male-headed, with a household head whose age ranged from 21 to 88 years. The average number of years spend in formal education is eight, which is consistent with national statistics which show literacy levels of over 90% (ZIMSTAT, 2014). However, less than half of the interviewed households (41%) completed agricultural training (Table 2).

Table 2: Descriptive statistics for variables selected for the MNL regression model (N=227)

Explanatory Variable	**Minimum**	**Maximum**	**Mean**	**Standard Deviation**
Total number of animals in dairy herd	1	48	4.30	5.01
Number of lactating cows	0	8	1.45	1.43
Gender of HH Head	0	1	0.79	0.41
Age of HH Head	21	88	56.41	13.88
HH completed agricultural training	0	1	0.41	0.49
Participation in innovation platforms	0	1	0.57	0.50
Fodder production adoption	1	3	1.7753	0.83
HH using ICTs in dairy	0	1	0.72	0.45
AI Adoption	1	3	2.0220	0.85

Stock type	0	1	0.35	0.48
Estimated Total Annual Dairy Income ($)	0.00	33,600	1,346	2,850
Years of formal education for HH Head	0	22	8.10	4.08

The results are similar to the findings from previous studies that also highlighted the numerous socio-economic variables affecting smallholder dairying in Zimbabwe (Hanyani-Mlambo et al., 1998). The study findings also reflect the characteristics found in other typical mixed crop-livestock systems (Somda et al., 2004). More than half the surveyed households (57%) participated in innovation platforms, while most households (72%) used ITCs to guide dairy production and marketing. Most smallholder dairy producing households had also either partially or fully-adopted fodder production and/or use of artificial insemination in crossbreeding programmes.

3.2. Factors influencing the adoption of artificial insemination

The MNL regression model is estimated using the maximum likelihood method. MNL model assessments found the Log-likelihood Ratio (LR) to be significant ($p<0.01$) (Table 3). This means that the independent variables selected into the model statistically significantly improved the model in predicting the influence on smallholder dairy producers' adoption of artificial insemination. This entails that the choice of variables is good. In addition, the measure of Goodness-of-fit shows that the model specification is good. Pseudo-R^2 measures also show that a greater proportion of the variation in the dependent variable is being explained by the given explanatory variables. The conclusion is that the MNL model employed is reliable and appropriate. Results show that the dairy herd size, the number of lactating cows, estimated annual dairy income, ICT use in dairying, and the stock type are statistically significant in explaining the adoption of AI. The result implies that the decision to fully, partially or not adopt at all is mostly explained by the five factors. The results of the MNL regression analysis of factors influencing the adoption of artificial insemination as a CSA innovation are presented in Table 3.

Table 3: MNL regression for factors influencing artificial insemination adoption (N=227)

Category	Variables	ß	SE	Wald	Df	Sig.	Exp(ß)
Fully	Intercept	-5.382	2.722	3.909	1	0.048	
Adopted	Herdsize	-0.270	0.150	3.245	1	0.072*	0.763
	Age	0.026	0.030	0.713	1	0.399	1.026
	Lactcows	1.877	0.536	11.126	1	0.001***	6.535
	Dairyincome	0.000	0.000	0.716	1	0.397	1.000
	Educ	-0.056	0.085	0.436	1	0.509	0.945
	Gender	1.101	0.955	1.329	1	0.249	3.008
	Agrictraining	0.277	0.805	0.119	1	0.730	1.320
	Innovation	-1.258	0.756	2.768	1	0.096*	0.284
	ICTuse	-3.144	0.893	12.395	1	0.000***	0.043
	Stocktype	5.356	1.033	26.896	1	0.000***	211.819
Partially	Intercept	-3.685	2.489	2.192	1	0.139	
Adopted	Herdsize	-0.153	0.149	1.056	1	0.304	0.858
	Age	0.022	0.028	0.595	1	0.441	1.022
	Lactcows	1.725	0.553	9.710	1	0.002***	5.611

Dairyincome	-0.001	0.000	1.644	1	0.200	0.999
Educ	-0.061	0.077	0.633	1	0.426	0.941
Gender	0.608	0.889	0.469	1	0.494	1.837
Agrictraining	0.524	0.778	0.453	1	0.501	1.688
Innovation	-1.332	0.715	3.468	1	0.063*	0.264
ICTuse	-2.433	0.812	8.964	1	0.003***	0.088
Stocktype	4.731	0.844	31.441	1	0.000***	113.416

-2 Log Likelihood	233.807	Cox and Snell	.685
χ^2	262.034	Nagelkerke	.772
Df	20	McFadden	.528
p-value	0.000		

***, ** and * significant at P<0.01, P<0.05 and P<0.1 respectively.

Factors that are statistically significant, for comparisons of the level of adoption between full adoption and non-adoption, are dairy herd size, number of lactating cows, participation in innovation platforms, ICT use and stock type. The implication is that smallholder dairy producers are more likely to fully adopt artificial insemination if the herd size is limited, have a large number of lactating cows, are participating in innovation platforms, are using ICTs, and the dairy stock type is not indigenous. For partial adopters, it is likely that they will partially adopt when compared to non-adopters when there is a high number of lactating cows, they participate in innovation platforms, are using ICTs in dairying, and that the stock type is not indigenous.

3.3. Factors influencing the adoption of fodder production

The Log-likelihood Ratio (LR) is significant at the 1% level. Again, this shows that the model statistically significantly predicts the dependent variable better than the intercept-only model, thus the choice of explanatory variables is good. Other preliminary assessments highlight the χ^2 result as showing that the selected factors are significantly different from zero at P<0.01 for the adoption of fodder production. The McFadden's R-square or Pseudo R^2 is 0.310. This implies that up to 31% of the variations in probabilities of adopting fodder production by the sampled smallholder dairy producers was explained by the selected explanatory variables. Results show that the factors that are significant in explaining the adoption of fodder production are the dairy herd size, estimated annual dairy income, participation in innovation platforms, and the use of ICTs. The other factors are not significant enough to explain the adoption of fodder production. The results of MNL regression on determinants of fodder production adoption are presented in Table 4 using non-adoption as a reference category.

Results in Table 4 show that for full adoption, the major determining factors are the number of lactating cows, the dairy herd size, participation in innovation platforms and ICT use. This means that the sampled smallholder dairy producers are likely to be full adopters than a non-adopter of fodder production if the household has a high number of lactating cows, have a large dairy herd, if it is participating in innovation platforms, and are using ICTs in dairy activities. Similarly, when compared to a non-adopter, households partially adopt fodder production when the dairy herd size is larger, dairy income is high, are participating in innovation platforms and are using ICTs in dairy activities. As before, the other factors are insignificant.

Table 4: MNL regression for factors influencing fodder production adoption (N=227)

Category	Variables	ß	SE	Wald	Df	Sig.	Exp(ß)
Fully Adopted	Intercept	3.017	1.634	3.408	1	0.065	
	Herdsize	0.492	0.147	11.130	1	0.001***	1.635
	Age	-0.006	0.018	0.100	1	0.752	0.994
	Lactcows	-0.565	0.298	3.595	1	0.058*	0.568
	Dairyincome	0.000	0.000	0.139	1	0.709	1.000
	Educ	-0.043	0.062	0.482	1	0.488	0.958
	Gender	0.287	0.554	0.270	1	0.604	1.333
	Agrictraining	-0.614	0.548	1.257	1	0.262	0.541
	Innovation	-2.552	0.648	15.499	1	0.000***	0.078
	ICTuse	-2.468	0.566	19.004	1	0.000***	0.085
	Stocktype	0.314	0.575	0.297	1	0.586	1.369
Partially Adopted	Intercept	1.671	1.680	0.989	1	0.320	
	Herdsize	0.474	0.149	10.153	1	0.001***	1.606
	Age	0.009	0.018	0.247	1	0.619	1.009
	Lactcows	-0.480	0.307	2.447	1	0.118	0.619
	Dairyincome	0.000	0.000	2.919	1	0.088*	1.000
	Educ	-0.068	0.062	1.197	1	0.274	0.934
	Gender	0.149	0.559	0.071	1	0.790	1.160
	Agrictraining	-0.273	0.565	0.233	1	0.629	0.761
	Innovation	-2.059	0.670	9.439	1	0.002***	0.128
	ICTuse	-2.212	0.573	14.923	1	0.000***	0.109
	Stocktype	0.738	0.588	1.576	1	0.209	2.093
-2 Log Likelihood		329.976		Cox and Snell		.479	
χ^2		147.905		Nagelkerke		.545	
Df		20		McFadden		.310	
p-value		0.000					
***, ** and * significant at P<0.01, P<0.05 and P<0.1 respectively.							

4. DICUSSION

The two sets of MNL regression results both identified dairy herd size, the number of lactating cows, participation in innovation platforms and ICT use as the determinants of adoption of CSA innovations such as AI and fodder production. Stock type is the other factor identified as influencing artificial insemination adoption. On the other hand, factors such as the gender, age of the household head, education, agricultural training, and estimated annual dairy income were found to be insignificant.

The findings are in line with a number of studies that highlight socio-economic variables such as the availability of cross breed cows, dairy herd size, the number of lactating cows, participation in innovation platforms or extension access, and ICT use as having a significant influence on CSA innovation adoption (Tefera et al., 2010; Dehinenet et al., 2014; Wodajo and Ponnusamy, 2016). However, these results also contrast the findings from research that has established that gender, education level, agricultural training, age of the household head and total dairy income have an impact on technology adoption decision-making processes (Mekonnen et al., 2010; Tata & McNamara, 2016; Dillon et al., 2016). These findings also create points of discourse from results of other studies. In a study of technology adoption among new entrant dairy farmers, McDonald et al., (2016) also established that AI and feed management were driven more by financial considerations than any other factors. Other factors identified as being significant in driving the adoption of CSA innovations in smallholder dairying include the distance to artificial insemination centres (Chelkeba et al., 2016), the willingness and ability of farmers to adopt appropriate new dairy technologies (Howley et al., 2012), the cost of implementation of adopted dairy technologies (Khatri-Chhetri et al., 2017), household size, farming experience, the availability of improved dairy practices, access to financial markets, and the participation in off-farm activities (Dehinenet et al., 2014; Wodajo and Ponnusamy, 2016).

Results that highlight the influence of participation in innovation platforms on the adoption of CSA innovations support findings from past studies. In Zambia, research showed that the adoption rate of technologies for underutilized crops, including sorghum, were higher within innovation platforms largely due to a higher market demand for inputs and crop commodities (Mbulwe, 2015). In India and Tanzania, contextualization and good facilitation of established innovation platforms were key drivers for success (Duncan et al., 2015). In Burkina Faso, technology adoption along the maize value chain succeeded more in innovation platforms where drivers such as improved access to information and market opportunities existed (Sanyang, 2012). However, other scholars argue that access to information and technology alone is not a sufficient condition for technology adoption without additional support from resource availability, technical guidance and improved perspectives (Batalha, cited by Dantas et al. 2016). In other contexts, it was established that socio-economic factors are more important in influencing adoption than participation in innovation platforms (Nyikahadzoi et al., 2012) and the need for commercialization of smallholder livestock production enterprises as a pre-requisite for successful innovation platforms (Tefera et al., 2010).

ICTs have contributed immensely to China's agricultural revolution by improving the efficiency of advisory services, improving agricultural productivity and incomes, and reducing the digital gap between rural and urban areas (Zhang et al., 2016). The same can be said of contexts where market-oriented agricultural production is supported by ICT regulations, appropriate policies and adequate infrastructure such as is the situation in Kenya (Mutunga & Waema, 2016). However, in other countries such as in Ethiopia, the impact of mobile phone use has been minimal largely due to a smaller proportion of farmers who use mobile phones as a source of technical production and/or marketing information and the lack of relevant information that can be accessed through such ICTs (Tadesse & Bahiigwa, 2015). In India, research established that although farmers had access to ICTs, they relied more on middlemen, local and official sources for agricultural information (Kameswari et al., 2011). Where poor adoption of ICTs was cited, the factors were, *inter alia*, variances between the design of the information system adopted and smallholder farmers' perceptions of the communication capabilities of the ICTs they have access to (Wyche & Steinfield, 2015).

5. CONCLUSION AND RECOMMENDATIONS

This paper has identified, *inter alia*, artificial insemination and fodder production as scalable and sustainable climate smart livestock technologies that can be disseminated through innovation platforms and ICTs to increase resilience and lower emissions in the dairy value chain. Thus, innovation platforms and ICTs are critical drivers for enhancing knowledge and awareness, and changing attitudes and perceptions, which are the prerequisites for CSA innovation adoption and adaption. This calls for support for the development and sustenance of private sector driven advisory services and pluralistic dairy extension systems, which enhances innovation platforms and use of ICTs.

There is thus an apparent need for both scaling out (diffusion of successful technologies) and scaling up (institutionalization) the use of innovation platforms and ICTs to enhance adoption potential, facilitate sustainable adoption of CSA innovations, and boost the potential impact in smallholder dairying, as mechanisms of enabling farmers to adapt and build resilience to climate change. However, for innovation platforms and ICTs to be more effective, there is also a need to address key institutional barriers such as poor access to information. Efforts to unlock the potential of smallholder dairy farmers through innovation platforms and ICTs should also focus on strategic and systemic implementation of training, technical backstopping and capacity building at both policy and technical levels.

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MAPPING AND MONITORING THE "FOOTPRINT" OF AGRICULTURE IN THE WESTERN CAPE

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ACCESS AND TRAINING NEEDS IN TELEPHONE APPLICATIONS AMONG EXTENSION WORKERS IN EDO STATE: IMPLICATIONS FOR CLIMATE SMART AGRICULTURE IN NIGERIA

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ABSTRACT

Climate smart agriculture (CSA) as an approach aims to achieve agriculture development and food security through application of integrated interventions to address climate change and variability. Part of such interventions are information communication technologies (ICTs) which have become veritable tools for generating and disseminating relevant information to cope with CSA and to build consensus among actors. This study examined the level of awareness, access to, and extent of use in job performance of the mobile telephone as an ICT tool by the Extension Worker. It also identified the associated constraints to and training needs of extension workers in the use of this tool with implications for CSA. Primary data were collected from 120 extension workers drawn from Edo State Agricultural Development Programme (ADP), Nigeria. Data collected were analysed descriptively and the hypothesis was tested using Pearson's Product Moment Correlation (PPMC). Results show that 55.8% of respondents were males and 40.8% were between 41-50 years of age, 54.2% were HND/B.Sc. holders and 50.8% had between 11-20years work experience. Respondents' awareness of telephone applications was lowest (41.7%) for such as GPS and highest (100%) for Voice Calls. The mean of frequently accessed applications was Phone Calls ($\bar{x}$=2.78), SMS ($\bar{x}$=2.33), e-mails ($\bar{x}$=2.12), Facebook ($\bar{x}$=2.08) and WhatsApp ($\bar{x}$=2.06). Tasks frequently performed included Voice Calls ($\bar{x}$=2.97) and Short Messaging ($\bar{x}$==2.56) to family and friends which were more for social than agricultural purposes. Constraints to high level use of MPAs for task performance included inadequate knowledge (3.75), erratic power supply (mean=3.53) and poorly developed phone infrastructures (mean=3.46). Indicated areas of high training needs included use of GPS (mean=2.85), browsing (mean=2.83) and conferencing/webinar (mean=2.82). Age (r=-.344), educational qualification (r=0.335) and job experience (r=0.515) were significantly related to training needs of respondents at 5% level. The study recommends strengthening capacity of and exposing Extension Workers to opportunities for enhanced knowledge, access to and dissemination of extension messages especially CSA technologies using telephone applications.

Keywords: Climate smart agriculture, ICTs, Extension workers, Nigeria

1. INTRODUCTION

Agricultural extension involves information exchange between Extension Workers (EWs)and farmers as well as other actors in agricultural knowledge and information/innovation system (AKIS). Jones and Garforth (2011) noted that extension programmes have different goals but all fall into systems of communication that aim to change the behaviour attitude, skill and knowledge of rural people. The use of conventional communication channels for agricultural information dissemination has left much to be desired due to shortage of extension agents. The Food and Agriculture Organization (FAO) recommended extension agents to farm families ratio of 1:250 (FAO, 2012) is far above 1: 4,882 for Oyo State, Nigeria with 415,030 farm families. This reinforces the

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need for use of information communication technologies (ICTs) by Extension workers. ICTs have potentials to reach a large audience, useful for networking, searching, dissemination and management of information. They are also handy in weather forecasts and in dissemination of early warning signals for diseases/pests and other disasters management, community learning, provision of market information and peer to peer information exchange in extension (CTA, 2003; Salau and Saingbe, 2008; Thomas and Laseinde, 2015; Umar *et al*, 2015). According to CTA, (2015), communication and information are fundamental building blocks of social and economic development. Advances in ICTs have potentials for revolutionizing development communication by ensuring wide spread and effective information dissemination by extension and advisory service (EAS) providers to all actors in the agri-food system.

Telephone as a tool, system or process for transmission of sound or speech to a distant point, (Hayden, 2014), emerged from the making and successive improvement of electrical telegraph to be heard directly (Thomas, 2014). The global mobile system (GSM) is an improvement over the conventional phone. It has the capacity to reach a large audience globally through its applications such as internet, messages, e-mail, WhatsApp (Arokoyo, 2012). It has great potentials in EAS provision as it combines various applications that are audio, visual and audio-visual as well as methods that are individual, group and even mass. In their various designs and capabilities, mobile phones can be found in the pockets of both the wealthy and the poor. Even in rural areas, mobiles are growing in number and sophistication (The Economist, 2010). Nyamba (2012) asserts that in Africa, the largest increase in the use of ICTs has been in mobile telephones. In Tanzania as well, the mobile phone market is growing in a steadfast manner. Its impact has been found to be strong and continues to grow as evident in EPINAV (Enhancing Pro-Poor Innovations in natural resources and Agricultural Value- Chain) project in Tanzania. In Nigeria, the e-wallet, the phone-based component of the of the Growth Enhancement Support Scheme (GESS) project, serves as an avenue to educate, inform and communicate with farmers on best agricultural practices and commodity prices.

The application of mobile phone to the agricultural sector and other aspects of livelihood is due to its characteristics, (Donovan, 2012) and its right utilization can significantly enhance rural communication. They are beneficial as they enable people to access instant information; reliable and timely communication of market information and extension advice. It offers accessibility for illiterate users through videos and images Apps. Mobile phones and their applications, like all technologies, face limitations including high cost.

To adequately explore the potentials in GSM, Ofolue, Adegbola and Egbokhare, (2013) designed mobile telephony for development in Nigeria with enabled application in local languages. However, Yakubu, (2013) and Agwu and Ogbonnah, (2014) identified poor ICT infrastructural development, erratic and unstable power supply, lack of technical know-how as some of the constraints to effective ICT use by EWs including their use in promotion of climate smart agricultural (CSA) practices.

The FAO (2013) defines CSA as “agriculture that sustainably increases productivity, enhances resilience (adaptation), reduces/removes greenhouse gases (GHGs) (mitigation) where possible, and enhances achievement of national food security and development goals”. This shows that CSA is an integrated approach; it goes beyond a technology / practice but puts in focus the totality of climate change. Papuso and Faraby (2013) assert that CSA has multiple entry points, ranging from the development of technologies and practices to the elaboration of climate change models and scenarios, information technologies, insurance schemes, value chains and the strengthening of institutional and political enabling environments. This shows that CSA if properly pursued will address food security and development. Information technologies constitute a vital component of CSA. However, the key to using these technologies to boost productivity requires complementary technologies. Technologies to analyse data (such as data mining or mediation software) and information dissemination technologies (such as mobile phones and radio) are essential to reaching smallholders effectively. Dissemination also includes the crucial human component: Extension agents and farmers themselves must transmit and share knowledge (International Institute for Communication and Development (IICD), 2006).

The entire process requires appropriate capacities to optimize the potentials and ensure food security, poverty alleviation and development in general. This is especially so as the field of extension now encompasses a wider range of communication and learning activities organized for rural people by professionals from different disciplines, including agriculture, agriculture marketing, health and business studies as well as in climate mart agriculture (CSA) in line with the "New Extensionist" initiative of the GFRAS. The availability of ICT tools is important, their accessibility by change agents particularly the field EWs is more crucial. Arokoyo (2014) asserted that the extent of application of telephone and computer as a tool in extension services depends mostly on the targeted audience. Therefore, EWs who facilitate the process of information exchange are expected to be aware, access and proficiently apply mobile telephone but it could not be categorically stated that they do.

1.1. Objectives of the study

The general objective of this study was to assess the awareness, access to and training needs of EWs in telephone applications in Edo State.

The specific objectives were to:

1 Describe the personal characteristics of EWs in the study area.

2 Examine EWs awareness of telephone applications and the tasks they perform with them.

3 Examine the frequency of accessing mobile phone application functions for task performance.

4 Identify the usage of MPAs.

5 Identify the constraints faced by EWs in the use of telephone applications.

6 Determine the training needs of EWs with respect to mobile phone application functions.

1.2. Hypothesis of the study

There is no significant relationship between the personal characteristics of EWs (age, educational level, years of experience, etc.) and training needs in use of mobile phone applications.

2. METHODOLOGY

2.1. Area/ scope of study

The study was conducted in Edo State, which is one of the States in the Southern part of Nigeria. The State has 18 Local Government Areas with the capital in Benin City. The population of the State is about 4 million people consisting of three major ethnic groups namely Binis, Esan and Afemais (Edo State Gov., 2014). It has a landmass of 19,794 km square and it is geographically located between 05^{0}44^{I}N to 07^{0}34^{I}N latitudes 05^{0}4^{I}E to 06^{0}45^{I}E longitude (www.Edostate.Gov/Geography).Edo State is low lying except towards the North where the Northern and Esan plateaus range from 183 metres in the Kukuruku hills to 672 metres in the Somorika hills.

It is so located that if forms the nucleus of the Niger Delta region. It is bordered by Kogi State to North and Delta state to the East and South, Ekiti and Ondo states to the West (www.Edostate.Gov.Ng/profile-Edo-state).

The climate is typically tropical with two major seasons. The wet (rainfall) about 2500 mm and the dry (hot seasons). The wet season lasts from April to November and the dry season between December and March with average temperature of about 25°C. Edo state is blessed with two major vegetative belts, namely the forest belt in the south and central parts and the guinea savannah to the Northern part. Apart from the wood products, the occupation of the majority of the people is farming and there is a high cultivation of crops such as cocoa, rubber, palm tree, vegetables, cotton, pineapple, mango, cashew and cassava (Edo State Gov., 2014).

2.2. Sample size and sampling technique

The population of this study consists of all the Agricultural Extension Workers in the three zones in the State's Agricultural Development Programme. Primary data was collected with the aid of a structured questionnaire. The questionnaire was divided into sections which addressed the objectives.

2.3. Measurement of variables

Extent of performance of tasks using MPAs: This was measured by rating activities on a 3-point rating scale of regularly = 3, occasionally = 2 and never = 1

The constraint to accessing telephone applications: This was measured by rating items of constraints on a 5-point scale of strongly agree= 5, agree = 4, undecided = 3, disagree = 2 and strongly disagree = 1.

Frequency of accessing telephone applications was measured by asking the EWs to rate their use of telephone applications on a 3-point rating scale of high access = 3, low access= 2, no access = 1.

Extent of using telephone applications was measured by asking the EWs to rate their use of telephone applications for task performance on a 3-points rating scale of highly used = 3, occasionally used= 2, not used = 1 point.

Training needs in computer applications: This was measured on a 3-point rating scale of highly needed= 3, needed = 2, not needed = 1 point.

2.4. Data analysis

Data were analysed using descriptive statistics such as percentages, mean frequency counts and standard deviations. Inferential statistics Pearson Product Moment Correlation was used.

3. RESULTS AND DISCUSSION

3.1. Personal characteristics of respondents

As Table 1 shows, 55.8% of respondents were males and 40.8% were between 41-50 years of age with a mean age of 47 years, 54.2% were HND/B.Sc. holders and 50.8% had between 11-20years work experience. This agrees with findings of Adedoyin *et al.,* (1999) and Salau and Saingbe (2008) that males dominate the agricultural workforce in Nigeria. This trend has significant implication for telephone and computer utilization as elderly people might be less interested in the use of advanced technological innovations and agrees with the result of the study of Salau and Saingbe (2008).A majority of the extension workers (78.3%) in the study area were found to be married, 54.2% were HND/B.Sc. holders, 100%owned telephone but 40.0% has mobile phones with low sophistication, i.e. less than 5 applications. The educational level was high which could imply greater appreciation of the need for mobile phones.

Table1: Personal characteristics of respondents

Description	Freq.	%	Mean
a) Sex			
Male	67	55.8	
Female	53	44.2	
b) Age			
≤30	10	8.3	
31 – 40	29	24.2	
41 – 50	49	40.8	
51-60	32	26.7	47.3
c) Marital status			
Single	26	21.7	
Married	94	78.3	
d) Education			
Cert/Diploma/OND	40	33.3	
HND/B.Sc.	65	54.2	
Post graduate	15	12.5	
e) Cadre			
Officer	59	49.2	
Superintendent	61	50.8	
f) Family size			
≤3	26	21.7	
4 – 6	70	58.3	
7- 9	38	31.7	
≥10	11	9.7	
g) Ownership of mobile phone	120	100.0	
h) Sophistication of mobile phone			
Low/regular	48	40.0	
Averagely sophisticated	58	48.3	
Sophisticated	14	16.7	

3.2. Awareness of mobile phone applications

Table 2 shows that at least 50% of the respondents were aware of SMS, call, internet, chat, radio and video maps, calculator, applications on phones. The level of awareness of these applications could be related to the level of sophistication of the EWs mobile phones. The findings to so extent agree with those of Dire, Onu, Jungur, Ndaghu and Giroh (2016) that 100% of EWs were aware of the use of one form of ICT or another in performance of their duties. Nyamba (2012) asserts that in Africa, the largest increase in the use of ICTs has been in mobile telephones.

Table 2: Awareness of mobile phone applications*

Telephone	Yes		No	
	Freq.	%	Freq.	%
Telephone				
Short message service (SMS)	120	100.0	-	-
Phone calls	120	100	-	-
Internet	105	87.5	15	12.5
Chat	109	90.8	11	9.2
Radio	116	96.7	4	3.3
Video	91	75.8	29	24.2
Google	55	45.8	65	54.2
Planner	50	41.7	70	58.3
Play store	40	33.3	80	66.7
Voice recorder	92	76.7	28	23.3
Maps	102	85.0	18	15.0
Memos	72	60.0	48	40.0
Hang outs	06	5.0	114	95.0
Calculator	104	86.7	16	13.3
Camera	69	57.5	51	42.5
Email	111	92.5	9	7.5
Gallery	78	65.0	42	35.5
Dropbox	19	15.8	101	84.2
Dictionary	39	32.5	81	67.5
Clock	87	72.5	33	27.5
Global positioning system	32	26.7	88	73.3

* >50%- high awareness

3.3. Extent of access of mobile phone applications for tasks performed

Table 3 shows the extent to which the respondents accessed MPAs. The significantly accessed MPAs were voice calls (2.78), short message services (2.33), internet (2.33), calculator (2.46), camera (2.46), Facebook (2.14), and radio (2.12). Some EWs (40%) do not even have phones that have most of these applications as shown in Table 1. These applications might not have been accessed for job performance. Various applications listed including GPS, google, dropbox, planner and video could contribute to the realisation of the goal of CSA if extension workers access them and are proficient in their usage to perform relevant tasks.

Table 3: Extent of access of mobile phone applications

Applications	Not Accessed		Little Accessed		Highly Accessed		Mean
	Freq.	%	Freq.	%	Freq.	%	
Voice calls	0	0.0	26	21.7	94	78.3	2.78*
Short message service (SMS)	0	0.0	80	66.7	40	33.3	2.33*
Internet	6	5.0	94	78.3	20	16.7	2.33*
Chat	3	2.5	75	62.5	42	35.0	2.28*
Radio	5	4.2	76	63.3	39	32.5	2.12*
Video	35	29.2	63	52.5	22	18.3	1.82

Google	46	38.3	50	41.7	24	20.0	2.14*
Planner	36	30.0	39	32.5	45	37.5	2.08*
Play store	93	79.2	21	47.5	4	3.3	1.09
Voice recorder	71	59.2	27	22.5	22	18.3	1.82
Maps	31	25.8	85	70.8	4	3.3	1.78
Memos	54	45.0	55	45.8	11	9.2	1.14
Hang outs	112	93.3	7	5.8	1	0.8	
Calculator	9	7.5	65	54.2	55	45.8	2.46
Camera	3	2.5	77	64.7	40	33.6	2.46
Email	45	37.5	63	52.5	56	46.7	2.43
Gallery	49	40.8	61	50.8	55	45.8	2.32
Dropbox	111	92.5	9	7.5	00	0.0	1.03
Dictionary	69	57..5	45	37.5	24	20.0	2.28
Clock	63	52.5	38	31.7	26	21.7	2.05
Global positioning system (GPS)	90	45.0	19	15.8	11	9.2	1.34
Facebook	46	38.3	50	41.7	24	20.0	2.14*
WhatsApp	36	30.0	39	32.5	45	37.5	2.08*
Skype	63	52.5	43	35.8	14	11.7	1.59
Twitter	76	63.4	38	31.7	6	5.0	2.05
Download	39	32.5	57	47.5	24	20.0	1.48
Attachment	22	18.3	70	58.3	28	23.3	1.78
YouTube	34	28.3	55	45.8	31	25.8	1.75

*Accessed (Mean $\geq$ 2.0)

3.4. Activities performed with MPAs

3.4.1. General use of mobile phone application (MPAs)

Table 4 shows the respondents' usage of MPAs to perform functions and the frequency of performance of activities/tasks with mobile phone applications. Results show that EWs performed some tasks/activities with MPAs, but these were significantly used for social activities (i.e. interactions with family and friends) more than for technical or job-related tasks. Voice calls to family and friends was mostly performed with a mean response of 2.97, followed by messaging (2.53), use of social platforms like Facebook and WhatsApp at2.35 linkages (2.15) and contribution to discussion (2.12). Only emailing was significantly used for job related tasks. This could be explained by the fact that salaries/low income are hardly enough to make ends meet and allowances are not paid to cover communications costs hence workers might prefer to spend their funds only on priority needs. Emails could have found fair significant use because most official transactions/communications are in recent times been done via emails.

Table 4: General use of mobile phone applications (MPAs)

Uses	Mean	Standard deviation
Social (non-job)		
Phone or Voice calls	2.97*	.211
Short message services (SMS)	2.53*	.654
Source information	2.04*	.583
Social platforms participation-Facebook, WhatsApp	2.35*	.733
Production of resource materials	1.81	.756
Linkages	2.15*	.807
Make orders	1.35	.754
Provide information/respond to enquiries	2.11*	.652
Contribute to discussions	2.12*	.691
e-mailing	1.65	.342
Browsing	2.14*	.853
Chatting	2.13*	.705
Skyping/video calls	2.11*	.533
Sourcing news	2.10*	.640
Blogging	1.01	.498
Conferencing	2.05*	.465
Twitting	2.02*	.788
Job related		
Phone calls	1.81	.623
Short message services (SMS)	1.74	.592
Source information	1.59	.544
Social platforms	1.55	.822
Production of resource materials	1.99	.385
Linkages	1.74	.566
Make orders	1.09	.451
Provide information/respond to enquiries	1.49	.474
Contribute to discussions	1.76	.712
e-mailing	2.08*	.463
Browsing	1.98	.526
Chatting	1.78	.510
Skyping/video calls	1.02	.614
Sourcing news	1.95	.563
Blogging	1.04	.598
Conferencing	1.01	.569
Twitting	1.14	.539

*highly used ≥ 2.00

3.5. Constraints to accessing mobile phone applications

Table 5 shows the constraints facing EWsin the use of MPAs and these were analysed using a 5-point Likert scale, with a decision mean of 2.5. Most of the constraints were found to be serious. They included inadequate technical knowledge of MPAs (3.71), inadequate funds to regularly buy air-time/data (3.68), epileptic supply of electricity to regularly charge phone battery (3.53), poorly developed phone and computer facilities (3.46), high cost of computer (3.3), etc. The constraints that were found to be non-significant were affordability of mobile phones (2.43) and low level of awareness (1.97). Perceived Constraints to the Use of ICTs by female EWs were lack of training opportunities in the use of MPAs, inadequate ICT facilities and a lack of technical know-how. On the other hand, variables not perceived as serious constraints included the high cost of ICTs, financial difficulties, corruption, poor education, mismanagement, and lack of access. Others included poor quality of network service, lack of power supply, ICTs not available and not in a useable state.

Table 5: Constraints to accessing mobile phone applications

Constraints	Mean	Std dev.	Rank
I don't have technical knowledge of many applications	3.72	.871	1st
Financeto buy enough airtime	3.68	.580	2nd
Epileptic supply of electricity	3.53	.777	3rd
Poorly developed telephone infrastructural Facilities	3.46	.564	4th
Shortage of professionals to training usage	3.39	.714	5th
High cost of computer	3.30	.866	6th
Poor communication network	3.23	.827	7th
Frequent breakdown of telephone and computer facilities.	2.98	.809	8th
Limited number of available telephone and computer facilities	2.60	.982	9th
I cannot afford it	2.55	.740	10th
Low level of awareness	1.97	.970	11th

3.6. Mean distribution of training needs in mobile phone applications by respondents

As shown in Table 6, the respondents indicated training needs in all the mobile phone applications, even for phone/voice calls and SMSs which they indicated that they accessed and used in their task performance. This might be related to dearth of knowledge in multiple, organizing phone contacts among others. Yakubu (2013) and Agwu and Ogbonnah (2014) also found lack of technical know-how for effective use of ICTs in development.

Table 6: Mean distribution of training needs in mobile phone applications by respondents

Applications	Mean	Std. Deviation
Phone calls	3.47	.354
Short message service (SMS)	3.22	.505
Internet	2.20	.559
Chat	2.19	.523
Radio	2.19	.569
Video	2.17	.540
Google	2.16	.534
Planner	2.15	.529

Play store	2.15	.442
Voice recorder	2.14	.455
Maps	2.13	.549
Memos	2.13	.501
Hang outs	2.13	.401
Calculator	2.10	.376
Camera	2.09	.467
Email	2.08	.460
Gallery	2.06	.416
Dropbox	.05	.500
Dictionary	2.04	.492
Clock	2.02	.534
Global positioning system (GPS)	2.80	.485
Facebook	2.95	.482
WhatsApp	2.08	24
Skype	1.42	11
Twitter	1.67	24
Download	1.08	66
Attachment	1.93	14
Youtube	1.70	.408

3.6.1. Relationship between personal characteristics and training needs in mobile phone applications

Ndag, Sanusi and Aigbekaen (2008) found that age and computer training were significant factors in determining the use of ICT to search for information by EWs in North -Central Nigeria. There is no significant relationship between the personal characteristics of extension workers and the access to telephone and computer by the extension workers. However, Adesina and Laseinde (2015)-had found inverse but significant relationship between extension agents' knowledge of social media and training needs in the use of MAPs.

3.7. Relationship between EWs socio-economic characteristic and telephone and computer access

Table 7 gives the multiple correlation values which at 0.001level of significance, age (p= -0.344), educational qualification (p = 0.37) and job experience (p = 0.515) were found to be significant, while at 0.05 level of significance, only family size was found to be significant. Cadre and sex were not significant and therefore, the reject of the null hypothesis that "there is no significant relationship between telephone access and socio-economic characteristics of respondents.

Table7: Relationship between personal characteristics and training needs in mobile phone applications

Variable	Correlation coefficient (r)	p-value	decision
Sex	-.029	.754	
Age	-.344*	.000	
Marital status	.004	.966	
Family size	-.184*	.044	
Educational Qualification	.335*	.000	
Cadre	.096	.296	
Grade Level	.317*	.000	
Job Experience	.515*	.000	

*Correlation is significant at the 0.05 level (2-tailed)

4. CONCLUSION

The study concludes that all of the respondents owned mobile phone however, various applications were not accessed and only voice calls, short messaging services (SMSs), calculator, time and date and emails were the mobile phone applications (MAPs) highly accessed EWs. Inadequate knowledge, lack of finance to purchase data, poor network connectivity, inadequate and erratic electricity supply, and dearth of technical information were among the major constraints to accessing MPAs for job performance. Training needs were indicated for most of the MPAs selected.

4.1. Implications for climate smart agriculture

The study found that all the EWs or respondents own a mobile phone thus indicating that EWs can access, disseminate and manage CSA information and technologies using MAPs. With adequate knowledge competence in the use of MAPs, the CSA actors can readily, synergize, network and strategize for effective dissemination of proven technologies and valid information. There is however a need to address improved access, utilisation for job performance and reduction of constraints to accessing MPAs which have been mainly due to technical knowhow. Training of EWs in MAP in CSA will increase awareness, enhance competencies to facilitate mitigation, adaptation and eventual improvement in food security.

MAPs such as google, emails, clock and time, GPS, help to strengthen livelihood by improve access to service, knowledge and resources and help address adaptations and build resilience. It will also assist in reducing barriers to CSA adoption and development, build strong linkages among stakeholders and service providers as well as support and provide early warning system and forecasts. As indicated by Koyenikan (2014), the level of utilization of climate instrument among agriculture professionals in south western Nigeria is low and the effective deployment of MAPs can significantly improve information and technical message dissemination for more effective CSA practices.

Ability/proficiency in the use of MAPs will contribute to EWs effectiveness and efficiency in their role performance and enhance productivity of farmers and various actors in the agri-food system. Appropriate use of MAPs will facilitate early warning enhance access to, dissemination and management of information to address adaptation and mitigation in CSA for sustainable increase in food security, agricultural productivity, and development. It could also improve Improved agricultural extension services provision, facilitate collection, processing and transmission of data, for quality extension services to farmers, policy formulation and decision making in a bottom-up and interactive manner.

5. RECOMMENDATIONS

Based on the findings of this study, the following are recommended:

1. Sensitisation and training of EWs by Edo State Agricultural Extension Service on the opportunities in MPA. This will provide them with technical knowhow to adequately access the applications. Such trainings could be organized or sponsored by the ADP management, service providers or self-development effort of EWs for proficiency and effective job performance.
2. There should be provision of adequate CSA information in terms of benefits, evidences, success stories etc. for EWs to access. In addition, availability of accurate weather information from Nigerian meteorological services and other development institutions should create platforms for CSA information dissemination for easy access by using phone-based services.
3. Continuous review of mobile phone usage.
4. Public, private and community efforts should be harnessed to address the identified constraints especially in the area of improving network reception at the communities and addressing erratic power supply.
5. CSA practices adoption, increased awareness should be pursed with the farmers and other actors to achieve the desired production of training manuals.
6. Allowances for communication could be provided for EWs for effective interaction with their client and other actors using MPAs.

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SOCIO-ECONOMIC DETERMINANTS OF MOBILE PHONE ADOPTION AS ICT TOOL FOR AGRICULTURAL MARKETING AMONG SMALLHOLDER IRRIGATION FARMERS IN SOUTH AFRICA

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ABSTRACT

Lack of access to markets occasioned by missing market information has constrained market participation among smallholder farmers in developing countries. Advances in Information and Communication Technologies (ICT) have helped in connecting rural farmers through mobile phones to market sources. This study investigated the adoption of mobile phones for marketing of agricultural produce among Qamata Irrigation Scheme (QIS) smallholder farmers in South Africa and the determinants of adoption. Two stage random sampling technique was used to interview 97 smallholder farmers employing a structured questionnaire. Data generated was analysed using descriptive statistics and a probit regression model. Analysis results show that 71% of the smallholder farmers currently use mobile phones for agricultural marketing. The majority of the respondents (55%) used mobile phones to market their produce among relatives and neighbours. Probit regression results indicated that gender, social grant as main income source, private traders and local market marketing channel, monthly income, political and economic factors influence mobile phone adoption in agricultural marketing. Hence, we recommend mobile phones as a marketing tool among smallholder irrigation farmers in South Africa. Concerted efforts should be made to address erratic networks and high airtime tariff challenges to encourage mobile phone adoption in marketing among smallholder farmers in the country.

Keywords: Agricultural marketing, ICT, mobile phone, smallholder farmer, South Africa

1. INTRODUCTION

Prompt delivery of vital market information to smallholder farmers via mobile phones could serve as an impetus for economic development, poverty alleviation and increase food security in sub-Saharan Africa. Several studies conducted in Ethiopia, Uganda, Tanzania, Zimbabwe and China have confirmed that mobile phones can be used to provide information to the farmers and rural households through SMS and multimedia-support systems (Martin & Abbott, 2008; Wei & Zhang, 2008; Nyamba & Mlozi, 2012; Chhchhar *et al.*, 2014; Tadesse & Bahiigwa, 2015; Masuka, *et al*., 2016). The effectiveness of mobile phones in facilitating information access among farmers is far reaching since it provides communication link even in isolated circumstances, and aids in reaching the farmers living in remote areas. Mobile phone helps farmers in accessing best agronomic practices and query agricultural experts (Banerjee, 2010). It can also facilitate agricultural decision making, provide information related to crops, weather forecasting, seeds, fertilizers, bio-pesticides, soil fertility, pest and disease diagnosis, demand and supply of agricultural products, different schemes and technologies (Singh *et al.*, 2015).

Despite the immense potentials of mobile phones in enhancing agricultural production and linking smallholder farmers to remunerative markets, limited market access still persists among smallholder farmers in most developing countries (Kawa & Kaitira, 2007; Magesa, Michael, & Ko, 2014). The prevalence of limited market

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access, particularly in rural areas, often necessitates farmers and entrepreneurs to travel several kilometres to designated markets due to poor communication facilities. In most cases, they frequently rely on intermediaries who normally exploit their ignorance of market information. Hence, accurate and timely market information, precisely for perishable agricultural produce, has been identified as a veritable means of significantly reducing transaction and travel costs. However, the high cost of delivering such valuable market information through face-to-face interaction, crumbling extension services and poor market information has paved the way for the use of modern Information and Communication Technology (ICT) like mobile phones in disseminating agricultural information to targeted farmers.

The explosion of mobile telephones has made Sub-Saharan Africa (SSA) “the fastest-growing region in the world for mobile phone users in the past five years, with mobile subscribers having increased 18% a year for the past five years to total 253 million as of June 2013” (Wall Street Journal, 2013). With a GDP of $357 billion, South Africa is one of the largest and most advanced telecommunications markets on the African continent (World Bank, 2012). The mobile telecommunications explosion has also been evident in the make-up of the use of ICT services in South Africa, where the use of mobile services has reached near saturation levels (Nedohe, 2014). Yet, little or no information exist on the use of mobile phones in facilitating market access among the impoverished smallholder farmers in the former homelands of South Africa. This paper therefore seeks to investigate the socio-economic drivers of mobile phone adoption as an ICT tool for agricultural marketing among smallholder farmers participating in the Qamata Irrigation Scheme (QIS) in the Eastern Cape Province of South Africa.

1.1. Hypothesis of the study

H_0: We hypothesised that there is no significant relationship between the socio-economic characteristics of the respondents and the adoption of mobile phone in the marketing of agricultural produce among smallholder irrigation farmers in South Africa.

2. METHODOLOGY

Study area: The study was conducted among smallholder farmers participating in QIS, which is located in Intsika Yethu Local Municipality in Chris Hani District Municipality of Eastern Cape Province, South Africa. The Qamata area climate varies from mild temperature conditions of 14^0C to 23^0C along the coastal areas to extreme conditions of 5^0C to 35^0C within the inland areas (Lent *et al*., 2000), and the rainfall ranges between 6mm to 86mm. The scheme spans a total surface area of 2601 hectare (ARDRI, 1996:6). It stretches across two tribal authorities, namely Qamata Tribal Authority in the North, and St. Marks Tribal Authority in the South (Republic of Transkei, 1986:2). The study area is predominantly rural with 95% of the population living in the rural areas while 71% of the population depend on subsistence farming (Chitsa, 2014)

Data and sampling procedures: The cross-sectional data used in this study came from a two-stage random sample of 97 farmers participating in QIS. In the first stage, five of the 32 sections of QIS were selected using non-probability quota sampling based on the premise that the five sections selected constitute largest area of the scheme with representative population of smallholder farmers participating in the scheme. The second stage involved simple random sampling of select representative sample of farmers based on the number in each section. In all, 112 farmers were interviewed, but only 97 gave valid and complete information sufficient for analysis. A questionnaire was developed and tested to collect the mobile phone adoption data. The questionnaire captured farmer’s socio-economic characteristics such as age, gender, income, and level of education, as well as mobile phone usage, market and market participation characteristics. The Theory of Reasoned Action (TRA) and Technology Acceptance Model (TAM) (Islam, 2011; Frias-Martinez & Virsesa, 2012; Donner, 2007) provided rich theoretical frameworks underpinning the analysis of the determinants of mobile phone adoption as an ICT tool for agricultural marketing in the study area.

Method of data analysis: The analytical technique used in this study includes descriptive statistics such as frequencies, means, percentages, pie and bar charts, and tables, employed in profiling the socioeconomic characteristics of the smallholder irrigation farmers. We further used Probit regression analysis to estimate the determinants of the adoption of mobile phone in agricultural marketing.

The Probit model: The Probit model is a log-linear approach used to measure the effects of the independent variables on the dependent variable. The Probit regression analysis, was used since the OLS estimating procedure will be inappropriate as the dependent variable is dichotomous. In this model, Mobile Phone Adoption (MPA) represents the dependent variable (Y). The model was estimated with the assumption that Y, MPA for agricultural marketing, is related to the following variables, explicitly stated as:

$$Y_i = \beta o + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots\ldots + \beta_n X_{ni} + v$$

Y_i = Mobile Phone Adoption (MPA = 1, 0 otherwise)

Farmers that use mobile phone for calls, SMS or both in agricultural marketing are consider adopter, whereas those that have never used mobile phone services (i.e. calls and SMS or both) for agricultural marketing are consider as non-adopters

X_{1i}, X_{2i}... X_{ni} = vectors of explanatory variable

βo $\beta_{1, \ldots\ldots}$ β_n = coefficients of the explanatory variables

Where:

X_1 = Gender of house head (1 = male, 0 = otherwise)

X_2 = Age of farmer (1= ≥50 years, 0 otherwise)

X_3 = Marital status (1=Married, 0 otherwise)

X_4 = Educational status (1= at least attended high school, 0 otherwise)

X_5 = Farming as main income source (1= Yes, 0 otherwise)

X_6 = Social grant as main income source (1= Yes, 0 otherwise)

X_7 = Size of arable land (Hectares)

X_8 = Private traders as marketing channel (1= Yes, 0 otherwise)

X_9 = Relatives or neighbours as marketing channel (1= Yes, 0 otherwise)

X_{10} = Local market as marketing channels (1= Yes, 0 otherwise)

X_{11} = Level of income (1= ≥R1000, 0 otherwise)

X_{12} = Political factor (1= Yes, 0 otherwise)

X_{13} = Economic factor (1= Yes, 0 otherwise)

X_{14} = Social factor (1= Yes, 0 otherwise)

3. RESULTS AND DISCUSSION

3.1. Socio-economic characteristics of the household

Presented in Table 1 is the socio-economic characteristics of the smallholder irrigation farmers that participated in the study. The smallholder farmer characteristics examined include age, gender, marital status, level of education, monthly income, main sources of income and the arable land size of the farmers. Most of the farmers (61%) were 50 years and above with only a few (11%) below 20 years of age. This implies that farmers in the study area may be ageing, and this may have serious implications on sustainability of agriculture among the younger generation who are supposed to succeed the older ones. The female farmers' population are slightly above their male counterparts indicating that females may be more active in the irrigation scheme than male farmers. This finding is similar to Chitsa and Gidi studies on QIS where females constitute higher percentages (Chitsa, 2014; Gidi, 2013). Almost half of the farmers (49%) completed primary school, whereas 43% attended high schools. Only 1%, 4%, 2% had matric, diploma and degree qualifications respectively. A further 44% of the farmers earned less than R1000 monthly, while 48% received R1000 – R4999 monthly, and very few (6%) earned R5000 and above monthly. Majority of the farmers (71%) were affirmative when asked if farming is their main source of income and almost 20% claimed social security grants received from government as the main source of income. A greater percentage of the farmers (71%) have less than or at most one hectare of arable land while only a few (6%) have five hectares or more.

Table 1: Socio-economic characteristics of the respondents

Variables	**Frequency**	**Percentage**
Age		
< 20 years	11	11.34
30-39 years	11	11.34
40-49 years	15	15.46
50-59 years	27	27.84
≥ 60 years	33	34.02
Gender		
Male	46	47.42
Female	51	52.58

Marital status		
Married	44	45.36
Never married	29	29.90
Divorced	7	7.22
Widow	17	17.53
Education level		
Primary school	48	49.48
High school	42	43.30
Matric certificate	1	1.03
Diploma	4	4.12
Degree	2	2.06
Monthly Income		
<R1000	39	44.32
R1000 – R4999	43	48.86
≥R5000	6	6.82
Farming as main income source		
Yes	69	71.13
No	28	28.87
Social grant as main income source		
Yes	19	19.59
No	78	80.41
Arable land size		
≤ 1 Hectare	47	71.21
1.1-5 Hectares	15	22.73
> 5 Hectares	4	6.06

3.2. Mobile phone services used for agricultural marketing by smallholder farmers

As shown in Figure 1, 48% of the smallholder farmers employed voice calls in the marketing of their agricultural produce. This may be unconnected to the perishability of their produce, which necessitates the urgency of communication between the farmers and potential buyers. Only 10% of the farmers employed Short Message Services (SMS) in their marketing. This low percentage may be due to the fact that writing messages may be burdensome to many farmers and may require a certain level of literacy that may be lacking among the smallholder farmers.

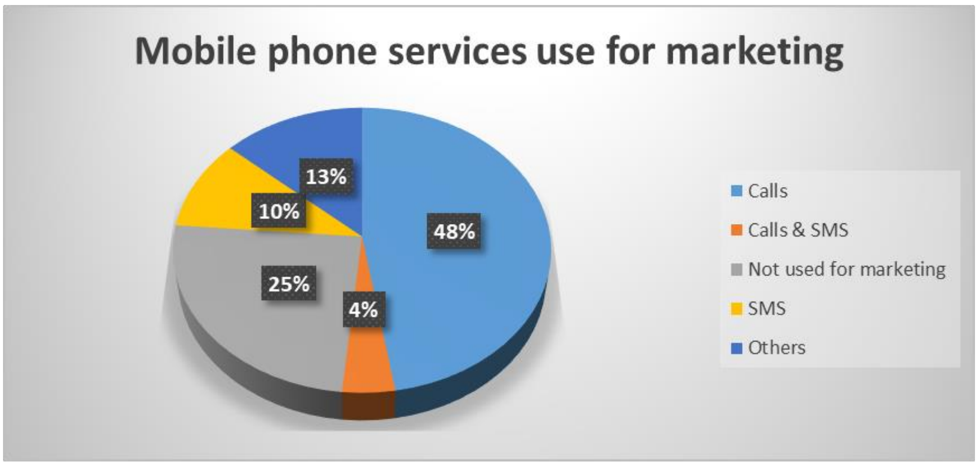

Figure 1: Mobile phone marketing services adopted by the smallholder irrigation farmers

3.3. Benefits of mobile phone adoption in agricultural marketing

The bar chart in Figure 2 shows the various benefits derived from the adoption of mobile phones in agricultural marketing by the smallholder farmers. Almost half (44%) of the respondents claimed that there is no substantial difference derived from their use of mobile phones in marketing their produce. However, 18% confirmed that the use of mobile phones facilitated easy access to the market. Since the scale of production of the farmers are generally low, this category of farmers may be those that use informal marketing channels such as relatives and neighbours, and local markets where they have already established contacts that can easily buy their small produce. Only 13% of the farmers claimed that the use of mobile phones links them to the market where their produce could be sold on time. Moreover, 9% of the respondents affirmed that the adoption of mobile phones reduced their transactional cost substantially and 15% derived other benefits that were not specified.

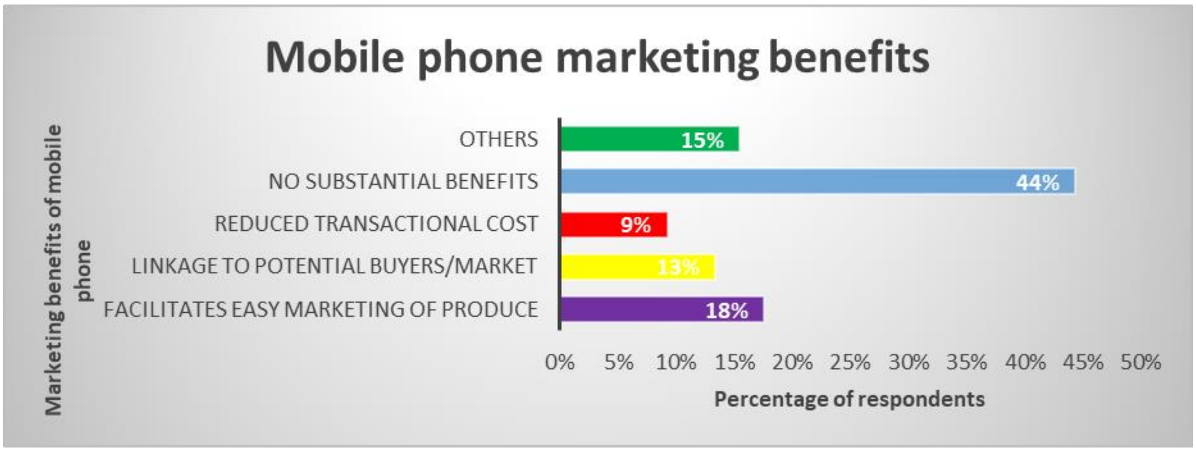

Figure 2: Marketing benefits derived from the adoption of mobile phones in agricultural marketing by the smallholder irrigation farmers

3.4. Extension services facilitated through mobile phones

Benefits derived from the use of mobile phones among smallholder farmers is shown in Figure 3 below. The study identified three major extension services that are commonly facilitated by the smallholder farmers over the phone without direct interactions with the extension officers. These include procurement of fertilizers, arranging for tractors and transport services. A relatively low 22% of the farmers had arranged for tractor services in the past using mobile phones, 15% ordered for the supply of fertilizers with the aid of mobile phones and only 3% patronised transportation services for their produce using mobile phones.

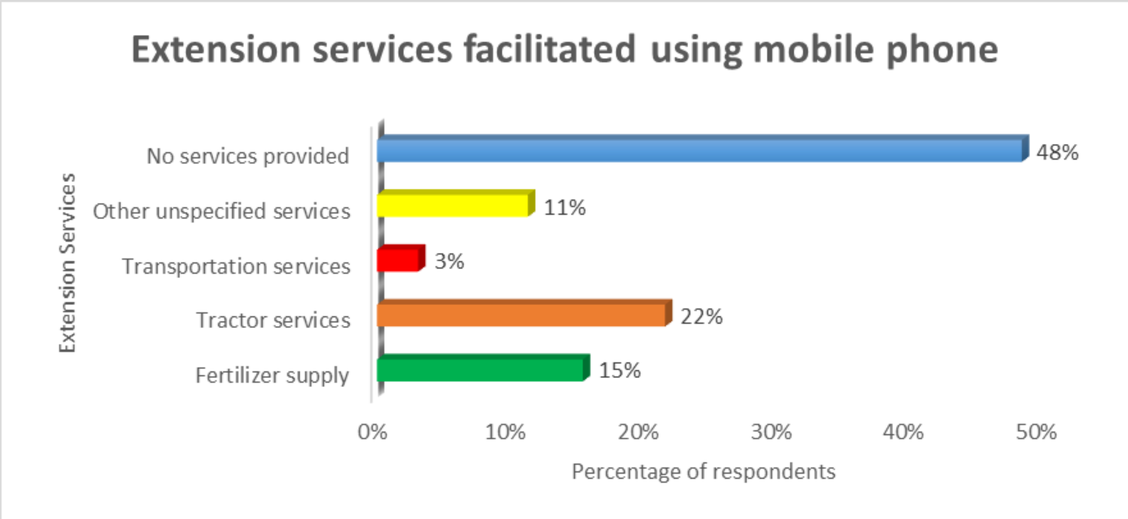

Figure 3: Extension services patronised through mobile phones by the smallholder irrigation farmers

3.5. Challenges to mobile phone adoption among smallholder farmers

Major challenges mitigating against the adoption of mobile phones in agricultural marketing among smallholder farmers in the study area is presented in Figure 4 below. Most of the respondents said that inability to purchase airtime with which they can make use of the mobile phone services constitute a major challenge to their adoption. This is understandable considering the fact that almost half of the respondents live on less than R1000 monthly. For these farmers, R5 airtime may be unaffordable due to their family responsibilities. However, 10% identified erratic networks as majorly confronting their adoption of the mobile phone in marketing their produce. This may be because the study location is far from major towns, hence, poor reception often persists in the area. A further 7% claimed that there are other challenges, which are not specified, but 33% are of the opinion that none of these constitute challenges to the adoption of mobile phones in marketing their produce.

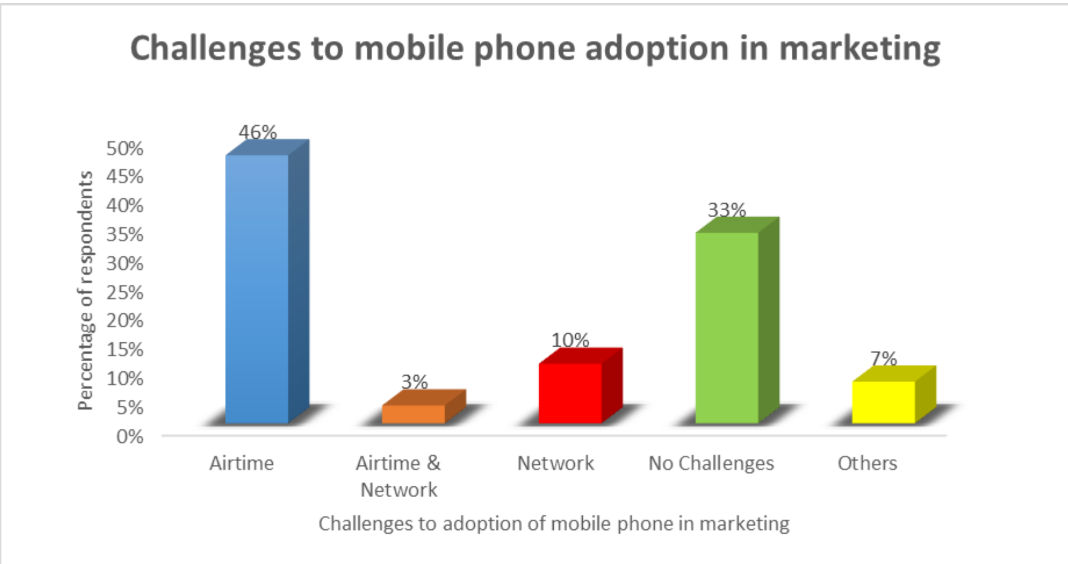

Figure 4: Challenges mitigating the adoption of mobile phones among smallholder irrigation farmers

3.6. Determinants of mobile phone adoption for agricultural marketing

The probit regression estimates and the corresponding marginal effects are presented in Table 2. The pseudo R^2 (adjusted coefficient of determination) shows that the dependent variables included in the probit model explained 41.32% of the variations in the mobile phone adoption probability. The variables that are statistically significant in the probit model include gender of the farmer, monthly social grant as main income source, private traders as main marketing channel, local market as main marketing channel, monthly income, and effects political and economic factors on agricultural marketing. The explanation of the significant independent variables presented below is based on the estimates of the marginal effects that show the change in the dependent variable for a 1 unit change in the value of the predictor variable. The gender of the farmer was significant at 10% with an inverse relationship with the farmer adopting mobile phone in agricultural marketing. This implies that the probability of a farmer to adopt mobile phones for marketing decreases by 24.19% among female farmers. This finding aligned with previous studies on QIS, which reported high participation of women in the scheme (Gidi, 2013; Chitsa, 2014).

Table 2: Probit regression estimates of the determinants of mobile phone adoption in agricultural marketing

	Probit Regression		Marginal Effects	
Variables	**Coefficients**	**Robust SE**	**dy/dx**	**SE**
Age	0.6860	0.5363	0.1362	0.1381
Gender	-1.2220*	0.6691	-0.2419*	0.1454
Marital status	-0.8564	0.6129	-0.1765	0.1316
Education level	0.6098	0.5254	0.1200	0.1456
Farming as main source of income	-0.1933	0.7486	-0.0496	0.1498
Social grant as main source of income	-1.7969***	0.6727	-0.3564**	0.1672
Size of arable land	-0.0991	0.2529	-0.0179	0.0612
Private traders as marketing channel	1.7883**	0.9214	0.3470**	0.2104
Relatives/neighbour as marketing channel	0.9409	0.7037	0.1979	0.1532
Local market as marketing channel	1.3867**	0.6875	0.2754**	0.1374
Income level	1.1264*	0.6358	0.2032*	0.1296
Political factor	-2.0553**	0.9420	-0.4125**	0.1781
Economic factor	-1.6463*	0.9340	-0.3215*	0.1772
Social factor	0.6657	0.9401	0.1166	0.2149
Constant	1.5107	1.2310		
Number of observation	54			
Pseudo R^2	0.4132			
Prob. > Chi^2	0.0116			

***, **, * indicate significance at 1%, 5% and 10% respectively

In addition, receiving social security in the form of monthly grant was strongly significant at 1% with an inverse relationship with the farmer adopting mobile phones in agricultural marketing. This implies that the probability that a farmer would adopt mobile phones in marketing decreases by 35.64% if the farmer's main source of income is social grant. This is because the majority of the farmer whose main source of income is social grant spends it on feeding and so may not have enough to pay for mobile phone airtime, which is necessary for facilitating agricultural marketing. Another plausible explanation is that, since these farmers received their main income from social grants, their production may be at subsistence level, which may not necessitate active participation in the output market. Choosing private traders and local markets as main marketing channels were both significant at 5% with a direct relationship with the probability of the farmer adopting mobile phones in agricultural marketing. These imply that the probability that a farmer adopts mobile phones in marketing increases by 34.70% and 27.54% among the farmers that use private traders and local marketing channels respectively. Similarly, the monthly income received by the farmer was significant at 10% with a positive relationship. This implies that the probability that a farmer adopts mobile phones in marketing increases by 20.32% among the farmers that receive more than R1000 monthly. This means that utilisation of mobile phones in marketing increases with increase in income of the farmer. This was anticipated *a priori* since increase in income would increase farmers' disposable income with which he/she can buy airtime. Moreover, political and economic factors as factors negatively affecting agricultural marketing were significant at 5% and 10% respectively with inverse relationships. This means that farmers that were affirmative to the questions that both political and economic factors negatively affect agricultural marketing are less likely to adopt mobile phones in marketing. Their probability of adoption decreases by 41.25% and 32.15% for political and economic factors respectively.

4. CONCLUSION

The study revealed that socio-economic characteristics drive adoption of mobile phones in agricultural marketing among smallholder irrigation farmers in the Qamata Irrigation Scheme. Mobile phone services such as voice calls and Short Message Services (SMS) are employed by the majority of the smallholder farmers. Most of the farmers are confronted with the challenges of inability to afford airtime and erratic networks from service providers like MTN, Cell C and Vodacom. The farmers often used relatives and neighbours, private traders, local marketers, co-operatives, private companies and state marketing agencies as main marketing channels. It can therefore be concluded from this study that the socioeconomic characteristics influenced the use of mobile phones in agricultural marketing in the study area.

5. RECOMMENDATIONS

Sequel to the findings, the following recommendations are made. The government through the Independent Communications Authority of South Africa (ICASA) should canvass for the extension of strong and reliable mobile telecommunication networks to rural areas to encourage effective utilisation among rural smallholder farmers. Major mobile telecommunication service providers such as MTN, Vodacom and Cell C should be tasked to provide subsidised service packages like SMS and call services for smallholder farmers in the rural areas. Government extension officers should also be encouraged to employ mobile phones in communicating new technologies and innovations with farmers, but due considerations should be given to the socioeconomic characteristics of farmers while doing this. Lastly, the Department of Agriculture and Agrarian Reforms (DAAR) should embark on more enlightenment programmes among smallholder farmers to encourage the use of mobile phones in agricultural marketing where market participation is dismally low.

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SCALING UP CLIMATE SMART AGRICULTURE FROM THE KOUP PILOT PROJECT OF 80 000HA TO 500 000HA: DOING IT THE LANDCARE WAY

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THIS PAPER WAS NOT AVAILABLE AT THE TIME THE PROCEEDINGS WAS PRODUCED.

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DEVELOPING FARMER CAPACITY TO PRACTICE CONSERVATION AGRICULTURE (CA) AT FARM LEVEL

Pierre, A., Du Toit, P. N. & Nemadodzi, E. A.[36]

ABSTRACT

Global warming, increasing population growth, degradation of soil, reduction in the availability of arable land and increased water consumption creates a sceptic view of the ability of farmers to produce sufficient levels of food in future. This calls for radical improvement of resource management. As such, conservation agriculture is one important option to explore. Such an intervention, over a period of seven years, was undertook by the ARC-Grain Crops Institute in South Africa. On-farm experiments served to provide, under local conditions, an effective foundation for farmers, researchers and extension partners/ to explore, communicate and reflect on the appropriateness and applicability of the system. On-farm experiments significantly contributed to give farmers guidance on several concerns and fears they had about CA and provided tangible evidence of various CA related technologies and practices.

1. INTRODUCTION

A fundamental cause of soil degradation in South Africa is the continuous application of conventional soil tillage methods with the mould board and disc ploughs as the most commonly used implements. Rigorous manipulation of soil is not only highly destructive to soil structure but also results in the decline of soil organic matter (SOM) content, beneficial soil organisms (both much neglected components of the soil), the reduction of soil-water-holding capacity and reduced soil fertility. In an African context, Aagaard (2010:1) reasons that degradation and deforestation are accelerating, and millions of farmers are busy depleting the soil upon which they and future generations depend. By 2009, it became clear to researchers and management at ARC-Grain Crops that conventional production methods have a negative effect on all the components of soil quality. At this point, the search for an alternative system, which will ensure better productivity, sustainability of the land and adaptability to climate change, became a high priority.

The search for an alternative system resulted in a survey conducted among developing grain farmers in the Highveld climatic region of South Africa. Over a period of seven production seasons (2009 - 2016), three projects evolved from the survey. In these projects, a range of practices and technologies, within the farming systems of this category of farmers, were investigated. The aim of the projects was to find strategies and solutions to overcome the obstacles preventing farmers to adopt the CA system as an alternative to the conventional approach. The core objectives of the projects were:

- To exploit all opportunities to expose farmers to the fundamental principles of CA (Minimal soil disturbance, establishment of a soil cover and rotation and associations of crops) through interactive learning and hands-on experience.
- To compare the practice of CA with conventional practices by means of on-farm experiments in close collaboration with farmers.

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- To use on-farm experimental plots to serve as platforms for interaction with and exploration by farmers.

1.1. What makes conservation agriculture a climate smart innovation?

1.1.1. Contributes to carbon sequestration

The FAO (2010:5) states that, when soil tillage is avoided, the occurrence of net losses of carbon dioxide by microbial respiration and oxidation of the soil organic matter is minimised. According to Lal (2015:57A) there are examples from around the world of measurable gains in the soil organic carbon (SOC) pool with conversion from plough tillage to a CA system, not just in the surface layer (0-15 cm) but also in the subsoil to a depth of 50 cm or more. CA, in depleted and degraded agricultural land in particular, contributes to SOC storage (carbon credit), which helps to reverse the greenhouse gas build up with its negative effect on the environment (Tshiombiano and Meshack, 2009:13).

1.1.2. CA Helps with the maintenance of soil cover

Mulching improves microbial activity

Maintenance of a mulch layer provides a substrate (energy) for an increase of microorganisms in the soil. Microorganisms are able to produce organic compounds that acts like a glue. The glue again binds the soil particles together (building soil structure) and that increases the water holding capacity of the soil. In addition, CA improves water infiltration and, in this way, helps to prevent runoff and erosion.

A soil cover helps to reduce crop vulnerability to climatic fluctuations

The protective soil cover shields the soil surface from heat, wind and the impact of raindrops when heavy rainstorms occur (prevents surface sealing). The soil cover also keeps the soil cooler and reduces moisture losses by evaporation. Farmers in dry regions can significantly contribute to reduce crop vulnerability. By establishing a soil cover, the farmer can help to minimise moisture losses as far as possible as this will assist in determining the level of plant available water content in the soil, which in turn will largely contribute in determining the yield of the crop.

To conclude, the objective of CA is not to produce the highest yield, but rather a sustainable optimum yield, especially during bad growing seasons. Thus, sustainability of a technology is judged, not by the highest yield in a good season but a respectable and stable yield in a poor season. This is the criterion of a climate resilient management system (La., 2015:57A).

2. METHODOLOGY

In order to achieve the objectives of the projects, on-farm experimentation formed the core activity of the projects. Since CA was not yet practised by any of the participating farmers, the approach was to enable farmers to compare the conventional system to CA. According to Lele and Makki (1996:55), risk averse farmers need to be convinced about the potential success rates of the innovation. Adesina and Baidu-Forson (1995:5) have shown that farmer’s participation in on-farm tests have significantly contributed to higher adoption rates.

In all cases, the experiments were designed to include all three fundamental principles of CA which is: firstly, minimum soil tillage and direct seeding, secondly, establishment of a soil cover and thirdly, rotation and association of crops. The aim of the experiments was to compare the conventional system with CA in the same field. In one case, crop rotation as a core principle of CA was investigated separately at Tafelkop, an experimental site in Limpopo (see Figure 4.3). On-farm experiments were purposefully used as platforms of communication, interaction and information sharing, at various field events. The on-farm experiments were monitored, harvested, analysed and the results were shared with the respective farmer groups in purposeful feedback and planning sessions. Several exposure trips to expose farmers to farmers already practicing CA on their farms were undertook.

Throughout the project implementation phase, interactive training was an activity making an important contribution to effective interaction and communication. In the seven years of project implementation forty-three events were conducted, in which a core group of 399 target farmers participated actively.

At an early stage in the projects, it became clear that links to and collaboration with the private sector in well-established partnerships was crucial in the provision of equipment and input-output markets (Thiombiano and Meshack, 2009:17). Since then, strong collaborative activities were created with agricultural businesses like NTK, Afgri, NWK, Progress Milling, Intrac Trading and Grain SA. Aagaard (2010:8) argued that any development activity (including the promotion of CA) not established on the premise to construct a foundation on which the private sector can flourish is doomed to failure.

3. EXPLORING CA TOGETHER WITH FARMERS

3.1. Improving access to CA mechanical equipment

According to the survey, cost savings on mechanisation was identified as an advantage of CA. At the implementation phase, farmers argued that CA could contribute to savings on mechanization costs due to less wear and tear of tractors and implements. In a purposeful attempt to close the gap between the CA mechanisation industry and the farmer the project management team significantly contributed to expose farmers to private initiatives in developing appropriate CA equipment. Since 2009, considerable efforts were made by local engineering companies to help farmers to gain access to more affordable no-till planters and hand operated planting equipment. One of the local planters that was developed in this category is the Piket planter, a planter favoured by farmers mostly due to its lower price. The planter is available in both a two-row and a four-row unit. The price of the two row Piket is R40 000 excluding VAT. This price is substantially lower than imported brands such as the Brazilian Vence Tudo of which the two-row unit cost R135 000 excluding VAT.

One possibility to curb high mechanization costs is to assist farmers to convert their existing planters to no-till planters. A company such as Germishuys Engineering specialises in converting certain models of used, conventional John Deere and Massey Ferguson planters into no-till planters. The cost of such a conversion is R13 500/ row unit. This implies that to convert a four-row unit will cost R 54 000 excluding VAT.

3.2. Experimentation serving as key activity in the projects: Results and discussion

During the survey in 2009, farmers indicated that they can-not afford the risk of reduced crop yields due to the implementation of a new production system. This concern of farmers was regarded valid as it is the short-term benefits which, to a large extent, will determine the attractiveness of an innovation. As soon as the survey was completed, on-farm experiments were implemented as a means to determine the yield response on the implementation of CA as compared to the conventional method. During the period 2008 – 2016, a number of on-farm experiments on CA were established with variable results. Unfavourable climatic conditions at some of the trial sites, in 2010 and 2011 and later in 2014/15 had a serious impact on crop yields. The detail below, gives a clear indication of the relative results obtained in the experiments.

Limpopo – Tafelkop (2008 – 2011)

During the three seasons of the experiment (2008/09–2010/11), the no-till plots performed progressively better than the conventional plots (see Figure 4.1).

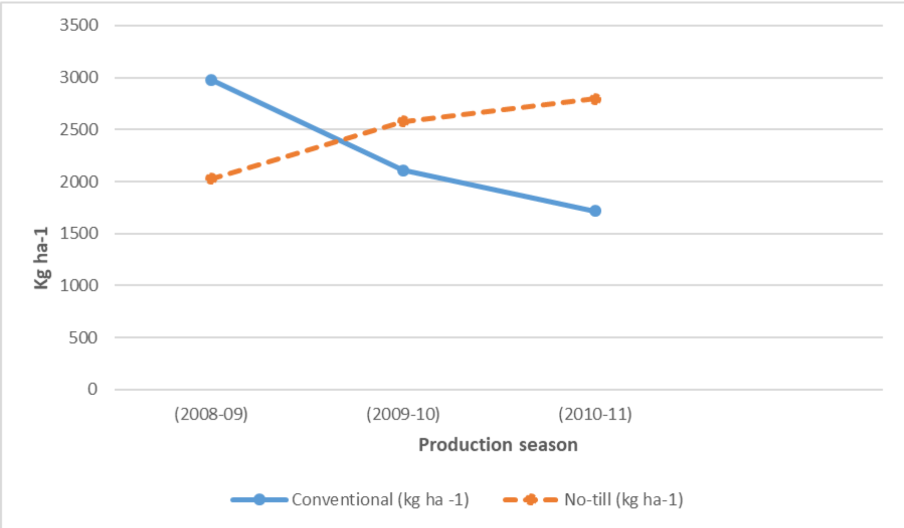

Figure 4.1.: Maize yields at the Tafelkop experimental site over three seasons

Mpumalanga – Balfour (2013 – 2016)

From Noncedo, the experimental site in the Balfour area, it is clear that the mean yield values of the CA plots gradually increased in comparison to that of the conventional plots (see Figure 4.2).

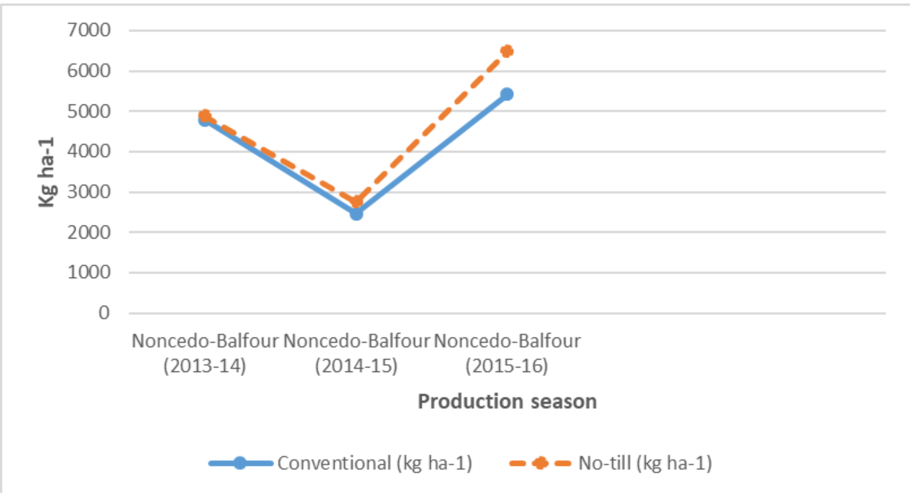

Figure 4.2: Maize yields at the Mpumalanga-Balfour experimental site over three seasons

The results thus show that in the longer term, there is no indication of a decline in yield in the case where CA was practiced. In this way it can be concluded that the experiments significantly contributed to allay the fear of a decline in yield (also called a yield penalty), as voiced by farmers participating in the survey. Research work done in Zimbabwe between 2010 and 2013 supports these findings. Under moderate rainfall and better inherent soil fertility conditions, illustrated by medium rainfall (500-800 mm) agro-ecoregions, CA systems outperformed the conventional practice (Mupangwa et al., 2016).

3.3. Soil cover (mulch) management and the implications for livestock

The benefits of CA are most directly attributed to the mulch of crop residues retained in the field (Giller et al. 2009:3). The attainability of a permanent soil cover should be viewed at two levels: firstly, the crop production potential of an area and secondly, the livestock component' in the area.

3.3.1. Crop production potential

Farmers interviewed in 2009 were sceptic about the attainability of a proper soil cover. They reasoned that the limited availability of crop residue, especially in dry seasons when crop yields are low, would make the establishment of a soil cover difficult to achieve.

Monitoring the level of soil cover in the experiment plots was an important activity in the projects. As a result of the no-till practices applied, farmers could observe and monitor the level of soil cover that was obtained. At the experimental sites in the North Western parts of Mpumalanga and in Limpopo in particular, the soil cover was insufficient (below 30 %) due to the dry conditions occurring in the seasons from 2009 to 2011. At the experimental plots in Balfour, conditions were better to successfully establish a soil cover. At planting time in the 2013/14 season, the percentage organic matter covering the surface was respectively 37 % at Mpembe and 41% at Noncedo.

3.3.2. The livestock component

On many farms, livestock forms an integral part of the farming system. Where farmers are relying on crop residues to be utilised by livestock, a conflict of interest arises as maize stover in particular, is well known for its highly valued fodder. The establishment of fences is the only way to control livestock in order to be able to maintain a soil cover. This proves to be a difficult and costly practice for low-income farmers, especially those in communal areas. Some farmers, however, succeeded in the establishment of fences with the purpose to be able to maintain their soil cover. Participating farmers were also encouraged to increase their fodder production by introducing a fodder crop with a high biomass potential on separate land. In the drier regions of South Africa, the limited availability of crop residue might be an important constraint contributing to the low adoption level of CA practices by developing farmers.

3.4. Crop rotation

Rotation of crops in a properly applied CA system is one of the basic principles of the system. It was important to cover all the components of CA in the project in order to provide participating farmers with a complete view of the practice of CA. Confirming this was that among others, a key finding at an African Congress on CA was that CA can only bring benefits to farmers if all three principles are practiced (Paul-Bossuet, 2014). This was the motivation for the experiment that was established at Tafelkop, one of the selected sites where CA was to be promoted. The purpose of the experiment was to evaluate what contribution cowpeas (Vigna unguiculata) and groundnut (Arachis hypogaea L.) can make in the cropping system of the Tafelkop farming community. These two legume crops were included in a rotation system with maize (see Figure 4.3). A trial was planted in 2010/11 growing season with three main blocks where maize, cowpea and groundnut were planted respectively. In the second season (2011/12) all blocks were planted with maize in order to see the benefits of residual N and rotational effect from plots previously planted with legumes compared to maize monoculture. Significant differences were observed in the yields and yield components of both maize planted after legumes and maize in monoculture. Maize in a rotation demonstrated higher yield compared to maize in monoculture. $N0_3^+$ and NH_4^+ were higher in soils where legumes were planted, compared to a maize plot in the previous season. Rotational effect could have also attributed greatly to the higher yield in maize grown after the two legumes.

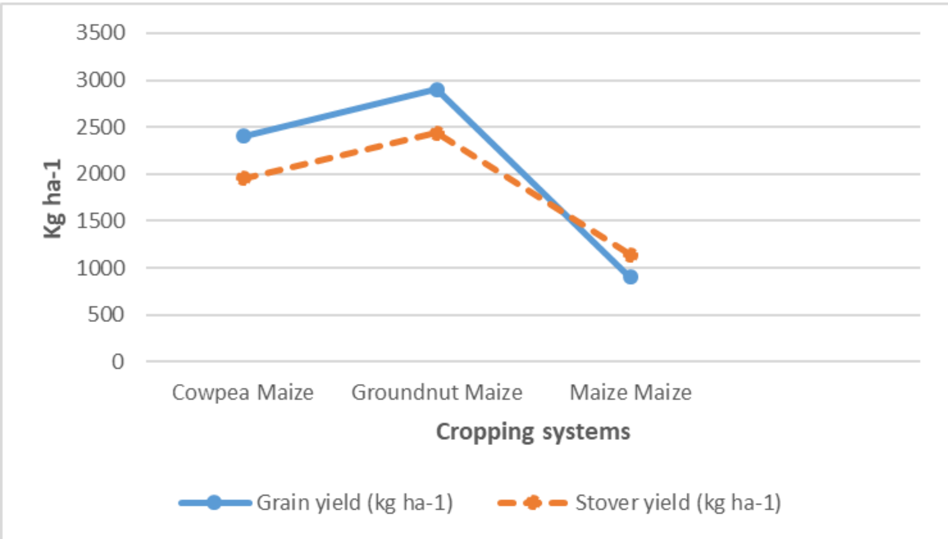

Figure 4.3: Effect of rotation on grain and stover yield of maize at the Tafelkop experimental site in Limpopo

The study confirms, however, the importance of including legumes like cowpea and groundnut in the cropping system to improve maize yield if planted in a rotation.

4. APPLICATION OF LIME IN A NO-TILL CROPPING SYSTEM

There is no guarantee that acidification will not occur in a no-till system. The major cause of soil acidification is the repeated application of nitrogen fertilisers (ammonium-based N fertilisers in particular). In the 2009 survey, farmers were concerned that they will not be able to curb acidification as lime needs to be incorporated in the soil by means of a tillage operation. Research, however, has proved that regular application of lime on the surface of no-till soils can prevent soil acidification. The application of smaller amounts as low as 750 kg ha^{-1} of surface applied lime each year before nitrogen fertiliser is applied, can reduce soil acidity (Phillips, 2016:54).

It is, however, essential that highly acidic soils be adequately treated with lime, before starting the implementation of a no-till and CA system. If this is not the practice, surface applied lime will not correct the effect of high levels of acidity and hence, no improvement in yield will occur. According to Lal (2015:59A), in degraded soils, a successful adoption of CA without prior amelioration can be a myth, especially for resource poor farmers. The application (in 2012 prior to the first planting season) and the positive effects of liming was well demonstrated and communicated to farmers at the two trial sites at Balfour, Mpumalanga.

5. EFFECTIVE WEED CONTROL IN A CA SYSTEM

In the 2009 survey, farmers were well aware of the importance of proper weed control in successful crop production. In a no-till system however, they perceived effective weed control as a practical problem since no tillage operations are applied. Weed control in a CA system differs considerably from the conventional system. As no soil tillage is applied, chemical weed control has to become a key activity of CA practice. In a conventional system, the farmer gains an early advantage over weeds as a result of overturning the soil. At the stage the survey was conducted, participating farmers had little experience in the use of herbicides as they relied on the traditional method of manual weed control.

In view of the lack of knowledge and experience in the use of herbicides, the project was seen as an opportunity to expose the farmers to various herbicide products and the correct application thereof. In the on-farm experiments, pre- plant weed control practices as well as pre-emergence and post emergence herbicide applications were demonstrated. In this way, some of the participating farmers were motivated to do their own experiments with some of the herbicides in their own fields.

6. CONCLUSION

The interventions over a period of seven years, served as great opportunities to explore and promote the potential value and implications of CA in the context of the developing sector. Considering the abovementioned project results, it can be stated that much progress has been made to broaden the perspectives and to allay farmer’s concerns about the CA system. At this point, farmers in the target groups have gained considerable levels of awareness, knowledge and insight into CA as an alternative practice.

Despite the valuable progress made, significant change towards CA among developing farmers will require much more time and effort. One prominent shortcoming of the projects was the low level at which farmers were involved in project activities despite the emphasis on open communication and tangible farmer participation. In future, a learning environment should be created in which small farmer groups participate actively in their own on-farm experiments. Yates, (1995:10) argued that the farmer has more at stake than any of his partners and will undertake his own evaluation of all proposed technologies. In a social learning environment, farmers are enabled to reflect on, to modify and to adapt CA technologies to their local circumstances (Smith et al., 2007:3). In this action research approach, the most important functions of researchers and extension workers are, firstly, to facilitate participating farmer groups through all the stages of the research cycle and, secondly, to ensure that a learning environment is established. Finally, the challenge is to manage the interventions beyond the stage of awareness and knowledge. Farmers, as managers of vulnerable resources, need to be motivated and supported towards the embrace of their own responsibility as workers of the land and the importance and high value of their stewardship.

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EXTENSION WORKERS' PERCEPTIONS REGARDING THE DIGITAL MOBILE TECHNOLOGY SERVICES IN ADDRESSING CLIMATE CHANGE ISSUES: A CASE STUDY OF BOTSWANA

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THIS PAPER WAS NOT AVAILABLE AT THE TIME THE PROCEEDINGS WAS PRODUCED.

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DEVELOPMENT OF A 'PLANTING APP' FOR MAIZE ACROSS SOUTH AFRICA

Walker, S.[38], Kaempffer, L. C., Newby, T., Ferguson, J. & Van der Burgt, F.

THIS PAPER WAS NOT AVAILABLE AT THE TIME THE PROCEEDINGS WAS PRODUCED.

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FOURTH SESSION

SUB-THEME 3: SCALABLE CSA TECHNOLOGIES AND INNOVATIONS

FRUITLOOK: A SPATIAL APPROACH TO ASSESS AND IMPROVE WATER USE EFFICIENCY OF VINEYARDS AND DEDIDUOUS FRUIT ORCHADS IN SOUTH AFRICA

Roux, A., Jarmain, C. & Goudriaan, R.

ABSTRACT

Water is a critical resource in South Africa, which challenges the irrigated agricultural sector to explore innovative solutions to improve the use thereof. New technologies developed, using satellite data, show the spatial and temporal variations of the actual crop water use, growth parameters and nitrogen content at field level and helps farmers to improve their production and reduce the inputs and associated costs. FruitLook uses this technology to offer weekly updates for grape and deciduous fruit producing areas in the Western Cape through the web-portal www.FruitLook.co.za. All users, such as farmers, researchers and farmer advisors could evaluate the service for free during the irrigations season of 2011/12 to 2016/17.

FruitLook makes use of a processing framework that utilises a number of algorithms (e.g. MeteoLook, SEBAL), satellite (DMC, VIIRS, MSG, Landsat 8 and Sentinel-2 images) and field data (weather) to produce data maps of nine parameters related to crop water use, growth and mineral content.

The accuracy of the parameters, specifically evapotranspiration, is important. Field work was done to estimate the evapotranspiration and was used to determine the data accuracy and further improve the algorithms. FruitSupport will warn users via email if a significant increase in variation occurs within an irrigation block.

FruitLook is a project assisting irrigators to optimise their water use efficiency and is funded by the Western Cape Provincial Department of Agriculture.

1. BACKGROUND

In South Africa, a wide variety of driving forces is leading to new claims on water, enhancing the competition for water between users (agriculture, urban sector, industry). Moreover, the National Water Act (1998) states that water should be used efficiently. Firstly, it has to be reserved for basic human needs and for protecting aquatic eco-systems, meaning that agriculture has received a lesser priority than before. Due to a general lack of water resources in semi-arid and arid zones of the Western Cape, and the fact that basic human and environmental requirements need to be met first, water is an increasingly scarce input in agriculture.

The fruit producing sector is the major contributor to agriculture in the Western Cape Province of South Africa and includes table and wine grapes as well as the various fruit crops produced. The challenge is to increase agricultural production while reducing water consumption – increase the water use efficiency (kg of produce per m^3 of crop water use). The challenge is to determine the actual evapotranspiration (ET_{act}).

2. SEBAL TECHNOLOGY

Information on crop water consumption is difficult to obtain. Field measurements are expensive and do not show the spatial variation. WaterWatch, a company in the Netherlands developed the Surface Energy Balance Algorithm for Land (SEBAL) technology to calculate the evapotranspiration and water use efficiency of crops through sophisticated remote sensing algorithms.

The SEBAL model estimates energy and evapotranspiration fluxes from earth observation data at different spatial scales ranging from field to entire catchments. SEBAL has been applied extensively across the world, also in the Western Cape from 2004 to 2017.

SEBAL involves a set of equations in a strict hierarchical sequence to convert the spectral radiances measured by satellites into estimates of the surface energy balance. SEBAL is based on the simplified energy balance of a surface. Inputs on land characteristics and atmospheric properties such as the vegetation index, surface albedo, surface temperature and cloud cover are derived from satellite data. In addition to the satellite data, SEBAL requires spatially extrapolated meteorological data (wind speed, humidity and air temperature) from local weather stations. SEBAL determines actual and potential evapotranspiration on a pixel-by-pixel basis. Besides crop evapotranspiration, SEBAL estimates biomass production, evapotranspiration deficit, leaf area index and the biomass water use efficiency. In combination with yield data, it can be used to determine the water productivity.

The energy balance of a surface is generally described by

$$LE = Rn - G - H$$

where Rn is the net radiation, G the soil heat flux density, H the sensible heat flux density and LE the latent energy flux density (Figure 1). The latent energy flux density is equivalent to the actual ET from a surface. Both the SEBAL model and the eddy covariance system, estimates all these components of the energy balance and the resultant ET

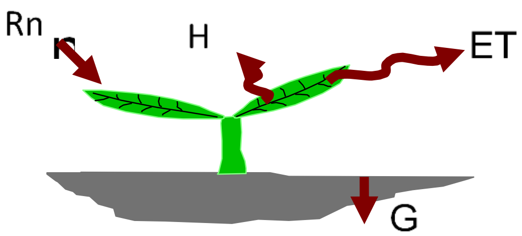

Figure 1: An illustration of the energy fluxes from a surface as used in the SEBAL calculations

Crop nitrogen status is not estimated with SEBAL, but can be determined from the reflectance in the green, red and near infrared spectrum, which are input data to SEBAL.As a result, the nitrogen status can be determined from various satellites' data including HJ-1A, HJ-1B, ASTER, Landsat 7 ETM, Landsat 8 OLI and DMC.

3. GRAPELOOK PROJECT

Through a retrospective study undertaken in 2008 WaterWatch assessed the application of remote sensing data to optimise irrigation water use of vineyards in a part of the Western Cape Province for the period 2004 to 2007. The results generated were compared with the data from ET estimates obtained from water balance. Calculations and an acceptable correlation between the two data sets indicated the relative accuracy of the SEBAL technology. See two graphs in Figure 2 below. Irrigators indicated interest in the project and the results, but as the results only became available at the end of the study period, the practical application of the data to assist irrigation management on farm level were not possible.

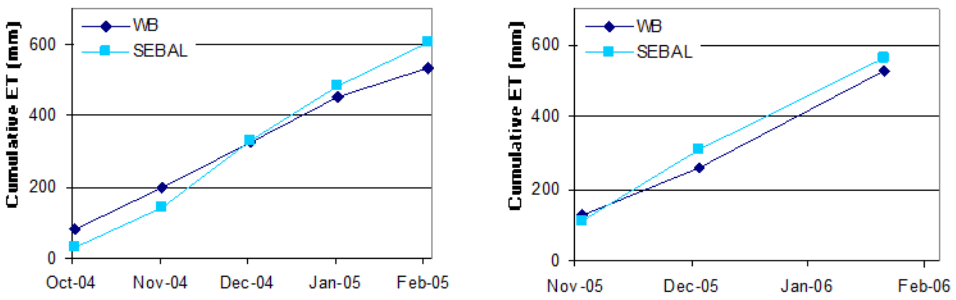

Figure 2: Validation of SEBAL ET results against ET estimates from water balance measurements in the Hex Valley

This led to a real-time demonstration project, called GrapeLook, which was launched for the 2010/2011 irrigation season. The objective of the project was to provide information on a weekly basis to irrigators of grape vineyards to assist them with irrigation and fertiliser management. The project (www.GrapeLook.co.za) provided weekly updates for the period 1 September 2010 to 30 April 2011 for the majority of table and wine grape producing areas of the Western Cape. Information relating to crop water, growth (bio-mass) and nitrogen status was made available using satellite technology.

3.1. Objectives of GrapeLook project

The objectives of the project were to:

- Use an innovative tool (remote sensing) to increase agricultural production while reducing water consumption, i.e. to sustain and increase grape production with the limited available water resources
- Provide weekly updated information on parameters such as evapotranspiration, evapotranspiration deficits, biomass produced, water use efficiency of biomass production, leaf area index and crop nitrogen status for individual irrigation blocks;
- Provide a forecast of soil moisture change over the five days after satellite image acquisition (to the participating farmers only);
- Disseminate this information through the GrapeLook website to all parties (farmers, irrigation consultants, etc.);
- Provide farmers and other users the opportunity to evaluate the benefits the operational service.

The potential benefits of the project to farmers were to:

- Increase sustainability and economic viability of irrigation farming enterprises;

- Schedule and monitor irrigation while aiming for sustainable resource management, i.e. development and implementation of on-farm irrigation strategies;
- Determine nitrogen use and actual crop nitrogen needs (to optimise fertilizer applications and to combat over-use);
- Reduce nitrogen leaching into streams and groundwater systems.

3.2. Information provided

The field data provided calibration and validation information to assess the outputs of the SEBAL algorithms. Soil moisture measurements were recorded on a continuous basis at various depths in seven grape blocks and submitted to the framework. This provided a better insight into how IrriLook, an irrigation advisory tool developed by WaterWatch, that provides 5-day forecasts on soil moisture in the root zone was performing. An Eddy Covariance system in a table grape block in Hex River valley provided information to evaluate the SEBAL estimates on energy fluxes.

The following information was provided through the GrapeLook website:

Growth parameter	**Unit**
Growth	
Biomass production	kg per ha per week
Leaf Area Index (LAI)	m^2 leaves per m^2 soil
Vegetation Index (NDVI)	
Moisture	
Actual evapotranspiration	mm per week
Evapotranspiration deficit	mm per week
Crop factor	
Biomass water use efficiency	kg per m^2 of water
Minerals	
Nitrogen content in all leaves	kg per ha

A group of participating farmers received forecasts on soil moisture and irrigation water requirements on a weekly basis on block level in graphs. Additional to the website, which was accessible to anyone, a SMS service was set up for the participating farmers. These farmers received regular SMS messages on their cell phone with specific information on one to three irrigation blocks. The SMS service was also used to inform the farmers about upcoming meetings and workshops.

Although very successful, the soils analysis required for each participating irrigation block (to determine the moisture retention properties) as well as installation and monitoring of soil moisture probes proved to be a tedious activity. Therefore, it was decided that this service be discontinued as part of providing near real time data.

3.3. Key lessons learnt

The objective of the GrapeLook project was to demonstrate an operational service to users in the Western Cape Province. Should this be successful, the service could be provided to all irrigation areas in South Africa. The following key lessons were learnt:

- An operational service should be reliable in terms of data quality and delivery. Therefore, there should be alternatives for all input data. For example, it cannot rely on one satellite source as satellites may break down. The development of a 'multi-satellite framework' that works on different satellite sensors can be used to spread the risk.
- A system such as GrapeLook requires a framework in which all data is processed similarly, and procedures are automated where possible to avoid (human) errors and ensure constant data quality.
- Existing algorithms require continuous calibration and validation. The validation of SEBAL with Eddy Covariance measurements resulted in an improved SEBAL version.
- The success of dissemination of information is strongly correlated with user friendliness, the speed of the website and the availability of a reliable and effective internet service to irrigators in the rural areas. During the demonstration project, a number of measures were taken to increase the website speed, such as subdividing the data into regions to reduce the data load, the removal of small blocks in the soil moisture forecasts and hosting the website data on a faster server. A website with a registration feature (login) will reduce the data transfer size considerably
- The quality of the service provided is very important as farmers question the accuracy of the data. The calibration and validation of the models/algorithms used with in-situ measurements can contribute towards user acceptance of the data provided

The project was funded by the Western Cape Provincial Department of Agriculture with financial support from the Department of Agriculture, Forestry and Fisheries and the European Space Agency. The project was executed by WaterWatch in collaboration with the University of KwaZulu-Natal (UKZN), responsible for field work required to validate the SEBAL generated data.

4. FRUITLOOK PROJECT

The positive response received from grape farmers and irrigation advisors on the GrapeLook project resulted in the continuation of the project into the 2011/12 irrigation season. It was extended to cover all fruit crops in the area covered by the satellite image – hence the name change to FruitLook. The project (www.FruitLook.co.za) provided weekly updates for the period 1 October 2011 to 30 April 2012 for the majority of the fruit producing areas of the Western Cape. The project was then repeated annually for the

2012/13 to 2016/17 irrigation seasons to provide near-real time data to the users through the web portal. As more funds became available due to the recognition of the value of the information provided to the agricultural irrigation industry, the eastern boundary of the area covered by the project, was extended over the last two seasons and reached the towns of Montagu/Bonnievale for the 2016/17 season.

4.1. Objectives of FruitLook project

The main purpose of FruitLook was to provide farmers with improved knowledge on the temporal and spatial variations on their farm. During workshops and farm visits, farmers received training. This included training on how information on the spatial variability allows high precision water and fertiliser management and reduces the number of field visits and field samples required. The weekly updates show when blocks need pruning to control vigour, show delayed grow, and identify problems with their irrigation system at an early stage. Comparison of the different parameters between and within seasons helps evaluating farm management practices. FruitLook services provide data on the irrigation efficiency and thus contribute towards improving the water use efficiency (kg of crops produced per m^3 of irrigation water used). It can also assist with reducing labour and input costs, increase product quality, yield and profits.

4.2. Changes to website

In GrapeLook (the 2010/11 season), the end-users could view all the spatial datasets at once through the web portal and navigate to their area of interest. The drawback was that data download of these entire datasets was slow, hence users were discouraged to revisit the website. Therefore, a strong requirement for FruitLook was to increase website speed to make the data available to all, also users with slow internet connections. For this reason, the data portal FruitLook.co.za was created for the 2011/12 FruitLook season. The following major changes were made to result in a faster and more accessible website:

- Reduce the amount of data downloaded and required to see the parameter maps: Due to the user login and area of interest delineation system, only relevant data is downloaded onto users' computers, which greatly improves the speed at which the website operates;
- Reduce general data download from the website by giving minor importance to design: The website speed was improved by simplifying the website design. For example, round corners have been removed, as well as shadowing effects.
- Continuous changes during the 2014/15 and 2015/16 season have been made to the FruitLook platform to improve the user experience. This includes the introduction of a new order system based on predefined field shapes, an easy re-order process of data based on field boundaries from previous seasons and a function to delete fields from an account. An updated version of the FruitLook manual has been made available via a prominent button on the FruitLook website. Furthermore, monthly newsletters have been disseminated to inform subscribers on FruitLook news and explain the use of the FruitLook parameters in farm management. In total 1 129 individuals (as of 30 April 2016) received the FruitLook newsletter.

4.3. Information provided and potential value adding to farming practices

The special variation that can occur in an irrigation block might indicate an irrigation system that is not delivering a consistent amount of water throughout the irrigation block, an adapted irrigation might be required to meet the soil type variations, plant diseases that impact on biomass production and thus evapotranspiration. See Figure 3 below. A study of all the parameters on which information is provided will assist to get to the reason for the special variability within the irrigation block.

The interpretation of the information provided assists farmers to make management decisions relating to the utilisation of resources such as water and fertiliser. This can result in reduced input costs, improved production and product quality and reduced pollution of water streams and rivers due to a reduced irrigation return flow.

The information can also be used by the Water Users Associations (WUA) to manage the water utilisation at an irrigation scheme level, whilst the farmers will only be interested on the farm level utilisation

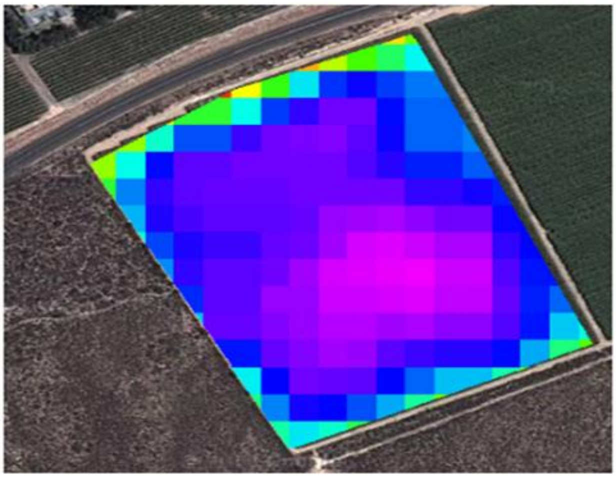

Figure 3: Spatial variation of actual evapotranspiration of an irrigation block

4.4. Utilisation of data provided through the FruitLook website

The actual test for the utilisation of the data can be obtained from the number of irrigation blocks registered on the web portal and the number of returning visitors to the web site.

For FruitLook to be successful, data provided through the web portal needs to be useful and be used. Google Analytics is a tool that can be used to analyse website traffic (registration and visits). At the end of the 2016/17 project year the total number of subscribers to FruitLook was 1 615, with the majority of them unfortunately not yet regular users of the website. 466 subscribers have registered irrigation blocks, an increase of 30% compared to the previous season. The increase can also be seen within the total amount of orders made (20 584 orders; +39%) and hectares ordered (64 410 ha; +41%). The orders are split in 10 796 orders for data from the running season (34 860 ha) and 9 788 orders for historical seasons (29 550 ha). A notable increase can be seen in the usage of FruitLook in the wine sector, citrus sector as well as on other crops. Close to 6 000 ha was ordered for use on other crops than fruit crops, which can be associated with the expansion of the project area and the increased coverage of field crops. Generally, most orders are made for grapes (15 327 ha; 12 831 ha wine grapes and 2 171 ha table grapes) followed by deciduous fruits (9 299 ha). FruitLook remains popular in the Breede River, with orders covering 13 935 ha. There is however a notable increase in the Berg River area, to 11 146 ha. The usage in the Olifants River catchment also increased slightly to 9 639 ha.

Table 1: Total orders, hectares and average order size per season. The columns on right hand provide an overview of the ordered hectares without taking orders larger than 25 hectares into account.

	Sum TOTAL (Orders)	Sum TOTAL (hectares)	Average Order Size TOTAL (hectares)		Sum Orders <25ha (Orders)	Sum Orders <25ha (hectares)	Average Order Size <25ha (hectares)
2010/11	1,089	11,664	10.7		1,053	3,512	3.3
2011/12	2,211	24,482	11.1		2,105	7,810	3.7
2012/13	1,970	19,413	9.9		1,896	6,646	3.5
2013/14	2,609	25,663	9.8		2,549	8,363	3.3
2014/15	4,921	39,003	7.9		4,834	15,608	3.2
2015/16	7 979	45 537	5.8		7 893	23 500	3.0
2016/17	10 796	94 597	8.8		10 523	34 860	3.3
TOTAL	38 296	310 130	8.1		37 432	120 698	3.2

Table 2: Total orders, hectares and average order size per crop type from data orders for the running 2016-17 season. Only orders smaller than 25ha are taken into account.

Crop Type	Orders	Ordered Hectares	Av. Order Size (ha)
Apple	2,507	6,961	2.8
Pear	790	1,950	2.5
Other Deciduous Fruits	106	388	3.7
Apricot	35	79	2.3
Nectarine	161	391	2.4
Peach	229	643	2.8
Plum	196	508	2.6
Other Stone Fruit	64	259	4.0
Citrus	627	2,430	3.9
Berries	19	71	3.7
Red Table Grape	641	1,687	2.6
White Table Grape	212	485	2.3
Red Wine Grape	1,849	6,529	3.5
White Wine Grape	2,221	6,302	2.8
Other Grapes	108	325	3.0
Vegetables	266	2,678	10.1
Other Crops	492	3,175	6.5
TOTAL	**10,523**	**34,860**	**3.3**

A survey has been done this season to investigate the type of user that is using the website. For this survey, the first time someone visits the FruitLook website (which is determined via their IP address) a popup is shown asking the visitor to identify which kind of user he or she is. In total 1402 website visitors responded to this survey and the results are shown in Figure 4.

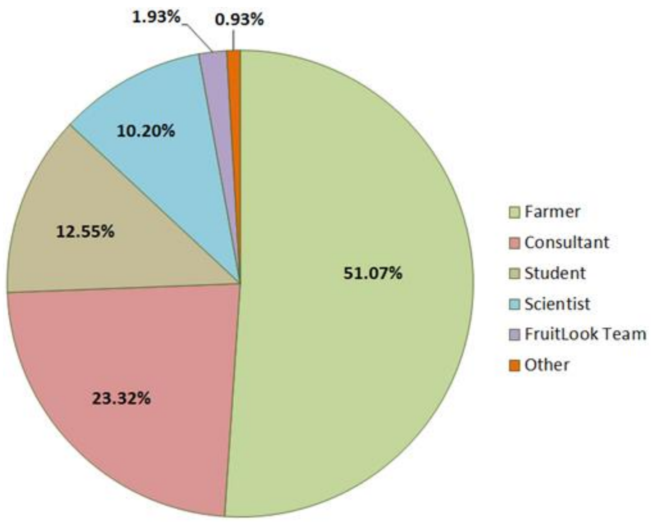

Figure 4: Type of visitors to the FruitLook website in percentage.

Google Analytics also provides information on geographical distribution of visitors. The highest amount of visitors came from South Africa, representing 82.1% of the total visitors (6,729 visits). Most other visits originated from The Netherlands (434) and the United States (171). The high amount of visits originating from the Netherlands can be linked to the eLEAF project team.

4.5. FruitLook questionnaire

A questionnaire on FruitLook impact has been disseminated at the end of the 2014/15 FruitLook monitoring period. The questionnaire focused on the usability of FruitLook in water management and the impact of FruitLook on farm resource management in general. In total 27 people responded. FruitLook was deemed most useful to detect over- or under irrigation, for the placement of soil moisture probes, the detection of drainage problems and post-season evaluation of irrigation efficiency. In this questionnaire over 60% of the respondents indicated FruitLook positively affected their water management by 10% or more. More than 40% of the respondents indicated that due to FruitLook they saved at least 10% irrigation water; 10% even indicated their savings were higher than 30%.

4.6. FruitSupport

A healthy high producing block is often homogeneous and develops accordingly during the season. A sudden increase in internal variation of a block can be due to disease, pest, water deficit or other crop development issues which might affect yield. Other, more innocent causes of increasing variation within a block can be extensive pruning or weeding. FruitLook provides spatial data at relatively frequent intervals which allows detection of these changes in block variation through time. When a part of the block shows a significant disposition in growth compared to other parts of the block, FruitSupport will detect this. If this leads to a significant increase in variation FruitSupport will warn users via email. These emails are emitted directly after the week data upload to FruitLook.

5. CONCLUSION

The GrapeLook and FruitLook projects indicated that an innovative tool (remote sensing) can be used to provide valuable information of important growth parameters that can result in an increase of agricultural production while reducing water consumption, i.e. to sustain and increase grape production with the limited available water resources. The actual increase in water use efficiency can only be calculated after running the project for a few years and then also taking climatic variations into account.

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INTRODUCTION OF BIOGAS-DIGESTER TECHNOLOGY AS A CLIMATE CHANGE MITIGATION MEASURE IN SMALL-SCALE FARMING COMMUNITIES OF AMATOLE DISTRICT MUNICIPALITY (EASTERN CAPE)

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THIS PAPER WAS NOT AVAILABLE AT THE TIME THE PROCEEDINGS WAS PRODUCED.

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CROSSBREEDING IN BEEF CATTLE FOR INCREASED EFFICIENCY IN RESPONSE TO ENVIRONMENTAL CONDITIONS

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ABSTRACT

Extension services will have to review and evaluate current production and breeding strategies and give new consideration towards cow efficiency that now includes composite and crossbreeding systems. Crossbreeding between British / European sire lines and indigenous dam lines may become more important to increase beef production in the near future. The importance of indigenous breeds that are adapted to the anticipated warmer climate, lower nutritional value of the grazing and harsher conditions is on the increase. The aim of this study was to evaluate the Nguni wean performance in a terminal crossbreeding system. The research was conducted over a period of four years in a semi-arid area. A total of 238 weaning weight records were collected (167 Nguni and 81 Angus x Nguni). The 205-day weaning weight of the Angus x Nguni calves were 177 kg and that of the pure Nguni calves were 145 kg. Although the adjusted weaning weight of the Angus x Nguni calves was 32 kg higher than that of pure Nguni calves, the difference was not significant. This can be attributed to the large variation in weaning weights, with that of the pure Nguni calves ranging from 56 kg to 230 kg and that of the Angus x Nguni calves from 105 kg to 303 kg. If cow efficiency is expressed as kilogram calf weaned per Large Stock Unit, the cow efficiency of cows with Angus x Nguni calves improves by 22%. The results showed that crossbreeding can increase the weaning weights of crossbred calves from Nguni cows.

Keywords: Climate change, adaptive breeding strategies, Nguni x Angus crossbreds

1. INTRODUCTION

The Climate Change sector plan for Agriculture, Forestry and Fisheries (Government gazette, Notice 7 of 2013) of South Africa calls for enablers and implementation guidelines that involve strategic issues and implementation tools to minimise the negative effects of climate change on the sector. The strategies for utilisation of available animal genetic resources to improve cattle production in changing production environments certainly forms part thereof. Cattle genetic resources in South Africa comprises of Bos *indicus* (Brahman and Boran), Bos *taurus* (Angus, Hereford, Red Poll, Simmental, Charolais, Braunvieh, Gelbvieh, Pinzgauer, Santa Gertrudis, Senepol, Shorthorn, South Devon, Sussex, Romagnola and Limousin) and Sanga (Afrikaner, Nguni, Drakensberger and Tuli) and a number of composite breeds (Scholtz, 2010). Some of these genetic resources have been characterised for traits of economic importance and may assist farmers to choose breeds based on performance data rather than ordinary phenotypic characteristics. In these studies, a high reproductive rate was emphasised as a fundamental factor to the overall efficiency of a beef cattle enterprise.

According to Maule (1973); Barnard & Venter (1983); Schoeman (1989); Scholtz *et al*. (1991) and Muchenje *et al.* (2008) indigenous breeds are more productive when compared to exotic breeds mainly due to their high reproductive rates and low progeny mortality rates. This is attributed to the fact that indigenous cattle breeds evolved in environments with high temperatures, limited feed and sometimes water resources and vector-borne diseases. As a result, indigenous breeds are better adapted to the harsh South African environment. It therefore infers that breed utilisation should focus on these breeds, more specifically as dam lines as they

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have proven to have better mothering ability than their counterparts (Moyo & Mpofu, 1999; Theunissen *et al*., 2013; Okeyo *et al*., 2015).

Extension officers should note that technology development in South Africa firstly moved beef cattle production from a purebred orientation to a production orientation, but the emphasis is shifting towards an efficiency orientation that now includes composite and crossbreeding systems (Theunissen *et al*., 2013; Mokolobate *et al*., 2014). In crossbreeding, important traits associated with fertility in particular, that have with low heritability, showed fast improvement (Theunissen *et al.*, 2014). Previous research outcomes also display improved cow productivity with cross breeding (Theunissen *et al*., 2014; Mokolobate *et al.*, 2015) and consequently reduces the environmental impact of beef production (Scholtz *et al*., 2014).

Calegare *et al*., (2007) recommended terminal crossbreeding practices with small framed indigenous cows for improved output of commercial beef cattle farming. This augmented efficiency arises from the potential increase in weaning weight of up to 26% per cow bred, while the energy requirements only increases by 1 % (MacNeil, 2005; MacNeil *et al*. 1991). Conversely, Morris *et al.* (1993) cautioned on the attempt to extrapolate research results to all environments other than those similar to where the studies were conducted because of the presence of genotype x environment interactions.

Improved breeding systems need to be sustainable. In this regard, a newly developed sophisticated Large Stock Unit (LSU) calculator and measurement of cow efficiency (to calculate kg calf weaned/kg LSU of the dam) by Mokolobate (2015) may initiate an alternative evaluation tool for multi-breed selection and breeding to improve cow efficiency. The prerequisite is that the nutritional needs of animals are fully met (MacNeil *et al.,* 2017). Multi-breed increases in cow productivity that increases output and reduces input will then support and facilitate the implementation of climate change adaptation and mitigation measures.

The importance of indigenous breeds in South Africa is on an increase (Scholtz, & Ramsy, 2007). Similarly, crossbreeding between British / European and indigenous breeds have become important to increase production efficiency, especially where cattle are finished in feedlot systems. In this article, the performance of Angus x Nguni calves are evaluated. The results will assist commercial, emerging and communal beef producers to make better use of available beef breed resources and to capitalise on the favourable effects of breed complementarity and heterosis.

2. MATERIALS AND METHODS

The research was carried out at the Vaalharts Research Station of the Northern Cape Department of Agricultural, Land Reform and Rural Development near Jan Kempdorp over a period of four years. The station is located in the centre of South Africa at 27°51’ South and 24°50’ East at an altitude of 1175 meters and is in an area with sandy red soil with lime rock underneath (Laker, 2003). The veld type is mixed Tarchonanthus veld, Veld type No 16b, 4 (Acocks, 1988). The highest monthly average temperature is around 32°C and is experienced during December and January and the lowest monthly average temperature is around –0.5°C and is experienced during July. The average precipitation is around 450 millimetres per annum. The cows used in this trial were purchased at sales under the auspices of the Nguni Cattle Breeders’ Society. Single sire matings were used in the first three years. The mating season was from the beginning of December until the end of February. Twenty-five to thirty-five females were allocated to each bull. Initially all cows and heifers were straight bred to Nguni bulls during the first part of the breeding season. Thereafter Angus bulls replaced all the Nguni bulls. The first calves to be born would thus be purebred Nguni calves from the most fertile cows, and replacement heifers and Nguni breeding bulls could be selected from these calves. The dilemma was that many more purebred Nguni than Angus x Nguni calves were born. During the last breeding season, the Nguni and Angus bulls were both used in the same herd for the whole breeding season and 38 crossbred and 42 pure Nguni calves were born. The traits recorded were birth weight (BW), actual weaning weight (AWW), age at weaning (AW) and cow weight at weaning of the calf (CWW). Commercial management practices were followed. All animals were weighed according to prescriptions of the National Beef Performance Recording and Improvement Scheme. There was a total of 238 weaning weight records (167 Nguni and 81 Angus x Nguni). Weaning weights were all corrected for 205-day weight (WW) and cow weights were converted to Large Stock Units (LSU) following equations by Mokolobate *et al*. (2015) for small, medium and large framed beef cattle. The specific equations for Nguni cows with calves is as follows:

Small frame $Y = -0.0000005714x^2 + 0.0025542857x + 0.2871428571$

Where: Y = LSU and x = cow weight

In South Africa, a LSU is defined as the equivalent of an ox with a weight of 450 kg and a weight gain of 500 g per day on grass pasture with a mean Digestible Energy (DE) concentration of 55%. To maintain this, 75 MJ Metabolizable Energy (ME) is required (Meissner *et al.,* 1983). This is similar to the Animal Unit used in North America by Thorne & Stevenson (2007). In this study, a kilogram of calf weaned per Large Stock Unit (KgC/LSU) was used as a measure to express efficiency.

All the traits were analysed using generalised linear model procedure of SAS (v 9.3; SAS Inst., Inc., Cary, NC) using the following model:

$Yijklm = \mu + B_i + S_j + Y_k + M_l + D_m + (S \times Y)_{jk} + \beta DW + \varepsilon_{ijklm}$

Where:

$Yijklm$ = performance trait (e.g. 205-day weight)

B_i = fixed effects of the i^{th} breed

S_j = fixed effects of the sex of a calf

Y_k = fixed effects of the k^{th} birth year of a calf

M_l = fixed effects of the l^{th} birth month of a calf

D_m= fixed effects of the m^{th} age group of the dam

$(S \times Y)_{jk}$ = calf sex and calf year of birth interaction

β = partial linear regression coefficient of the dependent variable on dam weight (DW)

ε_{ijklm} = residual error distributed as N (0, I�e2)

Mean separation was performed using the Tukey's procedure of SAS (v 9.3; SAS Inst., Inc., Cary, NC) as well.

3. RESULTS AND DISCUSSION

The number of observations, least square means (LSM), standard deviations (Std Dev), minimum and maximum values for WW, CWW and kilogram calf weaned per LSU (KgC/LSU is presented in Table 1. The average 205-day weight of the Angus x Nguni calves was 177 kg and that of the pure Nguni calves 145 kg (Table 1). Although the 205-day weight of the Angus x Nguni calves was 32 kg (22%) higher than that of pure Nguni calves, the difference was not significant. This could be attributed to the large variation in weaning weights, with that of the pure Nguni calves ranging from 56 to 230 kg and that of the Angus x Nguni calves from 105 to 303 kg.

Table 1 Summary statistics of 205-day weight, cow weight at weaning of the calf and kilogram calf weaned per LSU

Trait / genotype	N	LSM (Kg)	Std Dev (Kg)	Minimum (Kg)	Maximum (Kg)
205-day weight					
Nguni	167	145	35.4	56	230
Angus x Nguni	81	177	36.8	105	303
Cow weight					
Nguni	167	365	65.4	222	566
Angus x Nguni	81	355	53.2	250	492
Kg calf / LSU					
Nguni	167	116	29.5	45	181
Angus x Nguni	81	142	30.1	84	249

The cow efficiency of cows with Angus x Nguni calves improved by 26 kg (22.4%) when cow efficiency was expressed as KgC/LSU. It should also be noted that the CW of suckling Angus x Nguni bull calves was 10 kg (2.7%) lighter than the CW of suckling pure Nguni bull calves, indicating that the crossbred calves may be putting an additional strain on the cow.

4. CONCLUSIONS AND RECOMMENDATION

The results indicated that crossbreeding can improve beef production by up to 22% (26 kg of KgC/LSU) with appropriate use of crossbreeding. Crossbred calves from Nguni cows weighed 32 kg more than purebred Nguni calves. There was a large variation in the WW of the crossbred calves. However, there was a large variation in the weaning weight of the crossbred calves. Similarly, cow efficiency defined as kilogram calf weaned per LSU was 22% higher with crossbred calves. This breeding strategy reduced the environmental impact of beef production and may be advised to farmers in semi-arid production environments.

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SOLAR POWERED IRRIGATION TECHNOLOGY HELOING TO INTEGRATE WOMEN AND YOUTH INTO CLIMATE SMART AGRICULTURE (CSA) IN GWANDA, ZIMBABWE

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A FARMER CENTRED INNOVATION SYSTEMS APPROACH TO SCALE UP CONSERVATION AGRICULTURE (CA) IN SOUTH AFRICA

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1. Background

1.1 Environmental degradation a huge concern

There are rising concerns about the alarming rate of environmental degradation around the globe. One of Earth's finite natural resources, soil, is particularly threatened, which holds great danger for feeding the worlds growing population. Each year, 12 million hectares of land in the world, where 20 million tonnes of grain could have been grown, are lost to land degradation. In the past 40 years, 30% of the planet's arable (food-producing) land has become unproductive due to erosion. Unless this trend is reversed soon, feeding the world's growing population will be impossible.

Worldwide there is consensus that tillage-based farming, still widely practised, has unsustainable elements, whose continued promotion and application endangers global capacities to respond to the food security concerns. Tillage and removal of crop residues after harvest leave soil naked and vulnerable to wind and rain, resulting in gradual, often unnoticed erosion of soil. This is like tire wear on your car — unless given the attention and respect it deserves, catastrophe is only a matter of time. Tillage and erosion also puts carbon into the air where it contributes to climate change.

In South Africa, crop production systems based on intensive and continuous soil tillage have led to excessively high soil degradation rates in grain producing areas. This adds to the growing problems with profitability and poverty in some of the rural areas. According to a recent study by the Agricultural Research Council (ARC) in South Africa (Le Roux *et al.,* 2008), the average soil loss under annual crops (such as grain and cotton) in the country is 13 ton $ha^{-1}yr^{-1}$, which is much higher than the natural soil formation rate. If we have to offer farmers a better chance to survive on the farm and if sustainable and economically viable agriculture and food security is to be achieved, then the paradigms of agriculture production and management must be changed.

1.2. Conservation Agriculture presents an ideal vehicle to reverse the situation

There is general agreement among key role players, such as government, research institutions and producer's organisations (such as Grain SA), that these outcomes will be achieved through the adoption and implementation of Conservation Agriculture (CA). CA is seen as an ideal system for sustainable and climate-smart agricultural intensification, through which farmers can attain higher levels of productivity and profitability while improving soil health and the environment.

CA is an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. CA is characterised by three linked principles, namely:

1. Continuous minimum soil disturbance
2. Permanent organic soil cover

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3. Diversification with crops and animals

CA principles are universally applicable to all agricultural landscapes and land uses with locally adapted practices. CA enhances biodiversity and natural biological processes above and below the ground surface. Soil interventions such as mechanical soil disturbance are reduced to an absolute minimum or avoided, and external inputs such as agrochemicals and plant nutrients of mineral or organic origin are applied optimally and in ways and quantities that do not interfere with, or disrupt, the biological processes.

CA facilitates good agronomy, such as timely operations, and improves overall land husbandry for rainfed and irrigated production. Complemented by other known good agricultural practices, including the use of quality seeds, and integrated pest, nutrient, weed and water management, etc., CA is a base for sustainable agricultural production intensification. It opens increased options for integration of production sectors, such as crop-livestock integration and the integration of trees and pastures into agricultural landscapes.

Ample evidence now exists of the successes of CA under many diverse agro-ecological conditions, including South Africa, to justify a major investment of human and financial resources in catalysing a shift, whenever and wherever conditions permit it, towards CA.

1.3. Economic and environmental benefits of CA

Economic analyses showed that CA is a very profitable cultivation system compared to conventional tillage (CT). Net farm income increases considerably under CA within a period of 10 years, while under Conventional Tillage (CT), it is calculated to decrease. The changes in the returns on capital of CA compared to CT are also quite impressive. The following economic advantages have been found when comparing CT to CA in long-term experiments (Derpsch, 2004; Sorrenson, 1997):

- Investments for machines are 39% lower in CA
- Power requirements are 75% lower in CA
- Working time is 60-80% lower in CA
- Fuel consumption is 60-84% lower in CA
- Variable costs: wages are 70-84% and repair costs are 60-65% lower in CA

Increasing crop diversity (rotations) even marginally and building soil organic matter content and -biotic activity lead to higher natural soil fertility - it can have both large financial and environmental impacts. Cover crops (legumes) can contribute up to 250 kg of soil nitrogen per hectare annually, amounting to cost savings of above R2000 per ha on N fertilisers (2014 prices) reduce weed seed banks, reduce crop losses to some insect pests and diseases compared to mono-cropped farming systems.

These values will certainly change from one region/farm to the other, but the trend will probably be the same in most parts of the world. When making economic comparisons between CT and CA, we have to compare the whole system over several years and give a monetary value to such things as loss/gain of organic matter and soil fertility. In general, comparing results over several years (e.g. 10 years), farm income decreases under CT in response to declining crop yields, while it increases under CA. Changes in income and variable costs between the first and tenth years under CA, reflect increasing crop yields, a higher cropping intensity and savings per crop in fertiliser, herbicide and insecticide.

A very large monetary benefit was found by De Wit *et al.* (2015), as indicated by the Net Present Value (NPV) of adopting CA systems in the four major maize producing areas of South Africa (i.e. Western Free State, Eastern Free State, KwaZulu-Natal and North West), with or without the incorporation of positive externalities, such as improved ecosystems services. The viability of maize production is improved in all regions with the adoption of CA systems, but the potential is more so in the Eastern and Western Free State. This outcome is the result of cost reduction owing to lower input use, increases in yields, less emissions into the environment and carbon sequestration.

CA will also reduce carbon emissions, ensure less erosion, increase crop water availability and thus resilience to drought, improve recharge of aquifers and reduce the impact of the apparent increased volatility in weather associated with climate change. It will lead to more reliable harvests and reduce risks, especially for smallholders. The latter point is critical for household food security of around three million smallholder families in South Africa. It simply means that CA could sustain yields (and household food supply) on acceptable high levels using a minimum amount of external inputs.

Because of the multiple benefits that CA systems generate in terms of yield, sustainability of land use, incomes, timeliness of cropping practices, ease of farming and eco-system services, the area under CA systems has been growing exponentially in many countries, largely as a result of the initiative of farmers and their organisations. In South Africa, the total area under CA is still small relative to areas farmed using tillage, but there is a significant upswing in the number of farmers practising CA, as well as key research and development initiatives, promising significant improvements in promoting it. According to the most recent assessment, 40% of commercial farmers across all grain producing areas of South Africa have adopted all CA principles (Findlater, 2017) and it is expected that adoption trends will increase sharply over the next decade. The highest adoption levels are in the Western Cape (90%) and KwaZulu-Natal (80%) Provinces with the rest having an adoption rate below 20%. Although no formal CA adoption figures exist, all indications are that the adoption of CA within the smallholder production sector in South Africa is very low (below 5%).

2. Agricultural Innovation Systems

The linear approach to agricultural research and development (Chambers and Jiggins, 1987; Prasad Pan and Hambly-Odame, 2010) was in vogue during the 1960s and 1970s and remains present in a large number of programmes and institutes. This approach looks at knowledge development/production and application as separate activities, carried out respectively by researchers and farmers with the assumption that it will 'trickle-down' to land-users through a variety of extension or service providers. Researchers are in charge of producing knowledge, extension agents are expected to transfer the knowledge to farmers, who are expected to adopt it.

There is now increasing understanding that crop production research and development (R&D) to improve natural resource management (through CA) does not follow a linear process. An innovation systems (IS) perspective to R&D reveals that the actual change and innovation processes are much more complex and diverse.

Hall et al. (2006) provide a clear idea of what exactly is meant by innovation systems:

"An innovation system can be defined as a network of organisations, enterprises, and individuals focused on bringing new products, new processes, and new forms of organisation into economic use, together with the institutions and policies that affect their behaviour and performance. The innovation systems concept embraces not only the science suppliers, but the totality and interaction of actors involved in innovation. It extends beyond the creation of knowledge to encompass the factors affecting demand for and use of knowledge in novel and useful ways".

An important perspective from Agricultural Innovation Systems (AIS) is that land-users are not merely recipients of new knowledge but also potential sources and/or partners in its generation, i.e. they are researchers and innovators in their own right. Local (farmer-led) experimentation, adaptation and ingenuity are vital for finding locally effective practices. This recognition has led to approaches to Research and Development (R&D) that are designed to enhance systems of local empowerment, learning and innovation by multiple actors. Some of the most prominent and successful examples are Farmer Field Schools (FFS), Action Research and Learning (ARL) and Participatory Innovation Development (PID). These approaches build on and strengthen local (farmer-centred) innovation processes, such as farmer-led experimentation, social learning and involving partnerships between local land-users and outside R&D agents and/or facilitators through innovation networks and platforms (Smith and Visser, 2014).

3. CA Innovation Systems

CA is defined by three key principles that have to be applied simultaneously and adapted to each farm ecosystem. The inescapable consequence of this is that farmers have to function as applied ecologists (or researchers) who have to fine-tune (construct) universal principles to their own social, economic and ecological circumstances, as was exhaustively and authoritatively reviewed by Coughenour and Chamla (2000). A linked consequence of the uniqueness of each farm ecosystem, is the fact that 'one-size fits all' central research cannot generate custom-made solutions for every reality. Thus, as Wall *et al.* (2002) concluded: "It is unlikely that complex, multi-component technologies such as conservation agriculture can be successfully scaled out through traditional linear models of research and extension: instead they require the development of innovation systems to adapt technologies to local conditions. Accordingly, and at the very least, the emphasis has to be on on-farm research and the inescapable experiential learning that this generates; both of which critically place the farmer in the central role."

This 'radicalism' of CA is widely recognised but not usually translated into driving perspective when it comes to efforts to mainstream CA. Some examples of this recognition of CA's critical requirement for radicalism— in addition to the quote above from Wall *et al*. (2002) and in different terms, can be found in the selected references below:

- Bwayla (2006a; 2006b) have drawn attention to the fact that CA requires a radically different approach to both research and extension; and
- Kassam *et al.,* (2009) discuss CA in terms of paradigm shifts and build on 'second-paradigm approaches'
- Putter *et al.,* 2009 presenting new opportunities for CA education based on on-farm praxis.

4. Grain SA CA Farmer Innovation Programme

Within the realms of the situation described above, the South African grain-producers organisation (Grain SA), supported by two commodity trusts (The Maize and Winter Cereal Trusts) launched a CA Farmer Innovation Programme (FIP) aiming to mainstream CA by and through grain farmers to ensure sustainable use and management of natural resources while enhancing national and household food security and income in South Africa.

The CA FIP is designed to provide direct, fairly simple support and fair, transparent and competitive access to funds for key and interested stakeholders (including farmers) who wish to promote CA. The CA FIP funding of CA innovation will mainly be through solicited and non-solicited projects. Access to such funding allows a wide range of innovations to be tackled, and under proper conditions may expand enthusiasm and innovation capacity among farmers, other rural stakeholders, and those who support them, ultimately facilitating the mainstreaming of CA within the grain industry.

One of the key strategic objectives that have been implemented since the initiation of the CA FIP in 2013 is farmer-led, on-farm research.

4.1. Farmer-led, on-farm research

To design and integrate a complex system, such as CA, into existing socio-economic situations, there is an increasing awareness that innovation systems using constructivist methodologies has the potential to bridge the gap between the physical and social sciences (Carberry, 2001; Smith, 2006) and integrates the various components of the system (situation) under investigation (Röling, 2009). It is therefore essential to design/use a context-specific innovation process using constructivist methods, tools, techniques and activities as umbrella paradigm. This suggests that methodological diversity is essential for the facilitation of social, adult and experiential learning, in order to integrate or 'construct' CA systems within a specific farming system. Currently, a growing family of constructivist methodologies, such as Farmer Field Schools (FFS), action research and social learning, enables people to learn and adapt (innovate) aiming towards the implementation of sustainable land management practices (Allen, 2000; Smith, 2006). The value of this type of innovation process is firstly, that it is action oriented (i.e. it focuses on implementation) and secondly, it induces immediate, positive and sustainable change (empowerment) in the situation under research.

These (constructivist) innovation systems research methodologies offer opportunity to reinforce, through a mix of scientific and local knowledge, the four steps in the experiential learning cycles of experiencing (observation), sense making (reflection), drawing conclusions (modification), and action (See Figure 1).

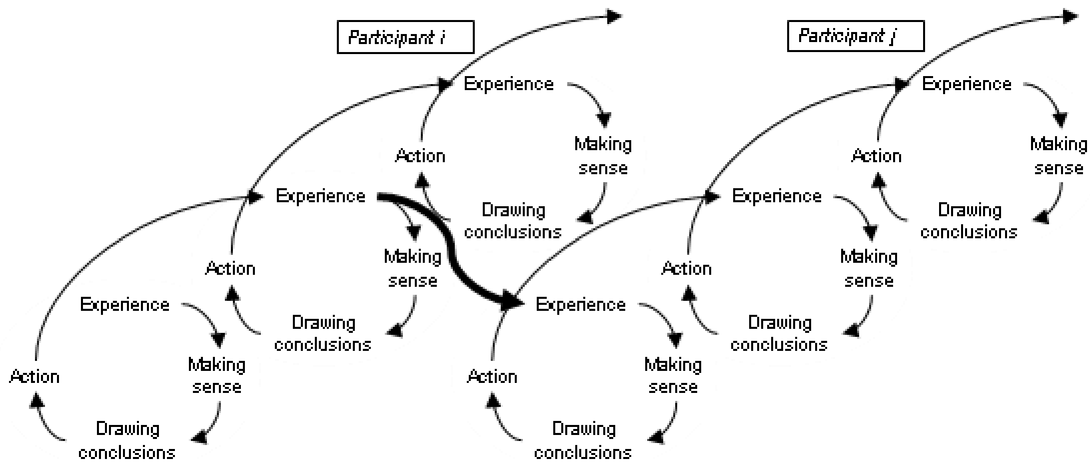

Figure 1. Iterative cycles in an experiential learning process (from Douthwaite *et al.,* 2003).

The Grain SA CA FIP assumes the position that an innovation systems approach is a prerequisite to design and develop CA research with key stakeholders. The CA FIP therefore deploy these constructivist methodologies mentioned, contributing to the experiential learning cycle, in full participation with multiple stakeholders (e.g. farmers, extension staff and policy-makers) and within the CA project context.

On-farm, farmer-led research and/or experimentation, where farmers are lead or equal partners (in identifying research needs, designing, implementing and evaluating experiments), give farmers independence, ownership and control. Experiments should preferably be well designed with appropriate treatments and sufficient replications spread over the entire agro-ecological zone and/or on a sufficient number of farms. Data from properly designed experiments provides a much stronger starting point for discussion and investigation of a farmer's claims or problems. Furthermore, the ability to generate scientifically valid data provides incentives for bringing people together in groups or networks across boundaries and on different levels. It is the potential for getting real answers that makes the group hopeful that working together will be worthwhile; it makes all parties interested in how the experiment is conducted. Involving agricultural scientists in group problem and on-farm research solving is also much easier if valid data and results are important outcomes.

The following major phases, methodologies and/or activities in the design and implementation of an on-farm, innovation systems research are considered by the CA FIP during the design, implementation and/or evaluation of any project proposal:

a) Stakeholder analysis and mobilisation (social mobilisation)

b) Diagnosis and profiling of whole agro-ecosystem (in the study area)

c) Awareness / sensitisation

d) Participatory and/or spatial design and planning

e) Season-long training (hands-on and based on cropping calendar)

f) On-farm, farmer-led experimentation (within AEZ or units)

g) Innovation platform development and social learning

The CA-FIP has viewed constructive participation in innovation platforms (IP's) on various levels of the stakeholder hierarchy, such as the National CA Task Force (NCATF), as a strategy of national importance. The purpose of these forums is to advance the promotion of CA in South Africa through facilitating vigorous dialogue among various interested and key stakeholders in CA. IP's have been vigorously created and/or facilitated on various levels, especially on farmer level. Grain SA believes that the best way for disseminating the results of the on-farm CA research is through the likes of individuals within a famer study group, or a particular study group interacting with other study groups, through large farmer information days, through community structures, and through multi-stakeholder innovation platforms.

The CA FIP primarily uses farmer-led IPs to launch activities such as on-farm trials and awareness events. Farmers conduct their own experiments, which are properly designed and well supported by researchers, input suppliers and manufacturers (Smith & Visser, 2014). Four major CA Innovation Platforms or projects with commercial farmers and three with smallholder farmers in different regions have been established and coordinated by the CA FIP. The commercial farming project sites are at Ottosdal (North West Province), in the sandy soils region of the north-western Free State, at Vrede and Reitz (both in north-eastern Free State). The focus in the KwaZulu-Natal and Eastern Cape projects is on challenges facing smallholder farmers in the adoption of CA.

The prime objectives of these projects are to empower farmers and to construct and scale out appropriate CA systems to as many other interested farmers as possible. After several seasons the progress and results of these projects have been remarkable, illustrating a very positive response by farmers as far as ownership and innovation are concerned.

5. Discussion and Conclusion

After four years of implementing the CA FIP, results show the multiple benefits of encouraging and supporting farmers to be active participants in adopting, and innovating for, CA. The IS approach builds a bridge between science and farmers, which leads to a range of social, economic and environmental benefits. This approach is vital to create a paradigm shift among the many SA farmers who have not yet moved towards CA in their farming systems.

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POTENTIAL AND FARMER-BASED DISSEMINATION OF CONSERVATION IN SEMI-ARID WEST AFRICA

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DELIVERY OF CLIMATE SMART AGRICULTURAL EXTENSION IN UGANDA: INCORPORATING GENDER & NUTRITION, ICT & YOUTH IN AGRICULTURE

Luzobe, B.

ABSTRACT

This abstract shares findings from the various stakeholders' fora including the public, private and non-state actors. Environmental degradation and climate change poses a threat to the realisation of sustained food security, nutrition, and incomes. This has resulted in the change in extension systems from the traditional approach to pluralist, group-based and participatory approaches which have the potential to overcome barriers to youths' participation in agriculture, foster gender and nutrition information dissemination and wider scope of targeted audience through the use of ICT in agriculture towards effective delivery of Climate Smart Extension (CSE). In an effort to promote professional development, information sharing and networking among AEAS actors and building their capacity in provision of innovative and client-orientated services, Uganda Forum for Agricultural Advisory Services (UFAAS) embarked on progressive identification of strategies, challenges, solutions and recommendations on key thematic issues of: Climate change, Gender and Nutrition, Youths involvement in Agriculture (YinAg) and Information and Communication Technology (ICT) for Agriculture (ICT4Ag) at the national and field levels in Uganda. The findings from the regional meetings, training of trainers, world café and individual surveys indicated that; cultural beliefs of different societies between men and women, long term return on investment of agricultural projects and limited knowledge on how to use ICT are the major challenges faced by gender and nutrition, youth in agriculture and ICT for agriculture respectively.

Keywords: Climate Smart Extension (CSE), Climate change, Gender and Nutrition, Youths involvement in Agriculture (YinAg) and information and communication technology (ICT) for Agriculture (ICT4Ag)

1. INTRODUCTION

Climate Smart Agriculture (CSA) is an approach that can help guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate (World Bank Group, FAO and IFAD., 2015). With the current climate change AEAS, therefore, has had to reorient and re-equip themselves to be able to provide farmers and other actors in agricultural innovation systems with the knowledge and technologies they need to identify agricultural strategies and practices suitable to their local conditions. Traditional approaches to extension have changed to pluralist, group-based and participatory approaches which have the potential to overcome barriers to participation, foster inclusiveness, and lead to demand-driven services. In addition to disseminating new knowledge through training and demonstrations, AEAS performs a wide range of roles including: developing networks; organising producers; sensitising on food and nutrition security; facilitating access to credit; inputs and output services; convening innovation platforms; facilitating knowledge management; promoting gender equality; and supporting adaptation to climate change (Silim M. Nahdy and Max Olupot 2013).

Climate Smart Extension (CSE), focuses on skills, approaches and strategies that provide farmers and other actors in agricultural innovation systems with the knowledge and technologies, while integrating and scaling-up Climate Smart Agriculture (CSA). Inclusive CSE, therefore, must consider those approaches that specifically emphasise active participation key groups notably youths and women, AEAS actors and or clients. The women and youth's involvement in agriculture is very critical for sustainability of agricultural interventions, hence the need to innovate how best to understand and address their challenges and interests. This also calls for appropriate but fast information and communication technology (ICT) methodologies available to reach and involve these stakeholders.

As much as Climate Smart Agriculture (CSA) transforms and reorients agricultural systems to effectively support development and ensure food security in a changing climate, there is need for more inclusive AEAS that further integrates Gender Responsive and Nutrition-sensitive Agriculture (GRENSA); Youths in Agriculture (YinAg) and Information Communication Technology for Agriculture (ICT4Ag). However, the challenges, dynamics and interaction within an integrative system like this are not yet well understood. Hence, the need to capture issues of integrating gender and Nutrition, youths and ICT within a changing climate.

1.1. Gender and Nutrition

Gender and nutrition are inextricable parts of the vicious cycle of poverty (FAO, 2012). Gender inequality can be a cause as well as an effect of hunger and malnutrition. Not surprisingly, higher levels of gender inequality are associated with higher levels of under nutrition, both acute and chronic under nutrition (Mucha, 2012) and (UNDP, 2011). Gender and nutrition are not stand- alone issues; agriculture, nutrition, health and gender are interlinked and can be mutually reinforcing. Some experts consider women to be the nexus of the agriculture, health and nutrition sectors (IFPRI., 2011). Gender and nutrition are increasingly acknowledged by the development community as important cross-cutting issues. Recently, the reciprocal relationship between the two issues was affirmed, giving rise to various efforts that seek to mainstream gender into nutrition policy and programming.

1.2. Youth in Agriculture (YinAg)

Amidst rising youth unemployment in Uganda, evidence reveals that youth engagement in agriculture is declining. It is likely that this will have implications on food security and employment. That could undermine government efforts to drive economic growth through agriculture.

1.3. Information communication technology (ICT4Ag)

Throughout Africa, ICTs have become increasingly integrated into information disseminated to farmers. For decades "traditional" forms of ICTs have become more prevalent in advisory service provision. Radio and TV programmes feature agricultural information. Rural tele centres provide information on education, agricultural and health issues and equip rural citizens with skills on how to use computers and provide basic literacy. National ministries of agriculture have attempted to integrate ICTs into the delivery of information and have established district information centres focusing on agriculture. Many NGOs and research organisations have also attempted to facilitate technology transfer in the agricultural sector (Gakuru *et al.,* 2009)

1.4. Purpose of the paper

The paper presents findings of phased and progressive process of identifying inclusive challenges and practical solutions and strategies of integrating these critical issues within extension, in a changing climate. The key thematic issues being analysed are: Climate Smart Agriculture (CSA), Gender and Nutrition, Youths involvement in Agriculture (YinAg) and information and communication technology for Agriculture (ICT4Ag), at national and field levels in Uganda. This is being carried out by the Uganda Forum for Agricultural Advisory Services (UFAAS) in an effort to promote professional development, information sharing and networking among AEAS actors; and building their capacity in the provision of innovative and client-orientated services. The specific objectives of the process are to: share with the participating AEAS actors at different levels the knowledge and skills on how to integrate Climate Smart Agriculture (CSA), Gender and Nutrition Security, Women / Youths involvement and ICT4Ag into AEAS; identify the various approaches, used by the different AEAS actors to integrate and scale up the issues within their programs and activities; and document and share the most practical ways and strategies of addressing these thematic issues at national and field levels in Uganda.

2. METHODOLOGY

Respondents that provided the data were selected using a progressive phased out approach which began with one Training of Trainers (TOT), three Regional workshops, three world café sessions and an assessment conducted using an interview checklist. The data collection was done over a three months' period from May-July, 2017 in all parts of the country; Northern, Western, Eastern and Central and at the Annual Agricultural and Trade Fair in Jinja.

The main objective of the process was to collect and document information and case studies on gender and nutrition within climate smart agriculture.

The specific objectives are:

- To document existing challenges faced during implementation of G&N, YinAg and ICT4Ag within CSAE
- To identify possible solutions to the identified challenges
- To recommend best strategies suitable for consolidating G&N, YinAgr and ICT4Agr within a CSAE

3. RESULTS

Key findings from the regional meetings, training of trainers TOTs and the world café at the annual Jinja show.

3.1. Gender and nutrition

Gender-based inequalities all along the food production chain "from farm to plate" impede the attainment of food and nutritional security. Maximising the impact of agricultural development on food security entails enhancing women's roles as agricultural producers as well as the primary caretakers of their families. Food security is a primary goal of sustainable agricultural development and a cornerstone for economic and social development (FAO 2006). It also demonstrates the vital and often unacknowledged role that women play in agriculture, as well as how their critical role in ensuring sustainable agricultural development translates into household-level improvements in food and nutritional security.

The results were obtained from the different meeting and discussions. Given that gender is society specific, the challenges were captured based on the four different regions of Uganda. At the regional level, discussions were held and identified the challenges and recommendation from the in regard to gender and nutrition.

Eastern region challenges were outlined as follows:

- Men are biased on gender related issues; this is because the women think gender and nutrition is concerned with women only.
- Gender is not well integrated in extension approach; extension service are only equipped with agriculture knowledge and with little or limited nutrition.
- Budgets are not available for gender related issues.
- The elite women segregate and tend to think that gender issues are only for them, yet gender is a concept meant to define the roles and responsibilities of men, women, boys and girls appropriately.
- The gender concept is not well understood by extension workers because it is a new concept in our curriculum that needs to be developed over time.
- Gender issues are not given priority in work plans.
- Institutions are further biased by putting women on lead in issues of gender.
- The current extension system does not incorporate nutrition.
- Nutrition being mirrored along health, indicators drawn from this do not have an inclement element in extension.
- Lack of clear data on impact by gender. Most of what we say is about what we believe.
- Ignorance of food values.
- Decision making on what to plant is by men.
- The sale of food by men and the proceeds do not come back to buy food.
- Cultural norms e.g. culture position men to take lead on every matter which dis- empowers women in participating in development programs.
- Resources are not adequate for extension workers.
- At farmer level, it is enterprise development not nutrition.
- Nutrition has no clear boundaries for who?

Recommendations from the eastern regional meeting:

- Collection of data on gender and nutrition related issues, analysing it and giving feedback on the problems in society in regards to gender and nutrition.
- Integration of nutrition as one of the performance measures at district level.
- Clear coordination mechanism on nutrition related issues at all levels.

- Women should be sensitised that gender is cross cutting issues.
- There should be allocation of budgets for gender matters.
- Gender analysis should be carried out to establish the roles and responsibilities of men, women, boys and girls.
- Men should be encouraged to take leadership roles.
- Extension workers need regular training on gender related issues.
- Extension workers should be facilitated to disseminate gender related matters.
- Gender concept should be integrated with other models or development plans.
- Sensitisation and awareness campaigns on gender matters should be intensified.
- Issue indicative planning figures by MAAIF to districts on nutrition issues.

Challenges highlighted during the Northern region meeting

Inability to win the projects by schools due to land issues and land shortages, limited extension coverage, delayed funding for projects on gender and nutrition, drought, pests and diseases. The participants recommended that; sensitisation of stakeholders on nutrition and gender integration in activities to be undertaken by all sectors. Additionally, training on management and control of pests and diseases – case is USAID community connector project and LIDNET project- contact person is Zamarada Auma-lira and Kole

Challenges highlighted in Western Uganda regional meeting:

- Domestic violence.
- Property ownership (by men) especially land.
- Decision making in the home is usually done by a man only.
- Commercialisation is affecting level of participation, food security, growing of only cash crops.
- Lack of knowledge of food values.
- Inadequate access to nutritious food.
- Eating habits/allocation of food with in the households affects the nutrition status of some household members especially the women.
- Shortage of land. Some crops are no longer grown.
- Neglect of indigenous crops.
- Post-harvest losses.

Recommendations

The meeting recommended that the gender and nutrition challenges should be addressed at both institutional and individual level.

Institutional

- Institutions should equip extension workers with key tools like computers, smart phones etc. to enable them access relevant information and build their capacities
- Institutions should build capacities of extension workers especially in soft skills e.g. communication, presentation, team building etc.
- There is need for an innovation plat form for extension workers (UFAAS and other actors) Individual
- Irrigation technologies-sensitisation of the available technologies i.e. Farmer friendly and appropriate technologies
- Forming groups/ existing groups- pull resources together to be able to get access to irrigation technologies. Integrate the irrigation access to technologies in other existing activities
- Motivation incentives-encourage farmer exchange learning

Challenges highlighted during the Central region meeting:

- Markets are available, but the problem is lack of market information.
- Flooding of vegetables in the markets leading to price fluctuation e.g. cabbages in Nakasero market.
- Short shelf life for vegetables due to poor post-harvest handling techniques.
- Lack of government support to cooperatives and farmer associations.
- Inadequate extension services.
- Politicising development work.
- Pests and disease.
- Fake seed on the market e.g. mixed tomato seed.
- Inadequate government support in marketing services (e.g. when Sudan market closed, Somalia market).
- Inadequate support in climate change interventions.

The participants gave the following recommendations to the gender and nutrition challenges:

- Farmer groups and associations need government support.
- Livestock production should be integrated in CSA.
- Intercropping should be practiced to also achieve nutrient balancing and crop.
- Crop insurance should be given some priority.

- Extension workers should embrace profitability analyses and evaluation of extension work.

3.2. Youths in agriculture (YinAg)

During the regional meetings in Eastern, Northern and Western Uganda, Training of Trainers meeting, and the world café at the National Agricultural and Trade fair, the participants were asked to outline the pertinent issues and challenges that affect youth participation in Agriculture. The participants were also asked to propose ways through which these issues/challenges could be addressed. Responses from the regional meetings show that a number of issues/challenges exist and they include the following:

- No access and control over land and capital.
- Agriculture considered as a dirty job.
- Youth want quick return on investment (quick money).
- The educated youth are not attracted to agriculture and like to adventure in; say going to abroad (kukuba kyeyo).
- Limited time due to school programs.
- Youth are dynamic/mobile and have lack concentration on agricultural enterprises.
- Additionally, poor youth's attitude towards agriculture.
- Lack of skills and knowledge on how to manage funding like loans and grants.
- Also selection of viable enterprises is difficult for youths.
- Poor mind set change among youth 'muganda tapakasa' but 'Muganda can steal'.
- Youth fear to join youth groups because when they go beyond the age limit, they are pushed out of the group forcing female youths to join women's groups.

The following solutions were outlined for possible involvement of youth in agriculture:

- Identifying interested youths and skill them in agriculture.
- Investing more in youth livelihood fund.
- Strengthening youth agriculture extension and institutions.
- Effective supervision and monitoring at all levels.
- To use available media and communication space to encourage more youth in agriculture.
- Sensitise them more using the Nokia youth in action story.
- Encouraging E-money cashless economy within VSLAs in region.
- Networking with private sector that have interest for financial support.
- Training youth in CSA, G&N and Agriculture services.

3.3. Information Communication Technology (ICT4Agric)

During the regional meetings in Eastern, Northern and Western Uganda, Training of Trainers meeting, and the world café at the National Agricultural and Trade fair, the participants were asked to outline the pertinent issues and challenges that affect use of ICT in Agriculture. The participants were also asked to propose ways through which these issues/challenges could be addressed. Three sources of information communication technology were listed as mobile phones, etlevision and radios. Responses from the regional meetings show that a number of issues/challenges exist and they include the following;

- Limited knowledge and skills in ICT.
- High initial costs of ICT equipment.
- Inadequate reliability of ICT services like internet.
- Power unreliability.
- Not easily accessible by the rural people Information is not accessed by all stakeholders.
- Budget implications due to the high costs of ICT equipment.
- Provision of inaccurate information.
- Lack of awareness of ICT policies in Agricultural Extension.
- Infrastructural capacity to equip, facilitate and maintain ICT.
- Challenge of attitude in use of ICT.
- Challenge of literacy levels in utilising ICT.
- Costs of subscription into E-Agriculture plat forms.
- Poor timing of messages.
- Quality control of information especially social media plat forms.

Participants further suggested a way forward for these identified challenges or issues:

- Capacity building in Information Communication Technology.
- Bringing ICT services closer in the rural areas.
- Lowering/subsidising the costs.
- Increasing budget allocation (advocacy for ICT).
- Dissemination of all ICT policies.
- Provision and update of existing E-Agricultural plat forms.
- Advocacy and lobbying.
- Networking.
- Encourage subscription as group.

- Creativity for user friendly packages.
- Increased sensitisation to change mind set to use ICT.
- Institute ICT as a key area to assess performance – Local Government.
- Institutions should equip extension workers with key tools like computers, smart phones etc to enable them access relevant information and build their capacities.
- Institutions should build capacities of extension workers especially in soft skills e.g. Communication, presentation, team building etc.
- There is need for an innovation plat form for extension workers (UFAAS and other actors).

Key findings from the organisational individual survey stalls at the Annual Jinja Agricultural and trade fair 2017.

3.4. Gender and Nutrition

The assessment was done in Jinja, a structured questionnaire was administered to the respondents who exhibited on the different stalls. Information was captured included: the challenges faced, the solutions and their possible recommendation in terms of gender and nutrition.

The results in figure 1 show that cultural beliefs, men not allowing women to participate in decision making are the challenges highly mentioned by the respondents as faced by gender and nutrition in their areas of operation. Additionally, unreliable weather, prolonged drought and lack of information were also highlighted to a lesser extent. Whereas having no skilled extension for nutrition and a few specialists also was a challenge faced by gender and nutrition mainstreaming in agriculture.

These findings are in agreement with (WFP, 2006) which suggests that gender norms and issues affecting nutrition assessment males and females often have different levels of access to and utilisation of nutrition management services that are age and sex-dependent. For example, women and girls tend to be less economically independent and have less decision-making power, which can prevent them from accessing health services. Male partners and mothers-in-law can play an important role not only in a woman's nutrition status, but also in the decision for her to access or be retained in nutrition services. In many communities, male partners hold decision making power about how money is spent and can be unwilling or unable to provide money for transportation or services.

The respondents further outlined the possible solutions to the above challenges as; sensitisation of people about gender and nutrition being the major solution followed by encouragement of women to participate in decision making and planting drought resistant varieties. Whereas land ownership by women, including gender and nutrition in school curriculum were listed to a lesser extent.

Additionally, the organisations listed various strategies that they are employing to incorporate gender and nutrition in agricultural extension system. Recruitment and training of farmers was the strategy highly (37%) used followed by formation of farmer groups at 27%. Use of participatory methods and a community approach method to get target persons were listed by few respondents (5%).

3.5. Youths in Agriculture

During the survey interviews, ten individuals representing the youth organisations were purposively selected and subjected to a pre-tested structured questionnaire and questions including what strategies, practices and approaches employed by their organisations while implementing Youth in Agriculture, challenges and how they were being addressed and respective recommendations. From the results in figure 2, it shows that training youth in urban farming, use of participatory approach in training and mind set change training are the most commonly strategies used by many youth organisations. Whereas running youths' academies and organising food-wise events were the least used strategies.

From the results in figure 3 below, poor market linkages, long time return on investment of the agricultural enterprises, agriculture being a labour-intensive venture, lack of access to finance, no land ownership, inferiority complex of being regarded as a farmer, and agriculture being for the poor are the challenges that deter most of the youths from getting involved. Whereas legal barriers are the least challenging outlined by the youth in agriculture implementing organisations. The findings of lack of land ownership is agreement with the assessment done by (FAO., 2014) which postulates that access to land is a fundamental in starting a farm, it's always difficult for the young people to attain and that also inheritance laws and customs in developing counties make transfer of land to young women problematic. FAO (2014), further indicates that another challenge youths face is inadequate access to finance given the fact that most financial service providers are reluctant to provide their services – including credit, savings and insurance to rural youth due to their lack of collateral and financial literacy. Lastly FAO also indicates that young people's limited access to markets is a major challenge to the youth as they will not be able to engage in viable and sustainable agricultural ventures. Additionally, young rural women in developing countries face additional constraints in accessing markets, due to the fact that their freedom of movement is sometimes limited by cultural norms. These are also supported by a study conducted by the young leader's think tank on policy alternatives (2015). Ahaibwe *et al*. (2013), confirms that the youth's lack of access to credit services, no land ownership are major challenges restraining their involvement in agriculture.

Results further indicate that collective marketing and training in farming as a business (FaaB) at (80%), use of fellow youths as demos, providing start up inputs and contracting their produce and exposure visits at (70%) are the most ways that youth's participation in agriculture can be increased. Advocating for legal aspects is the least (10%) suggested way of increasing youth's participation in agriculture by the youth's organisations. FAO (2014) also indicates that encouraging youth to group themselves into informal savings clubs, improving access to education, training and market information can all facilitate youth's access to markets, with niche markets offering particularly significant opportunities for young farmers. The same study further suggests that facilitating their involvement in (youth) producers' groups can be similarly beneficial in this respect.

3.6. Information communication technology for Agriculture (ICT4Agr)

During the interviews, the following challenges were identified as faced by the ICT for agriculture organisations; from the results; limited knowledge on how to use ICT for agriculture was named by most (60%) respondents as the biggest challenge followed by poor or no network and ICT being expensive as seen in figure 6. This finding is in agreement with a study by Seyed *et al.* (2009), which indicated that there is low level of knowledge and skills of ICT among farmers. Other challenges outlined by the respondents were not limited to ICT being expensive, network issues, limited connection and no ICT regulation in the country which is also in agreement with a study by Deven & Kapil (2014), that postulates; there are several loopholes in the present legislation for ICT system. Additionally Gakuru *et al.* (2009), postulates that with the widespread use of mobile phones, voice and SMS solutions should find more use as they offer easy accessibility. They also face some challenges: the SMS carries only a limited amount of information and requires a basic level of literacy. Voice-based solutions are complicated to develop as they require machines to produce natural speech, or good speech synthesis. They also do not offer detailed information such as pictorial illustrations as in web solutions.

The respondents further gave ways through which the ICT challenges could be solved in agricultural extension and these were not limited to; training of farmers, improving network, collaboration with other actors, providing phones and radio to farmers, introducing pocket friendly innovations and engaging policy makers. Additionally, respondents listed alert SMS, mobile application, print media, radio, drone for mapping and soil testing as the strategies employed by the implementing organisations.

3.7. Recommendations

The following recommendations were arrived at under the different three themes of agricultural extension.

Gender and Nutrition

The participants further recommended that the following measures could be taken to address the identified issues; these are not limited to; sensitise by providing information about gender and nutrition, including gender and nutrition into the school curriculum, training using household approach, encouraging women land ownership and drought resistant and early maturing varieties.

Youths in Agriculture (YinAgr)

The participants further recommended that the following measures could be taken to address the identified issues; these are not limited to;

- Identifying, mobilising and skilling interested youths.
- Investing more in youth livelihood fund.
- Strengthening youth agriculture extension and in institutions, effective supervision and monitoring at all levels of the agricultural value chains.
- Use of available media and communication space to encourage more youth in agriculture and sensitise them using the Nokia youth in action story.
- Creation of linkages for youths by networking with private sector that have interest to offer financial support.
- Participants also pointed out that having values like good behaviour, joint planning and a road map to be some elements that should not be ignored.

The respondents finally gave some recommendations that could help in youth participation agriculture. Results show that conducting trainings and establishment of demos close to target beneficiaries are the recommendations given by most of the organisations (80%) as a means of getting more youths participation in agriculture.

Information communication technology (ICT)

The participants recommended that for ICT to be highly utilised in agriculture the following be put under consideration:

- Documentation to identify existing gaps.
- More fund to upscale and out scale innovation.
- ICT to be tailored towards risk reduction.
- More research.
- Wider coverage.

4. CONCLUSIONS

4.1. Gender and Nutrition

From the results of regional meetings, TOTs, world café and survey, the challenges identified were similar and solutions proposed too hence calling for inclusive strategies.

4.2. Youths in Agriculture

From the results, regional meetings, TOTs, world café and the survey data show similar challenges or issues that are encountered during implementation of youth's participation in Agriculture. It is from this, that the individual interviews captured possible ways of solving the existing and emerging issue and gave particular recommendations.

4.3. Information Communication Technology (ICT)

It is important to realise that farmers and agricultural extension providers should not be treated as mere consumers of generic information. But the inventory suggests that systems which use a voice- platform or audio files provide an innovative and promising entry point to farmer information while the other platforms (SMS and web-based platforms) remain essential to provide a back-end offering more detailed information to the farmers. Therefore, more sensitisation and user-friendly ICT platforms need to be embraced for improved climate smart agricultural extension system.

5. POLICY OPTIONS

5.1. Gender and nutrition

For a gender and nutrition climate smart agricultural extension system, the following recommendations be adopted for action policy; availing technical information to the grass root farmers, sensitizing about gender and nutrition principles and practices, providing reliable weather forecast information, inclusion of gender and nutrition on school curriculum and promoting drought resistant and early maturing varieties.

5.2. Youth in agriculture

In order to demystify the challenges that limit youth participation in agriculture this assessment recommends the following to be adopted; training in farming as a business, provision of start-up inputs and contracting produce from the youth, collective marketing, use of fellow youth demos and exposure visits, engaging youth in short term return on investment ventures and introducing youths savings and loaning associations to enable access to finance.

5.3. Information communication Technology for agriculture (ICT4Agr)

For a modernised extension system that is inclusive, the following recommendations have been put forward to address the challenges that were identified. These include the following; documentation to identify existing gaps in the ICT usage, more fund to upscale and out scale the existing innovations, ICT to be tailored towards risk reduction, more research in use of ICT and capturing a wider coverage with ICT.

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CAPACITY DEVELOPMENT FOR SCALING UP CLIMATE SMART AGRICULTURE: THE SASAKAWA AFRICA FUND FOR EXTENSION MODEL OF EXPERIENTIAL LEARNING

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ABSTRACT

The concept of "New Extensionist" has stressed the need for a new approach to capacity development. Since the 1990s, the Sasakawa Africa Fund for Extension (SAFE), has introduced the Supervised Enterprise Project (SEP), where experiential learning and application of Kolb theory is used. The SAFE model has implications for acquisition of technical and soft skills by extension agents, through SEP on CSA innovation such as pitcher irrigation, use of compost and manure, agroforestry and minimum tillage. Data were collected on competence for CSA dissemination from 50 randomly selected extension agents trained under SAFE and 55 without SAFE training using structured, face-validated and reliable (r=0.85) questionnaire and analysed with frequency counts, percentages and t-test. The results show that the two categories of extension agents had similar educational qualifications (Higher National Diploma and BSc) with more male agents than female. The SAFE trained agents had more competence in the dissemination of selected CSA innovations ($t = 2.45$, $p < 0.05$). The high competence score was attributed to the SEP experience in practicing the innovation before dissemination. The implication is that extension curriculum should incorporate the aspect of learning by doing in order to improve competence for dissemination of innovations.

1. INTRODUCTION

Sasakawa Africa Fund for Extension Education (SAFE) emerged two development imperatives. The purpose being to bring African agricultural universities and colleges in totality to the agricultural and rural development process through the formation of new innovative continuing education programs. By expanding and strengthening the knowledge and skills of frontline agricultural and rural development advisory service providers more effective services are provided to the smallholder farm families.

SAFE is currently involved in reinforcement of the capacity of agricultural education institutions in sub-Saharan Africa. They need to play a more crucial role in rural development. This can be achieved by developing responsive, farmer-focused, formal continuing education programs for mid-career agricultural and rural development workers. In return, they will provide leadership in developing agricultural extension systems that effectively and efficiently contribute to sustained growth and transformation of agriculture.

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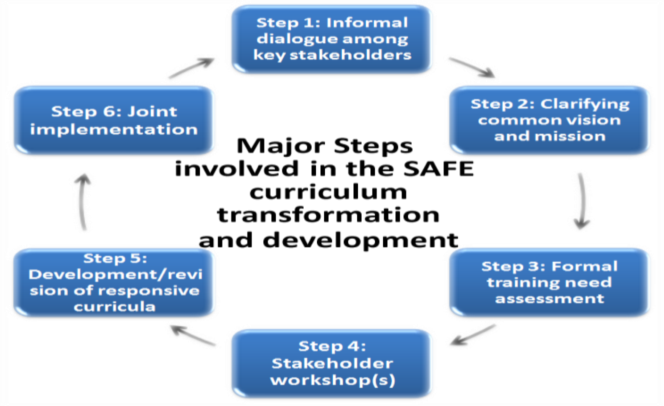

Source: SAFE 2017

SAFE's guiding philosophy is that African tertiary educational institutions can offer invaluable continuing education opportunities in support of agricultural and rural development. In this way, an increased number of mid-career students will have opportunities to receive quality extension education locally to upgrade technical and leadership skills. Consequently, the SAFE program is to primarily support those institutions that are flexible in designing and implementing responsive programs in agricultural extension and rural development.

SAFE has taken the lead in developing responsive, custom-made agricultural education and rural leadership programs that reach out to an ever-changing mix of development professionals that work directly with rural people to improve their livelihoods. The pillars of the SAFE's initiative are the principles of lifelong learning, demand-driven curricula, student-centred experiential learning, and rural leadership development.

Source: SAFE 2017

The SAFE initiative has expanded from one modest pilot program in Ghana to 24 fully established programs. The SAFE Model emphasises the Kolb's Learning Cycle. Kolb (1984) argues that individual learning is a transactional process between personal knowledge, and the external environment (a social process). Experiential learning maximises developmental opportunities within this framework. Kolb's learning model is a cycle (Figure 2) where the learning process draws on orientations that are polar opposites: active and reflective, concrete and abstract. Dimensions relate to the capturing, grasping of information and then the transforming and processing of that information. The model shows these dimensions in opposite quadrants of a learning cycle. Learners move through the sequence of concrete experience, reflective observation, abstract conceptualisation and active experimentation.

Figure 2: Kolb's Learning Cycle

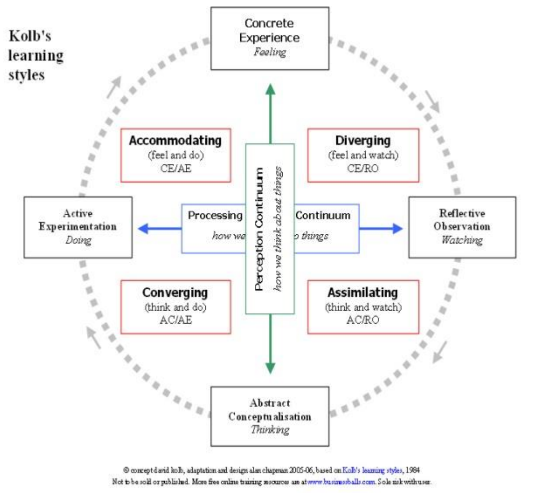

Figure 3: Honey and Mumford's (1992) Learning Cycle and Learning Styles

However, different people prefer to start at different points on the cycle. Although the cycle remains the same, the tendency to start at different points on the cycle identify preferred learning styles. Honey & Mumford labeled these learning styles as Activist, Reflector, Theorist, and Pragmatist (Figure 3). Some people prefer to think and then act, and others are the opposite. Activists tend to be task oriented, and learn best when involved in activity. Reflectors prefer to plan, to observe and to listen, learning best when given time to analyse and consider new information. Theorists are unable to tolerate ambiguity and uncertainty, learning best from ideas and concepts they find interesting. Pragmatists need to see the relevance of new material to reality, learning best from models that they can imitate.

While each person seems to have a bias, we each adapt our style to suit the challenge. The more flexible we are, the better we are at adapting to different learning situations.

The objective of this study is to compare the capacity development for scaling up Climate Smart Agriculture of The Sasakawa Africa Fund for Extension Model with the conventional training of extension agents.

2. METHODOLOGY

Kano State of the Federal Republic of Nigeria lies between latitude 13°N in the North, 11°N in the South and longitude 8°W in the West, 10°E in the East. Kano State is made up of 44 local government areas. The temperature of Kano usually ranges between a maximum of 33°C and a minimum of 15.8°C, although sometimes during the harmattan it falls down to as low as 10°C. Kano has two seasonal periods, which consist of four to five months of wet season and a long dry season lasting from October to April. The movement of the South West maritime air masses originating from the Atlantic Ocean, influences the wet season which starts from May and ends in September. The commencement and length of the wet season varies between northern and southern parts of Kano State. The length of the season in southern part of Kano State is from early May to late September, while in northern parts it is from June to early September. The average rainfall is between 63.3mm $\pm$ 48.2mm in May and 133.4mm $\pm$ 59mm in August the wettest month. This is also the harvesting season. The vegetation of Kano State is semi-arid savannah. The Sudan Savannah is sandwiched by the Sahel Savannah in the north and the Guinea Savannah in the south. The savannah has been described as the zone that provides opportunity for optimal human attainment. This is because it is rich in faunal and floral resources, it is suitable for both cereal agriculture and livestock rearing, and the environment is relatively easy for movement of natural resources and manufactured goods (Connah 1987: 97-99).

A comparative descriptive design was used in this study. The data collection method was also designed to be cross-sectional as samples were selected from only some of the population of the categories of the respondents and studied at a particular time. The target population of this study consists of extension officers involved in the dissemination of climate smart agricultural techniques of pitcher irrigation, use of compost and manure, agroforestry and minimum tillage. Random sampling techniques were used to select 50 extension agents trained under SAFE and 55 without SAFE training. A structured questionnaire that was subjected to face validity and split-half tests for reliability were used to collect data from extension agents. A reliability coefficient of 0.85, was obtained for the questionnaire. Data were coded and analysed with t-test.

3. RESULTS AND DISCUSSIONS

Table 1 presents the mean scores of competence on dissemination and demonstration of climate smart innovations by SAFE and non-SAFE trained extension officers in Kano States Nigeria. The selected climate smart innovations are based on their prevalent adoption by farmers in the study area. These selected climate smart innovations are pitcher irrigation, use of compost and manure, agroforestry and minimum tillage. The agents' competence was rated on a 3-point scale of very competent (3), competent (2) and not competent (1). The actual mean for competence is 2, which implies that mean scores below 2 for any innovation signifies incompetence while means above 2 shows competence.

SAFE trained extension officers indicated low competence in 2 innovations while non-SAFE training indicated competence in only 7 innovations. The high number of competence demonstrated by SAFE trained extension officer was due to the Supervised Enterprise Project (SEPs) experience they had while in training. The SEPs are "practical agricultural activities of educational value formulated by mid-career students under the guidance of lecturers and employers with active participation by beneficiaries and implemented to improve professionalism of students and livelihoods of beneficiaries through mobilisation of resources and creation of linkages with appropriate institutions and evaluative schemes over a 5 to 8-month period" (Annor-Frempong & Akuamoah-Boateng, 2002). SEPs is rooted in the concept of *experiential learning* – the combination of theory, experience, and critical reflection. Carr and Kemmis, (1986) and Kolb, (1984) stated that experiential learning helps learners to develop life-long learning skills, confidence and commitment to work in participatory ways. Each SEP has production (or development) and a learning (or research) objective. The production objective addresses the benefits of projects (improvement in yields, quality and post-harvest losses reduction) to beneficiaries (farmers). The learning (or research) objective addresses opportunities for learning by students as they improve the situation of farmers within which they intervene.

In SEPs conducted by trainees under SAFE model, the learning objective is a mini-action research as a way of solving farmers' problems with them within their communities. According to Annor-Frempong & Akuamoah-Boateng, (2002), planning, implementation and evaluation are three major phases in SEPs which are not mutually exclusive. Akeredolu (2010) noted that in Mali, The SEPs component of the training programme impacted significantly in the area of teaching and learning especially in centring the curriculum on authentic problems faced by producers along the whole agriculture value chain, invariably boosting the professional development of the students.

Table 1: Mean scores on competence by SAFE and Non SAFE trained extension officers

CSA Innovations	SAFE trained Extension Agents	Non -SAFE trained Extension Agents
Use of pitcher irrigation	2.72	2.44
Identification of pitcher	2.59	1.44
Materials for pitcher pots	2.38	1.34
Filling water to pitcher	2.34	1.44
Depth of placement of pitcher	2.47	1.38
Replacement of pitcher pots	2.09	1.13
Distance of pitcher holes to plants	2.25	1.32
Construction of ponds for water storage	1.78	1.16
Use of flood irrigation	2.09	1.25
Use of drip irrigation	2.16	1.34
Use of canal irrigation	2.09	1.22
Construction of artificial lakes	2.19	1.22
Water harvesting	2.59	1.44
Zero/minimum tillage practises	2.38	1.34
Farm Fallowing	2.34	1.44
Mechanical weeding	2.47	1.38
Use of herbicides	2.09	1.13
Use of soil amendments	2.25	1.32
Use of organic manuring	2.78	2.16
Use of crop residue	2.00	2.22
Conversion of waste to compost	2.09	1.25
Afforestation/ reforestation	2.16	1.34
Lengthened fallow	2.09	2.22
Use of mulching	2.19	1.22
Planting of cover crops	2.72	2.44
Zero grazing	2.59	1.44
Tree planting	2.38	1.34
Contour cropping across hill slopes	1.34	1.44
Agro-forestry such as alley cropping	2.47	1.38
Use of crop rotation	2.09	2.13
Use of inter cropping	2.25	1.32
Crop diversification	2.16	2.16

Table 2 shows the results of the t-test statistics comparing competence of SAFE and non-SAFE trained agents in dissemination and demonstration of selected CSA innovations. A higher mean was recorded by SAFE trained extension agents' competence on CSA innovations (104.16) while the non-SAFE trained agents' mean is 93.05

and standard deviation (31.13) reflects that data is more reliable. There is a significant difference in the competence on dissemination and demonstration of selected CSA ($t = 2.40$, $p < 0.05$), this may be due to the impact of the curriculum of training.

Lopokoiyit (2011) noted that competencies required by extension agents in Kenya cannot be acquired in a single course but requires that they be developed through continued use of the skill throughout undergraduate agriculture curricula and the design of appropriate in-service training programs. Afful (2016) reported that extension Agents in Limpopo province of South Africa need new competencies regarding correct application conservation agriculture to mitigate climate change. Kwarteng and Boateng, (2012) noted that at the completion of SAFE model of training extension officers in Ghana, all the graduates attained competencies that were rated from high to very high and attributed their high competence to demand-driven curriculum and a well-planned and supervised field component of the program known as the supervised enterprise projects (SEPs).

Table 2: t-test statistics comparing competence of SAFE and Non SAFE trained agents in dissemination and demonstration of selected CSA innovations

Groups	N	Mean	SD	SEM	t	df	sig
SAFE trained agents	50	104.16	18.75	2.40	2.40	98	0.001
Non-SAFE trained agents	50	93.05	13.32	4.10			

4. CONCLUSION

The increasing demand and changes in the environment have made a greater demand in the way agriculture is practiced and much greater demand on the extension agents that provide information to grant informal training to farmers. This demand has been envisioned and packaged in the SAFE model of using Supervised Enterprise Projects to train mid-career extension officer based on experiential learning. The findings in this paper have confirmed that in an environment of more experiential learning given by SAFE model of training as against the conventional training of extension officers in agricultural institutions, universities and colleges, the competence of extension officer would be greatly enhanced to serve farming communities better and proffer practical solutions to needs in farming communities.

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RAINWATER HARVESTING: CLIMATE SMART TECHNIQUES FOR INCREASED SMALLHOLDER PRODUCTIVITY

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THIS PAPER WAS NOT AVAILABLE AT THE TIME THE PROCEEDINGS WAS PRODUCED.

BUILDING CAPACITY OF AGRICULTURAL EXTENSION SERVICES IN SOUTHERS AFRICA FOR SCALING UP CLIMATE SMART AGRICULTURE INNOVATIONS

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ABSTRACT

The Southern African Development Community (SADC) is strongly affected by the impacts of climate change - increasing temperatures, higher frequency and intensity of extreme weather events. These impacts are already, and will continue to affect the agriculture sector in particular. Improving agricultural productivity and generating higher incomes while also increasing the resilience of smallholder farmers to climate change are at the core of climate smart agriculture (CSA). While CSA offers an approach to addressing these challenges, the availability of user-friendly information remains limited and the adoption of CSA practices and technologies is still low in the region. Empowering extension practitioners to support smallholder farmers in selecting and adopting CSA practises that work in their local context requires enhanced policy conditions at national level, improved financing, as well as strengthened national and local extension capacities. While regional and national agricultural policies are starting to take climate change into account, existing approaches have not been translated into concrete programmes and investments. The aim of this paper is to showcase and discuss the practical experience of the SADC Programme on Adaptation to Climate Change in Rural Areas in Southern Africa (ACCRA) in building capacity in the SADC region for the upscaling of CSA. The objectives are to describe the processes with which capacity development in Southern Africa is taking place, as well as discuss the lessons learnt to date, implications and moving forward. It concludes with implications of the findings for the region as a whole in terms of extension capacity and of mobilising climate finance for adaptation.

1. INTRODUCTION

The Southern African Development Community (SADC) is strongly affected by the impacts of climate change (Elum *et al.,* 2017; Maponya and Mpandeli, 2013). Climate scenarios predict rising temperatures and increasing frequency and intensity of extreme weather events such as droughts and floods. These impacts are already and will continue to affect the agriculture sector in particular, on which large parts of the population depend. The SADC Regional Agricultural Policy (RAP) recognises the need to address this challenge as one of the key priorities for regional integration and development (SADC 2014). Improving agricultural productivity and generating higher incomes while also increasing the resilience of smallholder farmers to climate change are at the core of climate smart agriculture (CSA) in SADC.

The impacts of climate change on agriculture in the region are potentially immense. Even considering low temperature increases by 2050 (which is predicted to be below 2ºC), agricultural productivity is likely to decline, current crop and livestock varieties are likely to be inadequate in many places and management practices need to be adopted to the new realities (Thornton *et al.,* 2011; Ramirez-Villegas and Thornton, 2015). Hachigonta *et al.,* (2013) estimate that the effects of climate change in SADC may result in reduced agricultural productivity which would not be able to meet increasing food demands through population growth, while

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maize and sorghum yields will decline on average, fuelling rural to urban migration. For example, the expected changes in growing season due to warmer temperatures will affect the primary cereal crops in Africa (i.e. maize, millet and sorghum) and result in 'novel' climates in more than half of the current crop areas by 2050 (Burke *et al.,* 2009). The possibilities of smallholder farmers to sustain their livelihoods are likely to diminish as food security will become more difficult to obtain (Thornton *et al.,* 2011), making climate change adaptation in agriculture (CCAA) a priority.

In order to achieve the required transformation towards climate-smart agricultural production, considerable policy and institutional support will be needed. CCAA and CSA has to be integrated into long-term planning and development strategies and programmes, capacity building in skills and decision-support tools for policy, planning and implementation is needed, and public support for climate change interventions has to be strengthened through public awareness (Thornton *et al.,* 2011; Hachigonta *et al.,* 2013). This can be achieved by improving and strengthening human capital through education, outreach programmes, and extension services at all levels to enhance the capacity to adapt to climate change (Akinnagbe and Irohibe, 2014). Agricultural extension and advisory services will have a key role to play since they are an important target and entry point for such interventions.

Whereas regional and national agricultural policies and strategies in SADC are starting to take climate change into account, these have not yet been translated into concrete programmes and investments. National extension strategies in SADC member states, to date, do not explicitly address the challenges of climate change at local level. A key constraint is that SADC member states do not have the capacity to integrate climate change aspects into agricultural programmes and operationalise these for investment (Masters and Duff, 2011). Moreover, while financing mechanisms for CCAA are available, SADC member states lack capacities to access these sources of funding effectively.

While CCAA and CSA offer approaches to addressing the challenges, the availability of user- friendly information remains limited and the adoption of CSA practices and technologies is still low in the region. CSA approaches, as well as evidence of specific CSA practices and technologies are available as scientific literature, and this needs to be translated into practical actions on the ground (FAO, 2016). Farmers are aware of the changing climate, as farming systems are increasingly being affected by its impacts. They are already employing practices and technologies to adapt and become more resilient, such as the use of drought resistant crop varieties or improved water management practices. However, the majority of farmers in the region are smallholder farmers whose vulnerability will further increase due to climate change, primarily because of being resource-constrained (Hachigonta *et al*., 2013). Smallholders are often struggling with a weak financial resource base without access to credit and savings, high dependence on natural resources, limited access to agricultural inputs and markets, declining soil fertility and land degradation, as well as weak support services (Simpson and Gaye Burpee, 2014). Climate change increases the need to strengthen farmer decision-making within these broader challenges. Here, the agricultural extension services have a key role to play in supporting farmers in strengthening their resilience in light of future climate challenges.

Public agricultural extension services have traditionally focused on disseminating information about specific technologies, but their mandate has expanded to support farmers groups, provide advice on natural resource management, agricultural inputs, marketing of agricultural products and accessing services from a broader range of providers, e.g. credit and insurance (Birner *et al.,* 2006). While extension services are key in all SADC countries, applied extension approaches vary from country to country and advisory services are provided by a broader set of institutions, including government departments, farmers associations, non-governmental organisations, agro-dealers and other private sector entities. These services are part of a bigger knowledge and information system for agricultural development (Birner *et al.,* 2006; Swanson and Davis, 2014).

Public extension services in the region are often guided by weak national policies and guidelines and limited funding (Swanson and Davis, 2014). Traditional extension approaches had been criticised as top-down, biased against women, technology-focused and providing blanket recommendations rather than context-specific advice (World Bank, 2012). Key constraints faced by extension agents include the lack of user-friendly knowledge products, weak links among extension, research, farmers, agro-dealers and other actors, and lack of incentives for extension agents (World Bank, 2012). However, particularly for small-scale farmers and other vulnerable groups, public extension services will continue to be critical support systems, since farmers are unlikely to access and afford private service providers.

Within this context, supporting farmers in adapting to climate change challenges the role of extension agents (Simpson and Gaye Burpee, 2014). Firstly, the technical challenge of determining when and where to promote which CSA practices and technologies, and thus providing location specific, timely and targeted advice that farmers can base their investment decisions on. Secondly, the challenge lies in supporting continuous adaptation and the transition from current to future climate conditions, while responding to short-term and long- term goals of productivity increase, vulnerability reduction and enhanced resilience (Simpson and Gaye Burpee, 2014). Agricultural extension services need to be strengthened in this important role so as to become effective knowledge brokers on the ground, supporting knowledge exchange and learning, and creating linkages between different actors. Empowering extension practitioners to support smallholder farmers in their local context requires enhanced policy conditions at national level, improved financing, as well as strengthened national and local extension capacities.

The SADC Programme on Adaptation to Climate Change in Rural Areas in Southern Africa (ACCRA), implemented by the Centre for Coordination of Agricultural Research and Development for Southern Africa (CCARDESA) and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), is supporting the region in building the capacities of SADC member states to bring CSA to scale. ACCRA sees the regional and national institutions mandated with agricultural development as strategic entry points, particularly the agricultural extension services which are being strengthened to become key knowledge brokers for delivering information on CSA. The underlying notion is that CSA technologies are known to the scientific community, but effort is still needed to translate them into practical actions by various end-users.

This paper highlights the approach of the ACCRA programme which focuses its interventions on building capacity of key stakeholders in SADC member states for the scaling of CSA. The objectives of the paper are to describe the processes with which capacity development is taking place, as well as discuss the lessons learnt to date and implications moving forward. It concludes with regional implications in terms of extension capacity and mobilising climate finance for adaptation.

1.1. Background

The German Government through the Gesellschaft für Internationale Zusammenarbeit (GIZ) and SADC have established the ACCRA Programme, funded by the German Federal Ministry for Economic Cooperation and Development (BMZ). ACCRA is jointly implemented by CCARDESA and GIZ and aims at increasing the capacities of SADC member states to integrate climate change aspects into agricultural programmes and investments. This will be achieved through promoting regional knowledge dissemination on CSA and supporting the climate proofing of priority agricultural value chains. ACCRA will thus contribute towards the implementation of the climate-relevant elements of the SADC Regional Agricultural Policy and increase the capacities of the SADC member states to integrate climate change aspects into agricultural programmes and investments.

CCARDESA is a sub-regional organisation that was established by the 15 SADC Member States to coordinate agricultural research and development (AR&D) in the region. It was established in 2011 and undertakes capacity building interventions as part of its mandate. This entails empowering smallholder farmers to improve their production efficiency and to generate higher incomes through increased market engagement. To undertake sustainable agricultural practices by stakeholders in the face of worsening climatic conditions requires better access to appropriate information and harnessing of emerging practices and technologies. Over time, resources have been committed towards developing agricultural practices and technologies which produce higher production and productivity under certain climatic conditions while minimising damage to the environment. However, adoption and use of climate-smart and sustainable practices and technologies is still low in the region (FANRPAN, 2014; Mango *et al.,* 2017, Murray *et al.,* 2016). Employment of appropriate systems, communication and information sharing tools, and appropriate capacities and skills is paramount to improving information and knowledge sharing. Coordination of AR&D among 15 SADC member states entails a great degree of transferring knowledge and developing training materials, knowledge and communications products for different audiences. CCARDESA aims to be a regional hub to facilitate access to agricultural knowledge and information to various stakeholders in the region.

2. METHODS AND DATA SOURCES

The paper aims to present and reflect upon a programmatic approach to capacity building to strengthen the capacities in SADC member states to take CSA practices and technologies to scale in order to strengthen the adaptive capacity of the region to the impacts of climate change. It is based on an action learning approach and draws on available programme reports that document planning and implementation, as well as monitoring, reflection and learning within the organisation.

Firstly, information has been gathered from existing internal programme documentation. This includes programme strategy and planning documents, policy baseline reports, workshop reports, monitoring documents, progress reports, etc. Secondly, from participant feedback collected after capacity development and outreach events as part of programme monitoring and reflection. Feedback was collected through focus groups discussions, structured questionnaires and key informant interviews. The results of these activities inform the results of this paper.

3. RESULTS

ACCRA operates in two areas: (1) Regional knowledge dissemination on CSA, and (2) climate proofing of priority agricultural value chains. The aim of the first area is for SADC member states to have improved knowledge management systems for the dissemination of CSA, while the second aims for SADC member states to increase their capacities to disseminate and finance climate-smart practices in agricultural value chains. Through these areas, ACCRA implements a series of activities ranging from strengthening the CCARDESA information, communication and knowledge management (ICKM) system[46], developing and disseminating CSA knowledge products, policy advice on climate proofing policies, strategies and programmes, climate proofing of priority agricultural value chains through member states' projects, institutional strengthening, as well as capacity strengthening at different levels.

3.1. Capacity strengthening through joint project implementation

In SADC member states, ACCRA is partnering with diverse stakeholders from the national research and extension departments, civil society, non-governmental organisations and private sector to jointly implement focused cross-country projects that aim to climate proof selected priority agricultural value chains. These combine vulnerability assessments and stakeholder driven selection of suitable CSA practices with the piloting of selected practices and technologies where insufficient evidence exists. The results of the vulnerability assessment and CSA practices selection inform feasibility studies which, in turn, form the basis for writing bankable investment proposals for the scaling of CSA innovations within particular agricultural value chains.

The capacity of national partners is being built through a number of direct and indirect measures, including hands-on training courses, one-to-one coaching, regional knowledge exchange, and peer to peer learning across countries in three ways. Firstly, the programme strengthens the technical capacities of the project stakeholders on CCAA and CSA. Specifically, stakeholders are trained to: identify climate risks and vulnerabilities for agricultural production systems, identify and prioritise CSA best practices and technologies for particular contexts while assessing the trade-offs and synergies for agricultural productivity as well as adaptation and mitigation co-benefits. Secondly, the capacities of the stakeholders to carry out pilot and feasibility studies are strengthened in order to document evidence of the benefits and costs of CSA practices and technologies. Thirdly, the capacities for understanding climate financing requirements and for writing bankable investment proposals for international, regional or national financiers are also strengthened. Overall, partners are empowered to develop evidence-based large-scale investment proposals for the scaling-up of CSA within priority agricultural value chains in the SADC region.

3.2. Capacity strengthening through regional trainings and awareness creation

At the regional level through CCARDESA, ACCRA is partnering with international, regional and national experts to offer training courses on: *Tackling climate change in agriculture: approaches to climate change adaptation and climate-smart agriculture in the SADC Region* (CCARDESA and GIZ 2017). The regional training package is being promoted through the CCARDESA ICKM system2. The training is geared towards national and sub-national extension decision makers, multiplicators and practitioners, as well as technical staff in the Ministries of Agriculture or other organisations in the SADC Region. It aims to provide an overview of the challenges climate change poses for agriculture in SADC, as well as elaborating on the relevant concepts of adaptation, mitigation, vulnerability, CSA and others. It provides technical detail, practical examples and good practices, and equips participants with the hands-on knowledge and expertise of climate proofing of agricultural value

[46] The CCARDESA ICKM system consists of various components: the Southern African Agricultural Information and Knowledge System saaiks.net, the CCARDESA website www.ccardesa.org, social media platforms: Facebook (@ccardesa), twitter (#ccardesaa) and d-groups platforms, and traditional print media.

chains or systems. The interactive training aims to bring together participants from different backgrounds and contexts to facilitate knowledge exchange and learning amongst peers.

In other additional trainings conducted jointly with ongoing CCARDESA programmes and other partners, the skills of stakeholders in the SADC member states are being built to understand the modalities of international (and other) climate finance and climate finance readiness, write investment proposals that are bankable and integrate social and environmental safeguards, and other aspects of mobilising large-scale investment for climate-smart agricultural development.

Furthermore, a series of outreach events and workshops are being implemented by CCARDESA through ACCRA and other partners in order to further increase public awareness (and among targeted audiences) of climate change impacts in agriculture, adaptation and CSA in the region. This included a Regional CSA Conference (CCARDESA, GIZ and FANRPAN 2016), a dry season management workshop in Botswana (AgriBusiness Forum, CCARDESA, GIZ, BUAN 2017), and an episode of Botswana's *Breadbasket* radio show, to name but a few. The CCARDESA ICKM system is also used to reach out to the regional stakeholders.

3.3. Lessons to date

Evidence to date shows that collaboration between national research and extension systems is key in bringing together the right experience, expertise and skills for climate proofing. However, stakeholders continue to work primarily within their own departments, while exchange, learning and collaboration between research and extension services needs to be further strengthened. Moreover, effectively representing farmers' and community perspectives, as well as engaging with private sector and civil society within national or regional programmes continues to be a challenge.

Observations indicate a number of isolated initiatives by different actors at both national and regional level, which requires coordination at both levels to bring interventions to scale for improved impact. Forming meaningful collaboration at national and regional level requires effort and has to be cultivated as it brings about efficiency gains and minimises duplication. Collaboration will enrich the multi-dimensional perspectives of interventions and moves away from a culture of working in "silos", enhancing synergy. The collaboration across regions and countries offers opportunity for learning and spill-over of technologies at lower cost. Overcoming organisational and cultural hurdles and competing interests in collaboration presents challenges in collaborative initiatives which requires investment in coordination to ensure success in addressing climate change challenges which transcend national boundaries. Consolidation of best practices provides validation and useful guidance to stakeholders to choose interventions suited to their individual contexts.

Regional and cross-country collaboration is key. Climate change is a challenge across national borders, while agricultural value chains in SADC are transnational in nature. While the value of regional information and knowledge exchange, peer to peer learning and collaboration is being highlighted, mechanisms for collaboration remain weak and operationalising regional collaboration requires additional capacities, high-level buy-in and dedicated facilitation. CCARDESA with the mandate for regional coordination of agricultural research and development is well-positioned to take on the role of regional broker. However, institutional capacities and resources need to be strengthened to that effect.

Climate proofing has to happen at different levels, from regional to national and local. A multi-level approach is needed in order to strengthen the enabling environment at regional and national levels where policies, strategies and programmes guide agricultural decision making, planning and investment. Here, policy formulation has to be followed by resource allocation for implementation and the design of programmes for implementation. The national agricultural policies in SADC are being formulated to consider climate change impacts, but specific interventions are still lacking, and the required resources need to be mobilised. The national agricultural extension services are key in bringing national policy to local level, but there are rarely specific agricultural extension strategies or guidelines in place. None of the ones that exist in the SADC member states give specific direction with respect to CCAA or CSA implementation on the ground. Evidence to date suggests that while many adaptation efforts are being implemented, the existing capacities for prioritising CSA in a particular context need to be strengthened. Training of extension agents through ACCRA (CCARDESA and GIZ, 2016) has resulted in several local initiatives of developing CSA plans and training of farmers on CSA implementation in SADC member states.

An in-depth understanding of the impacts of climate change on the agricultural sector and on farm level needs to be pursued. How an approach such as CSA can help address the challenges ahead, how context specific interventions that form the basis of the approach are to be selected, prioritised, adopted and applied, is lacking. Experience during various training events, conferences and other forms of outreach show that specific knowledge of adaptation options and how to prioritise for a specific context is mostly lacking.

Most critically, the international climate finance arena is complex. High hopes are being placed on additional resources being mobilised for the development of the Nationally Determined Contributions (NDCs) under the Paris Agreement of the UNFCCC. However, the landscape of funds that are being created for climate finance, their different funding options, mechanisms and modalities and how to write successful proposals for these financing streams are complex and difficult to understand. New skills and intensified collaboration across line ministries are needed. Implementing the countries' commitments for adaptation (and mitigation) will take a more concerted effort of strengthening the capacities for accessing international climate finance in the SADC region.

National agricultural extension services are key actors in supporting climate change adaptation in agriculture and scaling CSA practices. However, the national systems are often under-staffed, under-funded and lack the capacities, tools and products to bring CSA to scale effectively. Extension manuals and guidelines tend to be generic and not address the climate change challenge specifically. Targeted and user-friendly knowledge products for CSA need to be produced and disseminated in order to strengthen the capacity of extension services on the ground.

4. CONCLUSIONS AND EXTENSION IMPLICATIONS

While climate change poses additional challenges to agricultural development in the SADC region and threatens the livelihoods of smallholder farmers, in particular, it also creates opportunity. Opportunity for innovation, for cooperation and for re-orienting existing systems of agricultural development. International climate negotiations, regional momentum and national support, as well as local innovation, provide enabling conditions for the agricultural transformation required in light of climate change.

The national agricultural extension services have a key role to play bridging between national policy and local implementation and in supporting farmers in adopting climate-resilient, productive and less vulnerable farming practices. In collaboration with farmers, farmers associations, national extension research organisations, private sector and NGOs, CCARDESA and GIZ are contributing towards these efforts. New skills, new ways of working and new efforts for collaboration are needed. Evidence to date suggests that collaboration between research and extension is key, that cross-country collaboration mechanisms need to be strengthened, and that multi-scale partnerships need to be mobilised in order to effectively take CSA to scale. In combining different approaches to capacity strengthening on CSA and climate proofing agricultural value chains with climate financing and proposal writing, existing initiatives are contributing towards building capacities in SADC members states for scaling up CSA.

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CAPACITY DEVELOPMENT FOR SCALING UP CSA INNOVATIONS

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ABSTRACT

Climate change and climate variability are creating negative impacts on agriculture. It affects both food security, crop and livestock production. In the process it affects the livelihood of communities. Climate smart agriculture is seen as an alternative to mitigate the challenges of climate change. The paper used literature studies to critique journal articles related to capacity development for scaling up climate smart agriculture. The problem investigated is that Climate Smart Agriculture (CSA) is a recent concept which needs to be understood with Climate change and the extension advisors do not have the requisite skills to handle the matter.

The findings of the paper defined CSA and showed the linkage with climate change, defined both concepts, identified the CSA technologies for mitigating against climate change, recommended the area of competency required to serve farmers and it showed the strategy of scaling up the technologies. The paper recommended capacity development for extension advisors and concluded with a series of mitigation steps to improve productivity in agriculture.

Keywords: Climate change, mitigation, impact, climate smart agriculture

1. INTRODUCTION

Climate change and climate variability are creating negative impacts on agriculture. In the process it affects the livelihood of communities. Experts have attempted to explain the challenges that the continents will face due to climate change and also predicted that unless something is done it has potential to destroy the environment which promote food production (IPCC, 2007 and Swanson, 2008). It creates a lot of effects to food security and both affect animal and crop production. Developed and developing countries are going to be affected. Studies have shown that researchers can contribute by describing the potential role innovative agricultural practices and technologies can play in climate change (Nelson, 2009; Seo, 2010).

While efforts have been directed to the understanding of climate change its definition, causes and mitigation, not much has been done in technologies that can be used in the circumstances of climate change. According to Lybbert *et al.,* (2012) innovative agricultural practices and technologies can play an important role in climate change. If it can be mitigated and adapted to they can make a difference. This paper focuses on climate smart technologies with these specific objectives:

- to define climate smart and how it is linked to climate change;
- to indicate the impact of climate change on crops and livestock as well as the mitigation; and
- to identify climate smart technologies and strategies to scale up by extension advisors.

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2. BACKGROUND

Evidence suggests that climate change has become a big matter in the world with organisations attempting to find a solution (Simpson and Burpee, 2014). Climate change will exert increasing pressure on our ability to meet other major challenges, with feeding the world's growing population paramount (9.6 billion by 2050; UNDESA, 2013). Over the next 40 years, the need to increase global cereal production by a minimum of 60 to 70 percent (FAO, 2009; USAID, 2013), the questions that need to be asked are what is our understanding of climate change, what are the causes and can these be mitigated? Researchers and scientists have been grappling with these questions and some have given their understanding. Climate change plays a negative role in agriculture and causes excessive gasses in the atmosphere. The existence of "high levels of CO_2 would have a catastrophic effect on the planet's ecosystems" (Simpson, 2014 page 5).

Rising air temperatures trigger several important secondary effects. Increased global day and night time temperatures are causing changes to seasons. Warmer air temperatures are melting the polar ice caps, northern latitude ice shields and high-altitude glaciers worldwide, leading to changes in the timing and volume of freshwater discharge and rising sea levels (Simpson 2014). In order to slow down this process, human beings should be helped to understand some of the steps that need to be taken. One would interrogate as to what is the link between climate change and CSA. It can be argued that while climate change increases the vulnerability to agriculture which results in variability of temperature and reduced rainfall or in some instances brings out flood. On the other hand, Juvvadi, (undated) identified three critical contributiosn that as a result of CSA namely; a) CSA, reduce agriculture contribution to climate change, b) it strengthens resilience to climate change and variability, and c) it sustainably increases productivity and income.

International organisations such ICRISAT saw the importance of CSA to an extent that it has established projects in Africa reaching out to countries such as Ethiopia, Horn of Africa, and Sudan. The aim being to capacitate the extension functionaries in order to best serve farmers with climate smart agriculture. The project will develop CSA technologies and CSA farms in vulnerable regions of Ethiopia and Sudan. These technologies include improved crop varieties and land management, improved soil fertility management, integrated pest and weed management, agroforestry and improved livestock systems. These CSA farms will also serve as research and training sites for students from the universities and be used as demonstration sites. Gender equality and the promotion of female farmers is a core activity of the project.

3. METHODOLOGY

The paper adopted a literature review. Different search engines were used to search climate change and climate smart as well as capacity building in climate smart in agriculture CSA. A number of documents were consulted and related papers in journals and books were found and consulted. All these documents were found useful in terms of expanding the frontier of knowledge on climate smart in agriculture.

4. RESULTS AND DISCUSSION

4.1. Definition of climate smart

FAO (2010) defines climate smart agriculture (CSA) as agriculture that sustainably increases productivity, resilience, reduces or removes greenhouse gases while enhancing the achievement of national food security and development goals. This concept is supported by international multilateral agencies such as World Bank, International Fund for Agricultural development (IFAD), Consultative Group for International Agricultural Research (CGIAR) and practices have been documented (Scherr *et al*., 2012).

It should be realised that prior to the implementation of CSA one has to first understand what climate change is. The United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods" (United Nations (UN), 1992). It is viewed as the greatest environmental challenge facing the world this century (Department of Environmental Affairs and Tourism (DEAT), 2004).

4.2. Capacity development training for the officers and training for farmers

It is imperative that technical advisors be capacitated in the area of climate change. Literature shows that developing countries are putting in an effort in this regard (Simpson *et a*l., 2014). While there are also pockets of areas where similar efforts are being made in the African continent. Extension functionaries have to be capacitated in this area with competencies that include: communication, farming, science, social, technical and methodological (Chikaire 2015).

According to (Mwale *et al*, undated), such training was provided to technical advisors to enable them to have adequate technical knowledge and tools to better advice and train farmers, thus enhance their capacity to adapt to the effects of variability and climate change. The project will develop CSA technologies and CSA farms in vulnerable regions of Ethiopia and Sudan. The CSA farms will focus on integrating promising CSA technologies and creating synergies between the different technologies (Tabo, undated). Training manuals have been developed (Simpson, 2014, Cracknel, 2011).

There are many organisations that contribute towards training technical advisors. They have formed partnerships, for example ICRISAT working in the horn of Africa has formed partnerships with organisations like International Relief Development, Malian Agency for the Environment and Sustainable Development (AEDD), and Building Resilience and Adaptation to Climate Extreme and Disasters Program (BRACED) (Tabo, undated Wright et al., 2016).

These technologies include improved crop varieties and land management, improved soil fertility management, integrated pest and weed management, agroforestry and improved livestock systems. These CSA farms will also serve as research and training sites for students from the universities and be used as demonstration sites.

4.3. Types of innovations

Different types of technologies exist such as those that are related to water which may be called water-smart technologies. Taneja *et al.,* (2014) identified 5 types of technologies of which two are discussed while the other 3 are presented in a Table 4.1 According to (Taneja *et al.,* 2014), these are the kind of **i**nterventions that reduce water requirements to produce the same or a higher level of yield.

Rainwater may need to be managed such as harvesting it either from rain or from the run off by using different tools. Water management is another issue that need more attention. The impact of 2015/16 drought in Western Cape Province of South Africa has led to the major dams to dry. The dam levels were estimated to be

30-40 % (Du Preez, 2017). In situ rainwater storage in rice paddies with 20–25 centimetres (cm) bunds can also be regarded as technology. It is believed that this technique is for rice only (Taneja *et al.,* 2014).

Another technology is called laser land levelling. Here the land is levelled with a laser. This kind of technology is suitable in rice fields which is a system of rice intensification, in this technology 7- to 10-day-old seedlings are transplanted at 20 cm spacing with 1–2 seedlings per hill. Addition types of technology are presented in Table 4.1.

Table 4.1 Selected technology options for choice experiment

Type of Technology	**Definition**
1. Energy-smart technologies	Technologies that help reduce energy consumption during land preparation without affecting yield levels. These also help reduce water requirements for crops.
• Direct-seeded rice	Dry seeds are sown either by broadcasting or drilling in line.
• Zero tillage / minimum tillage	The crop is seeded through a seeder in an untilled field, and the crop residue is incorporated into the soil. At present, this technique is limited to wheat only.
2. Energy-smart technologies	Technologies that help reduce energy consumption during land preparation without affecting yield levels. These also help reduce water requirements for crops.
• Direct-seeded rice	Dry seeds are sown either by broadcasting or drilling in line.
• Zero tillage / minimum tillage	The crop is seeded through a seeder in an untilled field, and the crop residue is incorporated into the soil. At present, this technique is limited to wheat only.
3. Nutrient-smart technologies	Technologies that save/supplement/avoid chemical fertilizer use for crops and enrich carbon in the soil.
• Green manure	Cultivation of legumes in a cropping system. This practice improves nitrogen economy and soil health/quality.
• Integrated nutrient management	Integrated use of organic and chemical fertilizers to partially (25 percent to 50 percent) reduce NPK (nitrogen, phosphorus, and potassium) requirements without affecting productivity and improve soil health.
• Leaf colour chart	Standardized colour charts are used to identify nutrient deficiency to estimate fertilizer doses in different field locations.
4. Weather-smart instruments	Interventions that provide services related to financial security and weather advisories to farmers.
• Crop insurance	Crop-specific insurance to compensate income loss due vagaries of weather.
• Weather advisories	Information and communication technology–based forecasting about the weather.
5. Introduction of stress tolerant crops and diversification	Tolerant crops withstand biotic and abiotic stresses and crop diversification reduces water demands and helps in harnessing nutrients from different soil layers.
• Drought-tolerant variety	Seed variety that is tolerant to drought or relatively dry weather conditions.

Source: Taneja *et al.,* 2014

4.4. Strategies of scaling up of approaches

4.4.1 Policy match

Earlier studies have shown that the capital cost of technology has a great bearing on technology adoption (Garido 2005). Thus, if the cost of adoption is totally private, the technology will be implemented if the private returns from the investments are more than the private costs. If this is not the case, the adoption of technologies may be deferred until the benefits exceed the cost.

4.4.2 Financial support

Small and marginal farmers may not have access to the formal credit system. Studies have established that increased access to credit helps farmers overcome short-term liquidity constraints and increase technology adoption.

4.4.3 Strengthening capacity of institution

Access to information is a key element in the adoption of new technologies. A farmer will adopt technology that will maximise his food security. It is therefore recommended to create institutions to build capacity among technology developers, disseminators, and farmers. Farmers and other role players should be made aware that technologies should be adopted.

4.5 Mitigation

According to IPCC (2007) mitigation refers to the efforts undertaken to "reduce anthropogenic [greenhouse gas] emissions or to enhance natural sinks of greenhouse gases" (IPCC, 2007). In agriculture, mitigation generally refers to the sequestration of atmospheric CO_2 in plant tissue through photosynthesis and its storage in soil organic matter, and the reduction in direct emissions from fossil fuel usage and energy intensive inputs. Efforts to reduce the impact of climate change, on the other hand put it simply, mitigation is defined as activities aimed at "avoiding or minimising sources of pollution that can have a deleterious effect on levels of GHGs, global warming and climate change. Contributions towards reducing the levels of anthropogenic greenhouse gas production needs to be actively encouraged. This includes fossil fuel- related activities, methane and nitrous oxide emissions" (DAFF, 2013).

A number of considerations were identified when mitigating against climate change. In terms of livestock the herd sex, age and breed should be optimised to allow the national herd to be reduced while maintaining the same level of production. Supplementing the feed with high protein forage would reduce the methane production from enteric fermentation and increase productivity.

Extending feedlot manure management to include anaerobic digestion and the collection and use of the methane gas produced would improve the emission of negative gasses in the atmosphere. A positive impact could be made by promoting the use of game in place of beef production, avoiding the burning of agricultural residues, including those from sugar cane plantations, even where such methods are accepted management practice, reduction of the frequency of fires by enhanced fire management practices, promoting savannah thickening over substantial areas, effectively managing soil organic matter, adopting minimum tillage methods, and exploring synergies between adaptation and mitigation measures in the areas of agricultural product diversification and the application of more socially beneficial agro-technologies such as permaculture to provide sustainable livelihoods (DEAT, 2004).

The use of insurance can be used. Risk mitigation may involve a variety of private and government policy and institutions. While government supported crop insurance in developed countries has often been highly subsidised (Lybert *et al.,* 2012), whereas in developing countries the situation is different, insurance remains an individual's responsibility. In India farmers were prepared to buy weather index insurance products even when these products are not subsidised.

4.6. Impact of climate change on farmers

Different categories of farmers suffer the impacts of climate change. For example, the negative effects of climate change affect food security of the targeted households and small holder farmers. Furthermore, the most vulnerable to the expected impacts of climate change are developing countries and their citizens who have a lower resilience to climate change impacts due to limited financial and technical resources to support adaptation. Commercial farmers in different fields like crops grapes, livestock also suffer the impacts (Swart, 2016).

Climate change and climate variability have a negative influence on crops (Afful, 2016). Where irrigation is insufficient, crops wither and die thus reducing the yield. The reduced yield could further mean reduced profit, and increased poverty. However certain steps need to be taken in order to mitigate against this situation. If the advisors know about the impact they will realise the need to be capacitated in climate smart in agriculture. Advisors have to be in the fore front of knowledge in climate smart agriculture if they are to be meaningful to farmers.

4.7. Adaptation to climate change policy

According to IPCC (2012) adaptation can be explained at two levels, in the first level (human systems), it refers to the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In the second level (natural systems), is the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate". Smallholders require the ability to respond and adapt to changes that affect their livelihoods – changes in weather and natural resources, household labour availability and other assets, as well as fluctuating input prices (Simpson, 2014). Those who are closer advisory services should be readily available to assist them with the correct advice. In the context of South Africa, it is expected that each province develops a climate change policy.

5. CONCLUSION

Climate smart in agriculture has its basis in the climate change and its variability. It is important to understand the concept ot climate change and climate smart in agriculture (CSA). While the causes of climate change are known i.e. both nature and man induced activities, It can be concluded that efforts of mitigation should become a norm. The paper has identified some of the technologies that are needed in CSA.

These technologies were discussed as well as how they can be scaled out based on three strategies namely policy matching, capacitating the extension functionaries in CSA and financial support. CSA should be seen as an engine of green growth and a provider of environmental services. In order for the technology to be effectively promoted there is a need for: policy financial support and the willingness of farmers to adopt such technologies on conditions where the benefits outweigh the cost of implementing it; and, a policy to train the advisors in climate smart principles to enable them to be ahead of their farmers with knowledge in climate change and climate smart in agriculture.

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BEST TECHNOLOGY FOR ADDRESSING CLIMATE CHANGE IN SUDAN

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ABSTRACT

Climate change is one of the major challenges to the Sudan agricultural sector. The Federal Ministry of Agriculture designed and financed a special programme for the traditional rainfed sector of the country as a strategy for the 2014/15, 2015/16 and 2014/17 growing seasons in order to diversify and increase the production and productivity of cultivated crops in the traditional rainfed areas in the country such as sorghum, sesame, millet and sunflower. This programme was implemented by the Administration of Agricultural Extension and Technology Transfer in each State in collaboration with Sudan Agricultural Research Corporation (ARC) and Agricultural Bank of the Sudan. Results in Gezira State showed a promising increase in production average of demonstration plots of main the crops cultivated in the traditional rainfed sector of the State.

Keywords: Climate change, rainfed agriculture, technology, adoption, adaptation strategy, Sudan

1. INTRODUCTION

Agriculture is the backbone of Sudan's economy and food security. As in developing countries, the majority of Sudanese people live in rural areas and depend on agricultural production as the main source of their income and food security. The country has two main agricultural subsectors; irrigated and rainfed (traditional and mechanised) subsector. The traditional rainfed sector represents 60% of the total cultivated area in the country. Sorghum, sesame and millet are the main cultivated crops in this sector in addition to other crops such as sunflower, groundnut and cotton. The total yields of rainfed sector vary from season to season according to variability of rainfall (Ahmed *et al.,* 2013:133).

The effect of climate change on African agriculture represents a major challenge to continental agricultural development including food security, nutrition and management. Climate change is one of the major challenges to Sudan agricultural sectors as in other Sub-Saharan African countries (Ifeanyi *et al.,* 2012:54). Changes in temperature, rainfall, water availability, increased outbreak of pests and diseases, land degradation, soil erosion, shrinking of grazing and cultivable areas, ongoing desertification and the other aspects of climate change have direct significant impact on agricultural production, productivity and cultivated crops of the Sudan (Ahmed *et al*., 2013:133). The most suitable option for Africa to manage the impact of climate change is adaptation, but the continent's low adaptive capacity serves as a major constraint facing its ability to adapt. These major constraints include limited financial resources and low technical awareness to adapt to climate change (Nyong *et al.*, 2006).

Despite this unfavourable situation, there are many adaptation strategies which have been tried in Sudan, such as good agricultural management systems, drought resistant varieties, crop diversification and efficient water harvesting techniques. Therefore, Administration of Agricultural Extension and Technology Transfer in each State has an important role to play in transferring appropriate adaptation technologies to farmers particularly in the traditional rainfed subsector.

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2. PROGRAMME DESCRIPTION

The Federal Ministry of Agriculture has designed and financed a special programme for the traditional rainfed sector of the country. Integrated Solutions Programme is the main adaptation strategy for the 2014/15, 2015/16 and 2014/17 growing season to diversify and increase production and productivity of crops cultivated in traditional rainfed areas in each State of the country such as sorghum, sesame, millet and sunflower. This programme was implemented by the Administration of Agricultural Extension and Technology Transfer in each State in collaboration with Sudan Agricultural Research Corporation (ARC) and the Agricultural Bank of Sudan.

2.1. Technologies recommended

Water harvesting techniques: Different types of local rain water harvesting techniques such as disc plough, ridging and high terracing were recommended to store rain water in the field after each rainfall throughout the rainy season.

Improved seeds: Climate change has a direct effect on cropping systems; thus, adapting food production systems to rapid change in climate conditions is important to local and global food security. In some cases, rainfed farmers need to cultivate new crop varieties as an adaptive method to reduce the losses in yield of existing crops which can result from the variability of climatic conditions. Hence two new sorghum varieties; Arfaa Gadamac and Butana were recommended for the traditional rainfed sector.

Use of chemical fertilizers: Some chemical fertilizers were recommended for the traditional rainfed sector such as urea and DAP.

Cultivation method: Cultivation on furrow was recommended for the traditional rainfed sector which will help in keeping continuous and suitable irrigation for all rainfed crops throughout the rainy season.

Weeding: Manual weeding was recommended for the traditional rainfed sector.

Extension methods used: The following extension methods were used as the main extension activities in implementing the programme:

- Method demonstration
- Result demonstration
- Field visits
- Extension meetings such as workshops, seminars, lectures and panel discussions
- Field days
- Mass communication
- Extension publications

3. AGRICULTURAL PRODUCTION IN 2015/16 GROWING SEASON

3.1. Agricultural finance and credit

The total finance provided by the Agricultural Bank for this season is estimated at 1 232 million SDG. More than half of the agricultural finance was given to the semi mechanised sector, while the traditional sector was given about one percent (Table 1).

Table 1: Summary of the credit provided by the Agricultural Bank for summer crops, season 2015/16 in comparison with season 2014/15

Sector and equipment	Area financed/feddans			Agric. finance/million/SDG			Share of finance	
	2015	2014	% change	2015	2014	% change	2015	2014
Semi mechanized sector	6 433	5032	28	684	463.8	47	55.50	52.8
Traditional sector	90.4	126	-28	13.3	13.3	0	1.08	1.5
Irrigated sector	135.9	174	-22	83.9	75.1	12	6.81	8.5
Horticulture	16	18	-11	49.5	21.1	135	4.02	20.4
Agric. mach. Equipment	1 056.6	665	59	401.6	306	31	32.59	34.8
Total	**7 731.9**	**6015**	**29**	**1 232.3**	**879.1**	**40**	**100**	**100**

Source: Agricultural Bank of Sudan.

3.2. Seed distribution for 2015/16 growing season

The quantity of seeds distributed by the Ministry of Agriculture in collaboration with some NGOs is shown in Table 2 below.

Table 2: Quantity of seeds distributed in tons

Crop	Ministry of Agric.	NGOs	Total
Sorghum	277.1	34	311.1
Millet	244.4	-	244.4
Groundnut	150	243	393
Beans	-	1.6	1.6
Sesame	-	0.4	0.4
Watermelon seed	-	0.4	0.4
Vegetable	-	1.16	1.16
Total	**671.5**	**280.56**	**952**

Source: Annual Crop and Food Supply Assessment report/2016

4. GEZIRA STATE CF AS AN EXAMPLE OF 2015/16 GROWING SEASON

As in other States of the Sudan, the Integrated Solutions Programme as the main adaptation strategy to climate change started in 2014 growing season with the objective of diversifying and increasing the production and productivity of crops cultivated in the traditional rainfed areas in the State, mainly sorghum and new introduced crops such as sesame and millet.

4.1. Training of extension officers and innovative farmers

The extension officers and innovative farmers were trained for successful implementation of the programme in the State in the following training areas:

4.1.1. Extension officers

Capacity development is a major requirement for achieving impact on agricultural extension staff development to ensure effective service delivery to target audience. The generation and diffusion of technology, innovation and management skills for more intensive and modern agriculture and services become of high importance. This can only be achieved through the capacity development of human resources employed in the agriculture sector. Capacity building includes training and all other forms of learning that improve information, knowledge, competence and skills of individuals.

Table3: Areas of training of extension officers

Areas of training	Number of training sessions attended	Number of attendees
1- Water harvesting techniques	2	49
2- Agricultural extension	1	35
3-Participatory approaches	1	31
4- FFS approach	1	31
5- Innovation platforms	1	31
6- Maintenance of knapsack sprayers and agricultural machines	1	36
7- Extension methods, planning, monitoring and evaluation in extension	1	25

4.1.2. Training of innovative farmers

Farmer training is an important arm of agricultural extension which is widely used by agricultural extension organisations to facilitate the adoption process of agricultural innovations in rural areas. Therefore, considerable number of rainfed farmers were trained in order to achieve the goal of the programme.

Table4: Areas of training of innovative farmers

Areas of training	Number of training sessions attended	Number of attendees
1-Water harvesting techniques	1	129
2- Maintenance of knapsack sprayers and agricultural machines	1	15

4.2. Production average of demonstration plots

Sorghum is the main rainfed crop cultivated in the State. The production of sorghum in the traditional rainfed sector in the Sudan is low and does not exceed two sacs/feddan. Therefore, the adoption of the recommended cultivation technology will help to increase the production of rainfed crops as shown by agricultural extension activities using the method and result demonstrations in each locality of the State.

Table 5: Sorghum production average of demonstration plots in each locality

Locality	Sorghum production (sac/feddan)
Nm\21- Um Alqora	8.00
2- East Gezira	8.00
3- Managil	8.00
4- South Gezira	5.00
5- Wad Medani	6.00
6- Alqorashi	5.00

1 ton = 10 sacs

1 hectare = 2.38 feddan

4.3. Farmer's average production of sorghum, sesame and millet

Table 6: Comparison between famer's average production in the State before and after using the production technology of sorghum, sesame and millet

Crop	Traditional(sac/feddan)	Using production technology(sac/feddan)
1-Sorghum	1.5 –2.0	6.8

2-Sesame	2.0	4.0
3-Millet	2.0	3.5

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THE ROLE OF A VIRTUAL IRRIGATION ACADEMY (VIA) TO IMPROVE WATER PRODUCTIVITY IN MALAWI, TANZANIA AND SOUTH AFRICA

Stevens, J B (Joe)[49] & Stirzaker, R. J.[50]

ABSTRACT

Irrigation in sub Saharan Africa has for most part, failed to live up to its potential. Irrigation schemes have fallen into disrepair and higher productivity is required to address the challenge of feeding a growing population in Africa. This paper reflects on simple irrigation monitoring tools, namely the Chameleon soil moisture sensor and the Fullstop wetting front detector, which make it possible to move from curriculum-based training to experiential or people centred learning approaches where colours and observations are used. The VIA platform not only serves to capture physical data from the schemes, and the dialogue between extension advisors, farmers, researchers, but also serves as a platform where social learning in the small-scale irrigation community can take place. The results illustrate that farmers found the tools relatively easy to use and to learn from, and some farmers even changed their management practices within a short time. The role of learning platforms or coalitions, and extension advisors as facilitators, are crucial to enable farmers to move from coping to more adaptive irrigation management strategies.

Key words: *Virtual Irrigation Academy, Chameleon sensor, Fullstop wetting front detector, social learning, learning coalitions, adaptive irrigation management*

1. INTRODUCTION

Africa is facing a daunting challenge of feeding 1.5 billion people by 2030 and 2 billion by 2050 (NEPAD, 2003). Currently, an estimated 530 million people across the continent live in rural areas and depend primarily on rain-fed agriculture production with low yield. Increasing the area under irrigation can increase agricultural production, thereby reducing the food security problem, and increasing the income of farmers and reducing poverty in general. Yet, in sub Saharan Africa, only 7.3 million hectares are irrigated out of an estimated suitable area of 40 million hectares (You et al, 2011). The development of irrigation in sub Saharan Africa has experienced many challenges (Stirzaker and Pittock, 2014): a) a history of irrigation in the region failing to provide adequate return on investment, b) weak market integration, c) weak water governance institutions, and d) significant degradation and abandonment of irrigated land. Despite these drawbacks, African governments have ambitious plans to expand irrigated agriculture (Sullivan and Pittock, 2014). In 2015, the African Union Heads of State and Government through the African Union's Comprehensive Africa Agriculture Development Plan (CAADP) committed themselves to ending hunger by 2025, by facilitating irrigation.

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In sub Saharan Africa many irrigation schemes have fallen into disrepair, up to two thirds of the land with existing irrigation infrastructure in Mozambique lies unused (Chilundo, Brito and Muguambe, 2004), and over 50 % of smallholder schemes in South Africa are no longer in operation (van Averbeke, Denison and Mkeni, 2011). Irrigation projects in sub Saharan Africa are operating at significantly lower productivity than in other regions of the world. Despite numerous efforts to boost irrigation, most irrigation projects in the region proved to be costlier than elsewhere, with a total cost of $14 500/ha compared to $6 500/ha in other developing projects. As a consequence, investment in irrigation by donors during the mid-90's had fallen to just a tenth of what it was decades prior (World Bank, 2008). There is an urgent need for Africa's farming communities to increase productivity and improve the resilience of agricultural production systems in the face of changing climate.

Many lessons have been learned about design and construction of irrigation infrastructure, and in short, the physical resources, financial backing and political will are in place to ensure a rapid increase in irrigated area in sub Saharan Africa. The extent to which this strategy and concept will translate into practical action hinges on: 1) good water governance, 2) farmer access to markets, and 3) and improving skills of small scale irrigators in water management and agronomy. This paper provides some highlights of the learning experiences on how farmers applied soil water and nutrient monitoring tools through the linking of farmers, extension advisors, researchers and irrigation managers to form learning coalitions necessary to increase the profitability of small scale irrigation in selected irrigation schemes.

2. AN EXPERIENTIAL LEARNING SYSTEM

The Comprehensive Africa Agriculture Development Programme (CAADP, 2009) lists one of its key elements for successful water management projects as "people centred learning":

Based on innovative and participatory adult learning methods, this involves guided practical field based investigations through which land users learn themselves.....They also learn how to identify ways of addressing these challenges through observation, testing and monitoring of different treatments as well as reviewing and sharing findings through subgroups and plenary discussions with common interest groups.

Traditionally, irrigation has not been taught this way. The method favoured in the majority of training materials is a first principle approach requiring climate, crop and soil data that are manipulated through a set of calculations to provide the predicted irrigation volume (like the FAO training manuals to support smallholder irrigation in the 1980's (Brouwer and Heibloem, 1986) and also the comprehensive manual for the training of extension advisors to small scale farmer in South Africa by Stevens and Buys, 2012)) The challenge for farmers is to use estimates of potential evaporation, crop coefficient, effective rainfall, allowable soil depletion and effective root depths to calculate the required irrigation amount. Even if a farmer is 100% correct, the challenge for especially the smallholder farmer is, for example, to apply 27 mm of irrigation when flooding a field from an earth canal!

The core of the problem is that scientists and farmers operate from very different mental models. The mental model of the scientist is based on theory, which enables clear communication amongst specialist, and quantification and exploration of basic principles to new situations. The mental models of the farmers are built around the experiences and local knowledge (Abel, Ross and Walker, 1998; Stevens, 2006). Farmers use their experience and local knowledge to build a mental model that allows them to predict what might happen next and react accordingly. When an extension advisor tries to tell a farmer to change his/her irrigation practice, the message is filtered through the farmer's mental model and may be distorted or ignored if the message conflicts with farmer's experience of the local conditions or understanding (Abel et al, 1998).

The alternative way of approaching farmers is therefore to apply "people centred learning: or experiential learning or adaptive management where observation, monitoring and feedback form the structure of learning. For this approach to be applied, it is important that farmers must be able to observe to give themselves reliable feedback and stimulate learning. Farmers are getting some feedback from their water management and crop performance through observation, even if the water applied is not quantified. The use of simple tools (Figure 1) that fit the mental models of farmers so-as to engage them in learning-by-doing approach were developed and provided to farmers.

3. METHODOLOGY

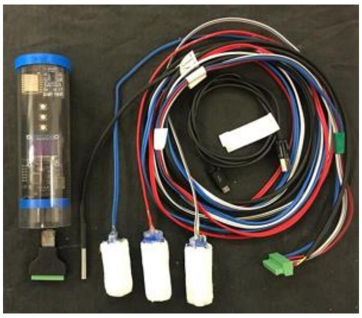
Given the fact that extension advisors are working with farmers with low literacy and numeracy, the following suite of tools were built to enhance understanding around soil water and solute management (Figure 1).

Three questions were taken into mind with the design and building of these tools:

a. What is the least information a farmer needs to make a better irrigation decision?

b. What is the simplest way to provide it?

c. How do we move from data, to understanding, to knowledge?

<table>
<tr><td></td><td>The Chameleon soil moisture sensor consists of an array of three or four sensors that are permanently installed at different depths in the soil. A portable hand-held reader is con- nected to each sensor array and displays the soil moisture as coloured lights (Stirzaker, 2014). Each depth is represented by a light, and each light can be blue (wet soil), green (moist soil) or red (dry soil). The lights give a picture of soil water conditions from the top to the bottom of the root zone. Successive readings through the season give a colour pattern that illustrates the wetting and drying of the soil, the depth of rooting and how well irrigation or rain refills the soil. The Chameleon measures soil tension, so that the colours have the same meaning for the farmer, regardless of the soil type. Both the Chameleon and the FullStop are described more fully at the Virtual Irrigation Academy website, https://via.farm/.</td></tr>
<tr><td></td><td>The FullStop wetting front detector, is a funnel-shaped device buried in the soil with an indicator above the soil surface (Stirzaker, 2003). Water infiltrates the soil; the wetting front is the boundary between the wet soil above and the drier soil below. How deep the wetting front moves into the root zone is a function of the amount of water applied, the soil type and the initial soil water content. If the wetting front reaches the buried funnel, some of the infiltrating water is intercepted. As water moves down the</td></tr>
</table>

	funnel, the soil water content increases as the cross-sectional area of the funnel decrease, until saturation occurs. This water flows through a filter and into a reservoir, activating the magnetically latched indicator at the soil surface. The soil water sample captured by the detector can be extracted for monitoring of electrical conductivity and nitrate.
	Soil nitrate and salt status is measured in the water sample captured by the FullStop. Most of the nitrogen available to the plants is in the form of nitrate, a negatively charged molecule that largely moves with the water and which is highly susceptible to leaching in irrigated situations (van der Laan, Stirzaker, Annandale, Bristow, & du Preez, 2010). Using the water sample from the FullStop, nitrate was measured in the field using colour test strips (Merckoquant nitrate test strips, Merck, Germany). Salt build-up is also a major problem in irrigated areas, and electrical conductivity is monitored using a pocket meter (EcoTestr EC High, Eutech, Singapore).

Figure 1: Simple tools to be used in an experiential learning system

The above tools are evaluated in two irrigation schemes in Zimbabwe (Silatshani and Mkoba), two in Mozambique (Boane and Khanimambo), three in Tanzania (Kiwere, Iringa district; Chinangali (Chamwino district; and Msolwa in Kilombero district), three irrigation schemes in Malawi (Kasinthula Irrigation Scheme, Chikwawa; Nanzolo Irrigation Scheme in Chikwawa; Bwanje Irrigation Scheme, Dedza) and in South Africa (Taung and Vaalharts Irrigation Schemes, Northern Cape Province; Nkomazi Irrigation Scheme, Mpumalanga Province; and five small scale citrus schemes in Northwest and Limpopo Provinces). At each scheme approximately 20 farmers are selected and each provided with Fullstops and chameleons. Farmers are required to visit the schemes each week, take a Chameleon measurement, and record whether the Fullstop has collected a water sample. If so, the water sample should be removed, and the conductivity recorded and the nitrate measured on the test strip. The nitrate, salt and water readings are plotted weekly to produce These selected farmers include women and youth involved in monitoring irrigation water, nutrients and salts and together with lead farmers, extension advisors, members of Water User Associations and researchers form "learning coalitions". Each coalition will be located around an irrigation scheme and will build their own case studies based on their experiences.

The VIA concept is based around the idea of a learning organisation, one that is "skilled at creating, acquiring and transferring knowledge, and at modifying its behaviour to reflect the new knowledge and insights". VIA combines the use of new irrigation monitoring tools with an on-line communication and a learning system. The role of the VIA platform serves the following:

- Physical data capturing from the scheme on a daily basis, so that project and country leaders can understand the situation and mentor extension advisors where necessary.
- Capturing of the dialogue between extension advisors, farmers and scientists for analysis of how learning occurs (Sensemaker)

- Training resources such as videos on equipment installation and maintenance, interpretation of data Training in the use of tools and instrumentation of farms has been carried out in several different ways to allow the project team to access which combination of methods are the most effective:
    - VIA website: 20 “how to videos” were produced and are loaded on the VIA website where detailed step-by-step instructions on issues like how to install equipment or pair Chameleon readers to phones are presented, including a FQA section.
    - Formal face-to face training by experts and country team members
    - Farmer-to farmer training - where farmers from the initial selected schemes share their experiences farmers from new schemes

4. RESULTS

The VIA project started already during 2015 in Zimbabwe, Mozambique, Tanzania and Malawi, while it only kicked off during June 2017 in South Africa. Therefore, the findings reflected here will mainly focus on the feedback from farmers using tools in Zimbabwe, Mozambique and Tanzania and different stakeholders’ interest shown in participating at different scales in the “learning coalitions”. Farmers were asked three questions regarding the use of the simple tools:

- Do the tools detect obvious problems with water, nitrate and salt status at each scheme (sites too dry, nitrate deficient or soil salty)?
- Can farmers understand the water, nitrate and salt colour patterns and act on information?
- What constraints prevent them from acting on the monitored information?

a. Do the tools detect obvious problems with water, nitrate and salt status at each scheme (sites too dry, nitrate deficient or soil salty)?

Farmers recorded the Chameleon colours once or twice per week. To get an overview of soil moisture conditions, the percentages of blue (wet), green (moist) and red (dry) lights from the Chameleon were averaged at each scheme. Apart from the two Mozambican schemes, Chameleon sensors showed blue (wet soil) over 70% of the time, and all sites showed red (dry soil) less than 20% of the time (Figure 2). Given that four depths were monitored, red at all four depths would be a certain indicator of water stress, and this only occurred after irrigation ceased at the end of the season. The Mozambican schemes, which relied mainly on pumping, did show more green (moist soil, approximately 25–50 kPa), but it is unlikely that the crops were seriously affected by water stress. Although farmers at all schemes complained of problems with irrigation infrastructure, the supply of water to planted crops appears to have been sufficient.

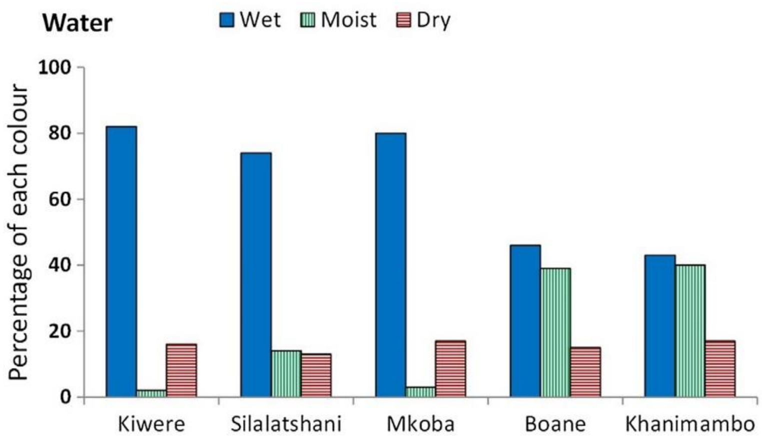


Figure 2: Soil water conditions at each scheme: the percentage of blue (wet), green (moist) and red (dry) colours reported on the chameleon soil moisture sensors, based on the following number of readings: Kiwere 944, Silalatshani 400, Mkoba 456, Boane 584, Khanimambo 284

There is extensive information available in the literature about how soil water tension affects crop yield, but much less information about soil nitrate (Stirzaker, 2014). Generally, crops appeared to have an adequate amount of nitrate in the soil in the early crop stages, and less as the season progressed, due to crop uptake and leaching due to over-irrigation (Figure 3). Salt was not a problem at any monitored sites, although Silalatshani and Kiwere did show signs of waterlogging and salt accumulation in low-lying parts of the scheme (Figure 4).

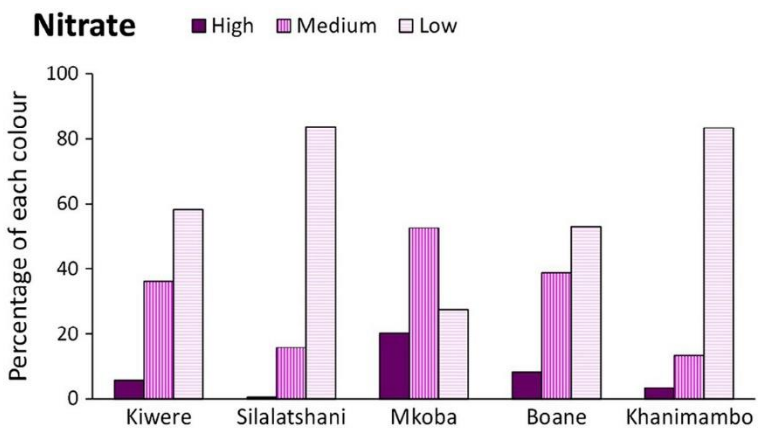


Figure 3: Soil nitrate concentrations at each scheme: the percentage of high, adequate and low nitrate colours reported from the Fullstop wetting front detector samples, averaged over both depths, based on the following number of readings: Kiwere 337, Silalatshani 203, Mkoba 179, Boane 49, Khanimambo 30

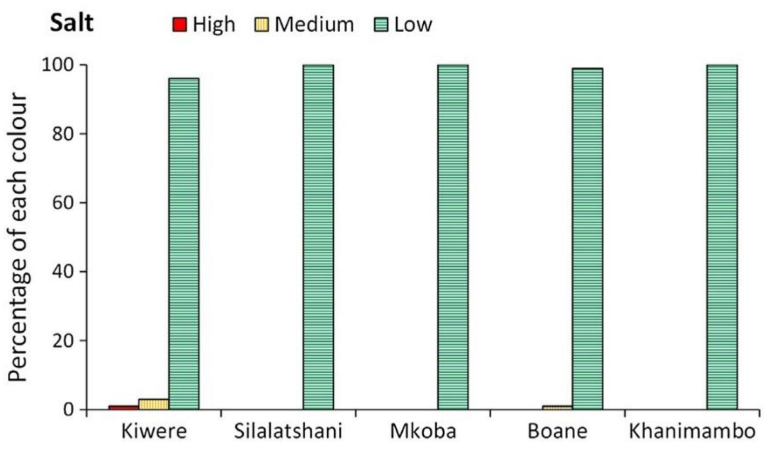


Figure 4: Soil salinity conditions at each scheme: the percentage of high, medium and low salt colours reported from the Fullstop wetting front detector samples, averaged over both depths, based on the following number of readings: Kiwere 336, Silalatshani 200, Mkoba 155, Boane 128, Khanimambo 77

b. Can farmers understand the water, nitrate and salt colour patterns and act on information?

This question was asked to the Kiwere irrigation scheme farmers in Tanzania, which provided the most comprehensive feedback following a tomato production cycle (Table 1). The data collected by using of the Chameleons showed that all farms recorded blue at all depths (15, 30, 45 and 60 cm). All the farmers on this scheme interpreted the data (Chameleon colours) correctly and responded by reducing irrigation.

Table 1: Responses to the Chameleon soil moisture sensor at Kiwere irrigation scheme each farmer could make one contribution under each of the four headings (n = 20)

Things changed	Reduced irrigation (20)
Future plans	Continue to monitor for irrigation management (13) Add more sensors to other crops (4) Apply fewer irrigations (3)
Lessons learned	How to respond to the chameleon colours (15) More water available for downstream irrigators (2) Can recognize over-irrigating (1) Soil can look dry on top but there is sufficient water below (1) Water stays in the soil longer than I thought (1)
Unclear issues	None (20)

c. What constraints prevent them from acting on the monitored information?

Monitoring data is only valuable if farmers can understand them and act on their new knowledge. The farmer has two options in responding to Chameleon data: to change the amount of water at each irrigation application, or to change the frequency of irrigation events. If a farmer only has access to water once per week, they are unlikely to miss the opportunity to irrigate unless they are convinced the whole root zone is wet. However, if water is freely available several times per week, then skipping an irrigation event in response to persistent blue indicators is perhaps an option? Farmers at Kiwere and Sililatshani schemes could generally get water on demand. At Mkoba, all farmers have to agree on the irrigation schedule because they share the same canal that carries water one day per week. The pumped schemes in Mozambique should have access more or less on demand, but in practice there were problems relating to pump breakdowns and disagreements on how to share pumping costs if multiple plots were watered at the same time.

Changing the amount of water applied at one time may not be easy under flood irrigation. If the irrigated plot is long, such as the 100 m lengths at Silalatshani, siphons are left running until the water reaches the other side of the field. Thus, once the decision is made to irrigate, there is a certain minimum amount of water that needs to be applied, regardless of the starting conditions shown by the Chameleon. Farmers do have the opportunity to add more siphons, apply water more quickly and potentially reduce the amount of water applied at one time. The small size of the individual farmer plots at Kiwere gave much greater control over irrigation, but also meant that each irrigation event put greater demands on labour.

At Kiwere farmers did exploit more flexibility of their system and make major changes to their irrigation management. The learning groups revealed that farmers were most concerned about the serious drop in soil nitrate levels early in the season. One farmer had started to skip scheduled irrigations and noticed that the new crop growth was greener and more luxuriant. The practice spread to the other farmers, and the concept of over-irrigation quickly became the common perception. At the start of the season, just less than 50% of the farmers irrigated twice per week and the others three or four times per week. By the end of the season (2015/16), most farmers irrigated once per week, and none irrigated more than twice per week.

Nitrate management is inextricably linked to irrigation management, and unless farmers can reduce over-irrigation, they will continue to leach nitrate from their soils. Since almost all farmers apply fertilizer to their fields, they do have the ability to time applications in response to soil nutrient levels, provide smaller side-dressing more often, or change to organic sources. Salt management is linked to the problem of over-irrigation at the scheme scale. All schemes have relatively fresh irrigation water, so salinity will only be a problem in lower-lying parts of the schemes where water tables have risen due to sustained over-irrigation in the past.

d. Perceived interest shown by irrigation stakeholders

Social benefits like reporting of less conflict over water when using monitoring at scheme scale add to benefits perceived by individuals. At one scheme the extension advisors reported that farmers with unlevelled fields take longer to complete an irrigation, which slows down the rotation of filling header canals, resulting in other farmers not getting water on time. Extension advisors expressed interest in using the tools to demonstrate at scheme level.

The example of the downstream irrigators at Kiwere illustrates a similar issue (Mziray, 2016), that the Chameleon colour patterns can highlight inequities at the scheme level which can be addressed through the rules of the Water User Association. In Tanzania, like in the rest of the irrigation schemes, there is significant confusion about who controls and is responsible for the irrigation infrastructure (Bjornlund, van Rooyen and Stirzaker, 2017). This have resulted in a lack of enforcement of basic rules such as membership in irrigation organisations, water levies which are far below what is prescribed and required for maintenance of infrastructure, up-versus- downstream water distribution issues (Mdemu et al, 2017). With this background, it was inspiring to receive feedback from a zonal irrigation manager in Tanzania who valued the information of monitoring at a higher scale. He had supervision over 100 irrigation schemes, all clamouring for infrastructure upgrades from a very limited budget. He is of the opinion that Chameleon patterns within schemes and across different schemes could help prioritize investment, because persistent red would show that the infrastructure, or the way it was used, could not supply farmers with water in a timely way. Table 2 illustrates perceived benefits of using monitoring tools by different stakeholders operating at different scales on an irrigation scheme.

Table 2. Perceived interest in the tools by irrigation stakeholders operating at different scales

Scale	**Interest**	**Opportunity**
Farmer	Crop yield	Avoid crop water stress and nitrate leaching
Extension advisor	Demonstrate good practice	Encourage land levelling and shorten the time taken for each irrigation event so the next section can be supplied water
Water User Association	Equity of water distribution	Feedback as to whether different areas of the scheme obtain water when required
Zonal irrigation manager	Rehabilitation of schemes	Identification of schemes with infrastructure contributing to poor water distribution
Government agency	Stewardship of common resources	Demonstration of learning systems to achieve best practice

5. CONCLUSION AND IMPLICATION FOR EXTENSION

In all of the schemes, government extension was reported as an important source of information and advice for irrigators. One of the major problems is that the number of extension advisors in comparison to farmers is far too low, and therefore extension is not regularly visiting farmers. Farmers therefore have to rely in many cases on their own knowledge and skills. However, farmers need to trust extension advisors before accepting advice, which is related to the extent that advisors understand and respect farmer’s goals.

The introductory highlights why it is necessary to move from curriculum-based training approaches to people centred or experiential learning approaches, where colours and feedback are used. The Chameleon provides concrete experiences of how colours represent the soil water status. Farmers through the reflection on these colour patterns come up with new conceptualisation: they were applying too much water and this lead to nitrate leaching. This understanding by farmers lead to the skipping of one or more irrigation events where required. This new irrigation plan generates a different colour pattern, which farmers use to continue with their learning cycle (like described by Kolb (1984)).

Where above describes the individual learning process, which can be very slow, social learning can be promoted by forming of learning coalitions. Ison, Röling and Watson (2007) contend that relying on scientific knowledge alone is insufficient for water management problems which are complex, with a high degree of uncertainty, and where multi stakeholders are involved. The monitoring tools and learning coalitions offer an opportunity where a large group of stakeholders can share problems, information and learning. It is evident that farmers are indeed gaining new insights, change their practices in response to new knowledge gained and that this new knowledge also spread to other farmers through farmer-to farmer interaction and participation in learning coalitions. Through the VIA (http://via.farm) effective learning platforms for sharing and facilitation of learning between farmers, extension advisors and researchers across physical and cultural differences were established.

Irrigation is often recognised as a complex socio-ecological problem. All interviewees and participants mentioned the role of climate change, weather variability and increase in the frequency of severe and extreme events as challenges affecting smallholder irrigation. The social complexity arises from multiple stakeholders with different goals and value systems, whose interests cover different time and spatial scales. Although the VIA website is seen as an important ICT tool that can help improve access to real time information, the role of learning platforms or coalitions, and extension advisors as credible facilitators, are crucial to enable farmers to move from coping to more adaptive irrigation farming strategies.

Acknowledgements

This research in this paper was supported by the Australian Centre for International Research. We thank the project team who collected the data at the different irrigation sites in Tanzania, Mozambique and Zimbabwe.

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THE FIRST TWENTY YEARS – THE DEVELOPMENT AND ADOPTION OF A CLIMATE SMART GRAIN PRODUCTION SYSTEM FOR THE SWARTLAND REGION OF THE WESTERN CAPE PROVINCE

Strauss, J. A. & Swanepoel, A.

THIS PAPER WAS NOT AVAILABLE AT THE TIME THE PROCEEDINGS WAS PRODUCED.

PROJECT CSA BATEKÉ: BUILDING COMMUNITY RESILIENCE

Kazika, A.

THIS PAPER WAS NOT AVAILABLE AT THE TIME THE PROCEEDINGS WAS PRODUCED.

DAY 3: WEDNESDAY, 1ST NOVEMBER 2017

FIFTH SESSION

FIELD EXCURSIONS

PROGRAMME

DATE	TRIP	PROJECT SITES	LOCATION
01 November 2017	1	Simbamabhele Piggery	Bhethani: Port Shepstone
	2	Cedara Research Facility	Pietermaritzburg: Cedara
	3	Denleigh (Stubbs Farm)	Karkloof: Howick
	4	Lungisisa Indlela Village (LIV) Agricultural Project & Cappeny Estates	Cottonlands: Verulam Ballito
	5	SASRI (South African Sugar Research Institute)	Flanders Drive (Mount Edgecombe)

SIMBAMABHELE PIGGERY

Location: Ugu District Municipality / Ray Nkonyeni Local Municipality

Traditional Authority: Ndwalane

Approximate Distance: 135km

Estimate travel time: 1h 20min

Profile

The family bought the smallholding out of their own saving and money from their previous property.

Mrs Mbalo had to resign from her nursing profession to run the farm.

The farm is 45ha in total, 35ha of sugarcane, the farm house and broiler production units producing 1500 birds per month.

The farms started a pig production unit with 5 sows, which progressed over the year into a 120-sow unit presently.

The farm now produces 3000 birds per month.

Project Scope (Overview)

The purpose of the project is to produce high quality pork to supply the demand in the district and supplying them to Fresh Meat Butchery, one of the biggest butcheries in the South Coast and produce healthy broilers for the local market.

Current Status/Activities

The 130-sow unit piggery.

Job Creation

45 people employed permanently.

Workers increase during harvesting of sugarcane.

Marketing

1500 live birds sold monthly to informal trades within the area.

55 porkers supplied every Thursday to Fresh Meat Butchery.

Agricultural/Business Support

Currently, the Department of Agriculture and Rural development provide extension support. Financial support to the project is in planning stages and a business plan has been approved for construction of a 50-sow unit.

Contribution to Community Development

The farm/project allows local students the opportunity for in-service training in fields like business management and farming.

It also allows prospective pig farmers to visit and take tours.

Contribution towards Research/ Technology/ Science/ Extension

South African Pork Producers (SAPPO) and the Department of Agriculture and Rural Development provide extension support to the farm.

The farm forms part of the provincial pork producers study group.

Other Interventions

The project supplies carcasses to Fresh Meat Butchery at a price per Kg, which yields more returns than sending pigs to the abattoir.

Future Business Plans

The farm plans to have their own abattoir in the near future and increase the customer base.

Thematic Focus/Linkage

The project is managed by a lady, Mrs. Mbalo, who is also a co-owner.

Youth members are also co-owners of the project as it is a family business.

The project sends workers to Bensfield academy for more knowledge in piggery.

Visit Requirements

For the reason of bio-security, the project will open up the curtains for visitors to be able to observe the project from the outside.

50-sow unit with automated water and feeds

Border piglet house

Selling stage of pigs

Finisher Pigs: Ready for marketing; the farmers have a contract with Fresh Meat Butchery of 55 carcasses per week.

Sow after giving birth on the farm

CEDARA PROJECT

Location: uMgungundlovu Municipality

Approximate Distance: 94 km

Estimate travel time: 1 hr

Profile

THE PAST

The land upon which the Cedara Research Station was developed was acquired by the Natal Government in 1902, "to establish a Central Experimental Farm and Agricultural College for the training of young men and women intending to go farming". It was under the control of the Director of Agricultural Experiments and Chemistry in Natal; the Director also acted as Principal of the College. At this time, the property was not fenced, there were few trees and no buildings.

Due to the poor grazing, the outspan that existed on the property was not popular with the transport riders. In fact, it is said that the name Cedara means "Bleak and Barren".

The farm buildings were built first, followed in 1905, by the erection of the College and hostel complex, and the launching of Cedara's Agricultural Diploma Course in April of 1906. Attention was given to the development of the property for research purposes and 1907 saw the introduction of the first dairy nutrition experiments. Sheep and poultry were also introduced and in time, Cedara poultry gained an enviable reputation at the national shows and in egg laying tests.

Hundreds of experimental plots were prepared and plant introductory work, fertilizer studies, and pasture and veld management studies were initiated. Maize and other crops were tested with varying experiments and under different treatments. An important activity on Cedara at that time was the testing and demonstration of agricultural implements.

A forestry nursery was established at an early date and over 90 000 trees (gums, pines and wattles) were planted. The potential for the establishment of a wattle industry was investigated as early as 1913.

NATURAL RESOURCE INFORMATION

In terms of climate, the summers are warm to hot and the winters cold, with frost. Cedara is situated entirely in the Moist Midlands Mistbelt BioResource Group (BRG) 5. This BRG falls in the 900 – 1 400m above sea level range and is generally a hilly, rolling country with a high percentage of arable land, where 47% is suitable for cropping. Mean annual rainfall for this area ranges from 838 – 1140 mm.

Mean maximum January temperature for the research station is 25°C, while mean minimum July temperature is 4°C. Frost severity is recognised as light to moderate where, depending on the altitude, an average of 3 - 9 days of frost can occur over a 35 – 70-day period.

This BRG is generally rich in water resources. Soils are relatively deep, highly leached and strongly acidic. Fertility is low, but physical properties are favourable. The topography of Cedara is rolling to flat with gradients varying from 7 to 16 %. It includes a fairly large area of wetland.

Cedara is an important source of information for the high rainfall BRGs of the Province. The natural grazing is characterised by the prevalence of "Ngongoni" grass (Aristida junciformis) and is relatively sour in type. Provision has therefore been made for the carrying of livestock through the winter months. Climatic conditions favour the establishment of cultivated pastures, both for hay-making and grazing purposes.

Project Scope (Overview)

RESEARCH STATION PROGRAMME

The research components at Cedara include agronomy, animal science, crop protection, biochemistry, biometrical services, horticulture, grassland science, and soil science and farm services (who provide services to all other sections).

The Cedara soil, feed, water, plant and plant health laboratories serve research and farmers throughout the province.

The Agricultural Research Council (ARC) and Universities also use Cedara for their research programmes as guest researchers.

More detail is supplied under the relevant research directorates.

Current Status/Activities

NITROGEN RESPONSE OF MAIZE SILAGE FOLLOWING RAINFED WINTER COVER CROPS

AD Manson, AJ Arathoon, CM Stevens, HE de Jager and AJ Kent

KwaZulu-Natal Department of Agriculture and Rural Development, P/Bag X9059, Pietermaritzburg, 3200
Email: alan.manson@kzndae.gov.za

INTRODUCTION

Production of maize silage leaves little residue for farmers that wish to practice no-till. In 2003, a cover-crop trial was initiated at Cedara Research Farm (near Pietermaritzburg) to investigate the consequences of winter cover crops in systems where silage maize is grown every summer season. In the 2011/12, 2012/13 and 2013/14 seasons, the plots were split for nitrogen.

MATERIALS AND METHODS

The trial is at Cedara Research Farm near Pietermaritzburg. It consists of 27 main plots (9 treatments and 3 replicates). Split-plots received either zero nitrogen or 120 kg N/ha in January. Winter cover crops were planted in April and were: black oats (var. Saia); black oats and grazing vetch (var. Max); stooling rye (var. Trojan); stooling rye and grazing vetch; grazing vetch; white clover (var. Haifa); white clover and black oats. There were two control plots per replicate (winter weeds were allowed to grow). No-till maize was planted in November. Above-ground dry-matter (DM) yield of the maize and cover crops were measured (harvested in March).

RESULTS

The use of vetch as a cover crop, either alone, or planted with a temperate grass, can allow N fertilizer savings, even if grown in winter without supplementary irrigation. In both years, above-ground N uptake for the vetch treatment at 0 N was similar to that of the control at 120 kg N/ha. The vetch-grass mixtures, however, had much smaller effects on above-ground N uptake.

Contribution to Community Development

Research and Technology Development performs one of the line functions of the KwaZulu-Natal Department of Agriculture and Rural Development within the vision and mission of the Department.

KwaZulu-Natal has vast agricultural potential, challenging agricultural Agriculture Research, Development and Training Institute components to respond by providing essential technology and information needed:

- to improve food security,
- to address malnutrition,
- to reduce poverty,
- to contribute to the expansion of high value crops within sustainable systems,
- to promote sustainable economic and environmentally sound development,
- to support departmental programmes with technical advice and research as required, and
- to add to the pool of knowledge.

Thematic Focus/Linkage

Cedara Research Station promotes Climate Smart Agriculture.

Cedara cover crop trial

DENLEIGH (STUBBS FARMING)

Location: Karkloof (uMngeni Municipality)

Approximate Distance: 103km

Estimate travel time: 1hr 30min

Profile

THE PAST

Britt and Rene Stubbs moved to Karkloof valley in 1986. Denleigh was a beef and maize farm at the time, but was developed into a dairy farm, planting maize, soya beans, potatoes and carrots using conventional methods. This type of land use was leading to severe erosion, soil pests and serious wear and tear on equipment. A decision was made to convert to no-till for the maize silage, cover crops and autumn pasture establishment.

Project Scope (Overview)

Mr Rene Stubbs has been doing conservation till on maize and soybeans for the last 21 years. He has been planting ryegrass pastures under conservation tillage for the last 10 years.

Area of farm: 790 ha – 540 usable and balance veld and wetland.

Current Status/Activities

Milk 1100 cows and have 890 young cattle as well.

Produce 24000lts milk per day.

The focus point is the use of conservation tillage and the benefits thereof.

Job Creation

46 employees

Marketing

Milk supplied to Dairy Day

Agricultural/Business Support

The business has benefitted from research outputs of the Department of Agriculture and Rural Development. This includes pastures and climate smart agriculture.

Contribution to Community Development

Milk donation to school feeding schemes via the involvement of other business partners.

Contribution towards Research/Technology/ Science / Extension

Some of the trials conducted in Cedara (e.g. NITROGEN RESPONSE OF MAIZE SILAGE FOLLOWING RAINFED WINTER COVER CROPS) are as a result of questions asked by dairy farmers like Stubbs Farming.

Thematic Focus/Linkage

All activities of Denleigh farm are about climate smart agriculture.

Healthy soils reading to healthy outcomes

Dairy manure

Wailing wall separating manure solids from liquid before solids are spread with Muck Spreader and liquid pumped through centre pivot into the pastures (waste recycling).

LUNGISISA INDLELA VILLAGE (LIV) AGRICULTURAL PROJECT

Location: eThekwini District, North

Local Municipality: Ward 60, Verulam

Approximate Distance: 45 km

Estimate travel time: 25 minutes

Profile

Lungisisa Indlela Village (LIV) is a non-profit organisation committed to uplifting the lives of orphans and vulnerable children in partnership with government and businesses. This organisation caters for the social and educational needs of approximately 160 children.

This organisation has undertaken public and private partnerships and received financial support from various government departments including The Department of Agriculture and Rural Development and has successfully completed a number of projects, namely:

- Construction of housing facilities.
- Food security and commercial agriculture projects.
- Sporting facilities.
- Construction of school.

Project Scope (Overview)

The establishment of a food security garden and hydroponic tunnels to produce fruit and vegetables to feed the orphaned children and the sale of surplus produce to generate income to sustain the village.

Current Status/Activities

Cucumbers at various stages of growth are under cultivation in the hydroponic growing facility which has a dedicated project manager. The pack house and cold storage facilities are used for value adding and ensure that produce meet with the desired quality assurance standards. In addition, LIV management have made substantial efforts in water harvesting and water purification. The borehole water was found to be unsuitable for irrigation, however, the water is treated at a purification plant before being used in the fertigation system. Another venture involves the production of moringa on marginal lands for the production of leaf powder and capsules which are sold at leading supermarkets and pharmacies.

Job Creation

The agricultural project has 20 permanent staff employed. Participants have been trained in vegetable and fruit production by KZNDARD advisors.

Marketing

Freshmark, who are the buyers for Shoprite Checkers and the Spar Group of chain stores.

Agricultural/Business Support

The Department of Agriculture and Rural Development has been closely associated with LIV since 2012 and have successfully implemented the following projects with a total investment of R1.6 million:

- Mechanisation services for 3ha.
- Establishment of 1.5ha banana orchard.
- Establishment of 0.5ha vegetable garden.
- Fencing of 1.7km.
- Drilling of borehole and supply of water storage tanks hydroponics.

The most recent project was the establishment of a hydroponic growing facility which cost R2.5million and was completed in September 2015. This project was planned and implemented in line with the Department's Agrarian transformation strategy using the 50:50 funding model. As a joint venture, LIV contributed R1.3million towards the completion of the hydroponic project which included the construction of a pack-house.

The hydroponic project is designed for the commercial production of cucumbers in 10 tunnels and LIV has secured markets at Checkers and Pick n Pay. The first crop was established in September 2015 and the project is currently fully operational.

Contribution to Community Development

The creation of both permanent and contract employment. The housing and provision of educational needs to orphaned children.

Future Business Plans

The construction of a Moringa Processing Plant.

Thematic Focus/Linkage

The project produces vegetables that are grown hydroponically in multi-span tunnel structures that enables production throughout the year. Water is harvested from a borehole and then undergoes treatment via a purification system where excessive salts are removed. Leachate from the tunnels are collected and used to irrigate crops that are grown conventionally. Rain water harvesting is done on all the building roof surfaces and used for various activities in the village.

Cucumber production: Hydroponic multi-span tunnels grown to English Cucumbers

Cucumber seedlings

Moringa leaf powder

Pack house

CAPPENY ESTATES

Location: D176 District Road, Off Esenembe Rd, Compensation, Ballito

GPS co-ordinates: 29°28'41.49"S; 31°10'20.73"E

Approximate Distance: 49.8km

Estimate travel time: 44 minutes

Profile/ Project Scope

Cappeny Estates is a commercial strawberry farm that was built from scratch in 2013. This followed a research period of 18 months that included technical tours to other commercial strawberry farms in Europe and the Middle East. The farm is 100% Black African owned and managed. It has 8.5ha production footprint and is 17.8ha in total.

Current Status/Activities

Current operations include growing and harvesting of strawberries as well as providing value-added strawberry products such as strawberry jam, strawberry dried fruit, and baked granola with strawberries.

Job Creation

The existing staff compliment consists of approximately 80 people of which 30 are permanent and the balance seasonal.

Marketing

Fresh fruit is supplied to most major retailers with access to more than 500 stores.

Agricultural/Business Support

Department of Agriculture grant funding support has been provided via the Agribusiness Development Agency (ADA). This was towards additional plant material, equipment and specialised implements including a high-clearance tractor.

Contribution to Community Development

Cappeny Estates continues to provide opportunities to young 'future' farmers to gain practical work experience. This is a 12-month programme that encompasses all the aspects of production at Cappeny Estates.

Cappeny Estates through its membership to the Strawberry Growers Association is widening the body of knowledge in growing strawberries in an atypical growing region.

Other Interventions

Processing of strawberry products.

Future Business Plans

The business is currently pursuing plans to expand its processing infrastructure in order to respond to the demand for these value-added products.

Thematic Focus/Linkage

- Integrating youth and women in CSA – Cappeny Estates employs 90% women of which 50% are youth.
- Scaling up ICT innovations for CSA – Cappeny Estates is pioneering a cloud-based farm-management system for all the aspects of business.
- Scalable CSA technologies and innovations – Hand held devices for real-time farm management.
- Capacity development for scaling up CSA innovations – Teaming up with CSA experts to pilot and pioneer new methodologies such as aeroponics and real-time digital checklist.
- Knowledge management for CSA – Cappeny Estates documents its operations incrementally innovates all entrenched practices.
- Innovation for entrepreneurship – Pioneering innovating growing methods and management systems.

Visit Requirements

None




SASRI (SOUTH AFRICAN SUGAR RESEARCH INSTITUTE)

Location: Mount Edgecombe, Durban

Approximate Distance: 18.5km

Estimate travel time: 30 minutes

Profile/ Project Scope

The South African Sugarcane Research Institute (SASRI) is a leading agricultural research institute in Africa, established in 1925 to serve the sugar industry. It is world renowned for its research into the development of new sugarcane varieties and improvement of crop management and farming systems to enhance profitability.

Research at SASRI is clustered within four multidisciplinary programmes, namely Variety Improvement, Crop Protection, Crop Performance & Management, and Systems Design & Optimisation.

An Extension Service provides the essential link between researchers and sugarcane farmers and makes a significant contribution to the sustainability of the industry through effective technology development and knowledge exchange.

SASRI's Biosecurity function aims to manage and protect the industry from known biosecurity threats and monitors for potential incursion from new pests and diseases.

SASRI also offers a range of services including fertilizer advice, disease diagnoses and education courses.

Current Status/Activities

The SASRI research site at Mount Edgecombe is the home to the Plant Breeding Glasshouse, a facility built to enable plant breeders to make crosses between a wide variety of parents, enabling conventional breeding of new sugarcane varieties.

Delegates will have an opportunity to see the oldest experimental trial site in Southern Africa (BT1) and then to wander through the shade house and weed biocontrol facilities where pot trials are conducted, and insect biocontrol agents are reared. The tour concludes with a visit to the NovaCane® facility (SASRI's newest facility) to gain an insight into sugarcane tissue culture.

Job Creation

SASRI currently employs around 625 staff who operate out of seven sites around the industry.

Marketing

SASRI serves South African growers and millers through the provision of research and specialist services. The support to SADC countries is provided through a user-pays Specialist Advisory Service.

Agricultural/Business Support

The SASRI Extension Service is engaged with the KZN Department of Agriculture and Rural Development (DARD) through an Extension Venture Agreement (EVA) that is renewable after five years. This Extension Venture Agreement has its own Programme of Work that gets monitored quarterly by DARD senior management. The primary objective of the programme is to upskill the Government Agricultural Advisors in sugarcane husbandry to be able to advise farmers in sugarcane production. The Mass Rearing of Biological Control Agents facility at SASRI is funded by the Department of Environmental Affairs, Working for Water Programme.

Contribution to Community Development

SASRI's Extension department contributes to building sustainable communities through supporting development projects. This support is in the form of well-planned farmer training events such as study groups, farmer days and field days. Skills development is achieved through hands-on training, using SASA's Shukela Training Centre to provide on-farm training without interfering with a farmer's production.

Contribution towards Research/ Technology/ Science/ Extension

SASRI contributes directly to the research of sugarcane agriculture through its four research focus areas. In addition to research projects, the focus is on technology development to support decision-making. The joint Government/SASRI Extension partnership contributes to uplifting and sustaining the industry.

Thematic Focus/Linkage

The theme of the 2017 conference is SCALING UP CLIMATE SMART AGRICULTURE: INTEGRATING YOUTH, WOMEN, AND THE DIGITAL REVOLUTION.

- Integrating youth and women in CSA
- Scaling up ICT innovations for CSA
- Scalable CSA technologies and innovations
- Capacity development for scaling up CSA innovations
- Knowledge management for CSA
- Innovation for entrepreneurship

One of the key areas in the SASRI Programme of Work is focused on "Climate Proofing Sugarcane Agriculture". This project portfolio addresses drought adaptation-related issues including:

- assessment of the potential impacts of predicted climate change scenarios on sugarcane cultivation;
- breeding of varieties with improved water-deficit stress tolerance;
- developing technology systems to enable the more effective management of water during periods of heightened water scarcity; and
- partnering with growers in knowledge exchange interventions to promote the adoption of technologies to improve crop resilience to stress and the efficiency of on-farm water use.

The Institute further undertakes bioenergy-related research to investigate possible means to mitigate drivers of climate change.

SASRI's first smartphone app called Pur*Est*® will be demonstrated. This tool assists with ripener and harvest recommendations and is an effective tool in enabling profitable production.

SASRI provides access to real-time and historical weather data through an on-line site called WeatherWeb. Real-time weather information is useful for decision making regarding irrigation, chemical application and harvesting operations. This site will be demonstrated to tour participants.

Visit Requirements

Comfortable clothing, hat, flat shoes, raincoat or umbrella if inclement weather.

NovaCane®

Tissue culture and micro propagation facility

Plant breeding and selection

Weed biocontrol

BT1 – Burning and trashing trial

Rain shelter

SUB-THEME 5: KNOWLEDGE MANAGEMENT FOR CSA

THE RELEVANCE OF SMALLHOLDER FARMERS' ADOPTION DECISION-MAKING BEHAVIOURS IN THE ADOPTION OF CLIMATE SMART AGRICULTURE (CSA) PRACTICES IN SOUTH AFRICA: THE CASE OF SOIL CONSERVATION AT QAMATA IRRIGATION SCHEME, EASTERN CAPE

Ighodaro, I. D.[51] & Mushunje, A.

ABSTRACT

This study evaluated smallholder farmers' adoption decision behaviours regarding the adoption of climate smart agricultural practices (CSA), using the adoption of soil conservation practices at Qamata Irrigation Scheme, Eastern Cape, South Africa as a case study. Using a case study research design, information was collected from 70 smallholder farmers at the scheme through focused group interviews. Based on results, and congruent with literature, the nature of smallholder farmers' adoption behaviour regarding the adoption of soil conservation technologies (a proxy for CSA practices) is complex, being affected by multiplicity of factors. These factors include age, gender, total income, marital status, sources of land, length of time of continuously farming on same piece of land, and level of crop production. The indication was that older farmers preferred their own practices to extension recommendations, and women farmers preferred their own practices to extension recommended practices. Also of particular note was that those farmers who have farmed continuously on one plot for a long time tend to prefer extension recommendations for soil conservation instead of their own practices, which is congruent with literature. It is therefore recommended that youth be encouraged to take up farming as a career, by providing soft loans and various alluring agricultural incentives. Closing the gap between rural and urban areas will help in no small measure in improving the adoption of climate smart agricultural practices in South Africa.

1. INTRODUCTION

According to literature, global food production must increase 70% by 2050 to be able to feed a population projection of more than nine billion people worldwide (Department of Agriculture, Forestry & Fisheries [DAFF], 2011). The daunting reality is that without strong adaptive measures, within the next 50 years, climate change impact will decrease food crop yields by about 16% (25% according to Voegele & Roome, 2016) globally and 28% in Africa (DAFF, 2011). If no adequate sustainable agriculture measures are imbibed, Africa is said to be the hardest hit by climate change, due to its larger rural population, and the level of rural dependence on agriculture for livelihoods (DAFF, 2011). Since agriculture is the sector most vulnerable to climate change, and also a major cause of climate change, directly accounting for about 15% of greenhouse gas emissions, or as much as about 30% when considering land-use change, addressing climate goals through agriculture is

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considered a step in the right direction (DAFF, 2011). Nosowitz (2014) suggests that as climate change changes the face of agricultural production, climate smart agriculture (CSA) could be the only way to feed the planet.

CSA, though coined in 2010 (Noswitz, 2014), is not really new. It is just another contemporary sustainable agricultural measure, which however focuses extra attention on climate change effects. "CSA uses the language and even some of the methods of ecological agriculture…" (Biowatch South Africa, 2015). It builds on existing efforts to actualise sustainable agriculture intensification such as Sustainable Crop Production Intensification (SCPI) (FAO, 2012, citing FAO, 2001d). CSA can be defined as an agricultural practice that increases agricultural production sustainably, with resilience and adaption, as well as contributing to reducing greenhouse gases' emission (NEPAD, undated). In another sense, CSA leads to overall food security and nutrition despite climate change activities. According to DAFF (2011), CSA includes tested practical techniques such as mulching, intercropping, zero tillage, agro-forestry, improved grazing and improved water management.

However, the major challenge facing smooth agricultural development today may not be whether or not there are improved technologies to mitigate agricultural problems like climate change, but bother more on adoption behaviours by farmers, especially smallholders. According to Ighodaro (2016), due to the informal nature of rural environments in developing countries, situations of reality, such as in farming, may be somewhat unpredictable. Supporting this, Ethical Trading Initiative (2005) states that smallholder farmers are usually considered as part of the informal economy. Hence, consideration of the adoption behaviour of this group of farmers is thought worthwhile.

Understanding farmers' behaviours is said to be central to enhancing the capacity of farmers to adapt and promote sustainable agriculture (Feol *et al.,* 2015). Feola *et al.* (2015), citing Home et al. (2014) and Moon and Cocklin (2011), maintain that since farmers are the ones carrying out adaptation and sustainability policies and programs, their behaviour therefore influences how and what success such interventions efforts achieve.

Duvel (1991) posits that the major problem agricultural development has to grapple with is not merely related to the invention of new technologies or new ways of doing things, but ultimately that of two types: (1) non-adoption or (2) inappropriate adoption of certain recommended practices. The obvious implication here has to do with farmers' adoption decision behaviour. In fact, it is said that despite the potential benefits inherent in the use of modern soil management technologies, research indicates that farmers' adoption has been low, which calls for great concern. According to Toborn (2011), the adoption decision-making behaviour of farmers is one of the most important factors influencing the spread or dissemination of innovations in agriculture. Moreover, Ajayi *et al*. (2007), citing Ajayi and Kwesiga (2003), in Southern Africa reveal that despite the potential of renewable soil fertility replenishment (RSFR) technologies in the region, the adoption and spread among smallholder farmers has generally lagged behind scientific and technological advances thereby reducing their impact.

1.1. Theoretical base

According to review, adoption literature has separated between researchers (such as Rahm & Huffman, 1984; Lee & Stewart, 1983; Anim, 1999; Traore, Landry & Amara, 1998), who see adoption analysis as a binary choice variable, and those (like Ervin & Ervin, 1982; Gould, Saupe & Klemme, 1989; Featherstone & Goodwin, 1993) who say it is not just an issue of whether or not farmers adopt, but also include level and intensity of adoption. The literature is also divided between the diffusion theorists (Annor-Frepong & Duvel, 2011, citing Roling, 1988), made popular by Everett Rogers in 1983 and 1995, which define human behaviours in five distinct stages (knowledge; persuasion; decision; implementation; and confirmation), and the economic theorists (Annor-Frepong & Duvel, 2011), who argue that farmers' behaviours are based on economic situations. However, the flaws bedevilling the economic theory led to the emergence of the behaviourist school of thought (Annor-Frepong & Duvel, 2011). The behavioural approach explains decision-making as a combination of motivational factors and structural/economic features that constrain, facilitate and, at the same time, reflect the motivational preferences of farmers (Burton, 2004, citing Gasson & Potter, 1988 and Shucksmith, 1993). Examples of behavioural models in history are Lewin (1951) field theory, Tolman (1967) model, Duvel (1991) model, et-cetera.

Due to the complexity associated with human behaviours, there is as yet no agreed theory for the explanation of why and factors responsible for human behaviours. Surry (1997) maintains that there are no unified theories of adoption decision-making. Supporting this, Duvel (1991) states that because of the complexity of adoption behaviour, and also due to the impermeable boundaries and perspectives of the traditions and disciplines of adoption research, there is as yet no generally accepted theory to guide the extension practitioner and users in the search for factors of adoption behaviour.

According to Oyewole and Ojeleye (2015), the most important factors influencing smallholder farmers' decision to adopt improved farm practices are age, level of education and extension contact. Also commenting, Chi and Yamada (2002) provided a list of reasons why farmers adopt technologies. These are: if farmers are progressive (i.e. if farmers believe in science and technology); if they are educated (i.e. if they know how to read and write); and if farmers are young, preferably less than 40 years of age. It was further noted, based on findings from farmers that if a technology increased farmers' profit, more effective income, farmers will change to adopt such a technology (Chi & Yamada, 2002). Reporting on the review done by Feder *et al.* (1985), Kaguongo *et al.* (2010) posit among other things, that farmer's adoption decision-making is controlled by four main factors such as socioeconomic, demographic, ecological and institutional, which are dependent on the technology in question.

As hypothesised by Ervin and Ervin (1982), and adapted by Asafu-Adjaye (2008), the process involved in a farmer's decision to adopt soil conservation practices begins with a perception of soil erosion (degradation). In their view, once the problem has been perceived, the farmer then adopts a soil conservation practice(s). This decision is affected by a number of factors, including personal, institutional, physical and economic factors. In addition, the level of perception is determined by farmers' personal characteristics (such as age, education, marital status, gender, et-cetera.) and the physical characteristics of the farmland (e.g. size of farm). Furthermore, institutional factors such as farmers' participation in extension services also play a part in the relationship in that they assist in increasing farmers' awareness of the problem. Economic factors such as farm income and off-farm income are also important in that they provide suitable conditions for farmers' decisions.

One of the aspects that seems to distinguish the views of behavioural theorists like Lewin (1951), Tolman (1967), and Duvel (1991), is the inclusion of an intermediate variable called intervening or mediating variable (which was later called cognitive field factors by Duvel, Chiche & Steyn, 2003) in the list of behaviour determinants. After extensive researches at the South African Institute for Agricultural Extension (Duvel, 1975; Louw & Duvel, 1978; De Klerk & Duvel, 1982; Duvel & Scholtz, 1986; Botha, 1985; Duvel & Botha, 1990; Brockman, 1990; et-cetera), Duvel (1991) was able to summarise the several mediating variables into three: needs, perception and knowledge. Due to the particular significance of the cognitive field factors in a decision-making process, Duvel (1991) emphasises that these must be the main focus of extension research.

In an attempt to contribute to providing a framework for the analysis of farmers' behaviours, Ighodaro (2016) suggests that any holistic understanding and analysis of smallholder farmers' behaviour regarding the use of soil conservation technologies must be based on the premise that adoption decision-making is best understood from four distinct stages (see Figure 1). These are perception; adoption; extent of adoption; and adoption impact stages.

The perception stage is the stage where farmers first form a view on a new technology or proposed behaviour change. There is a general agreement in the literature (Ervin & Ervin, 1982; Asafu-Adjaye, 2008) that farmers' adoption of a soil conservation measure can only occur when they have well perceived the problem of soil erosion. Amsalu and De Graaff (2007) also maintain that farmers who have positive perceptions of problems are also the ones most willing to invest in conservation efforts. Düvel (1991), Düvel, Chiche and Steyn (2003), and Annor-Frepong and Düvel (2011) agree that, due to the relevance of the mediating variables in decision-making, they should be of utmost concern in extension research, because they are the ones immanently responsible for decision making. However, from his study, Ighodaro (2016) argues that perception is not just a member of the mediating variables, but the main mediating variable directly responsible for behaviour, and through which the effects of all other variables (both independent and the other mediating variables), are reflected. It was lamented that despite the obvious relevance of perception as a behaviour determinant, there is currently a dearth of information on factors influencing farmers' perception toward technology adoption like soil conservation or CSA practice (Ighodaro,2016).

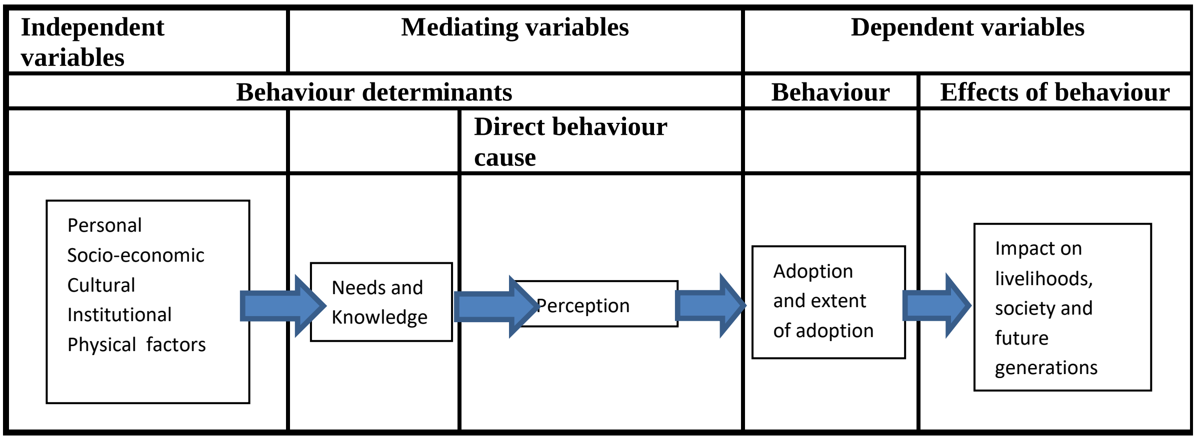

Figure 1: A framework of soil conservation adoption by smallholder farmers (An improved Duvel, 1991 model)

The adoption stage is the stage where farmers decide whether or not to accept the new technology or proposed behaviour change. Several factors prevail on the farmer at this stage, including the independent and mediating variables, which ultimately defines whatever decision the farmer adopts, whether for or against the new innovation. The extent (intensity) of adoption stage is stage farmers decide on how much of the innovation he/she can adopt in the farm. Obuobisa-Darko (2015) defines intensity of adoption as the level of adoption of a certain innovation (for example the number of hectares planted with an improved seed or the amount of fertilizer used per hectare of farmland). It could mean the number of soil conservation practices adopted by a farmer, or how much of farmers' farmland is given to the technology. The last stage according to Ighodaro (2016) is the adoption impact stage. This is the stage where a farmer determines how the technology or proposed behaviour change has or will impact on his livelihood. This is actually the stage that determines whether the farmer will continue using the technology or not. The goal of technology adoption like soil conservation technology adoption (as an example of CSA practices) is agricultural sustainability, which thus benefits the farmer, the generality of society and future generations to come. The effect of adoption has been widely documented. Li *et al*. (2011), citing FAO maintain that conservation agriculture (CA), an example of CSA practices aims at achieving sustainable and profitable agriculture, which subsequently aims at improved livelihoods for the farmer

Although Ighodaro (2016) argues for a holistic approach there must be a breakthrough in the understanding and analysis of farmers' behaviour, an approach which views the adoption process from where farmers develop a perception, and then decides to or not to adopt, followed by their choice regarding the extent of adoption, and finally how adoption is impacting or will impact on the farmers themselves. However, this paper focuses on the analysis of the second stage, which is factors affecting smallholder farmers adoption decision-making in the adoption of CSA practices, using the case study of soil conservation adoption at Qamata Irrigation Scheme, Eastern Cape, South Africa.

1.2. Objectives

1. To characterise smallholder farmers in the study area;
2. To determine the nature of smallholder farmers' adoption decision-making behaviours; and
3. To evaluate specific factors affecting smallholder farmers' adoption decision-making behaviours in the adoption of soil conservation practices in the study area.

2. MATERIALS AND METHOD

The study was conducted at Qamata Irrigation Scheme, Intsika-Yethu Local Municipality, Eastern Cape, South Africa. Qamata Irrigation Scheme was established in 1960 but only became operational in 1972. It focuses primarily on the cultivation of crops to address the situation of hunger and food insecurity in the study area and its environs, which is mainly due to low rainfall in the area.

A case study research design was adopted for the study, for which 70 smallholder farmers at Qamata Irrigation Scheme, were selected through focus group interviews, and agricultural extension officers who assisted farmers at the scheme, were selected purposively. Primary data was gathered using a pretested structured questionnaire. The questionnaire was used to capture data on farmers' demographic and personal characteristics, farmers' adoption decision-making regarding soil conservation practices, and factors influencing farmers' adoption of soil conservation technologies in the study area.

Data collected were analysed using the statistical package for the social sciences (SPSS) version 23. Data analysis techniques include basic descriptive statistics (like frequencies, percentages, and means) and the binary logistic regression analysis model. Although the binary logistic regression model was fitting for the analysis, since the dependent variable is a binary choice variable, the probit and the logit regression analyses were also conducted to provide a measure of comparison. Descriptive statistics are usually regarded as first steps required to determine the distribution of variables and to summarise large amounts of data, but to test for how variables relate, other higher statistical techniques are required such as the multiple regression model (Annor-Frempong & Düvel 2009).

2.1. Model specification: The binary logistic regression analysis model

The binary logistic regression analysis was used as the main analytic tool in this paper to analyse objective two and three because they deal with issues of whether or not farmers are adopting soil conservation practices (dichotomous variables).

The binary logistic regression analysis was used to investigate the manipulative power of adoption decision-making processes based on factors that may influence smallholder farmers to adopt soil conservation technologies among soil conservation technologies' participants and non-participants, to which smallholder farmers adoption decision-making processes is taken as the dependent variable. According to Tranmer and Elliot (2008), in scenarios where the response variable is dichotomous or 0/1 as in this study, the most common analytic technique is to use the binary logistic regression model.

Using randomly sampled data based on farmers' adoption decision-making processes; two homogenous mutually exclusive strata was created for independent variables' analysis. The SPSS statistical software package version 23.0 was used for the econometric analysis. The dependent variable was dichotomised with a value of '0' or 'yes' if a farmer preferred their own soil conservation practice (Non-SCP adopter) and '1' or 'no' if they preferred extension recommendations (SCP adopter). In other words, the question for dependent variable was constructed thus: 'do you prefer your own soil conservation practice to extension recommended practices? Seventeen input or predictor independent variables, based on farmer perceptions and soil conservation practice factors, were regressed against the binary outcome variable of soil conservation adoption decision-making status of smallholder farmers. Farmers participating in soil conservation practices are based on an assumption that each attains household food security through increased productivity from participating in soil conservation practices for production.

According to this theory, households are hypothesised more likely to participate in soil conservation practices, if the utility resulting from participation exceeds that of non-participation. The binary logistic model as indicated in equation (1), according to Tranmer and Elliot (2008) and Gujarati (1992), as cited by Mushunje *et al.* (2011) was used to predict the manipulative power of farmers' adoption-based factors that may influence smallholder farmers to participate in the use of soil conservation technologies introduced by extension officers.

$$\text{In}\left\{\frac{\left(p(Y=\frac{1}{X})\right)}{\left(1-P(Y=\frac{1}{X})\right)}\right. = \alpha + \beta 1X1 + \cdots + \beta nXn \text{ .... } (1)$$

Where p= the predicted probability of farmers' adoption making processes; 1-p= the predicted probability of non-adoption/ participants; α= the constant of the equation; β= the coefficient of predictor variables; X= the predictor variables. Incorporating all variables into the model, the model could be presented as follows:

$$\text{In } \frac{\left(p(Y=\frac{1}{X})\right)}{\left(1-P(Y=\frac{1}{X})\right)} = \alpha + \beta 1AGE + \beta 2EDU + \beta 3MAR + \beta 4GEND + \beta 5EXP + \beta 6FARMSIZE + \beta 7LANDOWN + \beta 8SOURLAND + \beta 9FARMINC + \beta 10OFFFINC + \beta 11TOTALINC + \beta 12HHSIZE + \beta 13FARMAWAR + \beta 14PARTEXT + \beta 15FARMTYPE + \beta 16LENTFARM + \beta 17CROPPROD + \beta 18LENTFARM \text{ .... } (2)$$

2.2. Description of independent and dependent variables

Table 1: Description and units of variables used in the binary and multinomial regressions

Variables		**Description**	**Unit of measurement**
	Dependent variables:		
Y_i	FARMPREF	Do you prefer your own soil practices to the recommended practices by extension?	0= Yes or 1= No
	Independent variables:		
X_1	AGE	Age of farmer	Years
X_2	EDUCATE	Education of farmer	Years
X_3	MARRIAGE	Marital status of farmer	1=Married; 2= Single; 3= Divorced; 4= Widow/widower
X_4	GENDER	Gender of farmer	0= Male; or 1= female
X_5	EXP	Farm experience of farmer	Years
X_6	FARMSIZE	Size of farm	Hectares
X_7	LANDOWN	Land ownership	0= Yes or 1= No
X_8	SOURLAND	Sources of land	1= Government; 2= Rented; 3= Inheritance; 4= Purchase; 5= Community; & 6= Others
X_9	FARMINC	Income from crops	Rand
X_{10}	OFFFINC	Off farm income	Rand
X_{11}	TOTALINC	Total income of farmer	Rand
X_{12}	HHSIZE	Household size	Numbers
X_{13}	FARMAWAR	Farmer's awareness of soil conservation practice	0= Yes; or 1= No
X_{14}	PARTEXT	Is the farmer attending extension programmes?	0= Yes; or 1= No
X_{15}	FARMTYPE	Farming type of farmer	1= Smallholder; 2= Commercial;3= Others
X_{16}	LENTFARM	Time of continuous farming on same piece of land	Years
X_{17}	CROPPROD	Level of crop yield	1= Insufficient for own consumption; 2= Just enough for own consumption; 3= Just enough for own consumption & ceremony; 4= Sufficient excess for limited sale; 5= Sufficient excess for expanded sale

3. RESULTS AND DISCUSSION

3.1. Characteristics of farmers in the study area

In any research study, individuals' personal and demographic characteristics cannot be overlooked because they are independent and indirect factors of behavioural change and decision-making. Examples of such variables, according to Bradmore (2004), are age, gender, income level, marital status, and educational level. In the opinion of Shaw and Constanzo (1970), they are very important because they assist in showing patterns of individual behaviours. In support of this, Lategan and Van Niekerk (2007) state that analysing such patterns may provide a vehicle for understanding the decision-making processes of any population being studied and their resultant production methods.

In this research, the farming population consisted of older people (60%) over the age of 55, with just one percent of the participants representing the youth at 18 to 35 years old. The education level of farmers is low, with only three percent exceeding Grade 12, while 20 percent have no formal education. The indication is thus that farming decisions are left in the hands of older and less educated people, which suggests a precarious situation for farming in South Africa. The farming population had a gender bias, consisting of more males (60%) than females (40%); this does not reflect the global advocacy for gender equality of which South Africa has been known to be one of the front liners. Also, it does not reflect the character of the overall population of the Eastern Cape, in which females are said to outnumber males slightly.

The majority (90%) of farmers in the study area had farms of no more than five hectares in extent, indicating that overall, the level of farming at the scheme comprised smallholdings. Moreover, 90 percent of farmers own their land, which seems to indicate a favourable condition for adoption of soil conservation practices in the study area. In terms of sources of land for farming, the majority of the farmers (21%) obtained their land by inheritance, while only a very few (4%) obtained their land through rent or lease – such ownership would seem to be favourable for adoption decisions. Moreover, over 60% of farmers have cultivated the same piece of land continuously for more than 10 years; this is long enough for signs of soil deterioration to have set in which eventually motivates farmers to adopt soil conservation practices. In addition, half (50%) of the farmers have been in farming for over 18 years, which indicates that farmers in the study area have reasonable farming experience.

3.2. The nature and factors affecting smallholder farmers' adoption of soil conservation practices in the study area

According to literature, several factors prevail on the adoption of the decision-making processes of farmers, which ultimately influences their adoption decisions. Examples of such factors are perception of risks (Lategan, 2007), household socio-economic factors, resource availability, physical characteristics of the land and institutional support (Tiwari *et al,* 2008, citing Garcia, 2001). Citing Cruz (1978), Chi and Yamada (2002), provide a long list of factors that affect farmers' adoption of technologies. Examples are characteristics or attributes of the technology, the adopter, the change agent, and the socio-economic, biological and physical environment in which the technology is transferred. Others are the age of the farmer, education level, income, family size, tenure status, credit use, values and belief system, the personal characteristics of the extension workers such as credibility, good relationship with farmers, intelligence, emphatic ability, sincerity, resourcefulness, persuasiveness, ability to communicate with farmers, and development orientation. As indicated, although there are several factors influencing farmers' adoption decision-making in the literature, this study chose seventeen deemed fit to assist in providing answers for the objectives.

Table 2: Correlation matrix of independent variables of the study

	AGE	GEN	MAR	EDU	SIZ	HHS	LAN	SOU	LEN	CRO	OFF	TOT	AWA
AGE	1												
GEN	-.315	1											
MAR	.024	.335	1										
EDU	-.530	.327	.062	1									
SIZ	.028	-.026	.216	.069	1								
HHS	-.185	.045	.041	.173	.045	1							
LAN	.171	-.214	-.180	.017	.091	-.070	1						
SOU	.108	-.061	-.207	-.117	.067	0.000	.166	1					
LEN	.396	-.119	.006	.036	-.135	-.234	.231	.136	1				
CRO	-.018	-.034	-.099	-.018	.050	.153	.223	050	.022	1			
OFF	.321	-.164	-.109	-.330	.307	.205	.044	.155	.027	.099	1		
TOT	.217	-.164	-.054	-.130	.198	.177	.169	.049	.024	.240	.701	1	
AWA	.126	-.167	-.093	-.227	-.072	-.230	0.000	.057	.040	-.112	.045	-.117	1

Note: AGE: Age; GEN: Gender; MAR: Marital status; EDU: Education level; SIZ: Size of farm; HHS: Household size; LAN: Land ownership; SOU: Sources of land; LEN: Length of time of continuously farming on same piece of land; CRO: Level of crop production; OFF: Off-farm income; TOT: Total income; AWA: Awareness of soil conservation

In order to check for multicollinearity, a correlation matrix of independent variables was conducted, as represented in the Table 2. Apart from the correlation coefficients for age and education, which was fairly negatively high (r= -0.530), and that of off-farm income and total income, which also was positively high (r= 0.701), the correlation coefficient of the remaining cases is low, with absolute values of majority (almost 75%) falling below 0.2. This thus suggests that the problem of multicollinearity is not serious among variables.

Further effort to ensure reliability of results and for better analysis of study objective, this study adopted in addition to the binary logistic regression analysis, the probit and logit regression models, to ascertain factors influencing farmers' adoption decisions regarding soil conservation practices introduced by extension. The goal was to provide a measure for comparisons of results. Results are as presented in the Table 3.

Table 3: Regression estimates for factors of adoption decision-making

Variables	Binary logistic		Probit		Logit	
	B	Sig.	Dy/dx	P>/Z/	Dy/dx	P>/Z/
AGE	2.470	0.099*	.1949689	0.086*	.1942641	0.088*
GENDER	4.383	0.031**	.4352119	0.000***	.4214774	0.000***
MARRIAGE	-4.522	0.025**	-.4017135	0.001***	-.399953	0.002***
EDUCATE	1.171	0.206	.0536222	0.414	.0503182	0.452
SIZEFARM	-1.532	0.198	.0499528	0.598	-.0505581	0.587
HHSIZE	-1.712	0.091*	-.0779686	0.177	-.0789872	0.159
LANDOWN	2.622	0.218	.1167045	0.581	.1204231	0.559
SOURLAND	-1.347	0.063*	-.0765876	0.097*	-.0770962	0.101*
LENTFARM	-2.980	0.013**	-.2603467	0.000***	-.264658	0.000***
CROPPROD	-0.947	0.103	-.1463721	0.002***	-.1512637	0.003***
OFFINCOM	0.000	0.147	-2.42e-06	0.837	-5.28e-01	0.967
TOTALINC	0.000	0.081*				
AWARESC	-6.345	0.169				
CONSTANT	23.006	0.033**	5.702022	0.069*		
Contingency table			**Prob. > x^2**	0.0185	**Prob. > x^2**	0.0199
Observed	Yes= 6		**Pseudo R^2**	0.3712	**Pseudo R^2**	0.3675
Expected	No= 5.899		**Log likelihood**	-19.360	**Log likelihood**	-19.474
Overall %	80%					

NOTE: Significance levels- *= p< 10%, **= p< 5% and ***= p< 1%

According to results (Table 3), except for household size (HHSIZE), crop production (CROPPROD) and total income (TOTALINC), where results of the probit and logit regressions vary from the binary logistic regression, values of all the other five significant factors are the same across all three models, thus indicating, to a large extent reliability of results. From the binary logistic analysis, household size was a fairly significant (p<10%) factor contributing to farmers' adoption decision-making, but insignificant in the probit and logit regression analysis, though its coefficient was negative throughout all three models. The indication of this is that, any unit increase in household size reduces the chance of farmers adopting their own practices as compared to extension recommendations, which partially is as expected. Authors are not in agreement as per the contribution of household to adoption decision-making. This is because, on one the one hand, large sized household implies more mouths to feed, and thus a reduction of money that would have been meant for agriculture. On the other hand, large household implies more family labour for smallholder agriculture. For example, Odendo, Obare and Salasya (2010) hypothesised that the proportion of household population available for labour on-farm has a positive influence on the adoption of all integrated soil nutrient management (INM) in Kenya, although, according to them, this innovation is labour-intensive. In this regard, Asrat, Belay and Hamito (2004) hypothesised family size to have a positive influence on adoption. According to them, soil conservation structures for example, are labour intensive to build and maintain, thus households with large human capital may invest more in conservation (Asrat, Belay & Hamito, 2004).

In terms of the level of crop production (CROPPROD), results of the probit and logit regressions indicate a negatively significant relationship with farmers' adoption decision-making, suggesting that every unit increase in the level of production of farmers' crops reduces the chance of adopting farmers' own practices, thus accepting extension recommendations. This is as expected, because increase in crop yield implies more income for the farmer, which eventually is ploughed back into farming. Ighodaro, Lategan and Mupindu (2016) discovered in their study in the Upper and Lower Areas of Didimana, Eastern Cape that farm yield of farmers was positively significant in propelling the adoption of soil erosion control measures.

In the results of the binary logistic model, total income of farmers (TOTALINC) was positively fairly significant ($p<10\%$) in propelling adoption decision-making of farmers. The suggestion here is that every unit increase in farmers' overall income increases farmers' tendencies to use their own practices as against extension recommendations. This is unexpected because income as it were, means higher social stability and purchasing power for the farmer, which supposedly should encourage adoption of extension recommended practices for soil conservation. Due to the informal nature of rural environments in developing countries, situations of reality may be somewhat very unpredictable. Some may sometimes prefer to marry a new wife when income increases, as the case may be, instead of investing it for the improvements of their farms. This also may not be surprising, especially in most rural part of the former homeland areas of South Africa, where people depend more on government social grants than on farming or any other income generating source. For example, this case was true in Sheshegu community and the Upper and Lower Areas of Didimana, Eastern Cape, as most farmers though still involved in agricultural production, actually obtain most part of their incomes from government social grants. However, Mbaga-Semgalawe and Folmer (2000), seem to support the above, when discussing the impact of off-farm income (an element of total income) on adoption of soil conservation practices. According to them, the impact is indeterminate.

3.3. The impact of age, gender, marital status, sources of land, and length of time of continuously farming on one spot on adoption behaviours of farmers in the study area

Based on the three models adopted for this paper, results for impact of age (AGE), gender (GENDER), marital status (MARRIAGE), sources of land (SOURLAND), and length of time of continuously farming on one spot (LENTFARM) seem to agree across all models, apart from differences existing in their coefficients.

Age (AGE) as a factor in adoption decision-making could be dual in impact. There are areas where research has found age to be negatively related with adoption decision-making process, while it was positive in others. Hence, results for age is unpredictable a priori. For example, Bonabana-Wabbi (2002) maintains that age was positively influential in the adoption of sorghum in Burkina Faso. However, in the same study, it was also mentioned that age has negatively impacted adoption decision-making or is not significant in farmers' adoption decision-making process. In this study, age was fairly positively ($p< 10\%$) related with farmers adoption decision-making process regarding soil conservation practices introduced by extension agents. The indication is that older people will prefer their own practices as against extension practices. This is as expected, because older people generally are very traditional and very conservative to change. According to Ighodaro, Lategan and Mupindu (2016), the problem of soil erosion was on the rise in the Upper and Lower Areas of Didimana, Eastern Cape, because the area consisted of elder people, and very few of them were willing to accept extension advices regarding soil erosion control. This was also supported by Bembridge (1991). It was stated that older people are often very conservative in behaviour and tend towards avoidance of risks.

According to the descriptive statistics of this study (see section 3.1), there were more males (60%) in the study area than females (40%). Males were ascribed the code '0' while females were coded '1' respectively (refer to Table 1). Based on results, gender (GENDER) was positively significant in influencing farmers' adoption decision-making process regarding extension recommended practices for soil conservation, implying that women are more likely to adopt their own practices as compared to extension recommended practices, which is congruent with literature. Most conservation practices are highly labour-intensive, thus making it difficult for women, except the ones who have the financial means to buy man-power. Supporting this, Bayard, Jolly and Shannon (2006) maintain that male farmers are most likely to invest in certain conservation practices like rock walls than their female counterparts. Furthermore, those female farmers who have the financial means to hire labour, have been noted able to adopt rock walls on their farms in Haiti (Bayard, Jolly and Shannon 2006).

Marital status (MARRIAGE) as a factor in adoption decision-making, according to Dűvel (1991), is one of the independent variables determining individual behaviours. Providing an explanation for this, Frank (1998), citing Goldman (1993a, 1993b) maintains that underlying these differences are the integrative and protective effects of married life, as well as the obligations married roles entail for individuals on one hand, and the possible contribution of health selection into marriage, on the other hand. Wood *et al*. (2007) state that a rapidly growing literature opines that marriage may have a broad range of benefits that may include improvements in individual's economic well-being, mental and physical health, and the well-being of children of such individuals. According to Dűvel, Chiche and Steyn (2003), most female respondents in a study in Ethiopia, considered their quality of life of less quality than women whose husbands are around, because of the absence of a partner to support and to share the burdens and tasks of household responsibilities. Based on this, marital status was expected to be positive in this study. However, according to results, marital status of farmers relates significantly negative with farmers' adoption decision-making. The indication therefore is that increase in the marital status of farmers reduces the chance that farmers will prefer their own soil conservation practice to extension recommendation, which is in consonant with literature. This is also supported by the descriptive statistics. According to findings, 74% of farmers' population said they are married, and 59% said they prefer extension recommendations on soil conservation to their own practices (refer to section 3.1).

According to this research, farmers who have easy and more stable access to farmland are expected to be positively related with adoption decisions. This is because land as a main factor of agricultural production is one of the main determinants that motivate farmers to invest or not invest on farmland. As results indicate, sources of land (SOURLAND) are fairly negatively influential on farmers' adoption decision-making regarding extension recommended practices for soil conservation. Land by inheritance is arguably the most stable form of access to farmland. The percentage of farmers' population who accessed land through means like inheritance (21%) in the study was lower than those who accessed land through the 'other' group (52%) of access to land (refer to section 3.1). Therefore, it suggests that the more people access land for farming through other means, the lower the chance that they will adopt their own practices at the expense of extension recommended practices. This is also as expected. Asafu-Adjaye (2008) posits that previous studies have revealed that farmers who own their own land are more likely to adopt soil conservation practices, as against those who do not. According to this view, the issue at play here is not just an issue of owning land per se, but issue of security of tenure.

Length of time of continuously farming on a piece of land (LENTFARM), in this study, was expected to be positive. This is because, farming continuously on one spot for a long time, especially without appropriate soil conservation technologies, is expected to lead to quick nutrient depletion, which will serve as motivation for adoption of conservation. According to results, LENTFARM is negative and significantly influential on farmers' adoption decision-making regarding soil conservation practices by extension at $p< 1\%$. The suggestion therefore is that as the length of time of farmers' farming continuously on one piece of land increases, the probability that they will adopt their own practices instead of extension recommended practices decreases.

This is as expected, and it also agrees with the descriptive statistics of this study, as over 60% of the population of farmers have been farming on one piece of land for over 11 years (refer to section 3.1).

3.4. Impact of education on adoption behaviours of farmers in the study area

Education was predicted to be significantly positive in affecting smallholder adoption decision-making processes regarding the use of soil conservation practices introduced by extension officers in the study area. But as results indicate, education is statistically insignificant in the analysis, which is unexpected. Although several literature indications are that education significantly impacts positively on adoption decision-making, certain situational factors do sometimes impact negatively on expectations in researches. One reason could be because most of the soil conservation practices introduced by extension do not require much educational knowledge to operate. This is alluded to by a number of authors. Bayard, Jolly and Shannon (2006) in their study in Fort Jacques, found that education was among variables unexpectedly negative in their influence on the adoption of rock walls. Similarly, among the Fujian cane farmers, although education was positively significant in influencing adoption of soil erosion control measure, it was however insignificant in exerting any influence on effort for soil conservation, as well as on the number of conservation practices used on farm (Asafu-Adjaye, 2008). More so, in the Upper and Lower Areas of Didimana, Eastern Cape, Ighodaro (2012) found that the impact of education in influencing the adoption of soil erosion control measures was also statistically insignificant.

4. CONCLUSIONS AND POLICY RECOMMENDATIONS

Climate smart agricultural practices, though a new concept, is not really new, but its goals however emphasise the contemporary challenges due to climate change. In this study, the adoption of soil conservation technologies was used as a proxy for the adoption of climate smart agricultural practices because most soil conservation practices are the same principles emphasized under CSA practices. As such, the adoption behaviours of smallholder farmers at Qamata Irrigation Scheme, Eastern Cape was studied to ascertain how smallholder farmers behave with respect to soil conservation practices introduced by agricultural extension officers in South Africa.

Based on results, and congruent with literature, the nature of smallholder farmers' adoption behaviour regarding the adoption of soil conservation technologies (a proxy for CSA practices) is complex, being affected by multiplicity of factors. These factors are age, gender, total income, marital status, sources of land, length of time of continuously farming on same piece of land, and level of crop production. The indication was that older farmers preferred their own practices to extension recommendations, and women farmers preferred their own practices to extension recommended practices. Also, of particular note was that farmers who have farmed continuously on one plot for a long time tend to prefer extension recommendations for soil conservation instead of their own practices, which is congruent with literature. However, education was unexpectedly statistically insignificant in the analysis. Although several literature indications are that education significantly impacts positively on adoption decision-making, certain situational factors do sometimes impact negatively on expectations in researches. One reason could be because most of the soil conservation practices introduced by extension do not require much educational knowledge to operate.

It is therefore recommended that encouraging more youth to take up farming as a career, by providing soft loans, various alluring agricultural incentives, closing the gap between rural and urban areas will help in improving the adoption of climate smart agricultural practices in South Africa. Also, women farmers should be assisted financially, since most soil conservation practices require extra man-power to operate, which most rural women do not have. Similarly, appropriate education should be provided for smallholder farmers on easy ways to improve the quality and sustainability of farmland since due to pressure on land, most farmers farm continuously on a piece of land for long time.

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MAIZE FARMERS' PERCEPTION OF THE EFFECTS OF CLIMATE CHANGE AND COPING STRATEGIES IN NASSARAWA INNOVATION PLATFORM, NIGERIA

Tologbonse, E. B., Arokoyo, T. & Akeredolu, M.

THIS PAPER WAS NOT AVAILABLE AT THE TIME THE PROCEEDINGS WAS PRODUCED.

FARMERS’ KNOWLEDGE OF ALTERNATE WET AND DRY TECHNIQUES IN LOWLAND RICE PRODUCTION IN NDOP, CAMEROON

Chimewah, A. N. & Oladele, I. O.

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DETERMINANTS OF FARMERS' ADOPTION OF ALTERNATE WET AND DRY TECHNIQUES IN LOWLAND RICE PRODUCTION IN GHANA AND UGANDA FOR CLIMATE SMART AGRICULTURE

Oladele, O. I.[52]

ABSTRACT

Lowland rice production has been introduced in many African countries because it more than doubles yields from upland. Irrigated lowland rice production generates greenhouse gas (GHG) emissions roughly four times the GHG emissions per ton of crop as wheat or maize, mostly in the form of methane and nitrous oxide. Alternate Wet and Dry (AWD) as a water management was introduced as a system to reduce GHG, however it is not known what factors affect the use of AWD. A simple random sampling technique was used to select 120, 150 and 300 rice farmers from irrigation schemes in Tema (Ghana), Doho (Uganda) and Ndop (Cameroon) respectively. Data were collected on their awareness and use of AWD and analysed with probit regression. The results show that the majority of farmers were female and male, married, with mean age of 50 and 45.6; having a mean farm size of 0.4 and 0.25ha in Ghana and Uganda respectively. Significant determinants of the use of AWD across the countries were knowledge of the production technique, contact with extension, farm size, farming experience, awareness of climate smart practices, timeliness of operations, sources of information and implementation accuracy of technology. These significant variables result in reductions of GHG emissions from lowland rice production and have important roles of extension in promoting climate smart agriculture. Farmers' knowledge of climate smart agricultural practices has an implication on the adoption and scaling of climate smart innovations.

1. INTRODUCTION

Improving performance of low-productivity smallholder agriculture and moving out of poverty in general have been the focus of recent development economics literature due to the fact that several proven technologies and improved farming practices have been impacted by farmers' adoption behaviour and consequently low agricultural productivity (Udry, 2010; Duflo, Kremer & Robinson, 2011). Hossain, Manik, & Bazlul Mustafi (2006) indicated that the adoption gap is the difference between potential and actual adoption rate. Demographic variables, technology characteristics, information sources, knowledge, awareness, attitude, and group influence affect adoption behaviour are part of the substantial evidence amassed across the globe over several years by different authors investigating farmers' adoption behaviour. Increasing the speed of technology adoption is a key requirement for enhancing food security, agricultural productivity, economic growth and reduction of poverty in economically vulnerable communities (Ndiritu *et al*., 2014).

Evidence over decades of adoption studies have led to the development of several terminologies and the categorisation of adoption behaviour into innovators, early adopters, early majority, late majority and laggard and that the adoption behaviour of any agricultural technology would follow a normal distribution curve in a given social system (Rogers, 2003). In the analysis of Italian users of agricultural tractors (Cavallo, Ferrari, Bollani and Coccia 2016) they found that the categories of adopter are ''Unwilling'' users, ''Willing-Cultural'' and ''Innovative-Owner'' adopters. The lack of technology adoption by farmers has also been attributed to different factors such as lack of knowledge of how to use the technologies, Martínez-García, 2011) Udry, 2010

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identified lack of knowledge among farmers responsible for the low adoption of innovations. Goswami and Sagar (1994) identified some factors associated with the knowledge level of an innovation. They found educational level, family educational status, innovation proneness and utilisation of mass media to be positively and significantly correlated with knowledge level.

Castle, Lubben and Luck (2016) found that more tech savvy producers and use of irrigation technologies are more likely to adopt a higher number of precision agriculture technologies. Mbugua (2011) stated that the number of extension contacts influences adoption because extension is a source of information regarding good farming practices and that farmers' age can also influence adoption positively because older farmers have accumulated a lot of knowledge through experimentation. Dadi *et al* 2004 used duration analysis to examine the impact of time-varying and time-invariant variables on the speed of adoption of fertilizer and herbicide by smallholder farmers. Langyinto & Mekuria (2008) examined the influence of neighbourhood effect on the adoption of improved agricultural technologies in developing agriculture. Mbugua (2011) stated that membership to farmer group was hypothesised to positively influence technology adoption because farmers in groups have access to technical information regarding legume-based multiple cropping.

The concept of sustainable adoption was defined as the degree to which an innovation continues to be used over time after a diffusion program ends (Rogers 2003). This is closely related to the term continued adoption which is the persistent use of an innovation. Ogunsumi & Ewuola (2005); Oladele & Kareem (2003) analysed sustained adoption among farmers and the concept was operationalised as the maintenance of the intensity of adoption by farmers. Extension polices are associated with the sustainable technological adoption. Several studies revealed contact with extension and participation in training courses are effective factors on adoption of sustainable agricultural practices (Okuthe, 2014). Wetengere (2010) reported that the concept of selective adoption exists among farmers and it was described as the selection of some parts of a technology or modification and re-invention as an option.

Adoption rent has been described as the economic benefits which accrue to early adopters. It is also depicted as a factor influencing adoption and the adopter category to which a farmer belongs. Gecho and Punjabi (2011) found that adoption of improved maize technology was associated to farmers' participation in demonstration, while Zegeye and Haileye (2001) ascertained that attendance of training contributed positively to farmers' decision to adopt sustainable agricultural practices. Oladele and Wakatusiki examined replacement adoption among rice farmers in Ghana as the change of a component of a technology package in order to improve the overall efficiency of the whole technology. Tsegaye, Aredo, La Rovere, Mwangi, Mwabu, & Tesfahun (2008) noted that partial adoption is the practice of using the least number of components of a technology, which could be any of the individual components alone.

Saha *et al*. (1994) recognised that producers' adoption intensity is conditional on their knowledge, amount of inputs used and proportion of farm size allocated to the new technology and on their decision to adopt. Arega (2009) reported that adoption intensity refers to the number of technologies practiced by the same farmer. Ex post adoption rely on actual, as opposed to potential, adoption events, and enable researchers to determine which characteristics are statistically associated with adoption (Mercer 2004). Sirrine, Shennan & Sirrine (2010) depict ex ante adoption as the potential feasibility, profitability, and acceptability of an innovation.

Oladele (2005) reported two types of discontinuance which can be replacement discontinuance, that is, rejecting an idea in order to adopt a better one that supersedes it, or disenchantment discontinuance, when a decision to reject an idea as a result of dissatisfaction with its performance. Ogunfiditimi (1993), and Kolawole, Farinde, & Alao (2003) examined "abandoned adoption" to describe discontinued use of previously adopted innovation and reported the varying degrees of discontinuance among farmers in Ekiti state Nigeria to be immediate, gradual and rapid based on the nature of innovation and farmers situation. Darr & Chern (2002) described discontinuance among farmers who previously adopted genetically modified crops by Ohio farmers as dis-adopters. Fu *et al,* (2009) examined farmers adoption and propensity to abandoned adoption of Sawah-based rice farming in the inland valley of central Nigeria. Anasstasova-Chopeva (2015) reported that motivating factors for adoption of agricultural innovation are: production, economic (financial), social, and ecological. The group of demotivating factors having a negative impact on the decision taking for innovations implementation in farms are financial, market; social-psychological and lack of necessary qualification and skills.

The stages of the decision-making process are; *Awareness:* the first stage towards adoption in an agricultural technology or innovation is to become aware that it exists. *Interest:* the second stage is to become personally interested in the innovation. *Evaluation:* this is the process of getting more information about the innovation. *Trial:* this is the stage of actual trial on the farm, possibly, on a small scale and *Adoption*: when the farmers feel satisfied with trial of the innovation, they may decide to continue the use of such innovation. The critique and expansion of this process led to the development other major steps in the innovation decision process as knowledge, persuasion, decision, implementation and confirmation.

There has been a shift in thinking away from taking adoption as a linear process such that it is the delivery of an external, typically science-based innovation with farmers as potential end users towards a more complex learning process involving a wide range of actors (Roling and Jiggins 1998). Rolling (1992) describes the emergence of knowledge systems thinking, in which an articulated set of actors, networks and organisations are expected or managed to work synergistically to support knowledge processes. Similarly, Fishbein and Ajzen (1975) developed 'theory of reasoned action' which is an expectancy-value model with emphasis on attitudes, subjective norms, intentions and behaviours directed at a specific focus. Expectancy-value models provide a framework for understanding the relationship between a person's attitudes and their underlying beliefs. The revision and extension of the 'theory of reasoned action' led to the 'theory of planned behaviour' (Ajzen 1991). This theory includes a third component, the perceived behavioural control, which predicts the behavioural intention. Using adaptations of the Technology Acceptance Model (TAM) (Davis 1989) and taking into consideration a predictive, ex-ante approach, other authors analysed the decision process regarding the adoption of technological innovations in agriculture. The scenario that technology uptake is a complex nonlinear process, influenced by multiple factors, the use of a single theory in analysing decision-making could not provide a full picture of the adoption process. A comprehensive framework which takes the interaction of various factors in decision-making into account is needed.

1.1. Features of rice production

Rice has become one of the major staple cereals in Africa as the second largest cereal consumed after maize due to increasing urbanisation, rapid population growth and the ease of preparation. The rate of consumption in urban areas is higher than rural areas. World rice production is spread across at least 114 countries (FAO 2013) and also dominates overall crop production (as measured by the share of crop area harvested of rice) and overall food consumption (as measured by the share of rice in total caloric intake). Taxes, levies and import bills due to rice have been an increasing trend in many African countries, therefore there is a need to improve local production in order to meet demand. Evenson and Gollin (2003) reported that green revolution has not yet taken place in West Africa while Otsuka and Kalirajan (2006) stated that contemporary Sub-Saharan Africa is similar to tropical Asia several decades ago with the attendant fear of famine. Many authors have reported that Africa has the potential to become self-sufficient in rice and also to become a net exporter into the world market due to the availability of land, water, ecologies, climates, new varieties, crop management options and human resources. The inability of many African countries to produce rice to self-sufficiency levels is indicative of the presence of major constraints. Local potential resources for production should be exploited with sustainable strategies at all levels of the rice industry. To bridge the supply gap between demand and domestic production, efforts have been directed towards implementation of policy measures that will help double the area under cultivation and increase yields through disseminating new technologies in collaboration with farmers.

In African countries major rice production ecologies include rainfed drylands; rainfed lowlands or hydromorphic; inland swamps and valley bottoms; and irrigated paddies, although more returns, yield and profitability is associated with production systems that guarantee sufficient and effective management of water. IRRI (1989) described major rice environments “irrigated rice (assured irrigation for each year); Rain-fed lowland rice (bunded fields with at least 50cm water depth, inundated for part of the season with no irrigation system) and Upland rice (unbunded fields with naturally well drained soils and no surface water accumulation)”. Rice is known to be less water efficient than many other crops and to produce one kg of rice 3000-5000 liters of water is required Cabangon *et al* (2014). Wakatsuki (2009) stated that for green revolution to be realised in SSA there is need for purposeful combination of biotechnological and eco-technology development. Wakatsuki, Buri and Oladele (2009) reported that common rice ecologies along a continuum of inland valley watershed and floodplains in West Africa as depicted in Figure1.

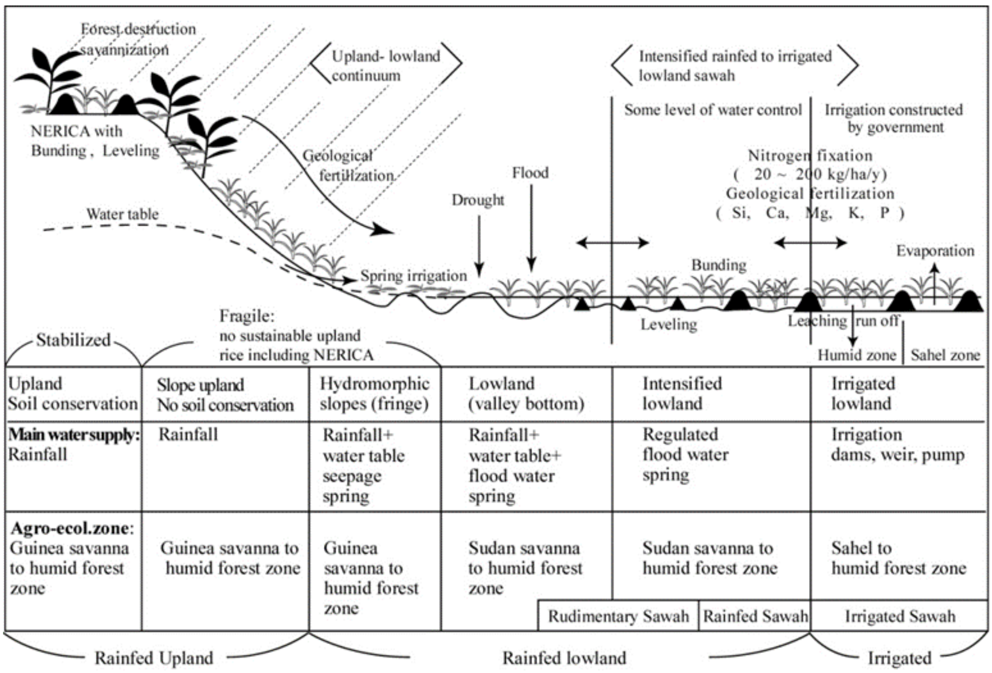

Fig. 1 Rice ecologies excluding deep water and mangrove swamp along a continuum of inland valley watershed and floodplains in West Africa.

Source: Wakatsuki T, Buri, M.M and Oladele O.I (2009) West African Rice Green Revolution by Sawah Eco-technology and the Creation of SATOYAMA systems. Kyoto Working Papers on Area Studies No. 63**,** JSPS Global COE Program Series 61 In search of Sustainable Humanosphere in Asia and Africa. March 2009. 30 p

One of the challenges facing the developing world today is how limited environmental resources can sustainably support an ever-increasing global population, a challenge which puts into perspective the issues of climate change for agricultural production and rural development (Cabangon *et al.,* 2014). There have been several attempts to stimulate green revolution in Africa as a major step towards achieving food security in Africa. Rice production technology that focussed on lowland rice production as against upland system of production has been introduced in many African countries because it more than doubles the yield from upland production. Closely related to irrigated lowland rice production is greenhouse gas (GHG) emissions, which vary depending on the system of production but, produces roughly four times the GHG emissions per ton of crop as wheat or maize, mostly in the form of methane and nitrous oxide as flooding rice fields blocks oxygen penetration into the soil, which allows bacteria that produce methane to thrive. To reduce greenhouse gas emission from irrigated lowland rice production Alternate Wet and Dry (AWD) as a water management was introduced as a system where rice fields are not kept continuously submerged but are allowed to dry intermittently during the rice growing stage. The adoption of AWD makes rice production climate smart. Richards and Sander 2014 reported that AWD can be practiced on lowland rice-growing areas where soils can be drained in 5-day intervals are suitable for AWD. Cabangon *et al.,* (2014) described AWD, as a method of irrigation where water is allowed to dry before the next irrigation, it can significantly reduce the amount of irrigation water input by as much as 35% without yield penalty. Water use in rice production cycle and agronomic practices consists of the amount of water required to prepare the land for crop establishment and the amount needed to meet the evapotranspiration requirement as well as to compensate for the seepage and percolation during the crop growth period (Tuong & Bhuiyan, 1999). Richards and Sander 2014 defined AWD is a rice management practice that reduces water use by up to 30% and can save farmers money on irrigation and pumping costs. Nalley *et al.,* 2014 states that AWD can increase the water use efficiency by reducing seepage and percolation during production. Vial (2005) stated that AWD rice systems increase water use efficiency in more permeable soils (such as northern China), because up to 60% of ponded water was leached from the soil. Richards and Sander (2014) stated that AWD can reduce water use by up to 30%, help farmers cope with water scarcity and increase reliability of downstream irrigation water supply. Van der Hoek *et al.* (2001) reported that rice yields under non-flooded conditions generally decreased proportionally with reduced water application because there were periods during the rice growth cycle when the yield was particularly sensitive to moisture stress. Richards and Sander 2014 indicated that AWD improved yields compared to continuous flooding, by promoting more effective tillage and stronger root growth of rice plants and also reduces cost of production by saving irrigation costs from pump irrigation with added advantage of reducing labour costs through improved field conditions (soil stability) at harvest, allowing a mechanical harvesting.

Cabangon *et al.,* (2014) indicated that due to increasing global water scarcity, water that is once diverted for agricultural production will be shifted to supply domestic and industrial sectors. Khairi *et al.,* 2015 stated that current rice production systems require about 1900 to 5000 litres of water to produce 1 kg of grain. When soil water is lower than saturated condition rice yield reduces (Tuong and Bouman, 2003); water deficit affected plant growth, flowering and grain yield by 21%, 50% and 21% respectively (Pirdashti *et al.,* 2004). Irrigated rice is more susceptible to drought and unable to regulate transpirational functions effectively (Vandeleur *et al.,* 2009). Khairi *et al.,* (2015) stated that it is important to present a logical use of less water in rice cultivation which would not affect plant physiological and soil chemical properties. IFPRI (2017) reported that irrigation investments together with water-use efficiency would increase sustainable agricultural production by 15% compared to having investments in irrigation alone.

Nalley *et al.,* (2014) reported that rice cultivation has a significant greenhouse footprint through methane emissions through the anaerobic decomposition of labile soil carbon pools; soil carbon losses as carbon dioxide, nitrogen losses in the form of nitrous oxides and fossil fuel usage for fertiliser manufacture, other inputs, field operations and transport and processing of the paddy rice. Nalley *et al.,* (2014) stated that methane is produced anaerobically by methanogenetic bacteria and flooded rice fields are the second largest source of methane emissions after ruminant livestock while EPA, (2014) indicated that methane is over 21 times more potent in terms of greenhouse warming potential than CO_2 over a 100-year period.. AWD irrigation can reduce methane emissions in rice fields by 40-50% compared to rice produced under continuous flooding (Wassmann, Hosen and Sumfleth, 2009, Lampayan 2012; IPCC 2006) Nalley *et al.,* (2014) concluded that AWD decreases the net global warming potential of paddy fields as long as nitrogen is applied in appropriate doses and when large amounts of rice straw are returned to the soil. Bouman *et al.,* (2007) concludes AWD generates multiple benefits related to reducing water use, reducing methane emissions (mitigation), increasing productivity, and increasing food security. Nalley *et al*., (2014) found AWD to reduce water usage from 20-70% and reduce methane emissions by over 50% as compared to rice produced under continuous flooding; as methane emissions from rice fields are determined mainly by water regime (flooding or alternative irrigation methods) and organic inputs, but they are also influenced by soil texture, weather, tillage management, residues, fertilizers, and rice variety. Vial (2005), noted that AWD rice systems have greater potential for nitrogen losses; often recording less than half the nitrogen use efficiency of flooded systems typically has 60-80% nitrogen use efficiency. Richards and Sander (2014) described the features of AWD as “reduction of methane emissions by 48% without reducing yield; efficient nitrogen use and application of organic inputs to dry soil can further reduce emissions and incentives for adoption of AWD are higher when farmers do not use pump irrigation. Vial (2005), indicated that AWD rice systems may well reduce rice field emissions by about half – provided denitrification (NO_2 production) is controlled – by confining the major decomposition of organic carbon to produce CO_2 rather than CH_4. Nalley *et al*., (2014) Flooding of the soil is a prerequisite for sustained emissions of methane such that periodic aeration of flooded soils inhibits methane producing bacteria; in this way AWD can substantially reduce methane emissions. Hosen (2012) reported that AWD water-saving technology has real potential to reduce the global warming impact of paddy fields to one-third of the conventional continuously-flooded field water management.

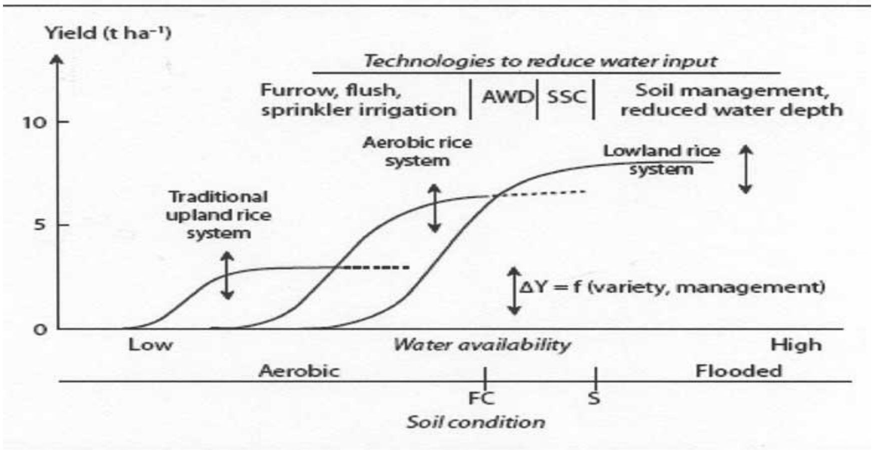

Fig. 2 Schematic presentation of yield responses to water availability and soil condition in different rice production systems and their respective technologies to reduce water inputs. AWD = alternate wetting and

drying, SSC = saturated soil culture, FC = field capacity, S = saturation point, Y = change in yield. Adapted from Cabangon et al (2014) and Tuong et al. (2005).

Climate change is a major problem in agricultural practices and the mitigation and adaptation strategies are of greater importance in adoption analysis. Despite the gargantuan accumulation of evidences through adoption studies the quest to unravel the application of the concepts and practice of technology innovation diffusion is serendipitously demanding novel approaches. According to the pioneering and classical research on adoption behaviour by Rogers 1960 and Rogers (2003) stressed that adoption is defined as the implementation of transferred knowledge about a technological innovation. Focus of adoption study has been the use, adoption intensity, outcome and not accuracy of implementation of technology packages. Implementation accuracy is the inherent part of the adoption process which ensures that technology or innovation being adopted is practiced by the end-users in specific terms as described by the diffusion sources. Implementation accuracy is not a concept of precision farming that is based on the recognition of spatial and temporal variability in crop production to be accounted in farm management. Precision farming is generally defined as a method capable of helping farmers to apply the right amounts of inputs, at the right place, and at right time. The concept of implementation accuracy has not been explicitly explored in the discourse of adoption of agricultural technology although the attributes of an innovation such as profitability, compatibility, complexity, trialability and observability have a significant role to play in its adoption (Chand *et al.,* 2011). In relation to implementation accuracy by end users, knowledge has often been used as proxy for correct implementation of the innovation and farmers' knowledge has been found to affect adoption decisions. The adoption-decision process is seen as a linear sequence of stages and is attained after an innovation-decision process that occurs in a five-step sequence namely: knowledge; persuasion; decision; implementation; and confirmation (Rogers, 2003). Knowledge stage is when a farmer gets information and knowledge about an innovation, (Nyanga, 2012). During implementation the technology is put into practice and finally confirmation phase refers to the stage where the adopter has to reaffirm or reject his decision to adopt the technology. The mitigation potential of AWD depends strongly on its proper execution. Incomplete drainage (not allowing the water table to drop to 15 cm below soil surface) can result in negligible reductions in GHG emissions. Nalley *et al.,* (2014) stated that in AWD, the rate and timing of the application of the water is determined by the producer and is a function of rainfall, soil type and the specific period of the rice life-cycle.

The components of the AWD are nursery preparation, use of improved variety, bunding, plot flooding, ploughing, puddling, levelling, plot drainage, transplanting, plot flooding, weeding, plot drainage, fertilizer application, plot flooding, and harvesting. The objective is to determine factors influencing farmers' adoption to AWD techniques in lowland rice production in Ghana, Uganda and Cameroon for climate smart agriculture. The specific objectives include the identification of personal characteristics, determination of levels of awareness, use of AWD irrigation, knowledge and implications of AWD for climate smart agriculture.

2. METHODOLOGY

The study was carried out in irrigation schemes in Tema (Ghana), Doho (Uganda) and (Ndop) Cameroon. The Dawhenya Irrigation Project located in the coastal savannah zone of Ghana was developed by State Farms Corporation in 1959 starting construction in 1975 but completed in 1978. Rice cultivation in Doho started in the 1940s. The Chinese government began to construct the irrigation scheme in 1976 and completed it in

1989. The DRS is the largest irrigation scheme in Uganda and is designed to serve irrigation water to 1,000 ha of paddy fields. The Ndop flood plain is located in the North West Region of Cameroon. In 1970, a large agro industrial scheme called the Upper Nun Valley Development Authority (U.N.V.D.A) was created in this region which promotes large scale rice cultivation using flood basin type of irrigation. Ndop also known as Bamunka, (Ramunka) is the only relatively flat plain area in the Northwest, where rice is grown. The features and descriptions of the study areas are presented in Table 1.

Table 1: Features of irrigation schemes in Ghana, Uganda and Cameroon

Features	Dawhenya- Ghana	Doho – Irrigation	Ndop- Cameroon
Vegetation	Coastal savannah	Derived savannah	Savannah
mean annual rainfall	737 mm	1164mm	1200-2000mm
Temperature ^{0}C	26.1-28.9	18	27.22
Altitude m asl	34	1083	1200
Year of establishment	1959	1940	1970
Irrigable size	450 ha	1,000 ha	136700ha
Developed size	200 ha	700ha	1828
Development partners	Korean International Cooperation Agency (KOICA),	Chinese government	Chinese/Japanese government
Water Source	Dechidaw River	Manafwa River	Nun River
Coordinates	5^o 04” N - 6^o 00” 0^o 10:W - 0^o 05” E	1^{0}N-0.56” N 34^{0}E - 34.02”E	5°37’N - 6°14’N 10°23’E -10°33’E
Land allocation size	0.4 -1 ha	0.4 -1 ha	1-2ha
Irrigation type	Pump and gravity	Flood	flood

An ex-post facto research design was used in the studies and the population of rice farmers on each of the irrigation schemes were the population of the study. A sample size of 120, 150 and 300 rice farmers from irrigation schemes in Tema, Doho and Ndop respectively were randomly selected from each of the irrigation schemes. The sample sizes of farmers were determined using the Raosoft Sampling Technique. Data were collected through the use of structured, face-validated and reliable (r = 0.80; split-half) questionnaire on their personal characteristics, awareness, use of AWD irrigation, knowledge and implications of AWD for climate smart agriculture. Completed questionnaires were coded, captured and analysed using version 21 of the Statistical Package for Social Sciences (SPSS). Descriptive statistics, frequencies, percentages, and means were used to summarise the data. The probit model was used to analyse the effect of factors on AWD adoption by farmers. The dependent variable Y is dichotomous, thus Y=1 if farmers adopt, and Y=0 if farmers do not adopt. A probit model highlights the fact that the discrete dependent variable Y is a rough categorisation of a continuous but unobserved variable Y^*. If Y^* could be directly observed, then standard regression methods would be used (with an assumption that Y^* is a linear function of some independent variables, for example):

$Y^* = \dot{\alpha}+\beta_1X_1+ \beta_2X_2+\ldots+ u_j$………………………………………………….. (3)

Y^* is AWD adoption which is used as a proxy for Y^*.

$X = (1, X_2, X_3, X_4, X_5 \ldots\ldots X_{12})$………………..………………… (4)

$\beta = (\beta_1, \beta_2, \beta_3, \beta_4, \beta_5 \ldots\ldots \beta_{12})$……………….……………….. (5)

$$Y_i^* = \begin{cases} 1\, if\ Y_i^* > Y \\ 0\, if\ Y_i^* \leq 0 \end{cases} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

$$P\left(Y = \frac{1}{X}\right) = F(XB) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{XB} e^{\frac{-(XB)^2}{2}} dx \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

Where Y^* *and* u_j are the AWD adoption and error term respectively.

3. RESULTS AND DISCUSSION

The results show that majority of farmers were female and male, married, with mean age of 50 and 45.6; having a mean farm size of 0.4 and 0.25ha in Ghana and Uganda respectively. In Cameroon, the majority of farmers were female, Christian married, with a mean age of 45, and having a mean farm size of 1ha. Across the irrigation schemes in the three countries, the proportion of rice farmers' membership in farmers' group is high while the use of power tiller and implementation accuracy were low.

Table 2: Descriptive statistics of rice farmers characteristics

Variables	Ghana (n = 120)	Uganda (n = 150)	Cameroon (n = 300)
Age mean	***50***	***45.6***	***45***
Gender+			
Male	35	70	69
Female	65	30	31
Marital status+			
Single	15	10	11
Married	80	75	79
Separated	5	15	10
Education level+			
No formal education	30	15	35
Primary education	12	43	45
Secondary education	50	32	15
Tertiary education	8	10	5
Group membership+			
Yes	66	76	55

No	34	24	45
Farm location+			
Upper stream	20	36	40
Middle stream	45	25	15
Lower stream	35	39	45
Farm size (Mean)	***0.4ha***	***0.25ha***	***1ha***
Farm income (Mean)	***250Gc***	***20000USh***	***50000CFA***
Use of power tiller (walking tractor) +			
Yes	15	10	20
No	85	90	80
Land rent (Mean amount)	***2000Gc***	***4000USh***	***6000CFA***
Household size(Mean)	***4persons***	***5persons***	***6 persons***
Sources of information*+			
Radio	50	40	15
Extension officer	25	75	75
Fellow farmers	50	66	50
Farming experience (Mean)	***15 years***	***19.5 years***	***17.2 years***
Implementation accuracy+			
Very Accurate	5	10	21
Accurate	35	55	65
Not Accurate	60	35	14

*Multiple responses

Table 3 presents the results of the Probit regression analysis of factors affecting adoption of AWD. The dependent variable is the proportion of rice farmers that adopted AWD on their rice plots at the time of data collection for this study. The probit model seeks to explain the probability of rice farmers' adoption of AWD. The signs of the coefficients of independent variables and significance of the independent variables were used in largely determining the impact of each variable on the probability of AWD adoption by farmers. The results show that significant determinants of the use of AWD across the countries were knowledge of the production technique, contact with extension, farm size, farming experience, awareness of climate smart practices, timeliness of operations, sources of information and implementation accuracy of technology. The implications of the findings from the probit regression analysis is that the significant variables for each category of AWD adoption influenced respondents to fall into each of the categories of adoption.

Table 3: Probit regression analysis of factors affecting adoption of AWD technique

	Ghana	Uganda	Cameroon
	SE (Reg Coeff)	SE (Reg Coeff)	SE (Reg Coeff)
Age	.013(.028)	-0.001(0.014)	-.004(.005)
Gender	-0.006(.002)	-.006(.047)	-.062(.072)
Education	.001(.046)	-0.04(.07)	-.001(.007)
Group membership	-.007(.011)	0.029(.03)	.006(.003)
Implementation accuracy	-.283(.074) ***	-0.231(.07) **	.066(.038) ***
Farm income	-.009(.008)	-0.66(.76)	-.066(.052)
Marital status	.005(.009)	0.04(.09)	-.003(.035)
Dependents	.006(.007)	-.011(.039)	-.012(.012)
Extension contact	-0.614(.12) ***	-0.35(.09) ***	-.194(.096) **
Membership of organisation	.016(.016)	-.024(.036)	-.004(.007)
Frequency of extension contact	-0.206(.070) **	0.042(.023) *	-.062(.107)
Farming experience	-.213(.12) *	-0.245(.065) ***	.163(.092) *
Farm size	0.168(.08) **	0.166(.057) **	.005(.002) **
Awareness of climate smart practices	-1.323(186) ***	-0.49(.21) **	-.067(.028) ***
Knowledge of AWD	0.63(.27) **	-0.32(.17) *	.249(.081) *
Timeliness of operations	-.137(.099)	-0.004(.02)	-.134(.059) **
Intercept	-17.17(7.31) **	-2.68(1.34) **	-1.32(.54) ***
Chi-Square	151.30	918.52	677.19
Df	68	78	112
Sig	0.00	0.000	.000

Key: *** p<0.01; ** p<0.05; * p<0.1

4. CONCLUSIONS AND EXTENSION IMPLICATIONS

This introduction of AWD techniques in lowland rice production in Ghana, Uganda and Cameroon for climate smart agriculture plays an important role in the reduction of irrigated lowland rice production generation of greenhouse gas (GHG) emissions which is roughly four times the GHG emissions per ton of crop from wheat or maize, mostly in form of methane and nitrous oxide. The need for extension services to make use of and implement technology is highlighted. Significant determinants of the use of AWD across the countries were; knowledge of the production technique, contact with extension, farm size, farming experience, awareness of climate smart practices, timeliness of operations, sources of information and implementation accuracy of technology. These significant variables have implication for reductions of GHG emissions from lowland rice production and important roles of extension in promoting climate smart agriculture. Farmers' knowledge of climate smart agricultural practices allows the adoption and scaling of climate smart innovations.

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ADOPTION OF AGRO-WEATHER INFORMATION SOURCES FOR CLIMATE-SMART AGRICULTURE AMONG FARMERS IN EMBU AND ADA'A DISTRICTS OF KENYA AND ETHIOPIA

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ABSTRACT

Adaptation strategies have gained more interest and are considered an effective measure to build resilience to the effects of climate change. The project agroweather tools for adaptation to climate smart agriculture a GOK/World Bank supported project has been implemented in Embu Ada'a Districts of Kenya and Ethiopia as pilot. The project has been used as a proof of concept that smallholder farmers are able to make more informed choices upon access to timely weather information and requisite advisory. The project uses newsletters, radio, IVR and SMS to provide information on different agronomic practices to farmers on tea, coffee sorghum and maize and beans in Kenya, and chick pea, lentils, teff and wheat in Ethiopia. This study examined the factors that affect the adoption of agro-weather information sources for climate-smart agriculture. A random sampling technique was used to select 360 and 171 farmers from the population of project's beneficiaries in Kenya and Ethiopia respectively. Data were collected with the use of a questionnaire. The overall results show that the farming experience and impact of agroweather information were significant determinants of the use of all the tools. Ownership/access, extension contact, frequency of extension contacts, and extension agency were significant determinants of the use of SMS, newsletter, and radio, while group membership, was a significant determinant of the use of SMS, newsletter, and interactive voice response (IVR). The significance of these variables stresses their need in the planning and policy formulation for the use of agroweather tools for information dissemination.

1. INTRODUCTION

Ensuring food security under a changing climate is one of the major challenges of the 21st Century. There are about 870 million people in the world that are food insecure, close to the number believed to be below the $1.25 per day poverty line. Three-quarters of these truly poor live in rural areas and depend on agriculture for their livelihood. A growing global population, changing dietary patterns, and increased competition for land and water will intensify the challenge of meeting future needs for food, fiber, and fuel. Climate change adds greatly to this challenge. Agricultural productivity is highly impacted by weather.

This and other factors make agriculture among the most vulnerable economic sector to climate change. Extended droughts and other extreme weather events can have devastating effects on agricultural productivity. These effects can contribute to food price volatility. The incidence of extreme weather events appears to be increasing, affecting food supply and livelihoods. The Agro-weather project aims to increase the adaptive capacity of farming communities by improving a) access to information on weather forecasting and climate patterns; and b) farm management capabilities under conditions of climate risk for selected pilot areas in Kenya. Innovative, agro-weather tools and ICT delivery systems will be developed. The project will also raise awareness of the practical utility of agro-weather information products and improve extension services for better agricultural decision making. The delivery of climate-smart advisory information using ICT such as SMS and smart phone applications and more conventional media such as radio messages are vital for enhancing

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farmers' resilience and adaptation to climate change. Weather information needs to be tailored to the microenvironment of the farmer to improve farm management capabilities under conditions of climate risks. This project develops agro-weather decision support systems including community farm radio messages for pilot areas in Kenya.

Mitigation strategies have traditionally received greater attention than adaptation, both from a scientific and policy perspective (Cohen et al., 1998). However, more recently, adaptation strategies have gained more interest in the literature, and are considered to be an effective measure to build resilience to the effects of climate change. Tarleton and Ramsey (2008) identify three key reasons for the growing interest in adaptation practices. First, adaptation measures can be applied on a much smaller scale, which makes their effectiveness less dependent on multiple decision-makers. Second, while the effect of mitigation may take several decades, most adaptation activities are likely to take effect on a much shorter term. Thirdly, no matter how robust mitigation measures are, scientific research shows that a certain degree of climate change is inevitable due to historical emissions and the inertia of the climate system (IPCC, 2007). Most countries in Africa are particularly vulnerable to climate change because of limited adaptive capacity, as a result of widespread poverty, recurrent droughts, inequitable land distribution, and dependence on rain fed agriculture (Smit et al., 2000). Because agricultural production remains the main source of income for most rural communities in East Africa, adaptation of the agricultural sector to the adverse effects of climate change will be imperative for protecting and improving the livelihoods of the poor and ensuring food security (FAO, 2012).

Smit and Skinner (2002) identify five categories of adaptation practices within local farming operations: 1) farm production, 2) land use, 3) land topography, 4) irrigation and 5) timing of operations. The most common adaptations identified in their assessment of farming practices in Canada are switching crop types and altering harvest dates. Although most of the identified adaptations have a long term scope and fall out of the range of potential immediate responses to weather forecasts, the actions related to changing timing of operations, such as chemical inputs, irrigation, mulches, planting, seeding and tillage are useful potential adaptation advises for Agro-weather tools in the East African context. A typology for Adaptation Practices related to local farm production management as identified by Smit and Skinner (2002) include 1) Farm production (diversify crop types and varieties, including substitution of plant types, cultivars and hybrids, designed for higher droughts or heat tolerance; altering the intensity of chemical (fertilizers and pesticides), capital and labor inputs). 2) Land use (change the location of crop production, by shifting production away from marginal areas to reduce soil erosion, use of alternative fallow and tillage products against droughts). 3) Land topography (land contouring and terracing, construction of diversions, reservoirs, and water storage and recharge areas). 4) Irrigation (introduction or enhancement of specific water management innovations, including specific types of additional irrigation systems, changing the scheduling of existing irrigation systems). 5) Timing of operations (change timing of production operations, including scheduling of crop and livestock production activities such as chemical inputs, irrigation, harvesting, mulches, planting, seeding, and tillage).

Another typology for categorising adaptations at the production level is differentiation between crop and water management, as also used by Iglesisas et al., (2011). In an assessment of practices in a farming community in Sri Lanka, Esham and Garforth (2012) have identified local crop management adaptations such as: use of mulches, changing planting dates, changing crop type, shorten growing season, planting shade trees and crop rotation. In addition, water management actions were taken such as increased supplementary irrigation during droughts and rainwater harvesting during wet seasons (Esham and Garforth, 2012).

In terms of climate adaptation strategies among farming households in four East African countries, Climate Change, Agriculture and Food Security (CCAFS, 2012) reported that more than 55% of households have taken up at least one shorter-cycle crop variety, and 56% adopted at least one drought tolerant variety. These practices help farmers work around periods of heat and water scarcity; 50% of households are planting trees on their farms, a practice known as agroforestry. These trees help stabilise eroding landscapes, increase water and soil quality, and provide yields of fruit, tea, coffee, oil, fodder, medicinal and energy products. In addition, 50% introduced intercropping—alternating different plants in the same plot—and 25% started rotating their crops during the last decade to help maintain and improve soil fertility and enhance crop yields.

The year-to-year variability of the climate is a serious challenge for agriculture. Beyond its direct impacts on production and market prices, the uncertainty associated with climate variability is a challenge to management, as farmers must make many critical, climate sensitive decisions months before the impacts of climate are realised. Climate variability imposes costs on farmers predominantly through two different mechanisms, the first primarily driven by information constraints in production decisions and the second by the burden that uncertainty imposes on risk-averse optimisers. In the first case, climate variability creates a moving target for management. That is, when a farmer must make management decisions before the climate variables are known for a particular year, the farmer must make decisions that are an optimal compromise for the full set of possibilities as opposed to an optimal solution for the particular year that will be actually experienced. The moving-target effect can lead to losses for both risk-neutral and risk-averse farmers. Opportunities for the use of seasonal climate forecasts arise in situations in which there is a combination of climatic predictability, system response, and decision capacity (Hansen 2002). In those cases, climate forecasts can increase farmers' preparedness and lead to better economic and environmental outcomes in the long run. A skillful climate forecast reduces uncertainty by reducing the spread of possible outcomes for the upcoming season relative to the climatological distribution, and by conveying shifts in the central tendency of climatic outcomes. This information allows farmers to better adapt management decisions to upcoming weather conditions, thereby attenuating the moving target problem; and, because uncertainty has been reduced, it allows risk-averse farmers to relax the additional protective strategies in climatically favourable or average seasons that they would use to stabilise returns. With seasonal climate forecasts having an impact on farmers' welfare, both qualitative and quantitative assessments are important to fully exploit the potential benefits associated with them (value) and to understand the limitations of their application (use).

Weather extremes and climate variability had the largest share in making rain-fed agriculture a challenge in the area. In addition to the constraints imposed by extreme poverty and often a degrading resource, the inherent risk caused by the within and between season variability of rainfall amounts and distribution is one of the main reason for under production in the area. This variability poses challenges for farming communities who have to make decisions each year without a clear knowledge as to how the season will evolve and the yields they are likely to achieve (Stern et al., 2011). It is also a challenge for researchers who are seeking to identify innovations which will improve farm productivity whilst at the same time reduce climate-induced risk.

Farmers have to make several decisions such as which crop or variety to grow on how much land, what inputs to use, and what soil, water and crop management strategies to adopt. The outcome of such decisions is directly linked to the amount and distribution of rainfall during the season. The high variability and uncertainty associated with total and in-season rainfall distribution cause farmers to make these decisions based on their knowledge and experience (Rao et al., 2010). In view of this, weather forecast based advisory service is key risk management and climate change adaptation tool that play an important role in farm level decision making process.

Occurrences of erratic weather are beyond human control. However, it is possible to adapt to or mitigate the effects of adverse weather if a forecast of the expected weather can be obtained in time. Agronomic strategies which are available to cope with changing weather are limited. Once the crop season starts, however, the resources and technology get committed and the only option left then is to adopt crop-cultural practices to minimise the effects of intra-seasonal hazardous weather phenomena, while relying on advance notice of their occurrence. Thus, medium range weather forecasts with a validity period that enables farmers to organise and carry out appropriate cultural operations to cope with or take advantage of the forecasted weather are clearly useful. The rapid advances in information technology and its spread to rural areas provide better opportunities to meet the rising demand among farmers for timely and accurate weather forecasts.

Agro-meteorological advisories' are an act of advice by experts to farmers (crop growers/livestock producers) based on possible future weather and climate conditions, regarding "what to do" or "what not to do" to maximise advantages and minimise losses in production (Sigter 2007). Weather and climate forecasts have little importance unless they are tailored enough to be used operationally. Any appropriate forecast on weather and subsequent advisory on it has tremendous benefits in terms of advance management of the negative impacts of weather. This is because the cost of weather-related risk reduction before the fact is much smaller than the post-facto management of the losses (Rathore et al., 2006). These advisories recommend implementation of certain practices or the use of special materials to help effectively prevent or minimise possible weather-related crop damage or loss. Advisories can be based on the outcome of response farming exercises, from planning agricultural activities and sowing window to harvesting time, using seasonal and medium-range weather forecast. All agricultural activities from pre-sowing to postharvest are influenced by weather. So, weather-based advisories to the farmers help them in day-to-day agricultural operations well in advance. The hypothesis is that the solutions to farming problems may be found by improved forecasting of expected weather behaviour in the cropping season(s). A good weather forecast is not always a good advisory. Not only the skills of the forecast count but also the absorption capacity of the target groups matter a lot. From previous studies and pilot projects we understood that weather forecast-based advisory service can make a significant influence in minimising climate related risks and increase productivity.

Farmers are 'weather-watchers', and they use traditional knowledge and experience to adapt their agricultural practices accordingly. But changing climates are affecting these age-old practices. Extreme weather events such as droughts or floods are becoming more frequent with climate change, and the damage they cause to agriculture, human health, productive assets and infrastructure affect rural livelihoods. Innovations in climate risk management offer win-win opportunities that contribute immediately to agricultural management and improving food security, while building resilience to production systems. These include new crop varieties, use of climate resilient seeds, improved crop management practices in response to seasonal climate forecasts, weather index insurance, and improved early warning and early response systems. This study will disseminate appropriate crop specific climate-smart outlooks and advisories on appropriate spatial scales based on available data base to support farmers in improving their crop management practices and subsequently increase the crop productivity.

The research took advantage of internationally available Decision Support System (DSS) tools such as crop simulation models to understand and demonstrate impacts of climate variability and crop management practices on specific crop yields and subsequently generates climate-smart agro-advisory. DSS collect, organise, and integrate all types of information required for producing a crop. DSS then analyses and interprets the information and finally uses the analysis to recommend the most appropriate action for sustaining maximum yields. Expert knowledge, management models, and timely data are key elements of DSS and are used to assist producers with both daily operational and long-range strategic decisions. Computer-based DSS have gained increasing importance since the 1980s, and a large number of DSSs have been developed to assist extension agents, consultants, growers, and other agricultural actors in crop management.

The development process comprises of stakeholder identification and consultation; data/information collection and dissemination of services to farmers. One of the tasks of the assignment was the identification of key stakeholders including agricultural union in terms of those, which get affected due to climate change, and those who can contribute towards adaptation and mitigation measures. The project team initiated the project with a high level meeting with focal agencies such as Ministry of Agriculture, Meteorological Department, Water Resource Department and Climate Change Cell. The objective of the meeting was to gather a sound knowledge base from systematic consultations with the climate experts, sector experts, country management, client and other stakeholders and to understand the nature of climate change risks in the agricultural sector and potential impacts (e.g., decline in agricultural productivity). The learning and information gathered as part of the consultation were utilised to assess the climate induced risks in the agricultural sector in the study regions.

In order to understand the underlying issues, the research team thoroughly studied the meteorological, ecological, crop health and field information needs for farmers. It will also help understand the most suitable way of processing the available data and disseminating knowledge to the farmers and the most suitable model that would be necessary to implement the processes. The team collected additional data/information from the various departments such as departments of Agricultural, Meteorological, Water Resource.

Agro-weather advisory system utilised short message services, interactive voice response, newsletter and other traditional ICTs for the transfer of activity specific information that is location specific and time bound to farmers in the coverage area on pre-cultivation strategic choices, and tactical decisions. This is predicated on the fact that digital technology is fast becoming a part of everyday life in sub-Saharan Africa," the report says. With a mobile penetration rate of 70% at the end of 2013, sub-Saharan Africa is rapidly closing in on the global penetration rate of 92%. Nigeria and South Africa still have the most mobile subscribers, followed by Kenya, the Democratic Republic of Congo and Ghana. Subscription growth in the first quarter of 2014 rose the fastest in Nigeria, the Democratic Republic of Congo, Uganda and Ghana. Sub-Saharan Africa is a prepaid market. In 2013, the report says, 99% of Nigerian subscriptions were prepaid, as were 98% in Kenya and 83% in South Africa (ITU, 2014). In 2008, an inventory of ICT-enabled farmer advisory services in Africa identified 120 projects, with the Internet (39%), mobile phones and SMS services (32%) and radio (14%) being the most common technologies used (Gakuru et al., 2009a and 2009b).

Weather and climate are key factors in determining the growth, development and production of agricultural crops. Therefore, agriculture is highly sensitive to climate variability and weather extremes, such as droughts, flooding, and severe storms. Global mean surface air temperatures have increased by ~0.7^0C since 1980, with even larger changes observed in several regions. The increased potential for droughts, floods and heat waves is likely to pose serious challenges for farmers in tropical Africa. Additionally, the enduring changes in rainfall, water supply, and soil moisture could make it less feasible to continue crop production in some regions. The increased frequency of extreme events in the recent past has drawn the attention of agro-meteorologists. Keeping this in mind, the team thoroughly assessed the climate induced risk in the agricultural sector for the Ethiopia and Kenya based upon concerned experts consultation and recently concluded stakeholder analysis that assessed climate information needs, gaps, and existing use of weather and climate information for agricultural decision making to be made during the post-sowing to harvest stage.

Based on the crop simulation model generated outputs, a detailed climate-smart agricultural management practices advisory framework has been developed. This framework embedded in the web-based agro-weather decision support system tool. The advisory includes the pre-cultivation strategic choices, the tactical decisions to be made during the cultivation phases (i.e., post-sowing to harvest stage), and several post-harvest decisions. Pre-cultivation and cultivation decisions are important because they cannot be postponed, are often irreversible, represent a substantial allocation of resources, and have a wide range of consequences that impact the farmers for years.

The objective was to determine factors influencing adoption of agro-weather information sources for climate-smart agriculture among farmers in Embu and Ada'a Districts of Kenya and Ethiopia

2. METHODOLOGY

Kenya, situated in the Eastern Africa on both sides of the equator between latitude 4^{o}N and 4^{o}S and between 34^{o}E and 42^{o}E, has a land surface of about 569,140 sq km (97.7% of the total area) with the land boundaries of 3,477 kms (Federal Research Division, 2007). Kenya rises from a low coastal plain on the Indian Ocean with 536 kms of coastline in a series of plateaus to more than 3,000 meters in the centre of the country. In the Northwest, it occupies high lying scrub lands, Lake Turkana (Lake Rudolf) and the Kulal Mountains. In the Southwest, it covers the most fertile grasslands and forests of the Kenyan Highlands, which are the most productive agricultural land areas. In the South, mountain plains descend westward to the shores of Lake Victoria. The Kenya's principal rivers are the Tana and the Athi, both flowing Southeast to the Indian Ocean. Other rivers include the Ewaso Ngiro, flowing Northeast to the swamps of the Lorian Plain and the Nzoia, Yala, and Gori, which drain into Lake Victoria. There are two major lakes, namely, Lake Turkana (also known as Lake Rudolf) and Kenya's portion of Lake Victoria (Federal Research Division, 2007).

Ethiopia is situated in the Eastern part of Africa and southern Red Sea region. The country is sub-divided into nine regional states with a total surface area of 1,127,127 sq km (Federal Research Division, 2005). The country is traversed by varied topography. Due to its typical geographical settings, the topography determines regional variations in climate, natural vegetation, soil composition and settlement patterns. A chain of lakes lie in the southern Rift Valley and largest lake is Lake Tana in the northwest part of the country. There are numerous rivers, originating in the highlands and drain into the surrounding lowlands. Due to its diverse topography and its location in the tropics, rainfall and temperature patterns vary widely. The highland above 1500 m altitude creates a pleasant temperate climate with daytime temperature varies between 16^{o}C and 30^{o}C and cooler nights. In the areas below 1500 m altitude, daytime temperature varies between 30^{o}C to 50^{o}C (FAO, 2006).

The population of the study is all agroweather tools project beneficiaries in Embu east Sub County and Ada'a District, Ethiopia. These are all tea, coffee sorghum and maize and bean farmers that have been reached with the agroweather tools namely, newsletters, radio, IVR and SMS. While in Ethiopia, these are all chick pea, lentils, teff and wheat farmers that have been reached with the agroweather tools namely, newsletters, radio, IVR and SMS. The sampling procedure was systematic in Kenya while in Ethiopia simple random sampling was used. In Embu, Kenya, from the list of farmers in the project a systematic sampling that allows sampling with replacement was used to select every 4th name on the list. The total sample size was 360 farmers. In Ethiopia, simple random sampling technique that allows sampling with replacement was used to select farmers. The total sample size was 171 farmers.

Data in Embu East, Kenya and Adaá district in Ethiopia were collected through the use of a structured questionnaire. The questionnaire was developed based on the objectives of the project evaluation. The data collection instrument was subjected to face validity among the different stakeholders for the agroweather tools project from the World Bank Office and national stakeholders in Kenya. Data was analysed by using the Statistical Package for Social Sciences (SPSS) 21.0. Descriptive statistics such as frequency counts and percentages were used to describe the data. Tables, graphs and percentages were used to sthe data and enhance the readability of the results; multiple regression analysis was used to determine the determinants of the use of agroweather tools as information sources.

3. RESULTS AND DISCUSSION

For Kenya, Figure1 presents the results on personal characteristics of the farmers in the agroweather tools project. This shows that over 60% were female, at least 56% were 30 years old, 80% were married and more than 30% had primary and secondary school education level. The trend of the results may be due to the fact that through small scale farming, female farmers are able to provide food for the households and over the surplus for income and that the marital status imposed a responsibility to ensure that such households are food secured. The age category emphasised the ageing farming population in most rural areas of the developing world as men and youth seek for other income generating opportunities outside their rural domain.

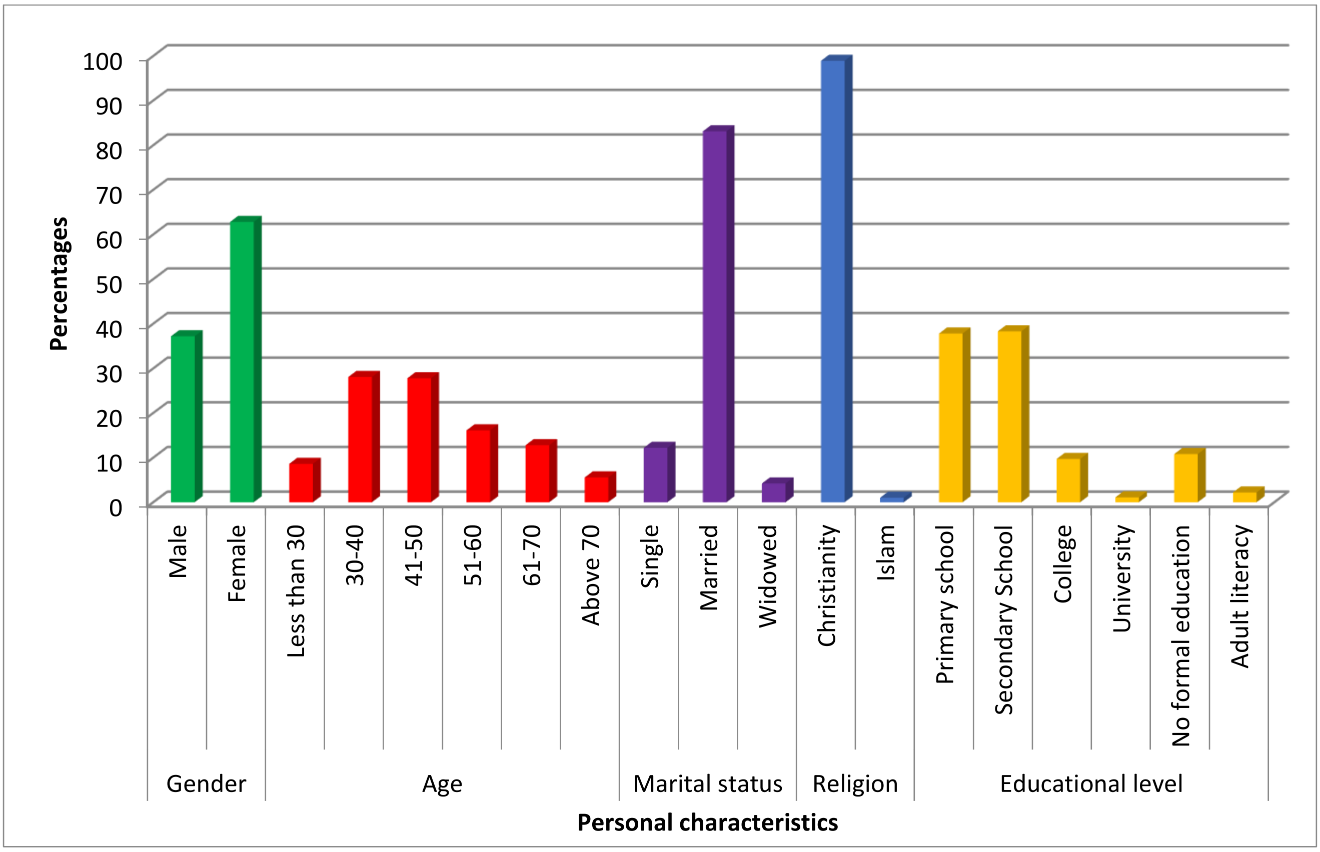

Figure 1: Distribution of farmers based on selected personal characteristics

Table 1 presents the results for Ethiopia on the personal characteristics of farmers. The majority were males, 96.2%, 82.9%, 89.1%, and 84.4% for chick pea, lentils, teff and wheat respectively. About 57%, 78%, 83%, and 77% were at least 30 years old for chick pea, lentils, teff and wheat respectively. The majority farmers of chick pea, lentils and teff were married, while for wheat the majority were widows. The majority of chick pea (57.7%) and lentil (68.6%) farmers had no dependants while the majority of teff (92%) and sheat (87%) had between 1 and 6 dependants. The majority had at least 4 persons per household across crops; 100%, 95%, 82% and 91%

percent for chick pea, lentils, teff and wheat farmers respectively. At least 62% of the farmers across crops had between 1 and 3 number of males and females. Most of the farmers had no formal education (chick pea (50%), lentils (54.3%) and teff (52%)) while the majority ofwWheat farmers (67.2%) had primary and secondary school education.

Table 1: Personal characteristics

Variables	Chick pea n = 26	Lentils n = 35	Teff n = 46	Wheat n = 64
Gender				
Male	**25(96.2)**	**29(82.9)**	**41(89.1)**	**54(84.4)**
Female	1(3.8)	6(17.1)	5(10.9)	10(15.6)
Age				
Less than 30	1(3.8)	8(22.9)	8(17.4)	15(23.4)
30-40	10(38.5)	12(34.3)	10(21.7)	16(25.0)
41-50	9(34.61)	9(25.7)	15(32.6)	20(31.3)
51-60	3(12.4)	6(17.1)	7 (15.2)	8(12.5)
61-70	2(7.6)	0(0.0)	3(6.5)	4(6.3)
Above 70	1(3.8)	0(0.0)	3(6.5)	1(1.6)
Marital status				
Single	0(0)	6(17.1)	2(4.3)	8(12.5)
Married	26(100)	27(77.1)	43(93.5)	6(9.4)
Widowed	0(0)	2(5.7)	1(2.2)	53(82.8)
Religion				
Christianity	26(100)	35(100)	46(100)	64(100)
Number of dependant(s):				
none	15(57.7)	24(68.6)	4(8.7)	13(20.3)
1-3	10(38.5)	10 (28.6)	19(41.3)	22(34.4)
4-6	1(3.8)	1(2.9)	11(23.9)	21(32.8)
7-9	0(0)	0(0)	12(26.1)	8(12.5)
Household size				
1-3	0(0)	5(14.3)	8(17.4)	9(14.1)
4-6	18 (69.23)	14(40.0)	15(32.6)	32(50.0)
7-9	6 (23.08)	11(31.4)	14(30.4)	17(26.6)
Above 9	2(7.6)	5(14.3)	9(19.6)	6(9.4)
Number of Males in household				
1-3	17(65.38)	22(62.9)	30(65.2)	40(62.5)
4-6	8 (30.77)	10(28.6)	14(30.4)	21(32.8)
7-9	1(3.8)	3(8.6)	2(4.3)	3(4.7)
Number of Females in household				
1-3	19 (73.08)	22(62.9)	29(63.0)	45(70.3)
4-6	6(23.08)	11(31.4)	11(23.9)	17(26.6)
7-9	1(3.8)	2(5.7)	6(13.0)	2(3.1)
Highest educational level				
Primary school	13(50)	8(22.9)	10(21.7)	23(35.9)
Secondary School	0(0)	8(22.8)	11(23.9)	20(31.3)
University	0(0)	0(0)	1(2.2)	1(1.6)
No formal education	13(50)	19(54.3)	24(52.2)	20(31.3)

3.1. Determinants of the use of agroweather tools as information sources

In Table 2, the results of the determinants of the use of agroweather tools (SMS, Radio, Newsletters and IVR) as information sources were presented. The use of agroweather tools were regressed independently against 30 independent variables. The overall results showed that farming experience and impact of agroweather information were significant determinants of the use of all the tools. Ownership/access, extension contact, frequency of extension contact and extension agency were significant determinants of the use of SMS, Newsletter, and radio, while group membership, was a significant determinant of the use of SMS, Newsletter, and IVR. The significance of these variables stress their need in the planning and policy formulation for the use of agroweather tools for information dissemination. Wood et al., (2013) found evidence that access to weather information, assets, and participation in social institutions are associated with households that have reported making farming changes in recent years, although these results vary across countries and types of practices. Understanding these drivers and outcomes of farm-associated changes across different socio-economic and environmental conditions is critical for on-going dialogues for climate-resilient strategies and policies for increasing the adaptive capacity of smallholders under climate change. User perception of climate vulnerability and understanding user decision contexts are critical factors that can influence forecast use (Yarnal et al., 2003). Okwu (2011) stated that farmer users of mass media are therefore those who have a good level of education, belong to a relatively high income bracket, and are typically male and of a relatively high socioeconomic status. Farmers' socioeconomic characteristics should be considered in planning mass media usage in agricultural information dissemination. Getnet, Kedir and Yousuf (2014) reported that age, year of education, information seeking behaviour and participation in trainings were significant determinants of ICT use among farmers in East Hararghe Zone, Oromia National Regional State, Ethiopia. Understanding these drivers and outcomes of farm-associated changes across different socio-economic and environmental conditions is critical for on-going dialogues for climate-resilient strategies and policies for increasing the adaptive capacity of smallholders under climate change. User perception of climate vulnerability and understanding user decision contexts are critical factors that can influence forecast use (Yarnal et al., 2003). The specific determinants of the use of each of the agrowether tools are discussed in the following sections.

SMS

In Kenya, the result of multiple regression analysis of relationships between farmers' socio-economic characteristics and determinants of the use of short message service as agroweather information source were presented in Table 6. The independent variables were significantly related to use of short message service as agroweather information source with F value of 5.83, $p < 0.05$. Also, R value of 0.59 showed that there was a strong correlation between independent variables and use of short message service as agroweather information source. The result further predicted 35 percent of the variation in use of short message service as agro weather information source by farmers. Significant determinants were ownership ($t = 2.976$, $p = .003$), education level ($t = -2.404$, $p = .017$), farming experience($t = -2.716$, $p = .007$), group membership ($t = 2.185$, $p = .030$), extension contact ($t = -2.273$, $p = .024$), frequency of extension contact ($t = -2.655$, $p = .008$), extension agency ($t = -3.966$, $p = .000$), labour sources ($t = -1.832$, $p = .068$), distance to market ($t = -1.707$, $p = .089$), other income ($t = -2.209$, $p = .028$), AGW information impact ($t = 1.706$, $p = .089$), constraints to AGW information($t = 1.744$, $p = .082$) . Most of the variables are inversely related to the use of short message service as agroweather information source. Chavas (2008) stated that mobile phone networks have the potential to revolutionise this service by significantly improving the efficiency of forecast dissemination, both to the individual farmer and between farmers, and by solving the evaluation problem.

In Ethiopia, the results of multiple regression analysis of relationships between farmers' socio-economic characteristics and determinants of the use of short message service as agroweather information source were presented in Table 6. The independent variables were significantly related to use of short message service as agroweather information source with F value of 3.99, $p < 0.05$. Also, R value of 0.66 showed that there was a strong correlation between independent variables and use of short message service as agroweather information source. The result further predicted 44% of the variation in use of short message service as agro weather information source by farmers. Significant determinants were number of dependents, farming experience, non-farming activities, non-farming activities types, constraints to AGW information and AGW information Impact.

Newsletter

In Kenya, the result of multiple regression analysis of relationships between farmers' personal characteristics and use of newsletter as Agroweather information source were presented in Table 6. The independent variables were significantly related to use of newsletter as Agroweather information source with F value of 4.70, $p < 0.05$. Also, R value of 0.55 showed that there was a strong correlation between independent variables and use of newsletter as Agroweather information source. The result further predicted 30 percent of the variation in use of newsletter as Agroweather information source by farmers. Significant determinants were gender (t =-1.977 , p =.049), ownership (t = 3.669, p = .000), farming experience (t =-2.940 , p = .004), group membership(t = 1.711,p =.088), extension contact (t =-2.340 , p =.020), frequency of extension contact (t = -2.948, p =.003), extension agency (t =-3.169 , p =.002), AGW information impact (t = 3.145, p =.002).

In Ethiopia, the result of multiple regression analysis of relationships between farmers' personal characteristics and use of newsletter as Agroweather information source were presented in Table 6. The independent variables were significantly related to use of newsletter as Agroweather information source with F value of 3.29, $p < 0.05$. Also, R value of 0.63 showed that there was a strong correlation between independent variables and use of newsletter as Agroweather information source. The result further predicted 39% of the variation in use of newsletter as Agroweather information source by farmers. Significant determinants were number of dependents, farming experience, non farming activities, non farming activities types, total cost, constraints to AGW information and AGW information impact

Radio

In Kenya, the result of multiple regression analysis of relationships between farmers' personal characteristics and use of Radio as Agroweather information source were presented in Table 6. The independent variables were significantly related to use of radio as Agroweather information source with F value of 4.56, $p < 0.05$. Also, R value of 0.54 showed that there was a strong correlation between independent variables and use of radio as Agroweather information source. The result further predicted 29% of the variation in use of radio as Agroweather information source by farmers. Significant determinants were ownership (t = 2.841, p = .005), education level (t =-2.448 , p =.015), farming experience (t =-3.791 , p =.000), extension contact (t = -1.717, p = .087), frequency of extension contact (t =-3.352 , p =.001), extension agency (t =-3.220 , p =.001), labour number(t = 2.355, p =.019), AGW information impact (t = 2.755, p = .006). Most of the variables are inversely related to the use of radio as Agroweather information source. The use of radio as alternative source of information to extension agent could be the reason for the inverse relationship. Similarly, less experience farmers, would rely on other sources of information to leverage skills and competencies.

In Ethiopia, the result of multiple regression analysis of relationships between farmers' personal characteristics and use of radio as Agroweather information source were presented in Table 6. The independent variables were significantly related to use of Radio as Agroweather information source with F value of 2.05, $p < 0.05$. Also, R value of 0.54 showed that there was a strong correlation between independent variables and use of radio as Agroweather information source. The result further predicted 28% of the variation in use of radio as Agroweather information source by farmers. Significant determinants were number of dependents, farming experience, land sources, frequency of extension contact, non- farming activities, non- farming activities types and AGW information impact

IVR

In Kenya, the result of multiple regression analysis of relationships between farmers' personal characteristics and use of IVR as Agroweather information source were presented in Table 6. The independent variables were significantly related to use of interactive voice response as agroweather information source with F value of 7.18, $p < 0.05$. Also, R value of 0.62 showed that there was a strong correlation between independent variables and use of IVR as Agroweather information source. The result further predicted 40% of the variation in use of IVR as Agroweather information source by farmers. Significant determinants were farming experience (t =-2.472, p =.014), group membership (t = 2.276, p = .023), credit obtained (t =-2.157 , p = .032), input costs (t = 1.957, p = .051), AGW information impact (t = 3.302, p =.001), constraints to AGW information(t = 6.981, p =.000).

In Ethiopia, the result of multiple regression analysis of relationships between farmers' personal characteristics and use of IVR as Agroweather information source were presented in Table 6. The independent variables were significantly related to use of IVR as agroweather information source with F value of 7.79, $p < 0.05$. Also, R value of 0.77 showed that there was a strong correlation between independent variables and use of interactive voice response as Agroweather information source. The result further predicted 61% of the variation in use of IVR as Agroweather information source by farmers. Significant determinants were age, number of dependents, farming experience, extension contact, extension agency, non-farming activities, non-farming activities types, lentil income and AGW information impact.

Table 2: Determinants of the use of agroweather tools as information sources

	Kenya				Ethiopia				
	SMS	Newsletter	Radio	IVR		SMS	Bulletin	Radio	IVRS
	B(SE)	B (SE)	B(SE)	B (SE)		B (SE)	B (SE)	B (SE)	B (SE)
(Constant)	15.70(6.30) **	13.06(5.11)*	16.98(6.73)*	11.04(4.68)**	(Constant)	-17.44 (3.403)***	-15.136(8.035) **	34.582(10.646) *	-35.99(13.695) *
Age	-.046(.077)	-.018(.062)	.034(.082)	.072(.06)	Gender	2.496(3.578)	-1.048(2.757)	-2.474(1.628)	1.297(2.094)
Gender	-1.31(1.40)	-2.26(1.14)**	-.983(1.50)	.90(1.05)	Age	.192(.149)	.144(.114)	-.020(.068)	.149(.087) *
Marital status	.21(1.40)	.087(1.141)	.316(1.50)	-1.28(1.04)	Marital status	1.416(3.184)	.696(2.453)	-.842(1.448)	-1.376(1.863)
Ownership/ Access	24.34(8.18) ***	24.36(6.64)***	24.82(8.73) ***	8.96(6.08)	Ownership /access	-5.573(15.514)	-5.243(11.955)	-.519(7.057)	-9.806(9.079)
Dependants (No)	.41(.37)	.079(.306)	.26(.40)	.050(.28)	Dependents No	1.711(.562) **v	1.018(.433) **	-.594(.256) **	.172(.329)
Household size	-.75(.61)	-.715(.500)	.44(.65)	-.080(.46)	Household size	-5.465(4.059)	-3.412(3.128)	-.775(1.847)	-2.177(2.375)
Male in HH	.91(.79)	.950(.646)	-.30(.85)	.015(.59)	Males in HH	4.036(4.183)	2.674(3.224)	1.360(1.903)	1.940(2.448)
Female in HH	.43(.74)	.681(.601)	.11(.79)	-.205(.55)	Females in HH	4.631(4.060)	3.412(3.128)	1.041(1.847)	1.682(2.376)
Education level	-1.50(.62) **	-.377(.507)	-1.63(.66) **	-.463(.46)	Educational level	-.468(.571)	-.602(.440)	-.409(.260)	-.260(.334)
Farming experience	-.18(.06) **	-.16(.05)***	-.272(.072) ***	-.123(.05)*	Farming experience	-.333(.175) **	-.164(.135)	-.037(.080)	-.239(.102) **

Land sources	-.93(.66)	-.29(.53)	-.837(.708)	.25(.493)	Land sources	1.303(.943)	1.068(.726)	-.787(.429) *	.489(.552)
Farm size	.58(.38)	.443(.314)	.539(.413)	.143(.28)	Farm size	.799(1.661)	-.254(1.280)	.761(.756)	-.571(.972)
Group membership	6.27(2.87) **	3.98(2.33)*	4.80(3.06)	4.85(2.13)*	Group Membership	-1.447(3.337)	-1.097(2.571)	.958(1.518)	.903(1.953)
Extension contact	-4.15(1.82) **	-3.47(1.48)**	-3.35(1.95) *	.65(1.36)	Extension contact	-1.313(4.593)	.584(3.539)	1.224(2.089)	-4.789(2.687) *
Contact Frequency	-1.95(.73) ***	-1.76(.59)***	-2.63(.78) ***	-.849(.55)	Contact Frequency	-.224(2.066)	.667(1.592)	-2.039(.940) **	-1.373(1.209)
Extension agency	-1.70(.42) ***	-1.10(.34)***	-1.47(.45) ***	-.448(.32)	Extension agency	-.096(7.262)	-8.538(5.596)	1.258(3.303)	7.678(4.250) *
Labour sources	-.097(.05) *	-.034(.043)	-.063(.056)	-.023(.04)	Labour sources	.086(.751)	.217(.579)	-.001(.342)	.535(.439)
Non farming ACT	1.49(1.12)	.44(.91)	.903(1.20)	.899(.83)	Non farming ACT	6.435(2.868) **	5.378(2.210) **	.836(1.305)	3.548(1.678) **
Non farming ACTTY	.08(.46)	-.066(.375)	-.251(.49)	.111(.34)	Non farming ACTTY	-2.344(.932) **	-1.676(.718) **	.727(.424) *	-.111(.545)
Distance to market	-.097(.057) *	-.022(.046)	.013(.06)	-.035(.04)	Wheat income	5.1E-05(.000)	2.2E-05(.000)	5.40E-05(.000)	4.16E-05(.000)
Distance to farm	.006(.025)	-.011(.020)	-.006(.027)	-.004(.02)	Teff income	-0.00008(.000)	-3.64E-05(.000)	1.75E-05(.000)	-7.21E-05(.000)
Farming income	1.11E-5(.00)	7.71E-6(.00)	7.89E-6(.00)	-9.51E-7(.00)	Chick pea income	.000(.001)	-3.6E-05(.001)	.000(.000)	.001(.000)
Labour number	-2.49E-5(.00)	1.44E-5(.00)	.000(.00) **	-1.71E-5(.00)	Lentil income	.000(.000)	.000(.000)	.000(.000)	.000(.000) **
Cost of production	9.18E-6(.00)	2.60E-5(.00)	2.66E-5(.00)	4.02E-6(.00)	Other income	9.998E-06(.000)	4.37E-05(.000)	-7.63E-05(.000)	2.41E-06(.000)

Other income	-1.88E-5(.00)**	-8.9E-6(.00)	-5.01E-6(.00)	-7.25E-6(.00)	Total cost	.000(.000)	.000(.000) *	1.03E-05(.000	-8.97E-05(.000)
Expenses	-1.22E-7(.00)	-9.1E-8(.00)	-1.20E-7(.00)	1.41E-8(.00)	Total credit	.000(.000)	.000(.000)	.000(.000)	.000(.000)
Constraints to AGW	.105(.06)*	.031(.04)	.05(.06)	.31 (.045)***	Constraints to AGW	-.409(.181) **	-.316(.140) **	-.008(.082)	-.131(.106)
AGW information IMP	.38(.22)*	.569(.18)***	.65(.23)***	.54(.16)***	AGW information IMP	4.299(.582) ***	2.772(.448) ***	1.099(.265) **	3.652(.341) ***
Input costs	1.91E-5(.00)	4.19E-7(.00)	-6.19E-6(.00)	3.72E-5(.00)*					
Credit obtained	5.32E-6(.00)	-7.86E-6(.00)	1.41E-6(.00)	-1.34E-5(.00)*					
R	0.59	0.55	0.54	0.62	R	0.664	0.627	0.537	0.778
R Square	0.35	0.30	0.29	0.40	R Square	0.440	0.393	0.28	0.606
F	5.83	4.70	4.56	7.18	F	3.99	3.29	2.05	7.796
p	0.00	0.00	0.00	0.00	p	0.00	0.00	0.003	0.00

4. CONCLUSION AND EXTENSION IMPLICATIONS

The project agroweather tools for adaptation to climate smart agriculture a GOK/GoE/World Bank supported project has been implemented in Embu county as a pilot has been used as proof of the concept that smallholder farmers are able to make more informed choices upon access to timely weather information and requisite advisory. The overall results show that farming experience and impact of agroweather information were significant determinants of the use of all the tools. Ownership/access, extension contact, frequency of extension contact and extension agency were significant determinants of the use of SMS, newsletter, and radio, while group membership, was a significant determinant of the use of SMS, newsletter, and IVR. The significance of these variables need to be stressed in the planning and policy formulation for the use of agroweather tools in information dissemination.

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PERCEIVED IMPACTS AND ADAPTATION RESPONSES TO CLIMATE CHANGE: AN ASSESSMENT OF LIVESTOCK SMALLHOLDER FARMERS IN AMATHOLE DISTRICT MUNICIPALITY, EASTERN CAPE PROVINCE, SOUTH AFRICA

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ABSTRACT

Livestock is a critical asset for many rural poor. The current climate crisis is, however, stripping farmers of the majority of their assets while simultaneously eroding their capacity to adapt to its harsh conditions. Appropriate adaptation choices or mechanisms available to rural communities in the Eastern Cape are described as extremely limited and carried out by a minority of livestock farmers. The conditions experienced and the limited range of appropriate responses is of great concern, particularly when considering the climate risk impact and adaptation responses of practising smallholder livestock farmers at the village level. A cross-sectional household survey was carried out. Using a multistage sampling procedure, a total of 142 smallholder livestock farmers were selected in 18 villages across the Mbahashe Local Municipality, from the Amathole District, Eastern Cape Province, South Africa. An assessment was carried out of livestock farmers' perceptions of climate change and its impacts, its induced threats and levels of severity in the area, the adaptation responses, the perceived effectiveness of the responses and the factors influencing livestock farmers' perceptions of both climate change impacts and their own adaptation responses. Descriptive and inferential statistical tools were used. Observed results showed that there has been a drastic decline of rainfall in the area, over the last 20-30 years resulting in severe drought conditions. The profound impacts of these conditions were poor vegetation and limited grazing, a scarcity of water resources, decreased livestock growth rate, reduced livestock weight, milk production and reproduction rates, an increased occurrence of diseases and livestock deaths, and loss of farm income earnings. Adaptation responses were limited; results showed that the only response measures taken amongst the many options available were changing grazing routes, increasing grazing distances, destocking, water harvesting and storage, and increased dependence on social welfare. An examination of farmers' perceptions of their adopted responses showed that none of the response measures were perceived as significantly effective to alleviate the effects of climate change in the region. The lack of effective response to the climate change crisis is cause for concern, as the livestock industry is endemic to the region and sustains families and entire communities.

Keywords: Perception, effectiveness, threat, drought

1. INTRODUCTION

Climate change has been described as the 'long-term change of the Earth's climate including changes in temperature, precipitation, and wind patterns over a period of several decades or longer' (Leiserowitz, Feinberg, Rosenthal, Smith, Anderson & Roser-Renouf 2014:6). The International Fund for Agricultural Development (IFAD) (2014) has predicted an increased occurrence of extreme weather events with extensive destruction of agricultural lands. This will have major implications for those whose livelihoods are dependent on farming. Livestock is a critical asset for the rural poor as it fulfills diverse economic, social and threat management functions (Calvosa, Chuluunbaatar & Fara 2010). The eroding force of climate change is a threat

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to livelihoods and simultaneously affects smallholder farmers' capacities to cope or adapt with its associated crises (Action Contre La Faim (ACF)-International 2013). For instance, resource-poor households whose major assets are livestock could lapse into poverty due to livestock losses (International Fund for Agricultural Development (IFAD) 2009) arising from loss of grazing land that could lead to reduction in milk, meat and wool production (Calvosa *et al.* 2010). The literature identifies some of the challenges that could arise, including heat stress, the spread of pests and diseases and loss of vegetation, all of which could compromise rural livelihoods and propel them further into impoverishment (Turpie & Visser 2013).

Appropriate coping and adaptation choices are limited, with most farming communities able to make use of only provisional coping or adaptation mechanisms to moderate the effects of climate change (Wiid & Ziervogel 2012; Otieno & Muchapondwa 2016). The limited responses are a perpetual challenge, as no farming population is immune to the impacts of climate change. It is thus critical to understand the impacts, know the response capacities and assess the effectiveness of the response measures in dealing with the current climate crisis. A brief by IFAD (2014) described how climate debates often overlook the effects of climate change in terms of economic and financial opportunities for smallholder farmers. According to the report, there are many opportunities farmers can capitalise on in learning to adapt to the changing climate.

'Despite worldwide coverage of climate change impact, there is inter- and intra-sectoral variation in vulnerability depending on location, adaptive capacity and other socioeconomic and environmental factors' (Belay & Sugulle 2011:4). This draws critical attention to the need for more comprehensive climate risk impact and adaptation assessments at every possible level. In view of this background, the study aimed to assess the perceptions of smallholder livestock farmers regarding climate change, the nature of climate change-induced threats, levels of severity in the area, perceived impacts of climate change on livestock production, adaptation responses, perceived effectiveness of the response measures and factors influencing livestock farmers' perceptions of both climate change impacts and their own adaptation responses.

2. RESEARCH METHODOLOGY

One hundred and forty-two (n=142) smallholder farmers practising livestock production in 18 villages were interviewed using a cross-sectional household survey. The villages were all located in the vicinities of either Willowvale, Elliotdale or Idutywa in Mbahashe Local Municipality and were: Willowvale: Ngxakaxa Sheshegu and Ngxakaxa Phesheya kwe dip (Ward 2); Gwadana Ngaphantsi and Gwadana Phezulu (Ward 3). Elliotdale: Keti Cimakala and Keti Lalini (Ward 31), Nqadu Phezulu and Nqadu Kumaya (Ward 11); Ematolweni and Ntlabane (Ward 25); Nxanxashe and Kwesika Gosani (Ward 30); Khasa and Fameli (Ward 13). Idutywa: Mbanyana and Ntlanyane Kulombombo (Ward 16); Ntlonyane Kulophungla and Ezithenjini (Ward 26). Simple random sampling was done to select the wards and villages, while a snowball approach was used to select the farming households.

Simple descriptive statistical tools were used to describe respondents' socio-economic characteristics and represent their perceptions of temperature and rainfall changes. Mean scores were used, following Farauta, Egbule, Idrisa, Victoria and Agu (2011), to analyse and describe the severity of climate change-induced threats, classified on a three-point Likert scale as 'very severe' = 3, 'severe' = 2, 'not severe' = 1. A computation of individual and overall mean scores was done. Threats with a mean score equal to or greater than (≥) 2.0 were considered very severe while those with a mean score less than (<) 2.0 were considered not severe in the study area. Mean scores were also used to analyse and describe the extent of climate change impacts on respondents' agricultural productivity, classified on a five-point Likert scale as 'to a very great extent' = 5, 'to a great extent' = 4, 'to some extent' = 3, 'to a little extent' = 2 and 'to no extent' = 1. A computation of individual and overall mean scores was done. Impacts with a mean score equal to or greater than (≥) 3.0 were considered as affecting the respondents to a very large extent, while impacts with a mean score of less than (<) 3.0 were considered as affecting respondents to a minimal extent. Mean scores were also used to analyse and describe results of the assessment of smallholder farmers' perceptions of the effectiveness of their adopted response measures, classified on a three-point Likert scale as 'very effective' = 3, 'effective' = 2, 'not effective' = 1. A computation of individual and overall mean scores was done. Adaptation response measures with a mean score equal to or greater than (≥) 2.0 were considered effective measures, while those with a mean score less than (<) 2.0 were considered not effective. Multiple regression analysis was carried out, following Bello, Salau, Galadima and Ali (2013), to determine the factors influencing livestock farmers' perceptions of both climate impacts and their own adaptation responses.

$$Y = a + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + b6X6 + b7X7 .... = U$$

where

(1) Y = perceived impacts of climate change on agricultural productivity

(2) Y = livestock farmers' adaptation responses

a = constant

b1 – b7 = regression coefficients

x_1 = household size

x_2 = household head's gender

x_3 = household head's age

x_4 = household head's marital status

x_5 = household head's educational qualification

x_6 = household head's years of farming experience

x_7 = household farming activities

x_8 = household land ownership

x_9 = household farm size

x_{10} = household sale of farm produce

x_{11} = estimated household annual farm income

x_{12} = household membership of agricultural association or cooperative group

x_{13} = household access to formal credit facility

x_{14} = household involvement in non-farming activities

x_{15} = estimated household annual non-farm income

U = error term

The authors and eight (8) enumerators conducted the survey over a period of nine (9) days. Respondents' mean age was 59.01 (SD=14.10) years, they had on average 18.2 (SD=11.61) years' experience as livestock farmers and the majority (66.2%) had either primary school or no formal education.

3. RESULTS

3.1. Perceptions of smallholder farmers on climate change

3.1.1. Climate change perception, threat and level of severity

The majority (86.62%) of the respondents perceived that there had been changes in temperatures. A total of 91.55% had perceived a decrease in rainfall intensity compared to 20 to 30 years ago. The majority (99%; M=2.73) viewed drought as the most challenging phenomenon, followed by fire outbreaks (70%; M=1.61), heat waves (69%; M1.53) and wind speeds (58%; M=1.25).

3.2. Perceived impacts of climate change on agricultural productivity

In addition to observed climate change-induced threats, livestock farmers had observed various impacts on their livestock production, as follows: decreased livestock growth rate (M = 4.06), decreased livestock weight (M = 3.55) and decreased milk production (M = 3.36) (Table 1).

3.3. Adaptation responses and perceived effectiveness of adopted response measures

Adaptation responses were limited to changing grazing routes (M = 1.83), increasing grazing distances (M = 1.59), destocking (M = 1.56), water harvesting and storage (M = 1.98) and increased dependence on social welfare (M = 1.74). None of these were perceived as effective response measures to the climate change stresses in the region (Table 2).

Table 1: Distribution of respondents according to their perceptions of climate change impacts on livestock production (n=142)

Perception of climate change impacts on livestock production	Livestock farmers (%)	To no extent (%)	To a little extent (%)	To some extent (%)	To a great extent (%)	To a very great extent (%)	Mean score
Growth rate of livestock has decreased	100	6	4	23	18	49	4.06*
Milk production rate has decreased	100	13	12	21	40	14	3.36*
There is an increase in pest occurrence	100	3	32	21	23	21	3.31*
There is an increase in disease occurrence	100	4	20	24	28	24	3.54*
Reproduction rates of livestock have been reduced	100	8	27	24	25	16	3.19*
Poor vegetation for livestock feeding has increased	100	4	6	23	35	32	3.10*
Grazing lands for livestock have become limited	100	8	5	14	25	48	4.07*

There have been decreases in livestock weight	100	3	17	28	32	20	3.55*
There have been increases in livestock deaths	100	6	22	38	22	12	3.16*
There is a scarcity of water resources	100	2	5	8	23	62	4.50*
Loss of farm income or earnings	100	14	15	26	27	18	3.22*

***** = Significant impact if mean score is ≥ 2

Source: Field survey, 2016

Table 2: Adaptation responses and perceived effectiveness (n = 142)

Self-adopted adaptation responses	**Livestock farmers (%)**	**No (%)**	**Yes (%)**			**Mean score of perceived effectiveness**
			Not effective	**Effective**	**Very effective**	
Using improved animal breeds	100	71	1	20	8	0.65
Dietary change for livestock	100	70	7	15	8	0.60
Dipping of livestock in liquid treatments	100	74	3	15	8	0.59
Using dose treatments	100	73	2	15	10	0.61
Vaccination of livestock	100	76	1	14	9	0.56
Increased use of veterinary services	100	89	2	6	3	0.23
Making arrangements for supplementary feeding in cases of poor vegetation for grazing	100	70	6	13	9	0.59
Practising mixed livestock farming system (stall fed and grazing)	100	87	6	5	2	0.23
Practising cross breeding of local breeds	100	82	2	14	2	0.37
Construction of shade to reduce heat	100	56	4	23	17	0.99
Water harvesting and storage	100	20	4	34	42	1.98
Storage of grasses (silage)	100	83	4	8	5	0.35
Changing of grazing routes	100	19	11	37	32	1.83
Increasing grazing distances	100	25	13	39	23	1.59
Diversifying sources of income	100	79	8	8	4	0.36

Destocking	100	23	21	32	23	1.56
Switching to another agro enterprise	100	92	1	6	1	0.15
Dependent on social welfare	100	25	8	35	32	1.74
Use of insurance	100	98	1	1	0	0.02
Selling assets	100	94	4	3	0	0.09

* = Significant perceived effectiveness if mean score is ≥ 2

Source: Field survey, 2016

3.4. Factors influencing smallholder livestock farmers' perceptions of climate change impacts on productivity and adaptation responses

The results indicate that selling of stock (destocking) was positively significant (β = 1.12), while membership of cooperatives or associations (β = -.551), access to credit facilities (β = -1.10) and household non-farming activities (β = -1.03) were negatively significant in shaping farmers' perceptions of climate change impacts on productivity. Results of the factors influencing smallholder farmers adaptation responses showed household farming activities (livestock ownership) (β = 1.38), sale of farm produce (destocking) (β = 7.27) and estimated household annual farming income (β = 1.63) were found to be positively influence their adaptation responses.

4. DISCUSSION

The profound impacts of climate change indicated by smallholder livestock farmers in the study area were decreased livestock growth rate, decreased livestock weight, decreased milk production, decreased reproduction rates, increased pest and disease occurrences, increases in poor vegetation and limited grazing land (veld), scarcity of water resources, increased livestock deaths, and loss of farm income earnings (Table 1). Similar findings were reported in Southern Malawi by Nkomwa, Joshua, Ngongondo, Monjerezi, and Chipungu (2014) in their study on indigenous knowledge systems and climate change adaptation strategies in agriculture. Findings were also similar to those of Mpandeli, Nesamvuni and Maponya (2015), in their study on adapting to the impacts of drought by smallholder farmers in Sekhukhune District in Limpopo Province, South Africa.

Sejian, Gaughan, Bhatta and Naqvi (2016) emphasised climate change-triggered heat stress in livestock as the precursor to reduced quality and quantity of meat and milk production. Scarcity of water resources (drought) (M = 4.50) and limited grazing lands (M = 4.07) are clearly overwhelming problems faced by the livestock farmers in the study area. Due to drying up of available streams, brooks and rivers, most livestock herders are compelled to travel long distances in search of water, and livestock frequently drink from dirty water, a potential source of water-borne diseases. There are reported cases of conflicts among herdsmen and communities over water usage. The drying and burning of grasslands has resulted in limited grazing lands, and a shortage of quality grasses to feed livestock, leading to increased livestock weight loss and, in some instances, deaths.

Findings revealed that adaptation responses were mostly limited to changing of grazing routes, increasing grazing distances, destocking, water harvesting and storage and dependence on social welfare (Table 1). These adaptation responses were also observed by Taruvinga, Visser and Zhou (2016), in their study of determinants of rural farmers' adoption of climate change adaptation strategies in the Amathole District Municipality, Eastern Cape Province. However, Turner, McPeak and Ayantunde (2014) and Speranza (2010) argued that short-distance mobility, which is critical to agro-pastoral coping and adaptation mechanisms, is becoming a difficult adaptation measure due to prevailing socio-political conditions in various communities. Destocking (mentioned by 55% as an effective response) is also an adaptation measure in the study area. It is seen by a number of agro-pastoralists as a major type of insurance and defensive mechanism (Mpandeli *et al.* 2015). Mpandeli *et al.* (2015) noted that destocking is a means used by some smallholder farmers during periods of uncertainty. This suggests that farmers may not necessarily want to sell their livestock but are forced to do so as a means of coping with climatic shocks such as drought. Speranza (2010) also indicated that destocking during harsh climatic conditions is primarily a precautionary strategy for the majority of livestock keepers and that the market prices at such times are usually lower, ultimately decreasing rather than increasing households' asset bases. The fact that farmers feel compelled to sell their livestock during times of drought indicates that farmers in these communities are bearing the brunt of climate change impacts.

Most of the respondents perceived that the effectiveness of their adopted responses were insignificant. Climate change adaptation may well be beyond what an individual farmer can adequately respond to, and institutional support in this case becomes crucial. An example of such institutional support may be seen in the case of Uganda, where continuous drought was addressed through an all-inclusive stakeholders' forum that led to the construction of valley dams and the provision of tanks (water reservoirs) by the government (Lim 2005). Likewise, the intervention of the Ethiopian government led to the development of a comprehensive Famine Early Warning System (FEWS) to improve the coping and adaptation capacities of the rural farming population. Zougmoré, Partey, Ouédraogo, Omitoyin, Thomas, Ayantunde, Ericksen, Said and Jalloh (2016) stated that the capacity of a community to adapt to climate change and its associated threats is dependent on available economic assets, geographical location, information, technologies, infrastructures, institutions and networks. The topographical layout of most of the study area in this study was undulating hills, making water transportation extremely difficult for farmers with no vehicles.

Factors influencing livestock farmers' perceptions of the impacts of climate change on their production were found to be the sale of livestock, membership of cooperative or communal associations, access to credit facilities and engagement in household non-farming activities. Membership of cooperative societies was negatively significant (β = -.551) indicating that belonging to a farmers' cooperative or association would decrease a livestock farmer's perception of climate change impacts. Membership could offer support and benefits that could mitigate the effects of climate change on their production. For instance, Mearns (1996) observed that cooperative herding arrangements under a grazing management system is efficient for optimum labour utilisation, as it exploits economies of scale in production. According to Uddin, Bokelmann and Entsminger (2014:234), 'membership and engagement in a cooperative encourages farmers to engage in a united strategies orientation, share knowledge and innovation ideas, and engage in collaborative decision-making'. It is therefore expected that livestock farmers who associate with related groups will feel fewer climate change impacts than those who struggle to adapt with the changes on their own. Livestock farmers' access to credit facilities was also negatively significant (β = -1.10), indicating that a unit increase in access to credit facilities decreases the livestock farmers' perceptions of climate change impacts by 1.10. According to Maponya and Mpandeli (2012), a lack of access to credit curtails farmers' capacity to obtain essential resources and technology to aid in mitigating climate change impacts. Household non-farming activities as a factor was also found to be negatively significant (β = -1.03), indicating that an increase in the engagement of household members in non-farming activities brings about a decrease in their perception of the impacts of climate change on their livestock production. One potential reason may be that households who have multiple streams of income, social grants inclusive, do not perceive climate change impact on livestock production as high because their immediate needs are partially met by external income sources.

Factors driving the adaptation responses of the livestock farmers to climate change include livestock ownership, sale of livestock (destocking) and estimated household annual farm income. Livestock ownership was found to positively drive the adaptation responses of the farmers ($\beta = 1.38$). For every unit increase in livestock holding, farmers' adaptation responses increase by 1.38 units. Balew, Agwata and Anyango (2014) made similar findings. Livestock ownership is known to be an extremely significant type of security, particularly in traditional rural communities (Mogues 2006; Berman, Quinn & Paavoli 2013) and livestock farmers have been found to be positively and significantly associated with climate change adaptation responses (Nkeme & Ndaeyo 2013). The sale of livestock (destocking) was also positively significant for smallholder livestock farmers' adaptation responses ($\beta = 7.27$); a unit increase in the sale of livestock increased farmers' adaptation responses by 7.27 units. A unit increase in estimated annual farm income increased their adaptation responses by 1.63 units ($\beta = 1.63$). Taruvinga *et al.* (2016) made similar findings on destocking as one of the limited available adaptation strategies practised by smallholder livestock farmers in the Eastern Cape Province.

5. CONCLUSION AND RECOMMENDATIONS

Findings from this study have revealed that smallholder livestock farmers in the study area are impacted by the vagaries of climate change, with impacts including decreased livestock growth rates, decreased livestock weight, low milk production, poor reproduction rates, increased pest and disease occurrences, poor vegetation, livestock deaths and loss of farm income earnings. The area is faced with drought which has led to intense water scarcity and the drying of available grazing lands. Identified adaptation responses are mainly limited to changing grazing routes, increasing grazing distances, destocking, water harvesting and storage and dependence on social welfare, all of which are perceived by the livestock farmers as not sufficiently effective to deal with the current climatic stresses.

There is the need to buffer the individual adaptation capacities of smallholder livestock farmers in rural communities through the implementation of adaptation schemes for rural livestock sustainability. Government climate change response policy and systems need to be invigorated at the local level and to target resource-poor smallholder livestock farmers. Institutional support is needed to mitigate climate change as climate effects are beyond the capacity of smallholder farmers working alone. In addition, farmers should also be motivated to join available production, marketing and other service-oriented cooperative groups geared towards combating climate change challenges in rural communities.

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STRENGTHENING SYSTEMS FOR REGIONAL KNOWLEDGE MANAGEMENT AND SHARING FOR CSA

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ABSTRACT

The effects of climate change in southern Africa (higher temperatures, droughts, cyclones, floods, outbreaks of pests and diseases) are increasingly being evident. Agricultural systems, particularly smallholder farmers, are vulnerable to these impacts, requiring efforts to build the resilience of the region to climate change. However, the knowledge base on existing information, evidence and lessons learnt about climate change adaptation in agriculture and climate smart agriculture remain weak. Systems for knowledge management and knowledge sharing are lacking as governments continue to operate in silos and access to information is constrained. The Center for Coordination of Agricultural Research and Development in Southern Africa (CCARDESA) is a sub-regional organisation with the mandate of coordinating agricultural research and development in the SADC region including brokering agricultural information and knowledge with the aim of ensuring that information and knowledge gained from different efforts are shared across the region. CCARDESA is thus working towards a regional information, communication and knowledge management (ICKM) system[56] that meets the needs of the various stakeholders in the region, i.e. extension services, policy makers, ministry departments and farmers. The ICKM system includes the use of several tools to facilitate the flow of information. These include, the website, discussion groups (dgroups), social media platforms (Facebook and Twitter) and the recently developed platform[57] called the Southern African Agricultural Information and Knowledge System (SAAIKS). The SAAIKS system[58] includes an online platform and a community of practice to facilitate knowledge sharing on Climate Smart Agriculture (CSA) in 15 SADC member states. Extensive use of the platform and increasing participation in information and knowledge sharing by researchers, extension and other stakeholders will help to reorient different players in supporting farmers through well informed interventions which are suitable to local conditions. The purpose of the paper is to share the experience and lessons learnt in building SAAIKS as a user driven system for regional knowledge sharing in CSA, targeted at different audiences. The paper was developed from reports of several consultations which were undertaken with partner organisations and member states to define needs of the region in knowledge management and sharing. Usage reports of the platform and feedback from users were also analysed. It presents an overview of the regional challenges, a description and analysis of the process used to build the system, engagement of the users, challenges faced and solutions being adopted for sustainability and effective knowledge sharing on CSA.

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[56] The ICKM system includes the website, social media platforms, dgroups and the SAAIKS system.

[57] The SAAIKS platform is an online tool for information and knowledge sharing developed by CCARDESA which is accessible at http://saaiks.net.

[58] The SAAIKS system includes the online tool and a Community of Practice which works to ensure its sustainability. The core group being the ICKM focal people which were appointed by member states. However, a number of volunteers are involved.

1. INTRODUCTION

Agriculture remains the major economic activity for all developing countries. It provides employment for about 65% of the population and contributes to 32% of the GDP (CTA, 2013). In the SADC region agriculture contributes in the different Member States between 4% and 27% of GDP. About 70% of the region's population depends on agriculture for food, income and employment. Agriculture is also a major source of exports in several countries, contributing on average about 13% to total export earnings and about 66% to the value of intra-regional trade (SADC, 2011). The performance of this sector has a strong influence on food security, economic growth and social stability in the region. The notable effects of climate change which include weather extremes like frequent severe droughts, floods, and increasing outbreaks of diseases and pests are causes for concern in the region. These justify the need for relevant information and communication mechanisms to inform preparedness of farmers, policy makers, researchers and the extension system. Sustainable methods of farming need to be adopted in order to preserve the environment and improve agricultural productivity. These challenges call for a joint approach among member states as they implement key regional policies to ensure food security.

Information and communication technology is rapidly growing as the most important tool for rural development in developing countries where most of the people are adopting these technologies for agriculture and education development. (Chhachhar, Abdul Razaque, et al., 2013). Modern ICTs can play a major role in communicating knowledge and information to rural agricultural communities, delivering education modules, accessing inputs, markets and market prices, credit, conducting business, facilitating networking and strengthening partnerships, scaling up inter-linkages of development interventions and increasing agricultural productivity (IDRC, 2007). When used as a broad tool for providing farming communities with scientific knowledge ICTs herald the formation of knowledge societies in rural areas of the developing world (Shaik. N. Meera, Anita Jhamtani, and D.u.M. Rao, 2004). The capacity and quality of extension systems are also improved by use of ICTs as they enable quick and timely flow of information. Information and knowledge sharing is critical if joint efforts of member states are to succeed. As such, the region has to come up with systems and modalities to ensure free and unhindered flow of empirical evidence, lessons learnt, experiences and challenges in improving agriculture. To address this need, the Centre for Coordination of Agricultural Research and Development for Southern Africa (CCARDESA) which is mandated to coordinate regional agricultural research and development effort of SADC member states embarked upon building and maintaining a system which can facilitate the flow of agricultural information within the region.

1.1. Problem statement

The knowledge base on existing information, evidence and lessons learnt about climate change adaptation in agriculture and climate smart agriculture remain weak. Systems for knowledge management and knowledge sharing are lacking as government entities continue to operate in silos and access to information is constrained. The World Bank (2012) observed that there is growing recognition of the potential of ICTs in transforming economic, social and institutional development including agriculture. This growing interest in ICT is generating strong demand for evidence, new approaches, business models, good practices and design guidance in using ICT effectively and appropriately in agriculture and rural development projects. Yet in many cases, concrete evidence of ICT's impact remains incomplete, and guidance on proper design and deployment of ICT interventions in sectoral work is not always easily accessible. This gives rise to the need for a coordinated inclusive regional effort in utilising ICTs to share information and knowledge among member states.

1.2. Justification and purpose of the paper

This paper shares the experience of CCARDESA in building the SAAIKS, a user driven ICT platform for sharing of regional climate change and climate smart agriculture information. It presents the challenges and opportunities which were faced in planning, building and in implementing a model which engages all members states in building and sustaining a system for information and knowledge sharing for the SADC region

1.3. Background

The development of the SAAIKS by CCARDESA began in 2014 with financial and technical support from the Technical Centre for Agriculture and Rural Cooperation (CTA) based in the Netherlands. The CTA supported the entire consultation process and building of the prototype system as a proof of concept. Since 2016 GIZ is supporting CCARDESA in developing the prototype system together with the rest of the ICKM system to a fully-fledged user-friendly tool for knowledge sharing in the SADC region.

1.3.1. The SADC adaptation to climate change in Agriculture Programme (ACCRA) Programme

The German Government through the Gesellschaft für Internationale Zusammenarbeit (GIZ) and SADC have established the ACCRA Programme, funded by the German Federal Ministry for Economic Cooperation and Development (BMZ). ACCRA is jointly implemented by CCARDESA and GIZ and aims at increasing the capacities of SADC member states to integrate climate change aspects into agricultural programmes and investments. This will be achieved through promoting regional knowledge dissemination on CSA and supporting the climate proofing of priority agricultural value chains. The aim of promoting regional knowledge dissemination is for SADC member states to have access to improved knowledge management systems for the dissemination of climate-smart agriculture (CSA).

The ACCRA programme intends to strengthen CCARDESA's agricultural information, communication and knowledge management (ICKM) system. The existing CCARDESA ICKM system will be enhanced by: i) developing it towards a tri-lingual, user friendly and innovative ICKM system for the SADC region, and ii) developing relevant user-friendly content in the form of targeted and innovative knowledge products.

1.3.2. CCARDESA

The Centre for Coordination of Agricultural Research and Development for Southern Africa (CCARDESA) is a sub-regional organisation which was established in 2011 by SADC to coordinate agricultural research and development efforts in 15 member states. The smallholder farmers make up the majority of farmers in the SADC region. Empowering smallholder farmers to improve their production efficiency and to generate higher incomes through increased market engagement as well as undertaking sustainable agricultural practices is very critical for regional agriculture. The worsening climatic conditions requires better access to appropriate information and harnessing of emerging practices and technologies by farmers and other agricultural stakeholders. Coordination of agricultural research and development (AR&D) and supporting the role of extension among 15 SADC member states entails a great degree of transferring knowledge, as well as developing new knowledge and communications products for different audiences. CCARDESA aims to be a reliable source, broker and facilitator of the free movement of agricultural knowledge and information in the region. To this end, CCARDESA has been mandated by the SADC Member States with building and operating a regional ICKM system which strengthens its capacity to manage and facilitate access to and the brokerage and sharing of agricultural information. CCARDESA undertook to build a robust information system to enable member states to share information, knowledge and experiences in agriculture.

2. METHODS AND DATA SOURCE

This paper was informed by workshop reports for several consultation and validation workshops which were conducted by CCARDESA with support from CTA, during the process of conceptualising and building the prototype system. Feedback from ICKM focal people from the member countries with regard to the functioning of the system was also taken into consideration. Current analysis done by GIZ of how the system is performing was informed by the results from the google analytics for the SAAIKS information platform.

3. RESULTS

3.1. Developing the system

Each SADC country has its own ways and approaches for disseminating and sharing agricultural knowledge at national levels. Initiatives, methods and tools for information sharing in the region vary from country to country. Therefore, CCARDESA wanted to establish the structure and functionality of a suitable system to address necessary gaps and regional needs well a common understanding of the added value of a regional system (information accessible to all member states) among member states were considered.

The development of the platform began with a consultation process which sought to discover the best possible niche which the system should fill in order to be relevant. The consultation took place in two phases, first with like-minded organisations and secondly with SADC member states. Whilst some quick recommendations (low hanging fruits) from the first consultation were being implemented, consultations with members states were meant to define the system which the region would expect in terms of functionalities. The whole process culminated with development of a prototype system which is called "The Southern African Agricultural Information and Knowledge System (SAAIKS)". The platform is accessible at http://saaiks.net and is supported by a network of ICKM focal people and volunteers from different member states. As a prototype system it is expected to undergo changes as more feedback comes from the targeted beneficiary groups. The next two years will be dedicated to improving the prototype to a fully-fledged and user friendly system.

In summary, the process entailed the following key steps (although some of these phases happened concurrently) which are discussed in detail below: a) partner consultation phase, b) creation of a Community of Practice (CoP), c) consulting member states and ascertaining the existing status of national systems in the region, d) developing the platform, e) validation f) testing g) evaluation and improvement.

3.2. Partner consultations (likeminded organisations)

As a first step to drive the theme of Information Communication and Knowledge Management (ICKM), CCARDESA undertook consultation of like-minded organisations which do similar work of coordinating agricultural research and development as well as extension in Africa. The main aim of this consultation was to find out how other organisations were driving ICKM and what CCARDESA could learn from their experiences. This was to identify tools which were being used, how they were being used, and their effectiveness. The observations were used to shape the system that CCARDESA was to develop towards meeting the information needs of the region. Organisations which were represented include the Forum for Agricultural Research for Africa (FARA), Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) and CORAF. FARA shared the experiences of the Regional Agricultural Information and Learning System (RAILS) platform, the West and Central African Council for Agricultural Research and Development (CORAF/WECARD) presented the CORAF – Reseau pour la Gestion de l'Information et de la Communication Agricole (CORAF-ReGICA)/ Network for Management of Agricultural Information and Communication known as ReGICA in short, and the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) presented the Knowledge Hub concept which ASARECA was developing. The organisations shared experiences and recommended actions for CCARDESA to fill certain gaps. Following are quick wins which CCARDESA was advised to consider:

- Setup of network of ICKM contact persons in organizations is southern Africa
- Keep stakeholders well informed (and actively connected/contributing) in the process of setting up a ICKM programme
- Interact with member states to identify current status / landscape of ICKM in the region
- Revive dormant existing groups/networks e.g. Agricultural Information Management System (AIMS) Dgroups and include contacts from the contact database (including farmer associations).
- Leverage on existing programmes like the Agricultural Productivity Programme for Southern Africa (APPSA) to facilitate information and knowledge sharing
- Make use of existing databases that are of relevance for compiling the CCARDESA knowledge base
- Create an ICKM support advisory group' (focal persons or champions)
- Create ownership from the beginning and allow for 'open' content contribution as much as possible while establishing platforms (e.g. web2, blog, social media)
- Make use of traditional and new media – press releases, newsletters etc.
- Create contact list of journalists who can be encouraged to publish about CCARDESA (consider CAADP media network approach where journalists get paid per article)
- Develop Terms of Reference (ToRs) for Focal Points to facilitate selection and clarify expectations
- Learn from (and build upon) the SADC-AIMS initiative and network and Implementation and Coordination of Agricultural Research and Training (ICART) programme
- Assess what tools are already there & used that work before considering building new IT tools
- Investigate if the blog initiative from CORAF/CTA is something that can be implemented as a 'tool' to make the network/champions visible.
- Advocate the CTA Web2 trainings to help building extended capacity (for focal points) for the region.

3.3. Setting up a community of practice in member states

To engage its audience CCARDESA requested member states to appoint focal persons for information communication and knowledge management (ICKM). These are usually government officers assigned to work with CCARDESA in information sharing and dissemination. This group would grow to become an expert group of champions which CCARDESA would informally consult on specific information and knowledge management issues. It is now a Community of Practice connected through discussion groups and WhatsApp for information sharing. During the initial phase only ten countries appointed focal people. These were Angola, Botswana, Lesotho, Malawi, Madagascar, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe. Later Mauritius, Seychelles and Namibia appointed focal people. Over time these have participated at different levels calling for need to better engage them.

To facilitate the selection of the focal people, Terms of reference (TORs) were developed and these gave member states room to appoint focal people from outside the government structures who would best represent the interests of the country in ICKM. Only Zimbabwe appointed one of the two focal persons from the private sector. Several volunteers participated in later stages of developing the system especially in mobilising content. Some of the volunteers are people who were once involved in similar capacity as focal people under the SADC AIMS project and are an important resource due to their valuable experience.

3.4. Consulting the member states and ascertaining existing status

In April 2015, a consultation was organised through the focal people. Each member of the network was tasked to identify key players in R&D in their respective countries and find out the initiatives which are being used in reaching out to farmers and other stakeholders in their respective countries. This country profiling was guided by TORs developed by CCARDESA to help ascertain the status of ICKM in every country. Focal people were asked to identify existing ICKM interventions and tools which are being used by various organisations in each country to support agriculture and food security. This led to the development of nine country status reports which informed the status of sharing agricultural information in the CCARDESA region. These were later synthesised into a SADC Regional ICKM Status report which is available for sharing.

Only countries which submitted reports were invited for a consultation during which the focal people discussed their reports and made suggestions of what CCARDESA could do to add value to existing initiatives. This included functionalities of a system which they thought would fill the gaps which they discovered in discussing their reports. The key output of the consultation was the definition of system functionalities which they wanted CCARDESA to build for the region. The network also outlined challenges related to:

- Affordability of ICT tools (data hardware, software, etc)
- Infrastructure challenges
- Sustainability challenges (initiatives start as projects but never last beyond funding)
- Availability, accessibility & affordability of internet-based information including journals
- Availability, accessibility, confidentiality, usability of content
- Capacity challenges (demand side – literacy of farmers, supply side (MoA) - demand for information exceeding capacity of the infrastructure)
- Repackaging and segmentation in the dissemination of the information

The following system functionalities and tools/actions were proposed:

Functionality	**Tools/Actions**
Advocacy and visibility	Communication and visibility tools such as: blog, newsletters, social media
Collaboration	A tool which can allow discovery and connection of researchers in the region. Features of AgriVIVO were discussed in this context. A platforms for discussion among the CoP, platforms for collaboration (co-creation, brainstorming)
Digitisation & document management	Member states to digitise content and build digital repositories following Information management of Standards of Interoperability and Accessibility for the CCARDESA system to harvest content from.
Information sharing	Directories of stakeholders, documents, people (related to the feature of collaboration) and projects in the region. Linkages to regional, continental, global initiatives eg CIARD
Internal Interaction platform	Tools to enable ICKM focal persons of the region to keep communicating and sharing best practices.
Coordination & Strategy	Working models for coordination of activities in information sharing eg identification of champions and engaging them and managing change

In terms of content, the participants envisioned a robust system which can be built gradually in a modular approach covering key agricultural issues. Following is a list of subject areas which were seen to be important for the region:

- Climate Change and Climate Smart Agriculture
- Sustainable Agriculture (e.g Conservation Agriculture)
- Gender and Youth in agriculture
- Policy Implementation
- Technology development
- Technology transfer
- Major agricultural events
- Success stories on
    - Entrepreneurship

   - Value addition
   - Post harvesting
   - Nutrition
   - Extension
- Farmers' organisations
- Appropriate technologies
- Early warning
- Discussion on CAADP pillar (iv)
- GMO's

3.5. Building the prototype

The two consultations were also used to define a system which would promote information sharing and a model which could be tried to ensure that information flows from member states through the system. To try out the idea it was decided to build a system which focuses on two categories of content; Climate Change and Climate Smart agriculture and Underutilised crops.

Development of the prototype system followed a rather complex approach as it involved four different groups of people who were working together. One team was of system backend developers, while the second group was of graphics and interface designers. The third team was mobilising content from member states and the fourth team was mobilising content from international databases. These teams were geographically dispersed. The backend developers were based in the Netherlands, interface designers were based in Madagascar and content mobilisers were based in member states (two people from each country). These were all being coordinated from CCARDESA Secretariat based in Botswana. The splitting of tasks was to facilitate speedy development of the prototype system and gathering of content to test the system.

CCARDESA organised webinars every Thursday to discuss the progress and recommended changes as and when necessary at different stages of work. Even though the initial system design was guided by a document which was developed from consultations, the final output was more informed by iterations of developers, graphic designers and the Community of Practice which was also helping in content mobilisation. Changes were recommended based on the practical experiences on the ground. The initial system was based on a Content Management System (CMS) called Django. However, the system could not easily provide some plugins which were expected by the graphics team. WordPress was later adopted to accommodate these expectations.

The content mobilising team uploaded content on the system and assessed the appearance and the behaviour of the system. Where things were failing to work well, changes were recommended and implemented instantly. The result of this effort was a platform dubbed the Southern African Agricultural Information and Knowledge System (SAAIKS) which is accessible at http://saaiks.net.

3.6. Validation

The philosophy behind the system is that it belongs to the region and the focal people are the gatekeepers on behalf of all users. Therefore, after the prototype system was built, a special wrap up meeting was organised. The objectives of the meeting were to:

- Get feedback and validation of the system from focal people
- Train focal people on adding more content to the system especially in selecting quality information and in adding metadata
- Engage member states in suggesting more functionalities of the system
- Establish mechanisms of marketing the system in member states.
- Establish sustainable mechanisms and action plans at member state level

Constructive feedback from the meeting included challenges which focal people were facing during the process of content mobilisation both at individual and institutional levels. These were listed as follows:

3.6.1. Individual level challenges

At individual level focal people indicated that they faced challenges which included:

Work responsibilities: Participants highlighted that the assignment of gathering content was not integrated into their day-today work in their offices. It was being done as and when they got free time. Their management was not considering the assignment as part of their official duties. As a result, pressure from their normal work responsibilities was high hence the delays in accomplishing the assignments as required.

Participants suggested that the assignment needed to be mainstreamed into their responsibilities. Meaning their supervisors must be aware and have these responsibilities included in annual activities which have an input in their appraisal. Other work colleagues should be made aware of the additional responsibilities of focal people so that they can support whenever it is possible.

CCARDESA and focal point credibility: It came out that some organisations and responsible people which were approached to provide content do not know about CCARDESA let alone respect the request for information by the focal people. Some of the questions which they had to deal with include: What is CCARDESA? What do they need our information for? What do we get out of giving out information to them? This implies that focal people were viewed with suspicion.

In that regard CCARDESA was encouraged to step up visibility initiatives and ensure that the institution is known to important players in the region. Some indicated that they managed to secure cooperation by mentioning that they were doing the assignment as SADC assignment to support a regional mandate on sharing agricultural knowledge. Participants requested for CCARDESA to consider providing focal people a form of identification or letter of introduction to present to institutions whose information focal people will be seeking to collect and share.

In addition, CCARDESA was encouraged to take advantage of existing networks in reaching out to stakeholders and build trust among its stakeholders. The need for an effective collaboration and feedback mechanism was also mentioned.

Intellectual property rights: It emerged that organisations and individuals are concerned with losing intellectual property over their materials especially in circumstances where the sharing is being done for profit. The fact that the CCARDESA system is based on Open Access implies that it needs to be rigorously promoted as a reliable information source as well as a dissemination channel for the good of all players including generators of information.

Resources (transport and communication): Focal people indicated that the assignment generally needed some form of communication as well as moving from one organisation to another. There is need to address transport and communication costs to support the tasks and provision of ICT gadgets like a laptop or a tablet could make it convenient for data contributors.

Knowing information holders: Despite the fact that their assignment started by identification of key stakeholders, participants indicated that they faced a challenge in identifying some institutions which could be having information besides the government departments.

3.6.2 Institutional challenges

Internet connectivity: Focal people reported that they faced infrastructural challenges which limited accessibility to internet. Their institutions had slow internet connectivity where internet was available. This factor together with other factors contributed to a lower than expected participation rate in webinars.

Bureaucracies: Generally, institutions have no guiding policies on knowledge sharing beyond their own countries. The government departments have no obligation to share their knowledge with other member states especially through open systems. It was recommended that CCARDESA engages member states in support of open access to information.

Where information is available it is usually under the control of the IT unit which monopolises the sharing of information. Persuading these officers to share information without a directive from senior officers is usually a challenge. As mentioned above, there is need to make sure that the responsibility of focal people as information mobilisers is formerly known and respected by their colleagues to minimise resistance.

CCARDESA was advised to seek political commitment of main institutions to information and knowledge sharing through the CCARDESA systems for the good of the region. This can be sought at ministerial level.

Unclear policy of engagement of CCARDESA with governments: It also came out that the engagement procedure of CCARDESA with stakeholders is not clear. What needs to be clarified is that CCARDESA has focal people in each country whose role is to engage with member states at general usually higher levels. The ICKM focal people are a special group which forms a think tank only on matters related to Information, Communication and Knowledge Management. That distinction has to be clear to avoid conflict of interest and failure to cooperate on the part of other focal people who may feel that their responsibilities are taken over.

It was jointly decided that some of the focal people take different roles in administering the system. Two who are excellent in Information Technology were given the roles of super users, two were given the role of administrators and each member of the CoP is an editor of content from and about their respective countries. This was done to ensure the system is owned by member states who happen to be both the information providers and users of the system.

3.7. Testing phase

The prototype system was made available for use in September 2016. In the process system errors were being documented to inform further improvements. The observations would form part of terms of references to improve the system by an independent international evaluator who was engaged to improve the entire CCARDESA ICKM system. When using the platform, google analytics was used to trace several indicators which include, the growth in content, growth in the user community of the platform, growth in the use of the platform (sessions), page views, behaviours of users especially returning visitors as well as gender and age distributions of users.

3.8. Growth in content

Focal people were requested to contribute content for the platform. The process was coordinated by a consultant who checked the quality and worked with CCARDESA to support the contribution of content from member states. By end of December 2016, 90 items were available on the platform. By end of March 2017 content had grown to 406 items. By end of June 2017 the platform contained 462 resources.

3.9. Growth in the user community

Over the first three months the platform was used by 207 users. During the second quarter 536 people accessed the platform and the figure dropped to 485 during the period April-June 2017. Of these visitors, some were new visitors and some were returning. During the first quarter 57.3% of the visitors were new and 42.7% were returning. Of the 536 visitors in the second quarter 67.9% were new and 32.1% were returning. During the last period in question 57.7% were returning when 42.3% were new visitors.

3.10. Growth in platform use (sessions and page views)

During the first three months the platform managed to generate 361 sessions from 207 users. For the period Jan - Mar 2017, the number rose to 751 sessions and 777 sessions from Apr – June 2017. These sessions generated 1115, 2616 and 3745 page views respectively.

3.11. Way forward

Development of the system is work in progress. Changes continue to be affected as feedback comes from the CoP and other users. GIZ supports the improvement of the system through technical assistance and assignment of a specialised consultant. The consultant will propose suitable developments for the prototype to come to a fully-fledged user-friendly system. CCARDESA knowledge products on CSA and climate change adaptation will be developed and uploaded.

4. CONCLUSION

Even though the ICKM focal people and all who participated in building the platform were geographically spaced, they were coordinated to work together and interact frequently. Due respect was given to views of the CoP which represent the members states who are the ultimate beneficiary of the system. Such a model has great potential for sustainability if well-coordinated and benefits well communicated to member states.

All member states are encouraged to access SAAIKS (http://saaiks.net) in order to access knowledge products shared by the region for the region. Other tools important to access include the CCARDESA website www.ccardesa.org, the CCARDESA Facebook page www.facebook.com.ccardesa and the CCARDESA Twitter account @ccardesaa. CCARDESA also shares information through a discussion group (dgroup) which can be joined by writing an email to dzengenene@ccardesa.org.

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FARMER PERSPECTIVE ON THE ROLE OF CONSERVATION AGRICULTURE ON FOOD SECURITY AND LAND RESTORATION ON THE MAIZE TRIANGLE, VANDERBIJLPARK, SEDIBENG DISTRICT, GAUTENG PROVINCE

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THIS PAPER WAS NOT AVAILABLE AT THE TIME THE PROCEEDINGS WAS PRODUCED.

PROMOTING ENTREPRENEURSHIP AND SMME'S THROUGH EXTENSION: CASE OF THE MNGCUNUBE MENTORSHIP PROGRAM AMONGST SMALL SCALE LIVESTOCK FARMERS

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ABSTRACT

The paper we present here shows a model of community based small businesses operating as a sustainable basic extension service. This model has been applied for over 20 years across communal lands in the Eastern Cape and Lesotho involving over 20 000 livestock owners and over a million small stock units. This cannot be undertaken by normal extension serves because they cannot buy and sell as part of their function nor can they keep up a supply/ delivery system to meet the needs of the Village Link Persons (VLPs). Demand driven extension is at the core of this project strategy with farmers willing to pay for support and services when they see the benefits. The results clearly show that an alternative extension and mentorship strategy can be highly rewarding for farmers and potential community-based entrepreneurs. The tragedy is that, while there is a high potential to grow livestock numbers and increase production as well as providing an opportunity for village members to participate in the value chain more fully, traditional extension services almost never change ineffective practices. High livestock mortality rates due to lack of access to affordable basic medicines in affordable quantities is a well-known obstacle to profitable livestock production amongst small scale farmers. The results further show that: (i) community based and demand driven extension services can work and that it is sustainable through the integration of Community Based Small Businesses, (ii) as climate change starts to affect the quantity and quality of natural grazing livestock poor owners are better placed by having animals that can handle the conditions more effectively because they are in better health, (iii) the approach provided opportunity for community members to share in the value chain through the establishment of CBSB's, (iv) CBSB's can operate profitable and sustainable to the benefit of all its clients and the regional economy.

1. INTRODUCTION

The Conference theme recognises that there are "*grave impacts on the resource poor African farmers and increasingly contributing to food losses along the whole value chain"* that arise from climate change.

It is also true that resource poor farmers, and most notably those on communal lands, experience food and value losses almost as a matter of course before any effects of climate change are considered. Few examples exist where traditional extension method succeed in elevating resource poor farmers from the poverty trap. The irony is that farmers, notably livestock owners, on communal lands are in many cases not really resource poor because they do own some livestock, even if only a few. The tragedy is that, while there is a high potential to grow livestock numbers so that the owner can participate in the value chain more fully, they almost never do so because of high livestock mortality rates and low birth rates due mostly to lack of access to affordable basic medicines in affordable quantities.

The paper we present here shows that there is a model of having community based small businesses operating as a sustainable basic extension service. This model has been applied for over 20 years across communal lands in the Eastern Cape and Lesotho involving over 20 000 livestock owners and over a million small stock units.

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This cannot be undertaken by normal extension serves because they cannot buy and sell as part of their function nor can they keep up a supply/ delivery system to meet the needs of the Village Link Persons (VLPs). Demand driven extension is at the core of this project strategy with farmers willing to pay for support and services when they see the benefits (Jordaan, Sissons & Blaker, 2009).

The paper will explain how this works and draw on the extensive and unique data base system we have built that shows the huge positive net benefit participating farmers and community based small businesses (CBSB) enjoy as a result.

The paper will show that:

- Community based livestock and demand driven extension services can work sustainably with a massive gain from lower livestock death rates and higher birth rates
- Sustainable Community Based Small Businesses (CBSB's) can be established and managed as part of the demand driven extension model.
- CBSB's allow resource poor people to share in the livestock food value chain to the benefit of rural communities
- As climate change starts to affect the quantity and quality of natural grazing livestock poor owners are better placed by having animals that can handle the conditions more effectively because they are in better health: the approach mitigates against potential climate change in that animals are stronger and use limited feed more efficiently.

2. LITERATURE STUDY

The consumption of animal products in developing countries has constantly increased over the last 20 years, and will certainly continue to rise. The greatest sectoral growth in the world now takes place in developing countries but the production has increased more slowly than overall demand. Globally, the deficit between supply and demand will probably increase; in Sub Saharan Africa, for example, the production of red meats, which currently satisfies 56% of the total consumption, will only cover 36% of needs in 2020 (Renard *et al.,* 2000). A desirable trend already perceptible is the improvement in the competitiveness of production through intensification in countries where the growth in demand is strongest (Delgado *et al.,* 1999). Delgado *et al.,* (1999) mentioned that livestock can be considered as the driving force of the "*next food revolution*".

Limited access to land and capital are some of the main reasons why poor people are not able to increase their incomes. Livestock production offers one of the few rapidly growing markets that poor rural people can join even if they lack substantial amounts of land, training and capital (Delgado *et al.,* 2003). Livestock also play an important role to include women in rural economies (Quisumbing, Brown, Feldstein, Haddad & Pena, 1995). Orskov (1999) rightly asked the question if developers and governments pursued the right science for development. He pointed out that the motive for livestock farming in developing countries differs dramatically from the goals of livestock farming in developed countries. This is equally true for livestock production on commercial farms vs. livestock production on the traditional communal areas and communal municipal land in South Africa. This is particularly important when considering the efficiency and productivity of the stock farmers on communal land in South Africa.

Orskov (1999) argued that while profit maximisation is the motive for market oriented or commercial systems, risk minimisation is the goal in social value oriented systems. Many other contrasts are made, including the fact that animal breeding for homogeneity has profit value in market oriented systems whereas diversity has survival value in social value oriented systems as the environment cannot be controlled. A summary of the main contrasts between the main goals and objectives for livestock production in market-driven industrialised countries and less industrialised countries is summarised in Table 1.

Table 1: Goals and objectives of livestock production in market-oriented livestock systems and livestock systems in less industrialized countries.

	Alternative risk-spreading research approaches	
	Market oriented systems	**Less industrialized countries**
Overall goals	Profit maximisation Cash generation Productivity	Risk minimisation Family support Stability and sustainability
Scientists' role	Design of systems	Management of ecosystems
Intermediate targets	Genetic homogeneity Increased production potential Single-purpose animals Nutrient mobilisation	Biological diversity Improved maintenance potential Multi-purpose animals Nutrient storage
Philosophical approach	Cartesian (specialistic)	Holistic
Scientific approach	Single discipline	Multi- and trans-disciplinary
Statistical emphasis	Mean Main effects	Variance Interactions

Source: Orskov and Viglizzo, (1994).

Livestock in developing countries are central to the livelihood of the rural poor in at least six ways (Haug 1989; Sere and Jarvis, 1992; Delgado *et al.*, 1999; Renard *et al.,* 2000; Adams and He, 2003; FAO, 2003; USAID, 2003). (i) First they are an important source of cash income, (ii) they are one of the few assets available to the poor, especially to poor woman, (iii) livestock allow the poor to exploit common property sources, such as open and communal grazing areas, in order to earn an income, (iv) livestock provide a vital and often only source of income for the rural poor and most marginalised people, (v) livestock products enable small-scale subsistence farmers to diversify incomes, helping to reduce income variability, especially in semi-arid regions characterised by one cropping season per year, (vi) livestock manure and draft power are vital to the preservation of soil fertility and the sustainable intensification of farming systems in many developing areas facing increasing population density.

Farmer mentorship is regarded by many as the miracle recipe that can turn the many failures in land reform in South Africa around. The expectations and suspicions of mentorship as a tool for extension, however, remain equally high. The intentions of many who proposed mentorship as an extension tool for South Africa's disastrous land reform programme and small-scale farming sectors are suspected of own interest by the government structures responsible for extension. The importance of extension as a critical element for rural development and poverty alleviation is reaffirmed by Birner *et al.,* (2006) and Anderson (2007).

The economic structures in South Africa provide no room for small scale communal farmers with imperfect markets on both the supply and demand side (Chikazunga, 2012). Livestock farmers for example require small quantities of medicines, which in most cases should be stored at low temperatures while these are available only in larger quantities. The result is that the majority of communal livestock farmers cannot afford a proper health management program (Jordaan, Sissons & Blaker, 2009; jordaan, 2012). Extension services on the other hand provide extension support and knowledge transfer and they are not structured to provide these types of services. The governmental veterinary services are also not efficient.

Vink & Kirsten (2003) reported that government extension services became so inefficient after 1994 that most commercial farmers switched to private advisory services. This is the extension service that is supposed to assist the land reform process and small-scale farmers. Extension officers today are poorly trained, and they focus mainly on project management with little time and understanding for true extension (Last, 2006; Williams, et al, 2008, Jordaan, et al, 2017). The paradox is that developing countries all over the world reaffirm extension services as a key element in rural development and poverty alleviation (Birner & Anderson, 2007). Feder, Willett, and Zijp (2001) further highlight the need for the establishment of well managed, effective and accountable extension services.

The traditional training and visit (T&V) extension program is replaced worldwide with alternative models, the most common being a pluralistic mode of extension. Major extension trends include decentralisation, cost recovery, privatisation, contracting and the involvement of private sector, farmers' organisations and NGO's (Rivera & Alex 2005). Birner & Anderson (2007) reported that the focus of extension is now demand driven where farmers dictate the type of service they require. Jordaan, Sissons & Blaker (2009) and Jordaan (2012) highlighted the demand driven approach of the Mngcunube mentorship program. They also showed that farmers are willing to pay for services when they experience the benefits first-hand.

Demand driven extension requires a paradigm shift from government extension services (Anderson, J. & Crowder, L.V. 2000). The Mngcunube approach discussed in this paper provide a successful template for a new extension model that is financially sustainable and in support of rural economic development goals. This model also includes communities in the value chain through the development of CBSB's.

2.1. Project philosophy

The starting point is to put the farmer first which is something that NGOs, academics, bureaucrats and the like often profess to do but seldom actually do. It is quite simple: go to the villages where farmers and their herds and flocks are and ask them: "*do you want better access to animal medicines and if so would you pay for what you use?"* Almost invariably farmers know that they need medicine, but they cannot do so for these reasons.

2.2. Service and supply

The next step is to get mentors who actually go to the villages and provide the animal health service and supplies on site as part of a regular monthly schedule of such visits. Note that this requires funding: there is no way that this can be a business from day one. Furthermore, not just anyone is a mentor: this takes selecting people with a specific set of qualities. The whole system also requires strong management, to better the current situation where almost no service providers ever go because it is too hard and too expensive.

2.3. Development and training of small businesses

The mentors identify and train individuals from among the participants in how to run a small business instead of the mentors themselves doing so. These businesses have been called Village Link Persons (VLP's). The project thus builds small businesses. They make their money from a mark-up on the medicines they sell to participating farmers. This paper will look at how successful these small businesses are but in a nutshell they can and do sustain the small businesses – some better than others. What needs continuing funding is the cost of organising the supply system to the small businesses, but this is at a level far lower than that of the original project. They need this support for the following reasons:

- The fact that the VLPs are living in the communities they serve is an advantage on the one hand because they can reach the farmers they serve but is a disadvantage on the other hand, because the ease of access to animal medicines and the very competitive prices they now enjoy from the project thus far and will continue to do until end June 2017.
- The issue they face is the cost of travel to town to get supplies and the fact that they have no real chance of negotiating prices in the way large commercial farmers or Agri businesses can because they are buying in smaller quantities.
- Forming co-ops is not an option to overcome the issue of buying in smaller quantities because they do not live near one another and do not really know one another so there is no natural connection behind the idea. And they will still have to travel to buy and distribute, even if they did form a co-op so the cost issue remains.
- Also, trends and opportunities in animal health and its treatment do change over time and the VLPs live in relative isolation in small communities so in the absence of not only access to supplies but to advice would prove difficult in staying up to date and keeping their customers, the livestock owners satisfied that they are getting the best service they can in the circumstances.

3. METHODOLOGY

3.1. Project background

Mngcunube has operated a number of livestock projects over the last 14 years. The concept was first applied in Lesotho, eventually reaching across almost every District. Work there came to an end in 2007. During that time it started in the Ukhahlamba District of the Eastern Cape (now called the Joe Gqabi District) within the Elundini Local Municipality there. The projects go through a phase where farmer interest was gauged in a number of public meetings to discuss the wish for an understanding of a process to improve animal health and thus improve birth and reduce death rates. Despite there being a precondition that all medicines used on an individual's livestock must be paid for in cash at the time there has been universal support for the work to start. The first phase involves treating animals on village visits (typically one a month) where the livestock mentor looks for those who could be trained as Village Link Persons (VLPs) to take over the project as a small business through selling the animal medicines that the livestock needs. This process leads in time to a situation where all work has been handed over to the VLPs and the project serves 'only' in a 'supply and support' role. In some cases financial support has dropped away before or during this phase but in summary the areas covered and the outreach have been as follows.

While the project is in the phase of being implemented by mentors while they train VLPs the mentors collect data according to a system devised by Mngcunube. Once the VLPs take over this is no longer possible so numbers of SSU are calculated from the amounts of animal medicines the VLPs buy, as is the level of net income that they make.

3.2. Project area

After successful completion of the Elundini livestock improvement program the project expanded to cover communal lands in the Chris Hani (almost every Ward outside of commercial areas), Joe Gqabi (only the Elundini District) and Alfred Nzo Districts (most areas). Sibanye was the sole funder in Elundini (Joe Gqabi district) with the Alfred Nzo Development Agency (ANDA) an equal funder with Sibanye in Alfred Nzo district. The project was fully funded by the Chris Hani district municipality in Chris Hani. Fig 1 shows eastern Cape province with the five district municipalities.

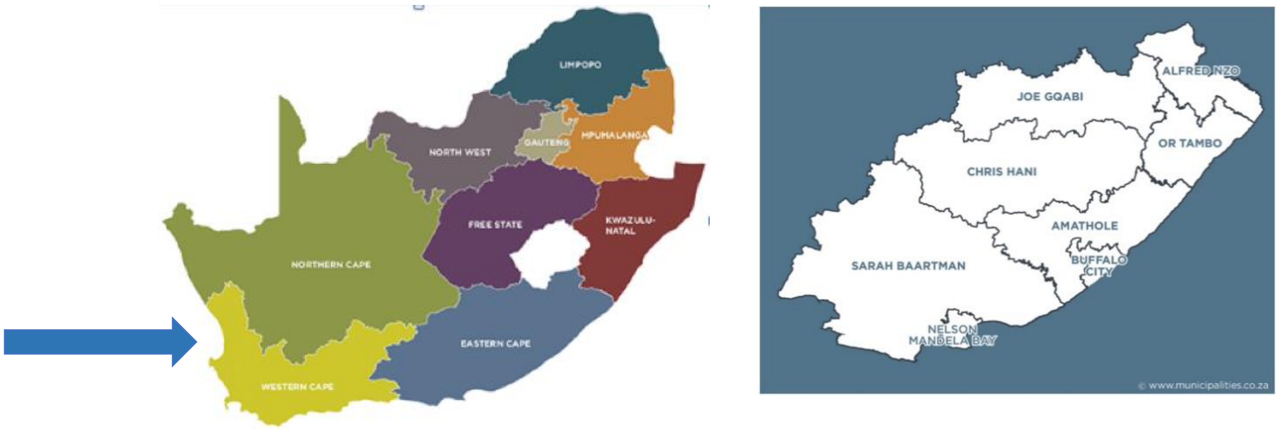

Fig 1: Study areas

3.3. Data collection

The data of more than 20 000 small scale livestock owners and 60 CBSB's were analysed in order to evaluate the impact of the mentorship program on productivity of small stock farmers and implementation of CBSB's.

When the project is being operated through mentors, detailed records per farmer per village and VLP were collected. It was analysis of this data that allowed us to put tables/graphs, numbers, costs and impact together. The process and its validity were examined by Jordaan, Sissons & Blaker (2009) and validated. It should be noted that there are many challenges because, unlike on a commercial farm, a participant may bring some or all of his livestock to the various visits or none at all.

When the small businesses take over they cannot afford the time or cost to collect such detailed information and there is in any case no project budget to process it. The figures shown in this paper on their businesses and SSU handled are generated from sales to VLPs through Mngcunube of animal medicines. There are set formulae for use of these so that per type of medicine it is possible to calculate how many SSU the VLP will reach. There is an agreement between Mngcunube and the VLPs on the level of mark-up or profit they will limit themselves to when selling the medicines to be fair to farmers who have few or no other sources of supplies and services. From this the profit figure was calculated (volume of sales adjusted for mark-up). In fact the profits are higher because VLPs are free to buy the medicines from any other source and these records are not always available in making the above calculations.

4. PROJECT IMPACT

Project impact for phase 1 was first studied and published by Jordaan, Sissons & Blaker in 2009. This showed for example that the potential average income for an average farmer increased from R1, 440 to R20, 577 per annum. The potential gross income for the region should increase from R6, 094 million per annum to R56, 72 million per annum without taking into consideration the downstream and upstream economic impact. The economic benefit therefore by far exceeds the project costs which to date add up to R6,355 million plus R 565,940 spent by farmers themselves (Note that potential income is per annum whereas the project cost were for the total period of 27 months).

The results calculated by Jordaan, Sissons & Blaker (2009) were closely mirrored in subsequent work on later phases of the project carried out on the same basis. Example data for Chris Hani district is shown in Tables 2 to 5 in the Chris Hani district of the Eastern Cape. The figures showed in Table 2 are the number of times that actual farmers attended and treatments were given to sheep, goats and cattle during village visits by mentor and VLP over the time period.

Table 2: Actual animal numbers treated and farmers supported: October 2014 to September 2016 in Chris Hani district

Area	Farmers	Sheep	Goats	Cattle
Intsika Yethu	1 166	43 540	4 192	221
Lukhanji	366	9 718	2 397	48
Ngcobo	811	37 427	3 546	454
Emalahleni	1 012	33 769	10 496	236
Total	**3 359**	**124 454**	**20 631**	**959**

The figures showed in Table 3 are the cumulative number of times that farmers attended the village treatments and the cumulative number of treatments provided by the mentor and VLP. Keep in mind that knowledge transfer is taking place every time during village visits.

Table 3: Cumulative numbers of animals treated and farmers supported: October 2014 to September 2016 in Chris Hani district

Area	Farmers	Sheep	Goats	Cattle
Intsika Yethu	4 035	123 088	8 375	259
Lukhanji	1 142	31 709	5 168	48
Ngcobo	1 942	83 219	6 186	510
Emalahleni	3 363	100 293	24 163	336
Total	**10 482**	**338 309**	**43 892**	**1 153**

As of September 2016, from October 2014 the following reductions in mortality rates were achieved through improved animal health accomplished through the medicines applied to the livestock of participants by the project in Chris Hani district. See Table 4.

Table 4: Reduced mortality rates achieved in Chris Hani

Area	**Sheep**	**Goats**	**Cattle**
Intsika Yethu	18% to 6.2%	20% to 5.6%	6% to 3.6%
Lukhanji	18% to 3.9%	21% to 11.5%	9% to 3.5%
Ngcobo	18% to 5.2%	19% to 4.5%	8% to 4.1%
Emalahleni	18% to 3.7%	20% to 2.3%	4% to 2.1%

Economic impact to farmers and the regional economy is shown in Table 5. These results mirror earlier analysis done by Jordaan, Sissons & Blaker (2009).

Table 5: Economic Impact Achieved October 2014-September 2016 in Chris Hani

Area	**Av. Cost per Farmer per SSU**	**Value of reduced deaths**	**Value of increased births**	**Av. total benefit per farmer**	**Ratio: Total Benefit to Farmer Cost**
Intsika Yethu	R 4 51	R 6 055 473	R 4 421 429	R 9 312	R 104 to R 1
Lukhanji	R6.47	R 1 609 468	R 589 420	R 6 007	R 78 to R 1
Ngcobo	R 4.02	R 5 001 239	R 1 730 873	R 8 301	R 114 to R 1
Emalahleni	R 5.75	R 6 699 963	R 4 910 386	R 11 472	R 138 to R 1
Total	-	R 19 366 143	R 11 652 108	-	-

The project assisted in the establishment of 22 small businesses in Chris Hani district during the period Sept 2012 to June 2017. They covered 445 villages and 5 743 farmers. Between January 2014 and April 2017, the VLP's reached:

- a cumulative total of 2 709 555 SSU[60],
- a cumulative profit of R2 562 338,
- this represents an average income (unweighted) per VLP of R5 901 per month.

[60] SSU denotes Small Stock Units where each head of cattle counts as 6 SSU and sheep and goats one SSU each. Horses, dogs, pigs etc are covered by the project but this data is not captured in the data base

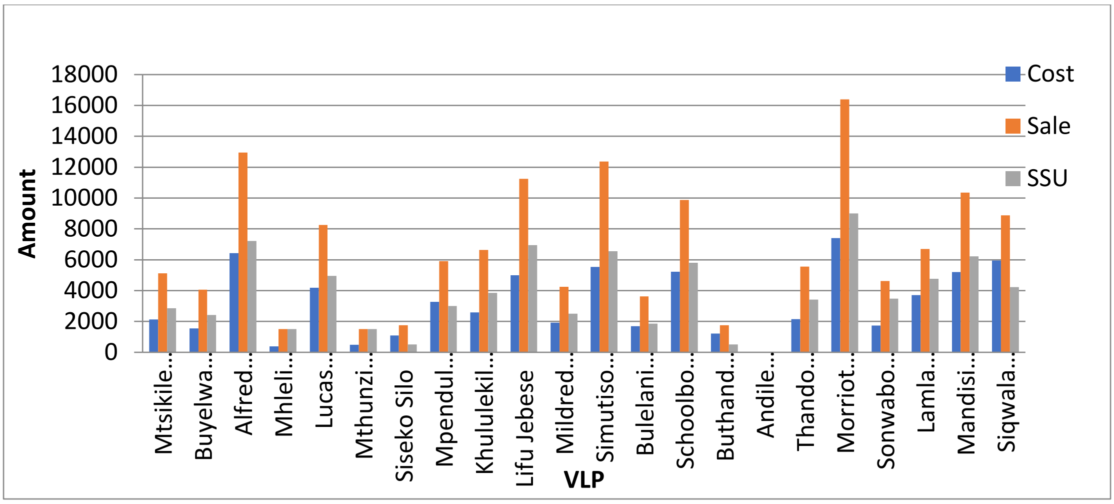

Fig 2: Chris Hani VLP performance for June 2017

In Alfred Nzo district the project assisted in the establishment of nine small businesses in during the period Sept 2012 to June 2017. They covered 201 villages and 4 347 farmers. Between January 2014 and April 2017, the VLP's reached:

- a cumulative total of 994 505 SSU, and
- a cumulative profit of R 899 372 with an average monthly profit of R2 578 per VLP.

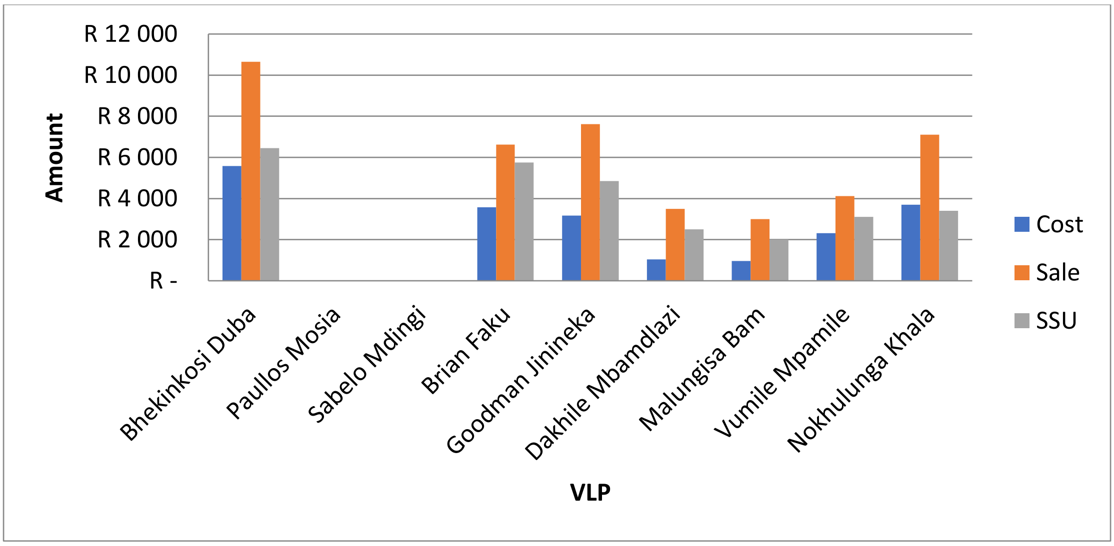

Fig 3: VLP Monitoring Graph for June 2017 - Alfred Nzo

Elundini phase 2 (January 2014 to June 2017) have equally impressive results with seven new VLP's with 2 928 farmers from 173 villages. These VLP's reached:

- a cumulative total of 1 317 845 SSU, with
- total profit of R1 406 501, and

- R4 832 profit per VLP per month

VLP activities is shown per district in Table 6. VLP's provided services to 13 026 farmers in 819 villages.

Table 6: VLP activities per district

Region/Project	Villages	Farmers
Joe Gqabi (Elundini)	173	2 928
Chris Hani pre June 2014	232	3 701
Chris Hani post June 2014	212	2 050
Alfred Nzo pre June 2014	91	2 021
Alfred Nzo post June 2014	110	2 326
TOTAL	**819**	**13026**

Analysis of the VLP financial transactions showed a turnover of R8 774 559 with R4 868 211. Gross profit margin of 55.6 % achieved is an indication of efficiency of this community based small business model. The net profit of R4 868 211 is money spent within the community by community entrepreneurs; money that would otherwise be in the hands of big agricultural businesses or not available at all.

Table 7: VLP business analysis

Project	VLP	Costs	Sales	Profit	Profit/ m	Profit/ m/VLP	SSU/m/ VLP	Cum SSU
Alhred Nzo	9	723491	1622863	899372	21399	2578	2616	994505
Elundini	7	1118337	2524838	1406501	33758	4823	5045	1318645
Chris Hani	11+11	2054520	4626858	2562338	64910	5901	6089	2709555
Total		3896348	8774559	4868211	40022	4434	4583	5022705

The numbers portrayed in Table 7 do not reflect the on-farm benefit of reduced mortality (R19 366 143) and increased birth rates (R11 652 108) totalling R31 018 251. Local poor communities thus benefitted at least the higher profits for farmers as well as profits generated by the VLP's. The value of extension and transfer of knowledge as well as the upstream and downstream economic benefits in the region is not even considered and one can expect the multiplier effect thereof to be uncalculatable.

5. CONCLUSION

The results clearly show that an alternative extension and mentorship strategy can be highly rewarding for farmers and potential community based entrepreneurs. The tragedy is that, while there is a high potential to grow livestock numbers and increase production as well as providing an opportunity for village members to participate in the value chain more fully, traditional extension services almost never change ineffective practices. High livestock mortality rates due to lack of access to affordable basic medicines in affordable quantities is a well-known obstacle to profitable livestock production amongst small scale farmers. The results further show that:

- Community based and demand driven extension services can work and that it is sustainable through the integration of Community Based Small Businesses.
- As climate change starts to affect the quantity and quality of natural grazing livestock poor owners are better placed by having animals that can handle the conditions more effectively because they are in better health
- The approach provided opportunity for community members to share in the value chain through the establishment of CBSB's
- CBSB's can operate profitable and sustainable to the benefit of all its clients and the regional economy

Vitally the approach described here is one based on self-interest of the livestock owner: they elected to opt in; they have been willing all along to cover the cost of treatment of livestock; and they continue to do this once the project has handed over to VLPs. The mitigating effect therefore does not depend on trying to persuade let alone force the livestock owner to do what he or she believes is not affordable or whose benefits they may find hard to be talked into believing.

Part of this last mentioned factor is that the livestock system is not just a business; it is part of a culture that covers the whole family, men, women and children alike – 100% in line with the true philosophy of extension work.

Challenges for "resource poor African farmers" is currently not in climate change; it rather focuses on increasingly contributing to food losses along the whole value chain as a result of poor management or imperfect markets for both input and output.

The Mngcunube mentorship program provides a workable and sustainable alternative for traditional extension models. In the first place it is clear that the average livestock owner is directly dependent on the physical environment for grazing and his family is potentially affected by climate change. So simply from the basis of enabling a household to cope with change, having a more robust asset is a first step.

Secondly, anyone familiar with communal areas in the likes of ORTambo, certain areas of Chris Hani and Joe Gqabi is aware that the livestock are very tough: only the fittest survive but in extreme conditions they too will succumb. It is mere common sense that any viable process that builds the health and thus the resistance of livestock helps mitigation against climate change in whatever form that change may take.

6. FINAL CAUTION

It is vital that whatever happens there is no break in continuity of support and supply services to VLPs. If this happens and they cannot meet the demands of their clients the livestock owners then the consequences will without a doubt be severe and certain. If the VLPs lose the trust of their clients the clients will stop using them. If the VLPs do not supply then matters will before long regress to the pre-project situation where livestock birth rates are low and death rates are high and the livestock asset declines to, being at best, a barely surviving one.

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DEVELOPING AGRIPRENEURSHIP BEHAVIOUR OF INNOVATIVE YOUTH FARMERS IN ETHIOPIA

Teklehaimanot, A.[61]

ABSTRACT

Today we need innovative approach in agripreunership that recognise farmers knowledge and wisdom and uses it in the dissemination of technology. In this context, studies of successful, progressive, and innovative farmers can form important content to agricultural system. Agri-business is gaining more attention in the domain of entrepreneurship development. It has been realised that small enterprises, like agri-business run by rural youths can contribute significantly to economic growth and poverty elimination program. But sometimes it happens that the stakeholders do not become serious in this profession. Keeping this in view, a study was undertaken in the Tigray Region of Northern Ethiopia to examine the status of agri-business in relation to rural youths. The present study was designed keeping the agri-entrepreneurs in mind. Accordingly, the objective was formulated to study behaviour of agripreneurs. Data were collected by personally interviewing farmers and participant observations. The research was purposively carried out in Tigray Regional State of Northern Ethiopia, because of intense micro-entrepreneurial activities in these areas. A total of 120 of the youths fulfilling the criteria were randomly selected to form the sample size. A well tested interview schedule was used for data collection along with intimate interaction. The data collected were statistically analysed to reveal relevant information. The collected data were tabulated, analysed and interpreted with the help of appropriate statistical tools to investigate the entrepreneurial orientation of youth behaviour in terms of socio – personal, agro-economic, communication and socio-psychological traits. The result of Q-sort indicated that achievement motivation was highly important value for agri-entrepreneurs. Innovativeness, punctuality, self-confidence, initiative, persuasiveness, creativity and cooperation were perceived as very importance for the entrepreneurs. Sixteen values which were relatively important i.e. values with above median scores were selected for the factor analysis. It revealed five factors greatly affecting the value-orientation of the entrepreneurs in the agriculture sector. The regression result showed that type of occupation, family size and mass media as important variables for gender based differential under agripreunership development on the other hand the correlation result showed extension contact, annual income mass media have association to entrepreneurship and youth. The result indicate that rural youths lack many of the entrepreneurial traits like ability to identify opportunities, honesty, dependence, humanity, hard work, patience, creating a gap in between expected and existing situation. These traits should be induced in them before the youths are motivated for agri-business.

Keywords: Behavioral traits, Innovative farmers, Entrepreneurship, Agripreunership

1. INTRODUCTION

Youth and development have been described in many different ways, but the accepted definition of youth is on the basis of age. In many countries youth are in the age group of 15-40 years. This will help them to successfully accomplish tasks. Youth in the horn of Africa are dependent on agricultural allied activities disadvantage group of the society. Rapid population growth, wide spread unemployment, inadequate health and education, lack of opportunities at farm level, has led the rural youth in continued loss of self-esteem and self-confidence and higher rates of unemployment. As a result, the youth are indulging in some dangerous

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acts like crime, terrorism, rebel group and migration etc. The Ethiopian youth policy trust, has initiated different educational, training and employment schemes for youth empowerment.

Youth Development & Entrepreneurship process starts when the entrepreneurs recognise an opportunity in the environment. The entrepreneurship development process goes through i) identification of enterprise ii) creation of enterprise nurturing of enterprise and iii) concluding /transition phase of enterprise. Thus, in order to safeguard the interest and future of the country, youth of today should be guided in the proper direction and should be motivated and empowered to undertake fruitful activities. Programs to promote employment and entrepreneurial skills, create cooperative enterprises, and motivate youth and entrepreneurship development should be promoted to harness the power of entrepreneurship, skill, economic and social entrepreneurship of rural families based on the principle of reaching the unreached and voicing the voiceless.

There are certain terms used in this statement of entrepreneur, entrepreneurship and entrepreneurial behaviour. An entrepreneur is a person whose job involves the quality of boldness, courage, dynamism and risk taking in sufficient measure. An entrepreneur in this context is one who could start a new activity or new enterprise which is a deviation from his traditional family occupation or profession. In this regard a youth farmer does not become an entrepreneur only through adopting new agricultural technology, but he becomes an entrepreneur only when he comes to be an operator of a farm business. In this regard, a business involves rational diction on investment after assessing risk, other alternatives and possibilities of profit and loss (Medhi & Abadi 2013).

Entrepreneurial behaviour is a function of an individual personality characteristics and environmental factor, it is represented as EB = f(PE) where EB = Entrepreneurial Behaviour P = Personality characteristics, E = Environmental factor. With emergence of a globalised economy, the role of entrepreneur as development catalysts has become crucial and essential. Conventionally, the concept of entrepreneurship has been appended to the industrial sector (Yabiyo & Abadi 2012). It is only recently that researchers look upon the youth farmer as a "farm-business manager" and with this starts the emergence of the agripreneurs. Ethiopia, made up largely of agricultural entrepreneurs is expected to initiate a chain reaction of progress in all spheres of life. Thus, a study was designed to assess the entrepreneurial characteristics and developing agri-preuneurship behaviour of innovative youth, keeping the gender entrepreneurs value-orientation in mind, from employment generation and mitigation rural-urban migration perspective point of view.

2. METHODOLOGY

The research was purposively carried out in the Tigray Regional State of the Northern Ethiopia, one hundred twenty youth were randomly selected (n=120). In consultation with villagers of respective villages a village wise list of agri–preneurs was made. Data was analysed using the Q-sort technique for rank ordering the agri-preneurs perception of value orientation. The process consists of a set of procedures used that implements Q-methodology (Abadi et al., 2016). It centres particularly in sorting decks of cards called Q-sorts. This particular technique is the most appropriate and suitable method when the number of variables to be studied is large.

Respondents were asked to sort out the selected items based on their relative importance into nine categories. The nine were assigned scores ranging from 1 to 9.

Table 1: Categories Scores Ranks

Sl.No	Particular	Score
1	Most important	8.5 to 9.5
2	Highly important	7.5 to 8.5
3	Very important	6.5 to 7.5
4	Quiet important	5.5 to 6.5
5	Somewhat important	4.5 to 5.5
6	Slightly important	3.5 to 4.5
7	Of little importance	2.5 to 3.5
8	Of very little importance	1.5 to 2.5
9	Least importance	1.5 to 1.5

In addition to the above, regression analysis and focus group discussion were conducted and used for the analysis of the determinants on youth entrepreneurship.

3. RESULTS AND DISCUSSION

The values affecting the agri-entrepreneurs behaviour are presented in Table 2 in order of their importance based on the mean score obtained. Critical examination of the Q-sorted data reveals that achievement motivation was perceived as the foremost and 'most important' value by the agri–entrepreneurs. Seven values were ranked as 'high important', three values as 'very important' followed by four values as 'quite important'. It can be seen that there were 16 values which were ranked above the median score.

For the agri-entrepreneurs the 'most important' value was achievement motivation with oneself, ones work and the customer, no one can sustain in long term. The fact that the achievement motivation syndrome is operating in the minds of the respondent entrepreneurs. Since achievement motivation plays is one of the guiding philosophy of agri-entrepreneurs. Innovativeness, punctuality, self-confidence, persuasiveness, creativity and cooperation were very important values for the agri- entrepreneurs. This might be because they were mostly first generation entrepreneurs.

Table 2. Mean Score of Preference Ranking of Variables

Values	Mean Score	Degree of important
Achievement (personal)	9.2	Most Important
Innovativeness	8.5	High Important
Punctuality	8.5	
Self confidence	8.4	
Initiative	8.3	
Persuasiveness	8.3	
Creativity	8.2	
Cooperation	8.2	
Responsibility	7.5	Very Important
Rationality	7.4	
Knowledge	7.3	
Commitment	6.5	Quite Important
Manageability	6.5	
Risk taking	6.5	
Optimism	6.4	

3.1. Results of factor analysis

It is evident from the Q-sorted data that 16 variables were adjudged as relatively important by the agri–entrepreneurs. These 16 variables were inter– correlated and the 16x16 matrix of correlation coefficients were analysed with principal component (Figure 1)

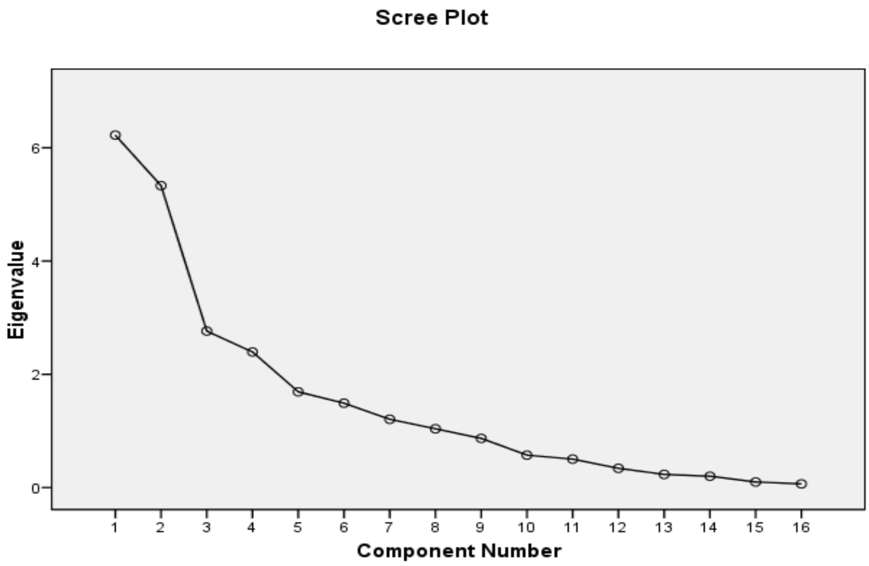

Figure-1: Scree Plot

This procedure tries to maximise the sum of variances of squared factor loading matrix. The varimax technique leads to a new set of orthogonal axes, keeping the sum of squared loading for each row of the factor loading matrix intact. Moreover, the sum of products of loadings in any rows of the rotated factor matrix (Table 4, Figure 1) equals the comparable quantity in the original factor loading matrix. As such the new axes explain (in total) just as much of the common variance as explained by the un-rotated loading matrix.

Table 3: KMO and Bartlett's Test (a,b)

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.629
Bartlett's Test of Sphericity	Approx. Chi-Square	779.539
	df	120
	Sig.	.000

The factors fitted the standard Kaiser-Mayer- Olkin (KMO) value. Abadi et al. (2011), explains that the minimum KMO value needs to be 0.50 for the data to be suitable for the factor analysis. The KMO measure of sampling adequacy for determinant of the study provided a value of 0.629. Items with values less than 0.30 were omitted from factor analysis (Ahson et al., 2011). For this study, at least two variables with significant loadings were measured in each retained factor (Table 5).

Table 4. Total Variance Explained (b)

Component	Initial Eigen values(a)		
	Total	% of Variance	Cumulative %
1	6.223	24.877	24.877
2	5.330	21.307	46.184
3	2.763	11.044	57.228
4	2.394	9.571	66.799
5	1.690	6.755	73.554
6	1.490	5.955	79.509
7	1.206	4.821	84.331
8	1.038	4.149	88.480
9	.869	3.472	91.952
10	.573	2.290	94.241
11	.502	2.008	96.249
12	.340	1.357	97.606
13	.232	.929	98.536
14	.201	.805	99.341
15	.099	.396	99.737
16	.066	.263	100.000

The varimax rotation merely breaks up this variance in a different way, the components as a group account for the same proportion of total explained variance. Interpretation of the rotated factors was achieved by selecting only those variables which possessed a significant factor loading (greater or equal to 0.3). These variables are used as the defining variables for that factor. These significant variables and their factor loadings (absolute value without regard to sign) are p+/resented below in Figure 2.

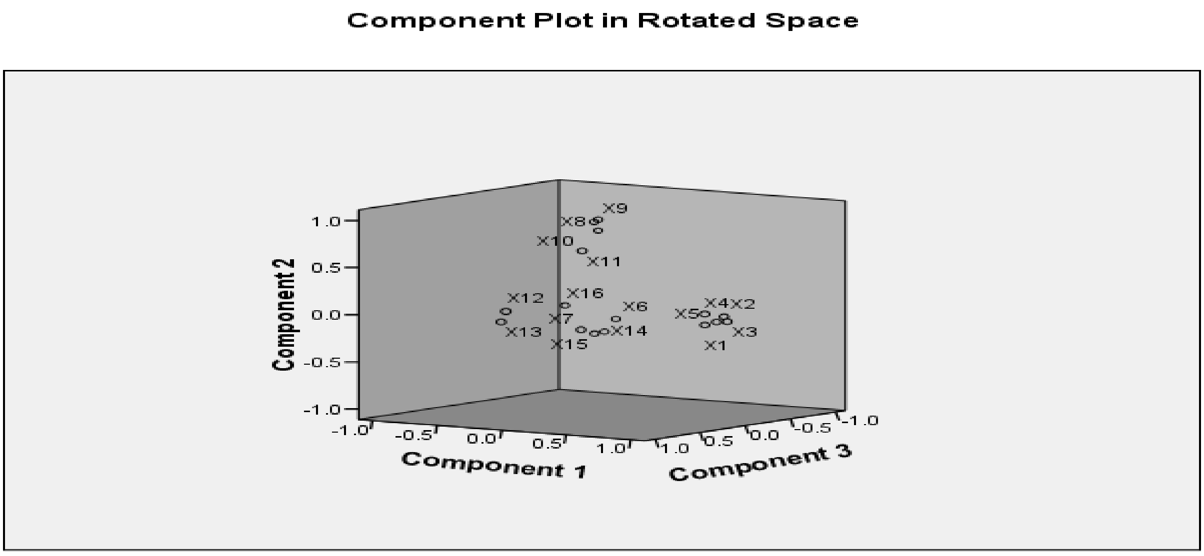

Figure 2: Component Plot

Table 5. Rotated Component Matrix.

Values	Components					Communalities
	1	2	3	4	5	
Knowledge	**.701**	.402	.189	.169	.135	.736[1]
Self confidence	**.689**	.487	.184	.137	.129	.780
Initiative	**.675**	.579	-.059	.031	.133	.813
Risk taking	.527	**.642**	-.154	.130	-.031	.731
Creativity	**.570**	.519	-.191	.003	.042	.632
Optimism	.136	-.102	.077	.023	**.356**	.162
Commitment	-.062	.177	**-.718**	.014	-.107	.562
Punctuality	**-.629**	.581	.336	.121	.186	.895
Cooperation	**-.619**	.583	.411	.086	.075	.905
Responsibility	**-.603**	.595	.200	-.078	-.118	.777
Manageability	-.487	**.615**	-.099	.259	-.211	.737
Achievement	-.343	-.016	-.457	**.725**	-.095	.863
Power	-.282	-.252	-.336	**.691**	.083	.747
Persuasiveness	.351	-.353	**.477**	.368	-.219	.660
Innovativeness	.346	-.347	.393	**.578**	.020	.729

Rationality	-.255	-.144	-.169	.080	**.852**	.847
Higher value	6.223	5.330	2.763	2.394	1.690	18.400
%of variation explained	24.877	21.307	11.044	9.571	6.755	73.554
Completion & variation Explained	24.877	46.184	57.228	66.799	73.554	

Five factors are have the highest percentage variance and high loadings. In interpreting the retained factors, the analysis used only variables with factor loading greater than 0.3, which is considered satisfactory. The loaded variables are grouped and indicated by numbers 1, 2, 3, 4 and 5. Ahson (2011) stated that at least two variables with significant loading are considered in each retained factor. The statistical result of factor analysis indicates $p< 0.000$ in the Bartlett's Test of Sphericity, as indicated in the Table 4.

Table 6: Variables with loading of 0.3 or more on factor 1

Sl. No	Variables	Factor loading
1	Knowledge	0.701
2	Self confidence	0.689
3	Initiative	0.675
4	Punctuality	-0.629
5	Cooperation	-0.619
6	Responsibility	-0.603
7	Creativity	0.570

Factor I accounted for 24.87% of the total data variability. The factor loadings for factor I are presented in Table 6. As can be seen from the results, knowledge, self-confidence, initiative, punctuality, cooperation, responsibility and creativity and initiative were found to have higher factor loadings in factor I.

Table7: Variables with loading of 0.3 or more on factor 2

Sl. No	Variables	Factor loading
1	Risk taking	0.642
2	Manageability	0.615

Factor II accounted for 21.30% of the total data variability. The factor loadings for factor II are presented in Table 7. As can be seen from the results, the variable risk taking got the highest factor loadings on factor II, followed by the variables manageability got clustered in factor II. A cursory look at these variables reveals that all these phenomena had their original of these values. Therefore, this factor can be named appropriately as 'social value orientation'. Thus, social value orientation can be defined as the value orientation that a person acquired and imbibed from the society through the process of socialisation and social learning. This constitutes value for risk taking willingness and manageability of working with and through people. Abadi (2016), revealed a strong relationship between the childhood social environment and the parents who were entrepreneurs themselves and self-employed. This could be due to the impact of the social environment on the learner. He interacts always in a place where discussions are held on matters relating to management of enterprise. The learner is a witness to the environment and hence builds positive attitudes, which would promote the continuance and enrichment of this environment. The environment creates in him an acceptability of such an environment and the process of entrepreneurship becomes more credible and valid in their minds.

Table 8: Variables with loading of 0.3 or more on factor 3

Sl. No	Variables	Factor loading
1	Commitment	-0.718
2	Persuasiveness	0.477

Factor III accounted for 11.04% of the total data variability. The factor loadings for factor III are presented in Table 8. The results indicate that the variable commitment and persuasiveness got the highest factor loading on factor III. A quick look at the results reveals that only two variables clustered under this factor. One who does have commitment and tolerance for ambiguity can achieve success in any endeavour and one who persistently with persuasiveness ability follow an achievement goal with determined efforts can achieve success. So this factor can be named as spirit value orientation as these two variables represent this phenomenon quite adequately. Hence, persuasiveness value orientation can be defined as the value orientation that one possesses with respect to persistently following an achievement goal with determined efforts, and patiently moving forward to reach the goal. A significant role in the making up of the entrepreneurial spirit of a person, and since all these variables clustered under a single factor, this factor can be appropriately termed as entrepreneurial spirit orientation.

Table 9: Variables with loading of 0.3 or more on factor IV

Sl. No	Variables	Factor loading
1	Achievement	0.725
2	Power	0.691
3	Innovativeness	0.578

Factor IV: The percentage of variance expressed by the variables under this factor is 9.57 with the Eigen value 2.394. It includes the variables achievement motivation, power affiliation and innovativeness which are very important variables for effective implementation of the training and should have to be considered. The name given to this factor is simply justified by the studies of Abadi et al., (2011) and confirms the studies on achievement motivation syndrome. Entrepreneurial orientation, thus can be defined as an associative network of such key components of high achievement need, power affiliation, innovativeness that make up the entrepreneur, what he is and what he can do.

Table 10: Variables with loading of 0.3 or more on factor 5

Sl. No	Variables	Factor loading
1	Optimism	0.356
2	Rationality	0.847

Factor V: This factor accounts 6.75% of total variance expressed with the Eigen value of 1.690. It includes optimism and rationality and it is named as "rational thinking". This factor implies that rationality on criteria for agribusiness. This entrepreneurial spirit orientation helps the entrepreneur to assess his or her potential, to take any challenge, to anticipate better future, to explore the opportunities for enterprises and to launch, run and manage any chosen enterprise. It can be concluded that agripreunership behaviour assumed greater significance among – entrepreneurs.

Through a focus group discussion, the rural youths mentioned apiculture as the most profitable agro-enterprise which was ranked first followed by vegetable farming, livestock production, oil seed production and goat rearing as comparatively due to climate change and related issues less preference is due given for agro-processing unit, agro-science centre, fingerlings production, raising planting materials and floriculture.

3.2. Relationship between Entrepreneurial behaviour and socio-economic traits

Table 11: Correlation of entrepreneurial behaviour with socio personal variables

Sl.No	Independent Variables	“R”	SE of RC	T-value
1	Sex (X_1)	.153	.096	1.679
2	Age(X_2)	.129	.095	1.428
3	Occupation(X_3)	.120	.093	1.315
4	Marital status(X_4)	.073	.090	.790

5	Family Size(X_5)	-.196	.095	-2.169
6	Education(X_6)	.034	.086	.366
7	Extension contact(X_7)	.615	.076	8.278***
8	Land holding(X_8)	1.000	.000	NS
9	Mass media(X_9)	.615	.076	8.470***
10	Annual income status(X_{10})	.615	.076	.8.470***
11	Social participation (X_{11})	-.175	0.94	-1.930

***, ** and * significant at 1%, 5% , 10% probability level, and NA Non Significant respectively

The correlation coefficients between entrepreneurial behaviour and other socio personal of the respondents are shown in Table 11. While explaining the relationship, the socio economic and personal traits of respondents are intermittently treated as independent variables because these traits are the presumed cause of entrepreneurial behaviour. It is evident from the table that the traits of the respondents i.e. extension contact, mass media utilisation and annual income status i.e economic motivation had a positive and significant relationship with entrepreneurial behaviour of the respondents. It was interesting to note that relationships of all these independent variables with dependent variable i.e. entrepreneurial behaviour had strong relationships and found significant at 0.01 level of probability. The socio-personal variables like mass media, extension contact and annual income status in one or other way may influence one or more attributes of entrepreneurial behaviour which is being important component of agrienterprise are found to be positively associated with entrepreneurial behaviour of agri entrepreneurs. Abadi & Tesfaye (2007) also reported similar result on utilisation of rainwater innovation. More utilisation of mass media such as radio, television, newspapers, magazines, etc. and frequent contact with different extension agencies helps agri entrepreneurs in acquiring different technical and managerial skills in running agri business enterprise, which in turn increase the entrepreneurial ability of the entrepreneurs. The possession of better income also leads to better economic motivation to manage the farm in best way also help the farmers in acquiring more and more attributes of entrepreneurial behaviour.

3.3. Influence of socio-economic traits on youth based entrepreneurial behaviour

Table 12: Regression Analysis among entrepreneurial behaviour and youth related traits

Sl.N		B-value		T-value
		Regression coefficient	SE of RC	B
	(Constant)	1.848	.127	14.568***
	Age(X_2)	.026	.045	.590

	Occupation(X_3)	.025	.008	3.131**
	Marital status(X_4)	.005	.030	.167
	Family Size(X_5)	-.210	.044	-4.732***
	Education(X_6)	-.008	.020	-.405
	Land holding (X_8)	.018	.071	.257
	Annual income (X_{10})	.026	.043	.598
	Social participation(X_{11})	.058	.021	2.739*

***, ** and * significant at 1%, 5%, 10% probability level, and NA Non Significant respectively

R-squared = 0.583 df=8 and 111; F(7, 134) = .554***; Prob > F = 0.000

In order to assess the contribution of independent variables towards the entrepreneurial behaviour on gender basis, the regression analysis was carried out and results are presented in Table 12. In the linear regression analysis, the entire set of independent variables were considered and as a result, type of occupation and exposure to mass media were found to have positive and significant at 5% and 10% level of probability to influence the entrepreneurial behaviour of the respondents respectively (Table 12). However, family size was found to have a negative and significant at 1% level of probability to influence the entrepreneurial behaviour of the respondents. On the other hand, age, marital status, land holding, and annual income had positive influence on entrepreneurial behaviour but was not significant. Other variables viz. education were found to have negative and non-significant contribution on entrepreneurial behaviour.

The R^2 value was 0.583 and indicates that all the independent variables taken together could explain a variation of 58.3% in the entrepreneurial behaviour of the respondents.

It may be concluded here that better occupation possessed by youth farmers ensures high entrepreneurial ability among agripreuners. With the increase in exposure of respondents to participate in social media their entrepreneurial behaviour has also increased. Possession of more social media or better acquaintances of respondents with different aspects of media society agri business farming guarantee enhanced level of entrepreneurial ability. In contrast, increase in family size had deleterious effect on the youth entrepreneurial behaviour. The youth respondents with large family size cannot be expected to be a good entrepreneur.

4. CONCLUSION

Youth agri entrepreneurs possess the moderate level of entrepreneurial behaviour traits. There is a possibility to enhance these traits among entrepreneurs by implementing suitable interventions. In this direction entrepreneurship development training programme can be implemented with the objective to enhance entrepreneurial ability of the targeted youth of both gender group.

The farmers, development agencies and extension managers for inculcating entrepreneurial ability among agri business farmers must consider this symbiotic relationship as an opportunity.

The concerned agencies must undertake training programmes, demonstrations and exhibitions to impart knowledge in various aspects of agri business farmers and follow up should be implemented to reinforce the entrepreneurial behaviour of youth agripreuner. The traits of entrepreneurs like achievement motivation, innovativeness, persistency and persuasive ability must find central place in entrepreneurship development training programme in order to strengthen these traits among entrepreneurs.

The road blocks to success and achievement should not deter the entrepreneur. The youth entrepreneurial spirit, social values and persuasiveness, possession of behavioural skills to persistence. Therefore, based upon this study entrepreneurs can be defined in terms of anticipate behaviour as one who possesses the entrepreneurial initiative, response value, commuted spirit value, achievement motivation syndrome values and rational value.

Enterprises like livestock, floriculture, apiary etc. have a potential to generate higher income opportunites for value addition and a huge market. It can be started with a small investment. It is emerging as a potential area for agricultural entrepreneurs. For promotion of agri-business, the important environmental factors identified were market demand, labour and credit.

The other factors mentioned were found to be preference of consumer, technical support, training and market survey. In relation to the mentioned enterprises, where the youth gives comparatively less preference, expansion of climate smart agriculture is quite important where the agricultural extension should give more attention to this innovative approach in the study area.

Thus, it is recommended that the appropriateness of the limited environment model where entrepreneurship is encouraged by providing adequate infrastructure, low level of taxation to create positive environment plus with the strategic interventionist model through training, research, finance, marketing know-how and support to entrepreneurs in order to confirm entrepreneurship plays an important role for positive development in society by creating jobs and the well-being of youth to mitigate migration.

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CULTIVATED PASTURES BY SMALLHOLDER FARMERS TO TRANSFORM AND REORIENT AGRICULTURAL SYSTEMS AND PROMOTE ENTREPRENEURSHIP IN COMMUNAL AREAS

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THIS PAPER WAS NOT AVAILABLE AT THE TIME THE PROCEEDINGS WAS PRODUCED.

ANALYSING URBAN HOUSEHOLD FOOD SECURITY IN THE CAPE TOWN METROPOLR OF SOUTH AFRICA, WITH REFERENCE TO THE ROLE OF URBAN AGRICULTURE

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ABSTRACT

It is generally accepted that households, who are engaging in urban agriculture (UA), could experience improvement in nutritional status and health standards, as well as provide income and employment, empirical research in the actual contribution of UA to household food security (FS) may be limited and / or lack in consistency. There are however opposing observations by researchers regarding the contributing role of UA to households and broader FS. Since there is no concrete evidence that UA contributes significantly to FS, many doubt whether UA deserves a place in urban planning and spending.

Keywords: Community gardens, food security, household gardens, urban agriculture

1. INTRODUCTION

The twenty first century, characterised by rural to urban migration, led to rapid urban growth. According to United Nations Human Settlements Programme (UN-Habitat) (2011), it is estimated that 60% of people will reside in urban areas by 2030. The result would be increased pressure on urban resources especially in cities of low and middle-income countries, thus leading to pressure on urban Food Security (FS). Battersby (2011) mentioned that more holistic interventions are needed to address FS. De Cock (2013) confirmed that these interventions need to include a better understanding of the scope of the problem and base line measurement should be applied in a particular locality. The improvement of both farm productivity and non-farm income are suggestions made by Lemba (2009).

Although it is expected that the numerous support systems implemented by the government will lead to an improvement in FS, D'Haese *et al.*, (2013) noted that food access insecurity levels are very high. Several researchers including Rogerson (1998) suggested that UA should be encouraged, and that more emphasis should be placed on UA. This statement was supported by Visser (2014) by concluding that there is no more need to debate efficiency of UA in improving the livelihoods of the urban poor households. Visser further advised that the only thing left to do will be for Government to put enabling policies in place to advance UA further.

Early studies by the likes of Rogerson (1998) and Wayburn (1985) supporting UA were seen as generalisations and repeated in literature by Webb (2011). Schmidt and Vorster (1995) could not find a link between food gardens and nutritional security and that no significant difference could be found between farming and non-farming households with regards to nutritional status. Van Averbeke (2007) reported that the contribution of UA to total household income and FS in the informal settlements of Atteridgeville, were mostly modest. UA did however contribute to a better livelihood status in the study group. The Western Cape Department of Agriculture implemented many initiatives concerning UA in the informal settlement areas of the Cape Town

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Metropole. The Department's extension division is responsible for advice and other extension services to the beneficiaries of these initiatives that include urban household and community food gardens.

The purpose of this article is to determine the significance of UA in addressing household food insecurity amongst lower income groups in selected informal settlement areas of the Cape Town Metropole.

2. METHODOLOGY

2.1. Study area

The study was conducted in the informal settlement areas that form part of the Cape Town Metropole of the Western Cape in South Africa. Households in the study area included a combination of community and household farmers involved in project gardens funded by the Department of Agriculture in the Western Cape. Farmers comprised of those owning house gardens or those involved in community gardens. Randomly selected non-farming households of the same area served as the control group.

The informal settlement areas in the Cape Town Metropole selected to conduct the surveys in are:

- Guguletu;
- Khayelitsha;
- Kraaifontein;
- Mitchelsplain;
- Bonteheuwel; and
- Philippi.

These areas are known to house some of the poorer communities in the Cape Town Metropole.

Both quantitative and qualitative data were collected by means of questionnaires. The questions were constructed to include different social characteristics of the household, the FS situation based on different FS indicators, household income and expenditure, household food production, access to water, access to markets and access to governmental support programs. It thus contributed to an in-depth comprehension of the social and economic aspects of FS at household level and the identification of the factors influencing FS at household level by including the four major FS components i.e. food availability, food accessibility, food utilisation and food system stability.

A total of 223 surveys were completed and three were eliminated due to outlying values, leaving 220 households that were analysed.

2.2. Data analysis

2.2.1. Propensity score matching

Matched comparison evaluation techniques are the most researched methods of evaluation methodology. Baker (2000) stated that it is one of the best quasi-experimental design techniques to use as an alternative towards experimental design. Rosenbaum and Rubin (1983) defined the propensity score as the conditional probability of receiving a treatment given pre-treatment observable characteristics.

To determine the contribution of UA on household FS, the propensity score matching method was used. According to Randolph *et al.* (2014) the attributing outcomes to programme interventions are often challenging since difficulties are experienced in observing outcome in counterfactual and treatment situations. The authors concluded that it is clear that propensity score matching is a useful tool for reducing selection bias and strengthening causal conclusions.

Another reason the propensity score matching method was used to determine the contribution of UA on household FS is due to the lack of historic data on the control group. Therefore, the econometric model was used to estimate the effect of urban farming on income and FS of the households experiencing food insecurity. A statistical counterfactual group is thus created based on the probability of the group contributing to UA by using observed household characteristics.

The validity of this method, however, depends on the provisional independence and overlap in propensity scores across the treated and control group. Whilst propensity score matching is data dependent for both the number of variables required to estimate participation and outcomes as well as in the number of participants and non-participants entering the matching process (Bryson *et al.*, 2002). Therefore, results based on small samples of non-participants should be cautiously interpreted. However, studies by Bryson *et al.* (2002) showed that even though the propensity score matching method requires data to show good matches, where single treatment is being evaluated efficient small samples can be sufficiently analysed.

2.2.2. Model specification and estimation

The first step in propensity score matching is to make an estimation regarding the probability of participation of urban farming. This is done by means of the Probit model, which in turn is required to estimate propensity scores. Heinrich *et al.* (2010) identified the Probit model as follows:

$P\{X \equiv Pr(D=1 \mid X) = E(D \mid X)\}$

The particular pre-treatment household characteristics influencing urban farming determines the conditional probability of participation.

D = (0, 1) indicator of participation in UA,

X = vector of pre-participation household characteristics

The most important household characteristics showing significance include:

- access to land;
- gender of household head; and
- distance from selling markets.

Where D=1, a household would participate in urban farming, and where D=0, the household would not participate in urban farming. The smaller number of conditional variables provide outcomes that are more robust.

When propensity scores are measured, matching is done by using methods as suggested by Heinrich *et al.* (2010) i.e. nearest neighbour matching, Kernel Matching, and Stratification

Matching algorithms. Y1 (D1) then defines the most likely outcomes for the total population. The treatment effect on the total population is written as:

$\tau = Y1 - Y0$

It is not possible to determine the effect of an individual treatment since it would produce only one possible outcome, thus the focus is on average impact (Heinrich *et al.*, 2010). The main purpose of this analysis is to determine the Average Treatment effect on the Treated (ATT) i.e. the display of the outcome of contribution of UA towards FS and income. This analysis therefor shows the difference in outcome between households involved in UA and households not involved in UA. Heinrich *et al.* (2010) defined this analysis as:

$ATT = E(Y1 - Y0 | D=1) = E(Y1 \vdash | D=1, P(X) \dashv) - E(Y0 | D=0, P(X)) \dashv$

Y1 = income per month or FS outcomes for households involved in UA Y0 = the situation for households not involved in UA.

3. RESULTS

3.1. Determinants of participation in urban farming

A variety of factors determines the decision for urban households to participate in UA. As seen in Figure 3.1, three main categories influence the decision-making process namely:

- Socio-economic characteristics;
- Limiting factors; and
- Perception of UA.

The socio-economic factors are influenced by demographic characteristics, livelihood characteristics and capability characteristics (Swanepoel *et al.,* 2017). Some limiting factors that may act as barriers for households to enter urban farming include access to finance, time, access to land and farming resources and knowledge of farming. Participation is also influenced by some perception factors, such as the nutritional and psychological benefits as well as income generation.

According to Adebisi (2012), the main reasons for women in Nigeria to enter UA include FS, income supplement and accessibility to land. Admire (2014) indicated that production for home consumption, to cover some food shortages and income enhancement are the main reasons for households to take up urban farming.

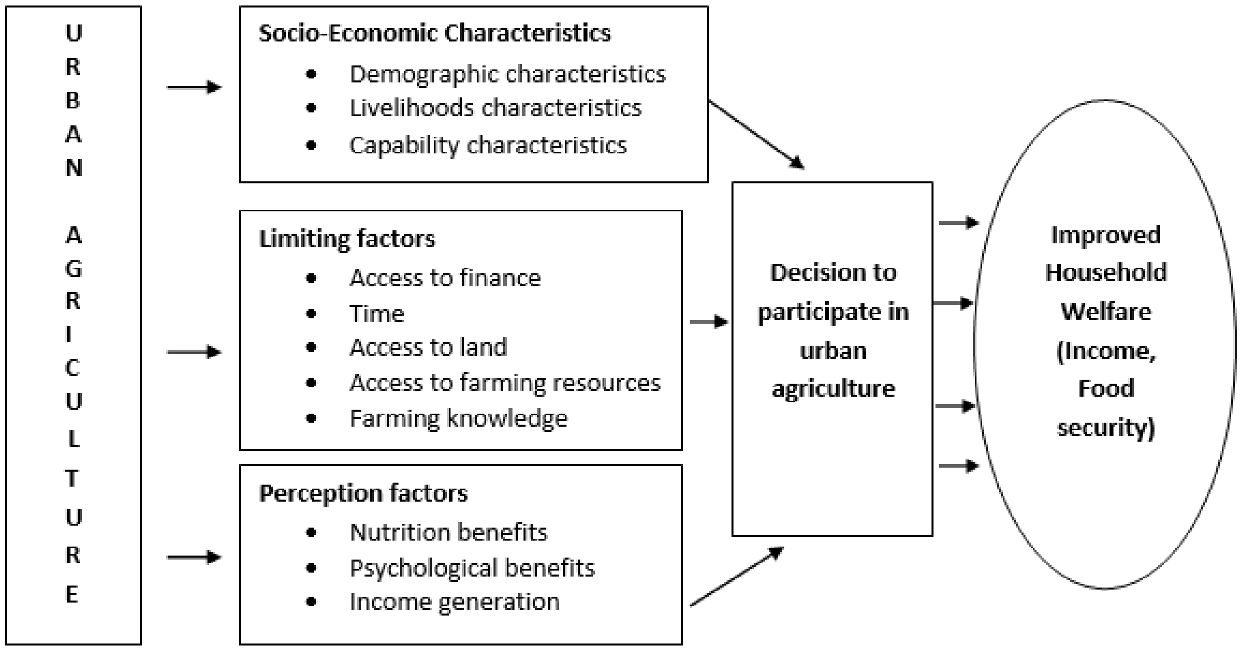

Figure 3.1 Conceptual framework for participation in UA (adapted from Gamhewage *et al.,* 2015)

3.2. Urban agriculture production levels

This study shows significant differences between male and female headed households for the production of maize, where mostly male headed farmers produce maize. Spinach, were mostly produced by female headed farmers produce, while other leafy vegetables where mostly produced by male headed farmers (Table 3.1). The reason for male headed households to produce more maize might be due to the effort of production thereof. From Table 3.1 it is clear that spinach is the most popular agricultural product produced by 29.3% and 39.7% of male and female headed households respectively. Cabbages, onions and carrots are other agricultural products produced by more than 20% of both male and female headed households. More than 10% of male and female headed households reported to farm with potatoes, beans and tomatoes. It is thus clear that the majority of households in the informal settlement area of the Cape Town Metropole produce vegetables, while 11% of male headed households also produce maize. Single households produce fruit, and breed with livestock and poultry.

Table 3.1 Urban agriculture production levels

Percentage of farming households			
	Male	Female	Chi-squared
Maize	11.11	1.65	5.45**
Sweet potatoes	5.05	6.61	1.62
Potatoes	15.15	14.88	1.87
Beans	17.17	13.22	.312
Cattle	1.01	0.83	.600
Goats	1.01		/
Pigs	1.01		/

Poultry	3.03	0.83	2.28.
Peaches	1.01	0.83	.18
Grapes		1.65	/
Bananas	1.01	0.83	.18
Avocadoes	1.01	0.83	.18
Carrots	24.24	22.31	.36
Spinach	29.29	39.67	7.07***
Cabbages	21.21	28.10	1.93
Tomatoes	11.11	17.36	1.89
Onions	25.25	29.75	.72
Other leafy vegetables	14.14	7.44	3.41*
Beet root	4.04	1.65	/

∗Significant at the 10% level; ∗∗significant at the 5% level; ∗∗∗significant at the 1% level. Values in parenthesis are standard deviation

3.3. T-tests

Table 3.2 shows the household farming status for the FS indicators. As seen in the table, the analyses show no significant difference between farming and non-farming households for any of the FS indicators. However, the non-farming households were more food secure than the farming households, due to the higher value on the household food insecurity access scale (HFIAS) where the two groups scored 14.05 and 13.52 respectively on the scale. Thus, the analysis on the FS status of farming and non-farming households shows that in both cases, more than 75% of the households experience severe food insecurity, with a higher percentage of farming households experiencing severe food insecurity.

There is almost no difference in the household diet diversity score (HDDS) for the different farm types in the Cape Town Metropole, although the urban farming households showed a slightly higher (10.4) level of diet diversity than the non-farming households (10.3). In a study conducted by The Western Cape Department of Agriculture (2015), it was reported that the households that participated in food production have a generally higher HDDS.

On the other hand, non-farming households spent R286.35 per month, while farming households spent R359.35 on food consumed. Although non-farming households spend about R70.00 per month less on food consumed than farming households, there is no significant difference between the two. This is also the case for the share of household income spent on food by non-farming (47%) and farming households (51%). According to Table 3.2, one can see that the average income per household for non-farmers (R3690.00) is higher than that of urban farmers (R3486.47).

Table 3.2 Household farming status by food security indicators

Variable	Non-farming households	Farming households	T-test
HFIAS	14.05 (6.48)	13.52 (6.83)	0.54
HDDS	10.30 (3.15)	10.42 (2.86)	-0.26
Total value consumed (Rand)	286.35 (196.14)	359.50 (349.29)	0.071
Income	3690.00 (4193.48)	3486.47 (4233.18)	-0.14
Share of food expenditure	0.47(0.21)	0.51(0.21)	0.646

∗Significant at the 10% level; ∗∗significant at the 5% level; ∗∗∗significant at the 1% level. Values in parenthesis are standard deviation

As seen in Table 3.3, 45.5% of non-farmers earn more than US$ 2 per capita per day, while this is the case for only 35.7% of urban farmers. The values are more or less the same for the US$ 1.25 level for non- and urban farmers. No significant difference could be found for farm type.

Table 3.3 Levels of per capita income per day in US$ in the different informal settlement areas of the Cape Town Metropole

	More than US$ 2 per day	Less than US$ 2 per day	More than US$ 1,25 per day	Less than US$ 1,25 per day
Non-Farmers	45.50%	54.50%	63.60%	36.40%
Urban Farmers	35.70%	64.30%	66.20%	33.80%
Pearson Chi-Square	1.849		0.247	
Likelihood Ratio	1.831		0.239	

∗Significant at the 10% level; ∗∗significant at the 5% level; ∗∗∗significant at the 1% level. Values in parenthesis are standard deviation

3.4. Propensity score matching

Three variables were identified to estimate propensity scores to include in the analysis, i.e. the gender of the household head, access to land and distance to markets. These variables were selected based on selections from previous research, information gathered, and understanding of the informal settlement areas' and urban farming in the city Cape Town metropole.

Even though household income may influence the household's decision to include urban farming as alternative means for contributing to the household's diet, income or food security situation, the variable not included in the Propensity Score Matching analysis due its independent nature. By means of the Probit regression analysis, the factors that would have an influence on the likelihood for households to be participating in agriculture were identified.

The results from the Probit regression analysis are presented in table 3.4. Consequently, the gender of the household head, distance from the markets and access to land proof to be significant determinants for households to participate in agricultural production.

Table 3.4 Likelihood of participating in UA (Probit Model)

Dependent Variable: UA: yes =1		
	Coef.	Z
Gender of household head: Female =1	-.448(.214)	-2.10**
Access to land	1.996(.224)	8.91***
Distance to markets	.466(.016)	2.93***
Constant	-.542(.222)	-2.45***
Number of observation	220	
Pseudo R^2	.387	

Wald Chi^2(5)	85.61***	

∗Significant at the 10% level; ∗∗significant at the 5% level; ∗∗∗significant at the 1% level. Values in parenthesis are standard deviation

3.5. Average treatment of participating in urban agriculture

Table 3.5 reports the average treatment effects on the untreated (ATT) of participating in UA on income and FS outcomes by using the propensity scores and identification of indicators of UA impact. The ATT analysis was done in STATA 11 based on a number of matching techniques. Since access to land, gender of household head and distance to markets were found to significantly affect the likelihood to participating in UA in the Probit model, these three factors were therefore used as conditional variables. The common support region and balancing property was satisfied.

From the results in table 3.5, it is clear that participating in urban farming has a significant positive effect on total value of food consumption (TVC) in all estimations. Significance was found, especially on TVC ranging from R78.00 to R88.06 per capita per month. From this result it can be concluded that urban farming does improve food availability and food access amongst households. Nonetheless, it is important to note that the TVC does not involve the diet diversity or nutritional value of the food consumed by the household. More so, the size of effect is very low given the high food prices in South Africa (NAMC, 2015).

As seen in table 3.5, UA had a negative effect on HFIAS, and consequently there was no significance as well for the Kernel, Stratification and Near Neighbour techniques. The analysis of the effect of UA on the HDDS showed a positive effect but had no significant influence on the three estimations as well. From the above results, it can be concluded that UA does not contribute significantly to the accessibility and nutritional diversity of household FS in the informal settlement areas of the Cape Town Metropole.

Although some researchers encouraged UA as a means to contribute meaningfully to FS, findings in this study show otherwise (Maxwell *et al*., 1998; Schmidt and Vorster, 1995). The fact that this study shows that UA does not significantly improve household FS and / or diet diversity in the informal settlement areas of the Cape Town Metropole are supported by researchers in the likes of Schmidt and Vorster (1995) (Slough, North West province); Van Averbeke (2007) (in the informal settlements of Atteridgeville, Gauteng Province); Aliber and Hart (2009) (Limpopo Province) and Battersby (2011) (informal settlements of the Cape Town Metropole).

Table 3.5 Average Treatment Effect on the Treated (participating in UA) using Nearest Neighbours, Stratification and Radius matching methods

Outcome Variable	Stratification	Kernel	Nearest Neighbour
Income (R/capita/month)	61.036 (182.83)	52.910 (198.85)	182.175 (210.00)
HFIAS	-0.590 (0.983)	-0.612 (0.971)	-1.173 (1.217)
HDDS	0.154 (0.467)	0.229 (0.613)	0.154 (0.496)
TVC (R)	78.001 (35.740)**	73.518 (32.274)***	88.064 (37.388)**
SHARE	0.078 (0.029)***	0.081 (0.029)***	0 .078 (0.042)***

∗Significant at the 10% level; ∗∗significant at the 5% level; ∗∗∗significant at the 1% level. Values in parenthesis are bootstrap standard errors with 100 replications

The effect of UA on monthly household income per capita was positive but not significant for all three tests. For the three matching techniques monthly household income per capita ranged from R61.00, R52.91 and R182.18 for the Stratification, Kernel and Nearest Neighbour techniques respectively. These values are very low in relation to other studies. This finding is inconsistent from the views accorded to UA in most large cities of Africa (Zezza and Tasciotti, 2010). This concludes that the impact of UA is still very low on income for the poor.

It is also noteworthy that UA has a positive effect on the total share of expenditure. This means that UA negatively affected the share of expenditure on total expenditure. Significance was found with all three matching techniques. The results of these analyses are a clear indication that UA do not significantly contribute to income. According to research by Frayne *et al.* (2014), it was found that in 2008 77% of households engaged in UA in 11 cities in Southern Africa reported conditions of food insecurity. However, given the high food price and inflation in South Africa (NAMC, 2015), it could be that the marginal effect on income has been outstripped by price changes. Nevertheless, this argument can be verified with further investigation on income and food prices.

4. DISCUSSION AND CONCLUSIONS

Even though literature show contradicting results regarding the contribution of UA on household FS, it is important to keep in mind that methods of measurement differ, cities differ with regards to their UA characteristics, different policy approaches are adapted and assistance towards UA also differs.

The results presented in this study show that households engaged in UA are benefiting in terms of diet diversity, income and accessibility due to their involvement in this activity. Even though extension services play an important role in assisting beneficiaries of urban home gardens and community gardens, there is no indication of a significant positive contribution of UA towards FS.

UA does however have a significantly low positive impact on total value of food consumed, which is an indication for energy availability (EA), but showed no significant contribution towards the HFIA, dietary diversity and income of the households residing in the informal settlement areas of the Cape Town Metropole.

Policy and support towards UA in South Africa and the Western Cape province were thoroughly discussed in the past, but further discussions and research are necessary towards land distribution, land utilisation, optimisation of land, analysis of urban farming constraints, measurement of FS and educating urban farmers (Drimie, 2016 and Webb, 2011).

It is thus concluded that households involved in UA are not significantly more food secure than non-farming households.

5. RECOMMENDATIONS

The Department of Agriculture in the Western Cape province's Farmer Support and Development division should do further research regarding the identification and implementation of the most suitable UA systems in the Cape Town Metropolitan area as well as the efficiency of extension services within these areas. Appropriate UA systems could have the ability to feed the ever- increasing population in the future.

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PERFORMANCE LEVELS OF AGRI-SMMEs IN ENTREPRENEURIAL LEADERSHIP: A CALL FOR EFFECTIVE TQM-EMPOWERED AGRICULTURAL EXTENSION SERVICES

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ABSTRACT

Introduction: *The Total Quality Management (TQM) philosophy was introduced to selected agricultural extension practitioners and owners / managers of agri-SMMEs in order to give the latter a competitive edge on a number of business functions, including entrepreneurial leadership.* ***Objective:*** *This study endeavours to investigate the extent to which agricultural small, micro and medium-sized enterprises (agri-SMMEs) that had adopted TQM had improved on their entrepreneurial leadership performance.* ***Methods:*** *Action research design and mixed methods were used, which included the internationally recognised South African Excellence Model (SAEM), on 67 agri-SMMEs of the Western Eastern Cape (WEC) that had adopted the TQM philosophy and from WEC and Eastern Eastern Cape (EEC) agri-SMMEs that had not adopted this philosophy.* ***Results:*** *Data analysis showed that both the agri-SMMEs that had adopted or had not adopted TQM were poorly performing on the entrepreneurial leadership function when benchmarked against world-class standards. Furthermore, agri-SMMEs that had adopted the TQM philosophy did not necessarily have performance advantage over those that did not adopt this philosophy.* ***Conclusion and Recommendations:*** *The use of SAEM for continuous improvement of performance on the entrepreneurial leadership function should be promoted, and interventions should be provided to the identified shortcomings of the entrepreneurial leadership function. Best practices on the entrepreneurial leadership function in the sector should be benchmarked.*

1. INTRODUCTION

Despite the collapse of the apartheid regime, South Africa still has a dual agriculture sector which comprises of integrated commercial and prosperous agri-businesses, which are mainly in the hands of a minority of the population. On the other extreme, the sector consists of poorly resourced and trained farmers and producers with little or no access to the benefits of the main stream agriculture sector (AgriSETA, 2010). The operations of this group of farmers are often relatively small, hence they are commonly called small scale farmers or agri-SMMEs as they are referred to in this study.

The competitive business environment, brought about by globalisation and changing consumer needs, among other factors, requires that South African agri-SMMEs produce products/services of corresponding quality. Yet, many studies have found that South African agri-SMMEs are not only under-developed, but are poorly performing under today's business environment (Hart 2007; Cloete, van Schalkwyk, and Idsardi 2011). TQM was introduced in the Eastern Cape and Orange Free State Provinces by South Africa's Department of Agriculture (DOA) between 2006 and 2010 among selected agri-SMMEs in order to improve their business performance so as to meet the challenges referred to above. Specifically, selected agricultural extension practitioners and agri-SMMEs received training on the TQM philosophy. Using a TQM-based quality model called the South African Excellence Model (SAEM), the agri-SMMEs were expected to continuously self-assess their business performance and their status on the implementation of the TQM programme.

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Notwithstanding the above developments, the researchers found no literature on studies to investigate the implementation of TQM in the agri-SMME band in South Africa. As a result, there is a lack of information on the effect that the implementation of the TQM philosophy has on the agricultural sector, in general, and in the agri-SMME band, in particular. In this study, this gap in knowledge raised a question of the extent to which South African agri-SMMEs perform an entrepreneurial leadership function, among many other entrepreneurial functions of SAEM (see Figure 1).

The objectives of this study were two fold. Firstly, it sought to establish a baseline data for performance on the entrepreneurial leadership function of agri-SMMEs in the Eastern Cape, South Africa, by employing SAEM. Secondly, it endeavoured to investigate the extent to which agri-SMMEs that had adopted TQM had improved their performance in the entrepreneurial leadership function.

2. LITERATURE REVIEW

2.1. Total quality management

There is no consensus on the definition of TQM (Gill, 2009; Doevendans, 2010). However, Vouzas and Pyschogious (2007) refer to TQM as a new approach to the art of management that was developed during the Second World War and seeks to improve product and service quality and increase customer satisfaction by restructuring traditional management practices. TQM is founded on numerous principles, and the most frequently cited ones are leadership, continuous improvement, customer focus, measurement, benchmarking, teamwork, transformation plan and budgeting (Oakland, 2004). Leadership and continuous improvement were points of attraction in this study.

2.2. Entrepreneurial leadership and the South African Excellence Model

Leadership is possibly the most important element in TQM, because it appears everywhere in the organisation (Arumugam, Chang, Ooi and The, 2009; Kempster and Cope 2010). With reference to TQM, the key elements of entrepreneurial leadership are (Dongare 2012; Suresh, Anton, Kumar and Douglas, 2012), namely; age, size and structure of the organisation, resource availability, staffing levels and succession planning, communication, unionisation status of the workforce, employee empowerment and/ or mentoring, and teamwork.

The critical importance of entrepreneurial leadership in TQM is reflected not only in the most popular quality models such as Malcolm Baldridge National Quality Award (MBNQA) and European Foundation for Quality Management (EFQM), but also in the South African based SAEM (see Figure 1). The SAEM, which is a hybrid quality model from EFQM and MBNQA comprises eleven criteria of different weightings, six of which are `enablers', and five are `results'. The `enablers' criteria are entrepreneurial leadership, strategy and planning, customer and market focus, people management, resources and information management and processes. As indicated earlier, this paper focuses on the entrepreneurial leadership criterion only. The `results' criteria comprise of community responsibility, customer satisfaction, people satisfaction, supplier and partner performance, and business results.

3. RESEARCH DESIGN AND METHODOLOGY

3.1. Research design

In this study, participatory action research was undertaken with the respondents from the selected agri-SMMEs (O'Brien, 2001; Mahone, Farrell, Hinton, Johnson, Moody, Rifkin, Moore, Becker and Barker, 2011). The participatory action research did not seek to merely evaluate or assess the performance of the agri-SMMEs on the entrepreneurial leadership function following the introduction and implementation of TQM. Instead, it sought to acquire a deeper understanding of the implementation of TQM in the local agriculture sector with a view to making a contribution to the knowledge base on a subject that is virtually unknown in the sector.

3.2. Research methodology

The research design determines the methodology to be used to carry out the study. Accordingly, this investigation, which was carried out in a theoretical, methodological and analytical fashion, employed a combination of quantitative and qualitative methods of collecting data, including the internationally recognised SAEM self-assessment questionnaire.

3.2.1. Study population and samples

The population of the study was the agri-SMMEs in the former Ciskei and Transkei homelands, referred to as the WEC and EEC, respectively. Accordingly, the unit of analysis was the agri-SMME. The 21 enterprises who had adopted TQM were regarded as the treatment sub-sample for the WEC, and were referred to as the WEC's TQM adopters. A control sub-sample of 21 enterprises who had never adopted TQM in the WEC was randomly selected, and was referred to the WEC's TQM non-adopters. In the EEC region, where TQM had never been adopted, 25 TQM non-adopters were randomly selected as third a sub-sample.

A total of 67 agri-SMMEs were, therefore, selected from the two sub-populations; that is, 42 enterprises from the WEC and 25 from the EEC regions. Table 1 shows that out of the three sub-samples, a total of 131 respondents, which comprised of both the owners/managers and employees of the agri-SMMEs, participated in the study. The overwhelming majority of the participants (96.9%) were employed by the agri-SMMEs on a full-time basis.

Table 1: Summary of some of the characteristics of the research sub-samples from the WEC and EEC regions

Research sub-sample	No. of employees who participated in the study	No. of participants according to their forms of employment	
		Full-time	Part-Time
WEC's TQM adopters	42	42 (100%)	0 (0%)
WEC's TQM non-adopters	41	39 (95.1%)	2 (4.9%)
EEC's TQM non-adopters	48	46 (95.8%)	2 (4.2%)
Total	131	127 (96.9%)	4 (3.1%)

3.2.2. Data collection and reliability checks

Selected WEC agri-SMMEs that had adopted the TQM philosophy were profiled and investigated alongside WEC and EEC agri-SMMEs that had not adopted this philosophy.

Data was collected by means of; semi-structured interviews, direct observation, internal administrative documents, and questionnaires. The latter were used to gather demographic data of the studied agri-SMMEs and establish the extent of implementation of TQM on focus areas of the entrepreneurial leadership criterion or function (see Table 2).

Reliability checks were applied to the questionnaires, semi-structured interviews, direct observation, and internal documents. The Cronbach's alpha for all three research sub-samples was 0.8551, 0.8033 and 0.8270, respectively; the average being 0.8301. A high Cronbach's alpha coefficient of above 0.7 indicates an acceptable degree of reliability (Gibson, 2007; Look, Schiffman, Truelove and Ahman, 2010). Furthermore, this study upheld internal, external, and content validity as described by Burns and Grove (1999).

Table 2: The matrix chart assessment for performance of the agri-SMMEs in entrepreneurial leadership

How the behaviour and actions of the executive team and all other leaders inspire, support and promote a culture of performance excellence.		
Step	**Description**	**Score**
10	All managers are pro-active in sustaining continuous improvement.	

9	Managers are able to demonstrate their external involvement in promotion of Total Quality Management as a business philosophy based on their own experience.	
8	Managers have a consistent approach towards continuous improvement across the unit.	
7	The management team are proactive in valuing, recognising and rewarding all employees for continuous improvement	
6	Managers are visibly involved in the development and support of improvement teams and act as champions.	
5	A process is in place to ensure managers are working with customers and suppliers, and that the effectiveness of this process can be assessed.	
4	A process is in place to ensure managers are visibly involved as role models in organisation improvement within the unit. The effectiveness of the process is reviewed.	
3	A process is in place to ensure mutual under-standing of organisation issues through two-way communication, both vertically and horizontally throughout the unit.	
2	A process is in place to create and continually in-crease an open awareness of organisation issues throughout the unit.	
1	The management team have a process in place to develop their own awareness of the concepts of, that is, Total Quality Management.	

Score (Assessment) Descriptions and Options	
Not started … or little progress across potential implementation area.	**0**
Some progress … across about ¼ of potential implementation area.	**1**
Good progress … across about ½ of potential implementation area.	**2**
Substantial progress … across about ¾ of potential implementation area.	**3**
Fully achieved … across entire potential implementation area.	**4**

3.2.3. Data analysis

Descriptive statistical analysis was performed on the quantitative data on the Statistical Package for Social Sciences (SPSS), Version 17. Accordingly, the mean scores of the entrepreneurial leadership criterion of the SAEM were computed and analysed to determine the entrepreneurial leadership performance of the WEC's TQM adopters and the WEC's TQM non-adopters and the EEC agri-SMMEs on the scale of the SAEM. For variation, the standard error, standard deviation and variance between scores of the entrepreneurial leadership criterion were calculated to describe the three research sub-samples.

Inferential statistics was used to answer cause-and-effect questions and also to investigate differences between and among research sub-samples (Van Epp, 2012). To this end, Analysis of Variance (ANOVA) or t-test was used to determine whether there were significant differences on the mean performance scores of the entrepreneurial leadership criterion among and within the three research sub-samples.

In order to complement the parametric statistics, non-parametric statistics were also performed (Beukman, 2005; Nordstokke, Zumbo, Cairns and Saklofske, 2011). That is, a Mann-Whiteny U test was used to explain the outcomes of the parametric t- test, while Kruskal-Wallis H test was used to compare variables of the demographic data and mean performance scores of the entrepreneurial leadership criterion from the three research sub-samples.

The qualitative data from the semi-structured interviews was analysed using content analysis. The analysis used key issues and themes from the semi-structured interviews, and information from internal documents and direct observation.

3.2.4. Ethical considerations

Research that involves human beings as subjects should be conducted in an ethical manner to protect their rights. Accordingly, the researcher obtained permission to conduct the study, obtained informed consent from the respondents, and respected their right to anonymity and confidentiality, and fair treatment (Burns and Grove 1999).

4. FINDINGS

4.1. Respondents' demographic profile

The respondents' demographic profile included gender, age, level of education, and the respondents' positions in the agri-SMMEs and work experience.

4.1.1. Gender composition

In the WEC, 66.7% of the TQM adopters were owned by males, while 76.2% of the TQM non-adopters were also owned by males. In the EEC, 80% of the TQM non-adopters were owned by males. The results on male dominance in the agricultural sector are historical and are of concern as the sector does not reflect gender equity at this stage, particularly in a province where 58% of the population comprises women Eastern Cape Department of Rural Development and Agrarian Reform (EC DRDAR, 2011).

4.1.2. Age

The majority of the enterprises among the WEC's TQM adopters (28.6%) and TQM non-adopters (23.8%), and EEC TQM non-adopters (24.0%) were led by owners/managers who fell within the age groups of 46-50, 41-45 and 51-55 years, respectively. In all three groups, none of the respondents were younger than 35 years or older than 75 years. In the light of the above results and due to other factors, the farming population in the Eastern Cape has been dropping drastically since 2011 (Stats SA, 2016). In response to this situation, there is a need to encourage the youth to participate in agribusiness.

4.1.3. Position of respondents in the agri-SMMEs, and work experience

In all three groups, most of the respondents occupied the position of both owner and manager, namely 76.2% of the WEC's TQM adopters, 61.9% of the TQM non-adopters and 68.0% of the EEC's enterprises. These enterprises generally operated as family businesses, as is the case in many non-agricultural SMMEs.

Regarding the respondents' work experience, in the WEC, 52.4% of the TQM adopters and 47.6% of the TQM non-adopters had 5-7 years, while in the EEC, TQM non-adopters (44.0%) had 5-7 years' work experience, followed by 28.6%, 23.8% and 28.0% who had over 11 years' experience.

The respondents who had more years of experience in the business were expected to perform better than those who had lesser years of experience. In all fields, experienced owners/managers are expected to perform better by making use of experiential knowledge which can be acquired through personal experience, among other things (Apostolou, Blue and Daigle, 2010; Blocher, Shastri, Stout and Swain, 2010).

4.1.4. Educational qualifications

In all three groups, the respondents' educational qualifications ranged between grade eight and a master's degree. In addition, in all three groups, the majority of the respondents held diplomas or bachelor's degrees. These diplomas and bachelor's degrees included agricultural management, business management, teacher's diplomas, and law. It was noticed that the respondents' level of education differed with the type of core business, with the respondents in the citrus enterprises being the most educated. For example, of the respondents in the citrus enterprises, 86.0% had diplomas in crop production, while 14.0% had a master's degree in economics. The respondents' higher level of education might partly have been due to the elimination of survivalist enterprises which are commonly run by people with a limited literacy level.

4.2. Business profile

The business profile entails the enterprises' size and period of existence, and available employment opportunities.

4.2.1. Size of the agri-SMMEs

The National Small Business Act, 92 of 1996 (Department of Trade and Industry, 1996) classifies the size of enterprises in the agricultural industry in terms of either annual turnover or gross assets or the size of the full-time workforce. In terms of annual turnover, the majority of the enterprises under study were categorised as `very small' in all three groups (see Figure 2). In terms of total gross asset value (excluding fixed assets), the majority of the WEC's TQM adopters (52.5%) were `very small' (see Figure 3). However, among the WEC's TQM non-adopters (52.4%) and the EEC's enterprises (60.0%), the majority of enterprises were `small'. Interestingly, in terms of the number of full-time employees, most of the enterprises included in this study were `micro' in size. This majority was 76.20% of the WEC's TQM adopters and 85.71% of the TQM non-adopters and the EEC's enterprises (see Figure 4).

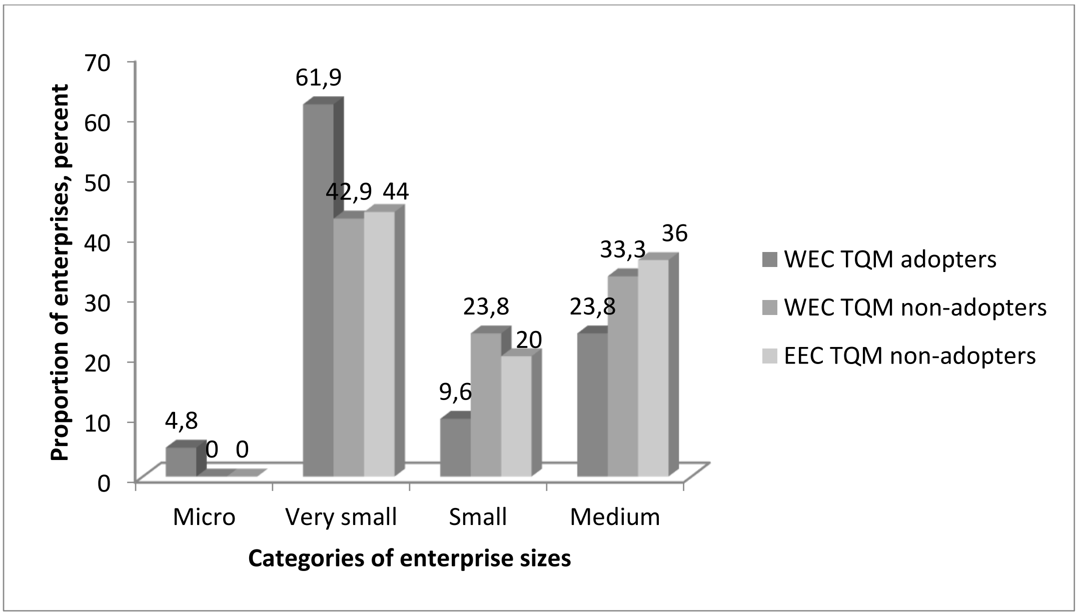

Figure 2: Distinction of the regional enterprises according to their annual turnover

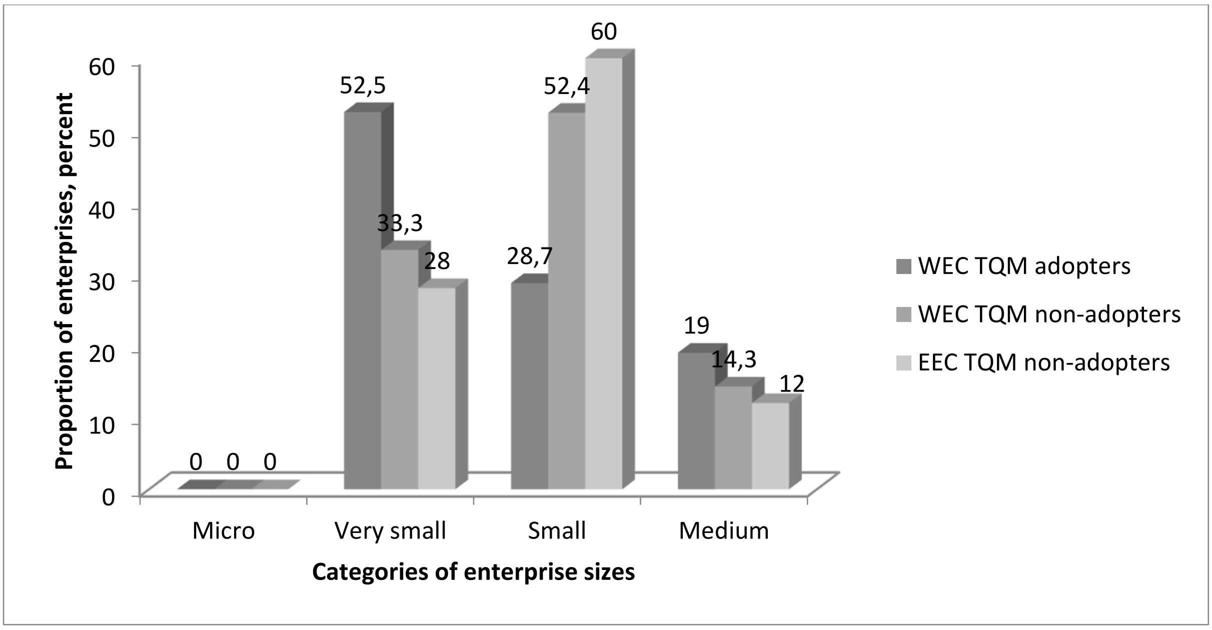

Figure 3: Distinction of the regional enterprises according to their total gross assets

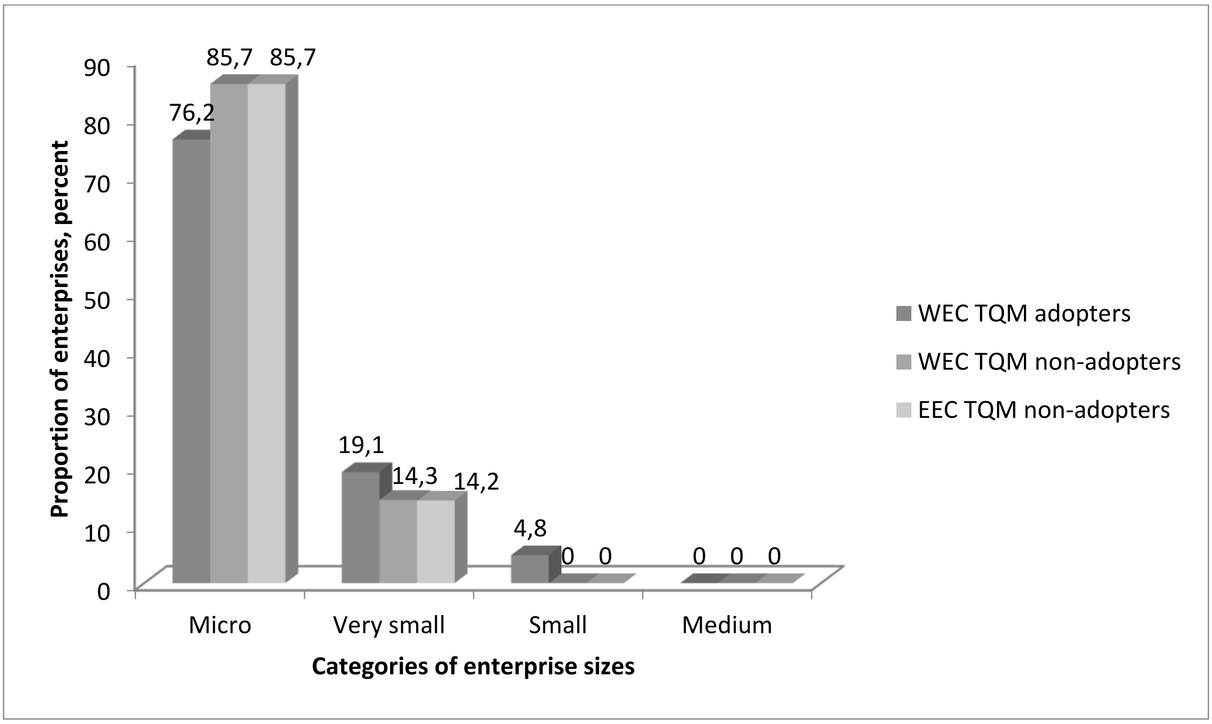

Figure 4: Distinction of the regional enterprises according to their full-time equivalent of paid employees

4.2.2. Duration the enterprises had been operating

All the enterprises under study had been operating continuously since their establishment. Some 33.0% and 28.6% of the WEC's TQM adopters and TQM non-adopters, respectively and 28.0% of the EEC's enterprises had been in operation for a period of 6-8 years. These results mirrored those on work experience of owners/

managers of the enterprises, where the majority of the enterprises in the three groups were headed by owner/ managers who had 5-7 years' work experiences.

4.2.3. Employment opportunities in the enterprises

According to the respondents, the first preference for employment opportunities available in the enterprises under study were generally given to local communities residing near the enterprises. The size of the workforce of the WEC's TQM non-adopters was similar to that of the EEC's enterprises, but different from that of the WEC's TQM adopters. For example, the average number of employees employed in each enterprise under the above similar groups was 5.52 people, ranging between 3 and 10 people. Among the WEC's TQM adopters, the average number of employees in each enterprise was 9.62 people, ranging between 4 and 79 people.

The forms of employment also differed among the three groups. For instance, among the WEC's TQM adopters and TQM non-adopters, and the EEC's enterprises, 38.2%, 52.6% and 55.1% of the employees were employed on a full-time basis, respectively. Furthermore, the form of employment was largely influenced by the type of core business of the enterprise. The WEC's TQM adopters had 61.80% casual employees due to the higher number (28.6%) of citrus enterprises which formed part of this group. Citrus enterprises require intensive labour during peak periods such as pruning and harvesting.

4.2.4. Performance in entrepreneurial leadership

This section describes the respondents' extent of performance in the entrepreneurial leadership function in all focal areas that were earlier presented in Table 2. Accordingly, performance scores, and the resultant achievement percentages, and performance gaps in entrepreneurial leadership were reported. The extent of progress made in performance in the entrepreneurial leadership function are presented by means of graphs, tables and percentages, thus facilitating the indication of entrepreneurial leadership's most critical focal areas that need immediate intervention.

The achievement percentages for the WEC TQM adopters and TQM non-adopters were 27.86% and 35.0%, respectively and for the EEC respondents, 31.60%. The average achievement percentage in entrepreneurial leadership for all the respondents was 31.49% (see Table 3), against the world-class standards of 100%. By comparison, this achievement percentage was lower than those found in South Africa by Eygelaar (2004) in the military health service (36%); Ferreira (2003) in higher education (44%), and Ladzani (2009) in the construction industry (72%).

Nevertheless, the significance of differences of performance scores between the groups was subjected to parametric and non-parametric statistical tests. Levene's t-test results showed that significant differences ($p<0.05$) existed between the WEC TQM adopters (6.96) and TQM non-adopters (8.75) in respect of the performance scores in 'entrepreneurial leadership' (see Table 4). However, the Mann-Whitney *U* test and Kruskal-Wallis *H* test found these differences non-significant ($p>0.05$) between the groups (see Table 5).

Table 3: Achievement performance in entrepreneurial leadership of the WEC and EEC regions' respondents

Criterion	Total achievement percentage	WEC achievement percentage		EEC achievement percentage
		TQM adopters	TQM non-adopters	TQM non-adopters
Leadership	**100**	27.86	35.00	31.60

Table 4: Levene's t-test results of the WEC TQM adopters' and TQM non-adopters' performance scores in entrepreneurial leadership

Max Score	WEC						*p* value
	TQM adopters			TQM non-adopters			
	Mean	*SD*	*SE*	*Mean*	*SD*	*SE*	
25	6.96[64]	2.2898	0.4997	8.75[65]	3.1909	0.6963	0.043

[64] Means bearing different superscript numbers are statistically different (P≤0.05)
[65] Means bearing different superscript numbers are statistically different (P≤0.05

Table 5: Results of Mann-Whitney U test and Kruskal-Wallis H test for comparing the performance scores in entrepreneurial leadership between WEC's TQM adopters and TQM non-adopters, and EEC's non-adopters

Mann-Whitney U test		**Kruskal-Wallis H test**	
Statistical components	**Leadership**	**Statistical components**	**Leadership**
Mann-Whitney U	150.500	*Chi-Square*	2.294
Wilcoxon W	381.500	*Df*	2
Z	-1.766	*Asymp. Sig.*	0.224
***p* value (2-tailed)**	0.077		

Figure 5 demonstrates a limited scale of progress made in entrepreneurial leadership among the three studied groups. The high performance gaps of 72.14%, 65.0% and 68.40% among the WEC TQM adopters and TQM non-adopters and the EEC enterprises, respectively, suggested that much work was still needed to successfully implement the focal areas of entrepreneurial leadership. Accordingly, Figure 6 depicts the focal areas needing the most urgent attention, and these are shown to further demonstrate the number of enterprises implicated. Some of these focal areas are common among the three groups. These focus areas are outlined below according to the superscripted number that represented them in Figure 6 and Table 2.

- [3]A process is in place to ensure mutual understanding of organisational issues through two-way communication, both vertically and horizontally throughout the organisation.
- [5]A process is in place to ensure managers are working with customers and suppliers, and that the effectiveness of this process can be assessed.
- [9]Managers are able to demonstrate their external involvement in promotion of TQM as a business philosophy based on their own experience.
- [10]All managers are pro-active in sustaining continuous improvement.

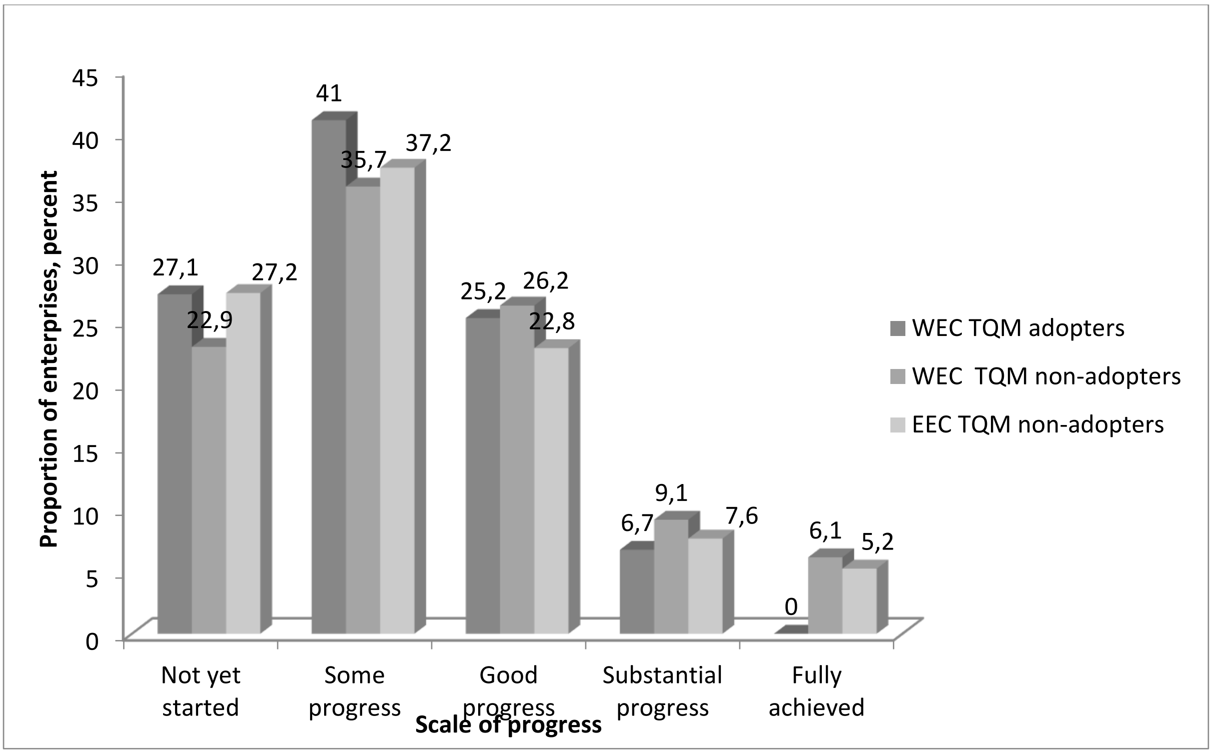

Figure 5: The respondents' scale of progress made in entrepreneurial leadership

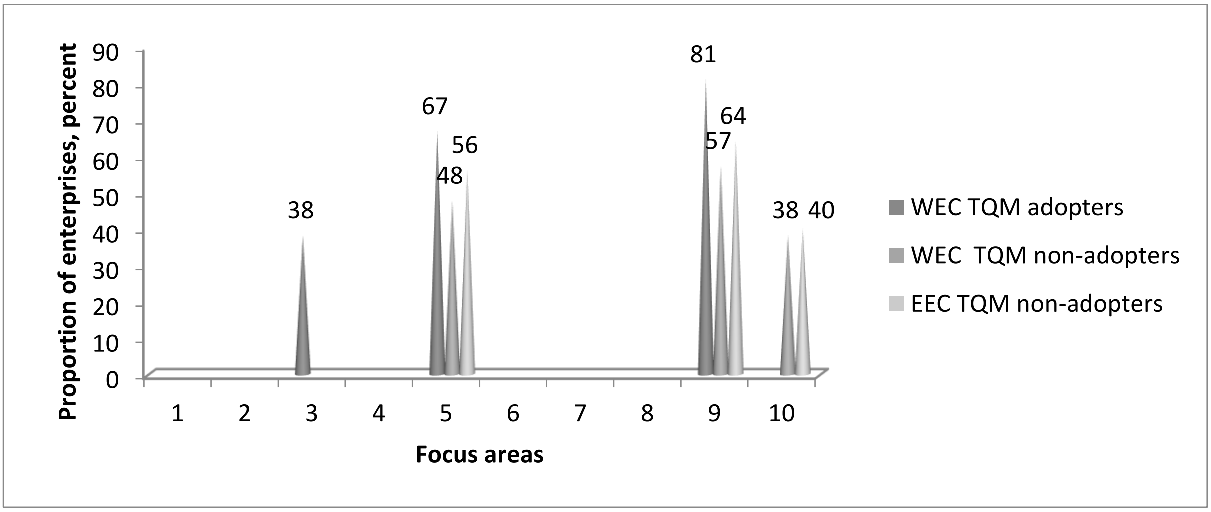

Figure 6: The respondents' most critical focal areas for improvement in entrepreneurial leadership

During the semi-structured interviews further issues specific to particular types of enterprise were consistently mentioned as needing the most urgent attention. These issues are outlined below:

- The respondents who sold agricultural inputs and fresh farm produce tended not to see the need to include the employees in leadership decisions, because their semi-literate status was a perceived barrier to understanding the decisions.

- Poor communication systems among the citrus enterprises led to mistrust between them. The most cited area of contention was the alleged exclusion of the previously disadvantaged farmers from citrus grading, packaging and marketing, thus resulting in their products fetching poor prices.
- Several of the respondents claimed that they did not know the names of their regular customers, because their managers did not involve them in decision making.

5. DISCUSSION

The state of the agri-SMMEs' performance in the entrepreneurial leadership function is discussed in relation to the literature reviewed. The findings suggest that the studied agri-SMMEs were still underperforming in the entrepreneurial leadership function, irrespective of whether they had adopted TQM or not. Yet, leadership is widely regarded as one of the key criteria critical for the success of any profit or non-profit making organisation. According to Gray and Mabey (2005), `… appropriate leadership and management competencies are now seen as the key to successful innovation and competitiveness'. However, in view of the three critical areas of entrepreneurial leadership identified as needing the most urgent attention, appropriate leadership referred to above should specifically entail visionary leadership and entrepreneurial leadership (Kantabutra and Gayle, 2003; Gray and Mabey, 2005; Kempster and Cope, 2010).

Furthermore, critical personal and business attributes such as age, work experience and level of education of owners / managers of the agri-SMMEs did not seem to play an expectedly positive role in improving performance in the entrepreneurial leadership function. This impediment in entrepreneurial leadership performance requires practical and reasonable intervention in the form of leadership education and training, on the premise that good leadership skills are not acquired naturally by everyone, but can be learnt, as well. According to Islam, Keawchana and Yusuf (2011), leadership skills are acquired and learnt from education, training, continual training, experience, personal business network and group influence.

Improving the agri-SMMEs' performance in the entrepreneurial leadership function should not be narrowly and directly targeted at improving the bottom-line only, namely profits. Instead, a systematic and systems approach to improving entrepreneurial leadership performance should be adopted so as to influence other performance criteria of SAEM (see Figure 1) that also have a bearing on profits. For example, Sadeh and Arumugam (2010) found entrepreneurial 'leadership' not only the most influential criterion in 'business results', but strongly related to 'people management', 'business planning', 'resources and information management', 'supplier and partner performance', all of which are criteria of SAEM.

The above issues should be considered when building the agri-SMMEs' capacity in entrepreneurial leadership in view of the following potentially impeding findings. Firstly, some of the causes of poor performance of the agri-SMMEs in entrepreneurial 'leadership' possibly emanated from the type of ownership of these enterprises, which were predominantly family-owned. Secondly, observations made from various semi-structured interviews suggest that the agri-SMMEs adopt a rather top-down management style, and paternalistic leadership (Mussolino and Calabro, 2014) against participative leadership which is desired by many of the employees who participated in this study. Such participative leadership should not be used to empower the underperforming agri-SMMEs only, but should first and foremost be employed in the agricultural extension services of DRDAR. To this end, the agricultural extension function that is performed by the DRDAR's Directorate of Extension and Advisory Services (EAS) and the agricultural extension organisation which constitute the support units and machineries of DRDAR should embrace the TQM philosophy along with its entrepreneurial leadership criterion. This envisaged paradigm shift is already provided in the National

Policy on Extension and Advisory Services which among things advocates for improved access to quality extension and advisory services that is professional, reliable, relevant and accountable, Department of Agriculture, Forestry and Fisheries (DAFF, 2014).

6. CONCLUSION AND RECOMMENDATIONS

The baseline data from the three research sub-samples indicated that the agri-SMMEs, whether adopters or non-adopters of TQM, were generally under-performing in the entrepreneurial leadership function when benchmarked against world-class standards. Contrary to the expectations of implementing TQM, agri-SMMEs that had adopted the TQM philosophy did not necessarily have an advantage over those that did not adopt this philosophy, in as far as their performance in the entrepreneurial leadership function is concerned. Similarly, the efforts of empowering extension practitioners with this philosophy did not seem to have borne any fruit in as far as the entrepreneurial leadership performance of agri-SMMEs that had adopted TQM is concerned.

Notwithstanding that the majority of owners / managers of the agri-SMMEs had good personal and business attributes such as mature age, work experience and tertiary education; these factors did not contribute towards improved performance in the entrepreneurial leadership function.

It the light of the above conclusions, it is recommended that:

- The TQM-trained agricultural extension practitioners and owners / managers of the agri-SMMEs should promote the use of the matrix of SAEM for continuous assessment of their performance in the entrepreneurial leadership function. This continuous assessment is envisaged to bring about a corresponding continuous improvement in performance in the entrepreneurial leadership function.
- Whilst focusing on the long-term business solution, it would be imperative for the TQM-trained agricultural extension practitioners and owners / managers of the agri-SMMEs to provide short- and medium-term interventions to the most critical focal areas of the entrepreneurial leadership function that have been identified as needing immediate attention. Attending to pressure points would be advantageous in as far as the following is concerned, namely; allocation of resources to where they are needed the most (i.e. prioritisation), focused budget, and fixing problems quicker due to prioritisation.
- The TQM-trained agricultural extension practitioners and owners / managers of the agri-SMMEs should benchmark their performance in the entrepreneurial leadership function against best practices followed by other owners / managers within the agriculture sector, locally or regionally or worldwide.
- Lastly, in order to improve performance in all 10 focus areas of the entrepreneurial leadership function, the TQM-trained agricultural extension practitioners and owners/managers of the agri-SMMEs need to demonstrate effective leadership in the first place. This entails a good understanding of TQM and its meaning and that the elements of leadership are communicated and executed continuously throughout the agri-SMMEs. In addition, these undertakings need dedicated management commitment if continuous improvement is to be realised.

7. LIMITATIONS OF THE STUDY

The study had the following limitations:

- It only focused on the business area of the agri-SMME band.
- Large-scale commercial agricultural enterprises and micro survivalists were excluded.
- Protocol restricted this study from being extended to other areas outside the Eastern Cape where the TQM programme has also been rolled out.

8. AREA OF FURTHER RESEARCH

The researchers recommend further research in the following areas:

- Conduct a similar study in the province of the Orange Free State, where the TQM philosophy has also being introduced to agri-SMMEs, in order to establish the consistency of the findings among agri-SMMEs.
- Investigate into the suitability of the TQM philosophy for relatively smaller agri-SMMEs.
- Determine a baseline performance of the entrepreneurial leadership function of relatively bigger and well-established agri-SMMEs, using the SAEM self-assessment tool.

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COLLABORATIVE RESEARCH PROJECT: CLIMATE SMART AND SUSTAINABLE VITICULTURE IN THE WESTERN CAPE, SOUTH AFRICA

Ponstein, H.[66]

ABSTRACT

Sustainable wine production has become a key topic globally. Critical environmental concerns encompass water and energy use, waste production, greenhouse gas emissions, land use issues and impacts on ecosystems. An additional factor that challenges the sustainability of wine production in several production areas, including the Cape Winelands, is climate change. Nowadays, the region is already experiencing tangible climate change impacts, while climate change is expected to manifest in terms of even higher mean temperatures, decreasing rainfalls and a reduced capacity for groundwater and dam level recharge in the upcoming years. This will translate into a fierce competition for water amongst all stakeholders, including agriculture, industry and a growing number of households. Since the drinking water reserves of Cape Town and other cities in the region are located in an agricultural area, the factors listed below must be reviewed with an updated perspective. This literature review based article aims at a better understanding of the interconnectedness of the concept of sustainable agriculture and climate smart agriculture. With a clear focus on wine grape production in the Cape Winelands, it elaborates on how climate change affects the dynamics amongst existing environmental challenges such as water use in vineyards, regional water quality, and soil management. In this context, the article presents an integrated approach to enhance the sustainability of wine grape production, while protection regional drinking water resources. Main components affecting the adaptive capacity of wine grape production in the Cape Winelands are (1) water use, (2) soil management, and (3) the selection of sites, rootstocks and cultivars. For effective implementation of sustainability measures, a farm-scale approach is necessary, as this is the level where farmers can directly be involved.

Keywords: Climate smart viticulture, sustainable agriculture, sustainable wine production, adaptation to climate change, soil health, water use efficiency, weed management, drought management.

1. INTRODUCTION

Sustainable wine production has become a key topic among the world´s leading winegrowing regions. Critical environmental concerns in the wine value chain centre around the use of water, impacts on water quality, the generation and management of organic and inorganic waste streams, energy use, and greenhouse gas emissions arising from viticulture, vinification, waste streams, bottling and transport. Further, the use of chemical pesticides and cleaning agents, land use issues, and overall adverse impact on ecosystems were identified as key issues (Christ & Burritt, 2013). Further, climate change is projected to challenge the sustainability of production in several renown wine regions, such as the Cape Winelands in South Africa (Hannah et al., 2013).

In the past decade, several sustainability programs, which aim to improve the social and environmental sustainability of wine production at farm and cellar level, have been developed and are being implemented. Examples thereof include the California Sustainable Winegrowing Program, the Sustainability Program by

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Wines of Chile, the FairChoice® Program by the German Institute for Sustainable Development (DINE), and Entwine in Australia. South African grape and wine producers rely on WIETA for social sustainability, and on the Integrated Production of Wine scheme (IPW) for environmental sustainability.

The underlying assumption of the sustainability programs is that the farmer can control the sustainability of the farming operation. However, as illustrated by Hannah et al. (2013), climate change can challenge this presumption in regions with low and decreasing water availability. The Cape Winelands have a warm-summer Mediterranean climate (Csb), which is characterised by dry and warm summers and mild and rainy winters. Conservative climate change scenarios for South Africa predict a further average increase in mean annual temperatures coupled with a decrease in rainfall (Carter 2006, Midgley et al., 2005). Higher temperatures will result in a rise in irrigation demand for agriculture, while the water requirements by other water users in the Western Cape, such as industry and a growing number of households is on the rise. This accelerates the already fierce competition for precious water resources amongst several stakeholder groups (e.g. Midgley et al., 2016).

2. CLIMATE SMART VITICULTURE

Climate-smart agriculture (CSA) is an approach to farming that aims to transform and reorient agricultural systems to ensure food security in times of climate change (FAO, 2010). Following this concept, climate smart viticulture is an approach to wine grape production that is in line with existing challenges which change their dynamics or are aggravated by climate change.

In the Cape Winelands, climate smart and sustainable viticulture and wine production are directly interrelated. The combination of high and rising summer temperatures increase the evapotranspiration in vineyards, which is mirrored by an augmented requirement for water, while decreasing winter rainfalls limits the availability of this resource, particularly in the hot summer months. The caps on water allowances for agricultural users in the past two years have provided an example of how the competition for water amongst agriculture, industry and households can affect farmers. However, the following irrigation season will start under the auspices of a millennium drought, with no clear plan of how to effectively secure the basic need of drinking water for households throughout summer.

The adaptive capacity and the resilience of an agricultural production system can be improved by enhancing its components (FAO, 2010). For viticulture, the key components affecting adaptive capacity and resilience include (1) water use, (2) soil management, and (3) the selection of sites, rootstocks and cultivars.

2.1. Water use

Agriculture is – and will be – the main user of fresh water resources (de Fraiture et al., 2007). Accordingly, ensuring the availability and efficiency of water use has been a top priority of stakeholders for decades (Prochnow et al., 2012).

Water is indispensable for wine grape production. In the Western Cape, water often is the limiting factor of grapevine yield. While there are irrigated and unirrigated (dryland) vineyards, there has been a tendency towards the installation of irrigation equipment in newly established vineyards, as well as in existing vineyards. Ironically, it is the irrigated vineyards that are most vulnerable in drought years once water allocations for agriculture are cut back.

In the Western Cape, climate change is projected to result in a warmer and drier mean climate, with possible increases in climate variability and a higher incidence of extreme weather events (Carter, 2006, Midgley et al., 2005; New, 2002). Future predictions of winter rain illustrate how water availability will be reduced based on two factors. First, there is an expected reduction in monthly winter rainfall of 15-30%. Second, the number of rain days above 20mm is projected to decrease. Precipitation of 20mm per day is of particular importance for the regional water availability in dry summer months, as this is the threshold for groundwater and dam level recharge (Carter 2006). In other words, in the context of an overall reduced amount of annual rainfall, there are even fewer rain days with the capacity to contribute to the recharge of groundwater and dams.

In this setting, it is of utmost importance to make the best use of scarce water resources – on a regional as well as on a farm-level scale. It is mainly on the farm scale where farmers can be directly involved (Prochnow et al., 2012). Practical measures that enhance the water use efficiency of vineyards and farms should be at the core of regional water allocation plans.

With the accelerating competition for scarce water resources, an increased irrigation demand for vineyards requires an increase in the water use efficiency (e.g. Souza 2005, Cifre et al., 2005) A strategy to increase the water use efficiency in vineyards is deficit irrigation. However, there is no uniform answer to the question of how much water should be applied in a given environment and with a given variety (Chaves et al., 2007). Therefore, further research should investigate this crucial question considering various soil types, rootstocks and cultivars.

Other measures to conserve soil water are elaborated on below.

2.2. Soil management

Tillage is widely used to avoid the competition for water amongst crop and weeds, to alter the soil surface for a better infiltration of rain water, as well as to prevent evaporation of soil water by breaking the macro pores. In regions with a Mediterranean climate this practice is continued, even though it is not a favourable strategy considering sustainability or productivity (Keestra et al., 2016a). The authors argue that, to maintain or restore soil functions in Mediterranean-type ecosystems, the promotion of organic farming, mulching and minimum or zero tillage is necessary.

A key challenge is the habit of farmers to keep the soil "clean", without weeds, even though this practice is known to enhance soil erosion and is detrimental to sustainable farming (Keestra et al., 2016a).

In the Cape Winelands, weed control largely relies on chemical herbicides. Resistant weed species, which result from the repeated application of one active ingredient, are commonly met with a cocktail of more potent active ingredients and an increase in the concentration thereof. Glyphosate, the world´s most widely used herbicide, has recently been categorised as a possible carcinogen (IARC 2016). Besides highly toxic effects on humans and mammals, this and other commonly used herbicides are bioaccumulative and persistent in soil, while having adverse effects on soil life (Reuter & Neumeister, 2010), and consequently, on soil functions.

Roughly two-thirds of the herbicides that are allowed for viticulture are on the Greenpeace Pesticide Blacklist (Reuter & Neumeister, 2010) for their harmful effects on human and mammal health, environmental toxicity and environmental fate. Besides, herbicide-based weed control favours erosion and runoff (Keestra et al., 2016a, Keestra et al., 2016b). This can result in the distribution of herbicides and pesticides within the ecosystem (Carter 2000, Reuter & Neumeister 2015). As a consequence, weed and pest control that relies on toxic synthetic herbicides and pesticides cannot be considered safe for humans and ecosystems. More to the point, this practice is in contradiction to sustainable or climate smart viticulture.

The severity of adverse effects on human and ecosystem health calls for the widespread implementation of alternative weed management options. Producers should reassess their traditional heavy reliance on toxic herbicides as they transition to an updated mix of alternative weed management options. These include the use of winter cover crops and mulch. Undoubtedly, mulching and cover cropping are necessary measures to protect soil functions (Keestra 2016a). In addition to that, farmers need to desist from the widespread use of toxic herbicides.

2.3. Soil functions and water quality correlate

Functioning, or "healthy" soils are indispensable for human needs such as agricultural produce, clean air, and clean water (Keestra et al., 2016a).

Agriculture pollutes water resources. In the Berg River (Western Cape Province) pesticides were detected by Jackson et al. (2013) and an agricultural area proved to be the point source of pollution. Since the catchment area for drinking water reserves of the City of Cape Town and other cities and settlements in the Western Cape is located within the agricultural area, the crosslinks presented in this article between measures that contribute to soil health and clean water should receive special attention.

2.4. Protecting water resources by climate smart viticulture

While sustainable soil management measures such as mulching and cover crops promote soil health, they also affect soil water dynamics.

Mulch is well-known to effectively prevent evaporation of soil water and to result in an enhanced soil moisture content (Bond & Willis, 1969).

A clear answer to the question of whether cover crops add to or alleviate from water stress in vines is yet to be answered for the Cape Winelands. Therefore, effects of cover crops on soil water dynamics should be investigated further to pre-select those measures that enhance the water use efficiency, while avoiding adverse effects on scarce water resources.

2.5. Selection of sites, rootstocks and cultivars

Vink et al. (2012), claim that managing diversity is the best strategy to "survive" climate change in South Africa. The diversity in soil type and mesoclimate allows growers to plant a variety of cultivars. According to the authors, the success of this strategy depends on the understanding of the climate at vine and vineyard level. This facilitates the optimal adaptation with regard to the location of the vineyard considering topography, soil and wind. The diversity of rootstocks should be considered as another relevant adaptation measure.

3. CONCLUSION

The sustainability of wine grape production in the Cape Winelands is challenged by climate change, as this aggravates existing environmental issues. In the Western Cape, climate change is expected to manifest in higher temperatures and decreased rainfall, which will trigger a higher demand for irrigation water. Together with a growing number of households and an expansion of water-intensive industry, this translates into an acceleration in the competition for already scarce water resources. While the installation of irrigation equipment in vineyards is promoted as an important adaptation measure by wine grape producers and other farmers, the effectiveness thereof can be limited in drought years as water allowances are cut back. If irrigation is to be a sustainable adaptation measure, this requires in-depth knowledge about how much water should be applied at a given site and to a given variety, which is a question yet to be answered for the Cape Winelands.

In summary, the main components affecting the adaptive capacity of wine grape production in the Cape Winelands are (1) water use, (2) soil management, and (3) the selection of sites, rootstocks and cultivars. Prevailing knowledge gaps in all of the three factors presented must be filled with the help of an interdisciplinary approach.

For effective implementation of sustainability measures, a farm-scale approach is necessary, as it is only at this level where the farmers' commercial interests and changing environmental challenges can best be harmonised.

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BEST POSTER AT JOINT AEW, 2017, DURBAN

Coping with climate change in the Western Cape.

Investigation to determine beef production potential of beef jersey crosses in an intensive rearing system:

J. B. Booysen, R. Meeske and H. J. F. Grobler

Introduction

Many farmers source calves from dairies to raise and market through the red meat chain. The growth potential, meat quality and market value of beef x dairy crossbreds lead to an investigation into comparative growth potential of different sire breeds on Jersey cows at Outeniqua research station.

Objective

The objective of this study is to compare the growth potential and carcass quality of crossbred calves from Jersey cows, inseminated with four different beef breed sires, reared intensively from birth to slaughter.

Materials and Methods

Calves will be raised intensively through the following phases:

Milk Phase

Calves are housed in hutches and fed cow's milk and calf pellets. Weaning will be on day 67 when calves will be moved to a bigger enclosure.

Solid food Phase

Calves are housed in 4 camps (according to bull breed) and fed pellets (4kg) with ad lib access to Lucerne hay, up to 6 months of age.

Feedlot phase

Animals are grown and finished on an industrial Phase C ration. They will be marketed to the abattoir when they reach body condition to grade at A2. Carcass quality will be determined.

Results for the period September 2015 to February 2017

Cows were inseminated during December 2015 to March 2016. Semen from four beef breeds namely, Angus, Brangus, Tuli and Limousin were used representing European, Sanga and Composite types. Available bulls were selected mainly on breeding values for low birth weight. Cows were randomly allocated to one of the four beef breeds until 15 cows were pregnant per bull breed.

Three days before expected, calving cows were moved to a small paddock close to the dairy parlour to monitor the calving process. Three digital cameras were used to record the calving process of each cow. The cows gave birth from September to December 2016.

Calves were weighed after birth. Proper care was taken to ensure that all calves receive 2L colostrum within 12 hours after birth. All calves hosted in the hutches received 3L of milk on a daily basis and received adlib feeding. The calves were kept in separate pens next to each other in the same environment. Calves were housed in individual calf hutches from birth till weaning. Hutches were moved every day to ensure a clean environment.

Dystocia monitoring

A calving ease score was allocated to every cow during parturition. The score was allocated as presented in Table 1 with the results shown in Table 2.

Table1: Calving ease scoring system

Score	Description
1	No difficulty, no assistance
2	Minor difficulty, some assistance
3	Major difficulty, assistance or puller
4	Caesarean birth
5	Abnormal presentation

Table 2: Cow calves ease outcomes

Breeds	Score 1	Score 2	Score 3	% Assist
Beefx	48			85.71
Beefx		6		10.71
Beefx			2	3.57
Purebred Jersey				<5

The results show that there was no significant difference between breeds in terms of calving ease. Few cows needed drastic assistance during parturition. Beef breeds 85.71% need no assistance,10.71% minor assistance was needed and 3.57% drastic assistance needed. In case of jerseys the percentage assistance needed for cows was below 5%.

Phase one comparisons

The milk phase of the trial has been completed. The average calves birth and 67 day weaning weight is presented in table 3 and figure 1.

Table 3. Birth and weaning weights of beef bull crosses and Jersey calves.

Breed	Birth weight bull	Weaning bulls	Birth weight heifers	Weaning heifers
Angus/Jersey	36	76	31	65
Brangus/Jersey	32	74	29	66
Tu li/Jersey	35	73	33	64
Limousin/ Jersey	31	65	32	63
Jersey	25	55	23.5	53

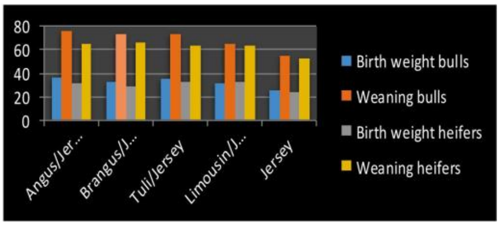


Figure 1. Performance of beef crosses compared to purebred Jersey calves.

Discussion and Conclusion

Performance of calves during the milk phase indicates an advantage to beef crosses over purebred Jerseys. Differences between bull breeds are small and insignificant at 67 days. Data generated in the following growth phases will be reported to farmers as the trial progresses.

At 18 months of age all animals in the experiment will be slaughtered to determine the dressing percentage and meat quality.

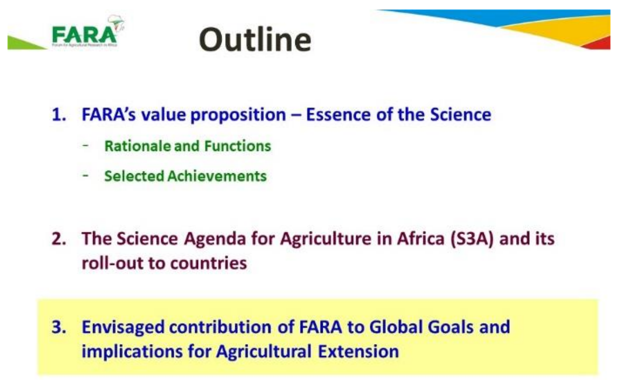
Acknowledgement: B. Myburg, L. Kuboni and RTDS farm

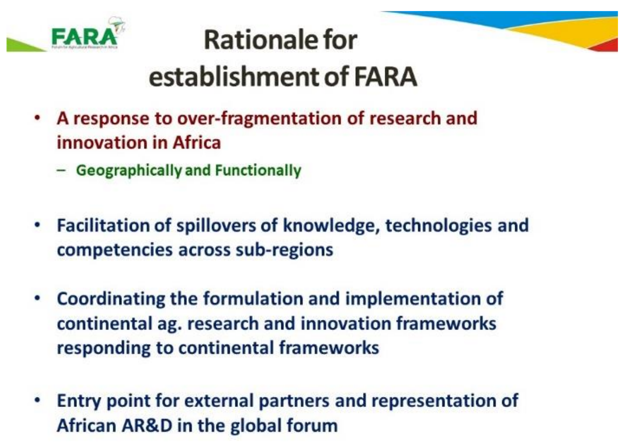
REST OF THE POSTERS OF THE POSTER SESSION

WE HAVE RECEIVED 27 OF THE POSTERS THAT WERE DISPLAYED AT THE JOINT AEW 2017, SOUTH AFRICA. THEY WERE HOWEVER TOO LARGE (IN MB) TO INCLUDE IN THE PROCEEDINGS DOCUMENT. THEY WILL BE PUT IN A SEPARATE FOLDER ON THE CD WITH THE PROCEEDINGS DOCUMENT.

PRESENTATION OF SCIENCE AGENDA FOR AGRICULTURE IN AFRICA AND ITS IMPLICATIONS FOR AGRICULTURAL EXTENSION AND ADVISORY SERVICES

Dr Yemi Akinbamijo [67]





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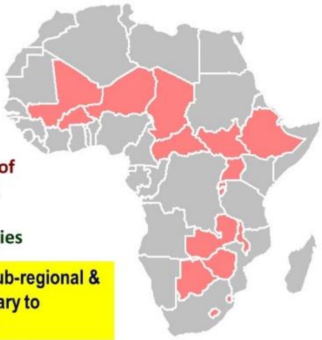
[67] Executive Director: Forum for Agricultural Research in Africa (FARA)

Africa: a fragmented continent

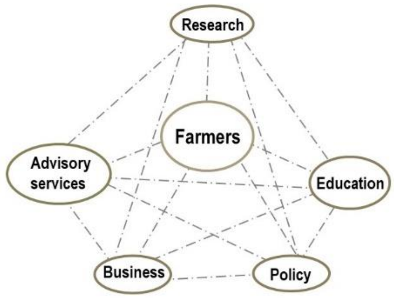
- 55 sovereign states
- 31 countries have a population of less than 12m (small markets)
- 16 countries (home to 25% of population) are land locked
- Heterogeneous agro-ecologies

Collective actions through sub-regional & regional approaches necessary to capture economies of scale



Functional fragmentation

Fragmentation extends to the way stakeholders in the agricultural knowledge system and value chain function



FARA's value proposition

A strategic (continent-wide) mechanism for facilitating collective actions in agricultural research and innovation to increase agricultural productivity and competitiveness

The collective actions are focused on strengthening the capacity for agricultural innovation at country level

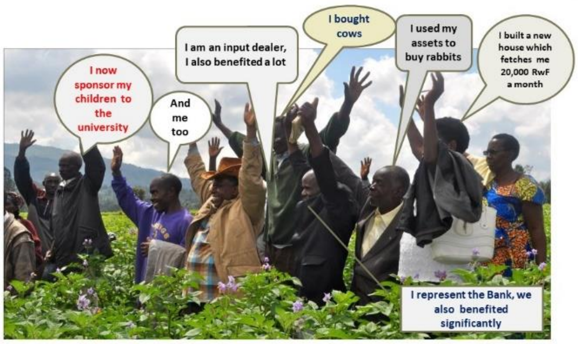
- Capacity is an overarching constraint—FARA's interventions are aimed at increasing the effectiveness (impact) of national ag. Innovation systems

Functions of FARA

How FARA adds value to national agric. Innovation Systems (NAIS)

- Jointly with SROs, facilitates multi-country programming that enables countries to gain access to facilities, competencies, technologies and knowledge they lack
  - E.g. Mobility of capacities; collaborative research and resource sharing agreements within and outside Africa, etc
- Provides perspectives from across and outside continent to the NAIS (the NAIS is composed of national & supra-national actors)
- Coordinates development of frameworks and facilitates their translation to national level
  - E.g. FAAP into NAIPs pillar IV; S3A into national agric STI policy) → increased productivity

Impact of IAR4D

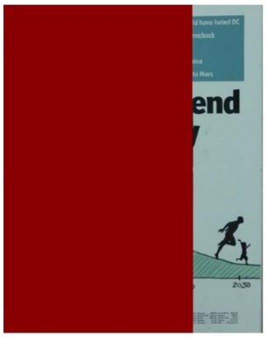


By participating in IAR4D, farmers increased their yields and had better access markets; agribusinesses increased their sales, and researchers reported higher adoption of technologies in a short time. *Every one is winner!!!*

Africa befo and now

1984

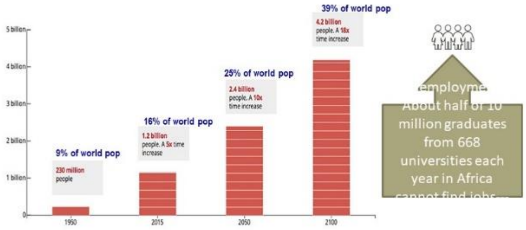
2000



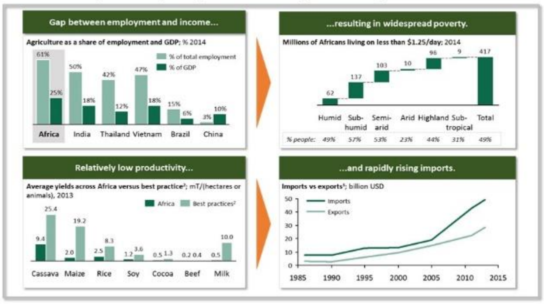
Agriculture: a driver for sustainable and inclusive growth in Africa

- Wide scope for growth
  - Bridging the productivity gap
- Offers the highest poverty reducing potential
  - (2- 4 times compared to other sectors)
- Scope for intensification: to reduce land degradation

Africa's population rising fastest



Agriculture remains a major source of income in Africa; however, untapped potential has resulted in persistent poverty and deteriorating food security



Malabo 2014: Implications for S3A

1 Recommit to the Principles and Values of the CAADP Process- *AIS*	Recommit to enhance investment finance in Agriculture: *Connecting to mainstrea*	3 Commitment to Ending Hunger by 2025: *Double productivity: Reduce PHL by half*	4 Commit to Halving Poverty by 2025: incl. 6% growth. *STI Preparedness, land accompanied by labor productivity*

Malabo 2014: Implications for S3A

Commit to Boosting Intra-African Trade in Agricultural Commodities & Services:
Triple – Regionalising Food Systems

Resilience in livelihoods & production systems to climate variability & other shocks:
Multi-sector strategies, indigenous knowledge

Commitment to Mutual Accountability to Actions and Results.
Through the CAADP Result Framework – CAADP RF, S3A RF, PPI, Biennial Agricultural

Baselining for S3A: Total Factor Productivity Studies

Country	Agric TFP Growth	Years to Double	Doubling Year
Burkina Faso	0.017	41.1	2051
Cameroon	0.023	30.4	2040
Malawi	-0.029		
Morocco	0.019	36.8	2047
Nigeria	0.039	18.4	2028
Tunisia	0.014	50	2060
Uganda	0.014	50	2060
Zambia	-0.016		

- With Business as Usual, no country will meet the goal of doubling agricultural productivity by 2025
- Agric. TFP growth positively correlates with poverty reduction
- TFP growth in manufacturing and services is influenced by TFP growth in Agric. Agriculture is the way to start transformation

Demands on Africa's agriculture & food system

1. Produce significantly more food ..
   - on less land,
   - with less water
   - In conditions of increasingly unpredictable climate and markets
   - With less manual labour
2. Reduce the amount of waste and losses
3. Produce more nutritious and safe food
4. Move up the value chain (processing and marketing industry grows 2X faster than production)

Calls for increased application of Science, Technology and Innovation

Increasing Productivity, Competitiveness, Integration and decent lives

- **Applying Science to Agriculture is not an option, it is an imperative!!**

Pivotal role of Agriculture

"Everything can wait but agriculture cannot wait!"

Jawaharlal Nehru
Indian Statesman and First Prime Minister

Historically, with few exceptions, no country has been able to sustain a rapid transition out of poverty without raising productivity in its agricultural sector

Forum for Agricultural Research in Africa

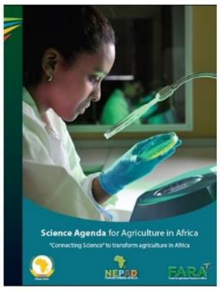
Outline

1. FARA's value proposition –Essence of the Science
   - Rationale and Functions
   - Selected Achievements
2. The Science Agenda for Agriculture in Africa (S3A) and its roll-out to countries
3. Envisaged contribution of FARA to Global goals and the implications for Agricultural Extension

What is the Science Agenda for Agriculture in Africa?

Science Agenda for Agriculture in Africa (S3A)

- Seeks to scale up the application of Science and Technology in resolving constraints across value chains: *(inputs, production, processing and marketing)*
- Target is to double productivity by 2025
- Main actions and impacts are at country level, but actions at sub-regional & continental level are also important because of fragmentation



S3A

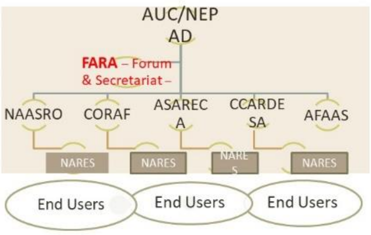
- Each country to set targets for increase in agricultural productivity and the requirements to achieve them, in terms of:
  - Science, technologies and innovations
  - Capacity strengthening
  - Enabling environment / Policies
  - Investments
- Countries to learn from one another and share resources, e.g. competencies and infrastructure
- Productivity Programmes and other mega-initiatives e.g. TAAT, AARP, CRPs are S3A programmes

Institutional arrangements for advancing implementation of the S3A

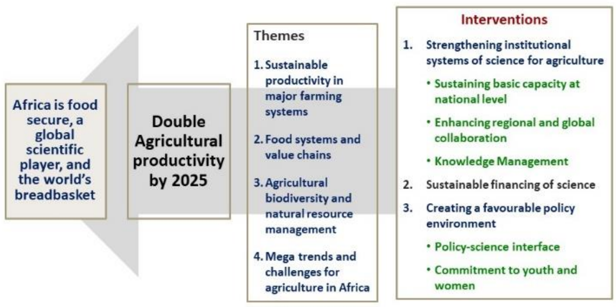
The Science for Agriculture Consortium (S4AC) (supra-national) interfacing with national STI platforms

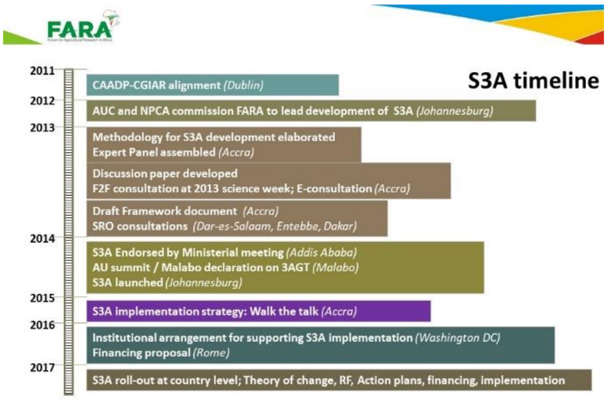
The Science Agenda for Agriculture in Africa

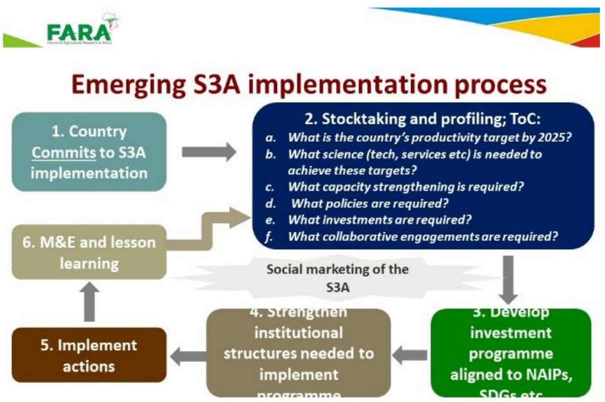
- To operationalize the Malabo target, the AUC and NEPAD mandated FARA to lead the development of a country-driven Science Agenda in 2012.
- FARA is the entry point to AR4D in Africa, technical arm of the AUC



Realizing the S3A vision



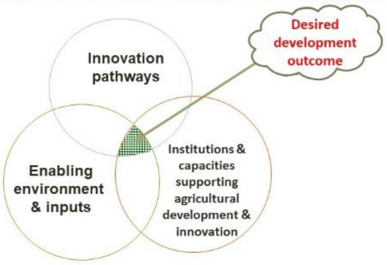




FARA

Role of Supranational Organisations in S3A Implementation

Knowledge & innovation are *essential*, but are not themselves *sufficient* for development



The Framework

The S3A is an instrument for mobilising the physical, human, institutional, financial and policy resources required to increase the application of STI to achieve agricultural development goals and targets

Vision of the S3A:

"By 2030 Africa ensures its food and nutrition security; becomes a recognised global scientific player in agriculture and food systems and the world's bread-basket"

Leadership, Solidarity & learning

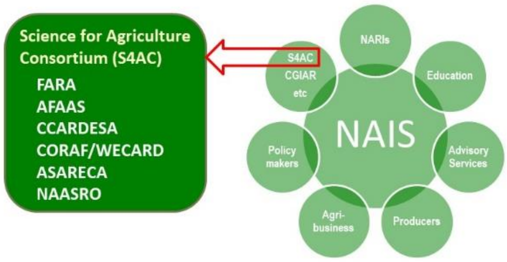
41 countries

Regional and National engagement for S3A roll out

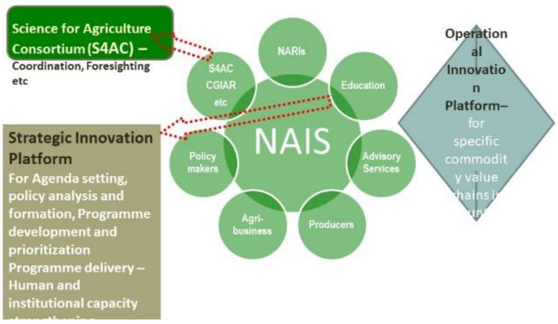
Tier One Country	Sub Region
Malawi	Southern Africa
Rwanda	East and Central Africa
Ghana	West and Central Africa
Senegal	West Africa
Egypt	North Africa - NAASRO

- West, Central and North Africa
- East and Central Africa
- Southern Africa
- National consultations

Institutional arrangements for supporting the roll-out of the S3A



Institutional arrangements for supporting the implementation of the S3A



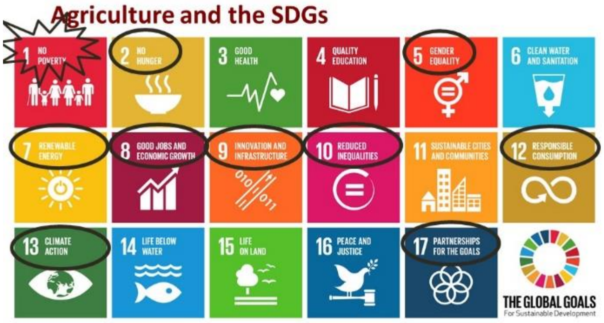
The real challenge

"Challenges will always abound; overcoming them is the real challenge"

Yemi Akinbamijo

Forum for Agricultural Research in Africa 40

Agriculture and the SDGs



Concluding Remarks

1. Achieving the continental target of doubling agricultural productivity and the national productivity growth targets on which the continental target depends will not happen by chance.
2. The S3A is the instrument designed to galvanize action towards achievement of these targets.
3. The S3A seeks not only to support the increased application of STI in agriculture, but also more efficient utilization of resources (investment, capacities, partnerships, Innovative Ag Extensison systems, etc) in ARD
   - By enhancing coherence of initiatives
4. S3A actions primarily happen at national level. Thus national commitment is a condition for success (achievement of targets)

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FORMAL CLOSING MESSAGE

Mr Kuben L Moodley

The Programme Director,

May I acknowledge and recognise our honoured dignitaries, political principals of National, Provincial, Local and International Governments. Our Strategic Partners, International Delegates, National Delegates and Officials of the Agricultural Extension Fraternity.

May I start by congratulating all the Organisers, Service Providers, Discussants, and Delegates for partaking and making this week so very successful.

We have indeed been given our marching orders by the Honourable Deputy Minister for Agriculture, Forestry and Fisheries, General Beki Cele.

The Deputy Minister recommended that we immediately start in taking forward the commitments of this conference and it should not be a tourist event. Later we will hear on the declaration of the Conference, which we have to take forward in full force as of today.

Mobilisation of our critical partners is essential to further the mandates received and MOUs and MOAs with TORs have to be enforced. In this regard, my mandate is to conclude the above with SARFAAS, AFAAS, GFRAS. This is the role of SASAE.

We also have to understand the acceleration of the programme, encourage incubation and flag the disruptors as a means of addressing the triple challenges facing this country and the continent.

How do we go forward from this space? I take note of the previous speaker who referred to the *RI* in *AFRICA*. This stands for Research and Innovation and this will be the catalyst in ensuring success in the declaration.

I thank you and look forward to further deliberations.

SASAE President

Kuben L Moodley

MESSAGE OF SUPPORT BY THE HON. DEPUTY MINISTER, GENERAL BHEKI CELE, AGRICULTURE, FORESTRY & FISHERIES

Hon. Dep. Min. Gen. Bheki Cele

The Ministers of various Government Department's with us here today

The Premier of the KwaZulu-Natal Province

MECs for Agriculture and Rural Development

Members of the Traditional Leadership

Councillors

The Chairperson of the African Forum for Agricultural Advisory services (AFAAS)

The President of the South African Society for Agricultural Extension

Distinguished guests

Ladies and gentlemen;

His Excellency, President Jacob Zuma in his State of the Nation address (2017) stated that, "We need to focus on a few key areas packaged as the Nine Point Plan to reignite growth so that the economy can create much-needed jobs. The focus areas include agriculture and agro-processing, mining and attracting investments". He further mentioned that, "Our farmers went through a difficult period last year because of the drought".

With that in mind, there is no doubt that climate change associated with global warming is widely considered to be amongst the most serious threats to environmental integrity and sustainable development, affecting human well-being and the global economy. The Department of Agriculture, Forestry and Fisheries, with its sector partners, will continue to conduct climate change research in order to inform policy making and also to assist in determining interventions in the sector.

After four days of intensive discussions, presentations, debates and plenary sessions, we have come to the last formal session of the 3rd Agricultural Extension Week Conference under the theme "***Scaling up Climate Smart Agriculture: Integrating youth, women, and the digital revolution***". I believe that you have all learned a lot from the field visits we had on Wednesday and that you are now preparing to go back home. Let me take this opportunity to congratulate the winners of the National Extension and Advisory Services Awards. I have no doubt that these awards are well-deserved and that, with the calibre of Extension Practitioners you all witnessed on Monday night, the future of the sector is in good hands. Events like this indeed present an opportunity to bring together Extension and Advisory Services Practitioners, Producers, Researchers, and institutions of higher learning in South Africa under one roof. This is in line with the recommendations of the National Policy on Extension and Advisory Services. These annual national awards also promote and create awareness of the imperative role Extension and Advisory Services play in the sector and motivate Extension Practitioners to work even harder in their endeavours to render a professional and quality technical advice to our producers.

I further believe that this conference has given us an opportunity to gain valuable knowledge, share experiences on viable technological advancements, and to establish partnerships. I cannot overemphasise the importance of strong partnerships to improve continental challenges of poverty, food and nutrition insecurity. The idea of extension services that traditionally focused on pre-production aspects is outdated; we need to broaden the knowledge and expertise of our Extension Practitioners in a way that enables them to participate along the full value chain. I therefore urge all of you to share the recommendations from the papers, posters and implement these at country, regional and continental levels. The outcomes should inform the research agenda, climate change and climate smart agriculture and in the long run lead to improved policies, increased investment and better institutions that will build resilient and sustainable food production systems across the continent.

The legacy projects emanating from this conference will ensure that the key issues identified are addressed in order to benefit the sector. I believe that after this conference you will go back home and implement everything you have learnt since Monday.

As we close this event, we are proud that we have hosted this successful Joint Conference. The Conference Declaration reflects issues of climate change and mitigation measures, Conservation Agriculture, food security and ICT innovation for Climate Smart Agriculture which are precisely the same issues that we as African countries are currently grappling with. Therefore, this conference addressed the real issues affecting the continent and the world at large. Dr. Kgakatsi, I hope and trust that Climate Smart Agriculture Strategic Framework that you presented on Monday will assist in dealing with this challenge.

I understand that over 500 participants attended this conference with representations from various countries inside and outside the continent. The event was graced by representatives from international organisations such as African Forum for Agricultural Advisory Services (AFAAS), Global Forum for Rural Advisory Services (GFRAS), International Fund for Agricultural Development (IFAD), the United Nations (UN), South African Society for Agricultural Extension (SASAE) and also other departments, civil society, non-governmental organisations, farmer organisations, intergovernmental organisations (including African Union (AU) entities), researchers, academia, financing institutions, private sector and youth organisations. This demonstrates the eagerness of different stakeholders in building future resilient agriculture and food systems through extension and advisory services.

My sincere gratitude goes to the MEC of KZN Provincial Department of Agriculture and Rural Development, Mr Themba Mthembu, for hosting us and introducing our Honourable Minister, Mr Senzeni Zokwana. I would also like to recognise the good work done by our key note speaker, Dr M.N. Mangheni for gracing this conference. My biggest gratitude goes to the Executive Mayor of eThekwini Municipality, Councillor Zandile Ruth Gumede for hosting and welcoming us. I also want to thank our benevolent sponsors who generously offered to support this prestigious event.

Let me also acknowledge all the chairpersons for chairing the sessions, leaders of commissions, academia and the Intelligentsia for their posters and papers; you indeed did an excellent job.

On behalf of the South African Government, I would like to complement the host organisations, Local Organising Committee, for making this Joint Conference a success and also for ensuring robust discussions and participation of all members. I believe it has been a good week and a time of creating sustainable working relations by making new friends and meeting old friends. From the look at the programme, the briefings I got and the session I attended, indeed this has been a great learning and knowledge sharing experience that has enhanced everyone's knowledge.

To all foreign delegates, although, you have been here for a short period, I'm sure you will all be carrying very happy memories of this visit to South Africa, especially to Durban. Many of you may not have had the opportunity to see this province and the city itself, but this event will make the visit to South Africa always memorable.

I wish you all a safe journey back to your different destinations.

Thank you

OFFICIAL CLOSING SPEECH BY ACTING DIRECTOR-GENERAL, DEPARTMENT OF AGRICULTURE, FORESTRY AND FISHERIES

Mr M Kgobokoe

Minister of Agriculture, Forestry and Fisheries, Honourable Mr Senzeni Zokwana and the Deputy Minister of Agriculture, Forestry and Fisheries, Honourable General Bheki Cele (both in absentia)

MEC for Agriculture and Rural Development in KwaZulu-Natal, Mr Themba Mthembu (in absentia)

MECs also in absentia Northern Cape, Mr Norman Shushu; North West, Ms Manketsi Tlhape

The Executive Director of the African Forum for Agricultural Advisory Services (AFAAS), Dr. Silim M. Nahdy

The Chairperson of the Southern African Regional Forum for Agricultural Advisory Services (SARFAAS), Professor Elliot Zwane

The President of the South African Society for Agricultural Extension (SASAE), Mr Kuben Moodley

Respective Board Members of the Joint Hosts

Distinguished guests

Ladies and gentlemen;

Programme Director, the past five days have been very interactive and inspiring as delegates responsible for extension and advisory services gathered and shared experiences on topical issues affecting the sector and the proposed pragmatic solutions.

We have now come to the end of our 3rd Biennial Africa-Wide Agricultural Extension Week Conference held in conjunction with the 51st Annual Conference of the South African Society for Agricultural Extension (SASAE). As I stand before you, I am proud not because the conference has come to an end but on the basis that you have accomplished your mission as per the conference objectives.

The conference was held under the theme "***Scaling up Climate Smart Agriculture: Integrating youth, women, and the digital revolution***". The legacy that this conference is leaving includes: (i) enhanced knowledge among Agricultural Extension and Advisory Services (AEAS) actors on how climate-smart agriculture (CSA) can help farmers to mitigate impacts of climate change and (ii) best-fit practices of climate-smart agriculture for reducing pre- and post-production food losses documented and reinforced by Agricultural Extension and Advisory Services actors.

Ladies and gentlemen, climate change has a profound impact on food security. The number of South African households engaged in agricultural activities decreased by 19,1% between 2011 and 2016 (i.e. from 2,88 million to 2,33 million). This decline is attributed to the drought experienced throughout the country during 2014 and 2015 growing seasons.

Programme Director, the above statistics are testimony to the fact that when the situation is dire in rural areas, most people migrate to urban areas to look for better opportunities. It is on this basis that the South African government in partnership with the Food and Agriculture Organization of the United Nations (FAO), Free State Department of Agriculture and Rural Development and the Maluti-A-Phofung Local Municipality celebrated the World Food Day on the 16th of October 2017 under the theme ***"Change the Future of Migration. Invest in***

Food Security and Rural Development". We emphasise this as Government is committed to ensuring national food security and the eradication of hunger as per the objectives of the National Development Plan (NDP).

Let me take this opportunity to congratulate the winners of the inaugural National Extension and Advisory Services Awards. I have no doubt that these awards are well-deserved and that the future of the sector is in good hands. These awards are meant to promote and create awareness of the imperative role extension and advisory services play in the sector. This will also motivate Extension Practitioners to work even harder in their endeavours to render a professional and quality technical advice to our producers.

Ladies and gentlemen, we reaffirm our commitment to ensure that the newly established National Forum for Extension and Advisory Services is fully operational. This multi-stakeholder forum will serve as a coordinating structure at a national level to enhance effective implementation as well as monitoring and evaluation of Extension and Advisory Services in the sector.

I hope that you enjoyed the project visits on Wednesday and that you will have something to take home with. I also believe that your comments and questions posed to the farmers during the visits will assist them to reflect and possibly improve on their practices.

Ladies and gentlemen, the Conference Declaration reflects on issues of climate change and mitigation measures, Conservation Agriculture, food security and ICT innovation for climate smart which are precisely the same issues that we as African countries are currently grappling with. [

On behalf of the South African Government, the people of the Republic of South Africa and in particular the Minister of DAFF, Honourable Senzeni Zokwana, and the Deputy Minister Honourable General Bheki Cele. I would like to complement the host organisations (DAFF, SASAE and AFAAS), the Local Organising Committee, and most importantly our sponsors for their generosity and for making this Joint Conference a success.

But of course, I also want to express many thanks to everyone who found their way to Durban, South Africa and contributed to this meeting in one way or another. I am very proud to take note that this was one of the biggest audiences we have had at the AFAAS conferences. To put this in numbers: we have had about 700 delegates from all over Africa. I think this is a living proof that there is a need for an organisation like the AFAAS. All of us are now going back home to our offices-back to work at the end of such a long conference. I think it is fair to look back and ask oneself: Was it worth it? Does an event like this bring you forward? Was it worth your time travelling to another country or continent? Was is it worth your personal investment?

With powers vested in me, I declare this conference officially closed.

Ngiyabonga! Baie dankie! Ndo livhuwa! Re a leboga!

Na khensa! Thank you! Asante sana!

Bon voyage!

DECLARATION

WE, the more than 700 representatives from African ministries of agriculture; agricultural extension and advisory systems (including public, private and civil society organizations); farmers and their organizations; academia; national, regional and international agricultural research institutions; the private sector; bilateral and multilateral development partner organizations; financial institutions and the media from over 40 countries; met in Durban, South Africa from 30th October to 3rd November, 2017 to deliberate in the Third AFAAS Africa Agricultural Extension Week 2017 (AAEW 2017) on the theme "**Scaling Up Climate Smart Agriculture (CSA): Integrating Youth, Women and the Digital Revolution".**

APPRECIATIVE of the Government and People of the Republic of South Africa for graciously hosting the AAEW 2017 which was jointly organised by African Forum for Agricultural Advisory Services (AFAAS) with the Department of Agriculture, Forestry and Fisheries (DAFF) and South African Society for Agricultural Extension (SASAE), a forum that afforded us the opportunity to rededicate ourselves to the development of Africa's Agricultural Extension to effectively and efficiently play its roles in scaling up climate smart agriculture by integrating women, youth and the digital revolution.

ACKNOWLEDGING the critical role of agricultural extension and advisory services to effectively respond to farmers and other value chain actors demands to increase agricultural productivity for food and nutrition security and livelihoods improvements especially among smallholders, women and youth.

SEEKING to address the threat posed by climate change and variability to sustainable agricultural growth and rural transformation, and the serious implications it has for food and nutrition security and livelihoods improvement and wealth creation.

RECOGNISING the centrality of women and youth in Africa's agricultural and rural transformation and the barriers that hinder their optimum participation and access to AEAS.

COGNISANT of the African governments commitment to UNFCCC/COP21 and the Paris agreements on climate change through ensuring and tracking their nationally determined contributions (NDCs) to mitigate and adapt to climate change.

ENCOURAGED by the increasing contributions of the agricultural sector to the economies of African countries and its rapid ascent towards becoming a trillion US dollar market to create jobs and decent employment for over 100 million African youth.

NOTING that the average age of the African farmer and the extension worker or advisor or service provider is more than 50 years, we realize the importance of attracting youth into agriculture and related fields as well as into Agricultural Extension as a profession.

AWARE of the African Union's translation of the Malabo Declaration into an agenda for sustaining the momentum of the Comprehensive Africa Agriculture Development Programme (CAADP) through three thrusts namely: (i) Institutions, policies and leadership, (ii) Knowledge and knowledge support; and (iii) Financing Agricultural Investment.

NOTING the low Agricultural Extension worker to farmers ratios in Africa and limited resources for provision of extension services and the opportunity provided by information communication technologies (ICTs) in promoting wider coverage, efficiency and effectiveness in service delivery.

RECALLING our commitment in 2015 during AAEW II to value the learning and innovation of Africa's farmers as we pursue the greater adoption of climate smart agriculture; we emphasise the need to further recognize the African's farmers indigenous knowledge as 'good practices'.

WITH THIS IN MIND, WE HEREBY CALL UPON ALL ACTORS IN AGRICULTURE EXTENSION AND ADVISORY SERVICES (AEAS) TO TAKE ACTIONS THAT WILL SCALE UP CLIMATE SMART AGRICULTURE, SPECIFICALLY:

INTEGRATING YOUTH AND WOMEN IN CSA

1. **Public and Private Institutions** to provide an enabling environment for women and youth to develop and fully utilize their capacities and innovativeness to enhance climate smart agriculture for equitable development outcomes.

2. **AFAAS/DAFF/SASAE** to mainstream women and youth into their institutions and programmes.

3. **AFAAS** to advocate for AEAS and to attract financial institutions to the Forum and to encourage them to fund women and youth entrepreneurial initiatives.

SCALING UP ICTs IN CSA

1. **AEAS Community Members**[68] to promote the development and up-scaling the use of ICTs to enhance innovative response and actions in climate adaptation, mitigation and resilience.

2. **AEAS Community Members** to facilitate accelerated engagement of tech-savvy youth in the development and use of ICTs for the benefit of and rejuvenating the aging farmers in our communities.

3. **AEAS Community Members** to invest in ICTs infrastructure, including products created in indigenous languages, and human capacity development.

SCALING CSA TECHNOLOGIES AND INNOVATION

1. **AEAS Community Members** to promote the scaling of CSA technologies and innovations with a view toward developing a robust system of support for their adoption to effectively mitigate challenges of climate change across Africa.

2. **National AEAS Actors** to forge relationships with the economics and business faculty of national academic institutions to undertake research and analysis on the business viability of new technologies, to develop marketing strategies for these technologies, and to create commercialization plans for useful, but technical, breakthroughs in the CSA research.

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[68] These are all actors in the agricultural extension and advisory system at all levels.

SCALING CAPACITY DEVELOPMENT FOR CSA

1. **AEAS Community Members** support capacity development of public and non-state extension and advisory service providers to effectively deploy, support, and implement CSA innovations for Africa's agricultural and rural development.

2. **National AEAS Actors** engage with farmers and farming communities early and often to ensure that CSA innovations are developed with relevant inputs from agricultural innovation system stakeholders toward full adoption and use of new knowledge and technologies when these are later released on the market.

3. **African Governments, and their Development Partners** to work diligently to strengthen the capacity of our national agricultural extension and advisory services and infrastructure to formulate and deliver inclusive climate smart agricultural information, knowledge and practices for sustainable increase in agricultural productivity on the continent.

4. **African Governments and AFAAS** to work towards professionalizing Agricultural Extension and Advisory Services, as exemplified by the South African Extension Recovery Plan (ERP), to strengthen service provision, catalyse agricultural productivity, and attract young professionals into agriculture as a decent means of livelihood.

SCALING KNOWLEDGE MANAGEMENT FOR CSA

1. **AEAS Community Members** to promote public-private partnerships that focus on the development, capture and maintenance of CSA knowledge within the public sector and among the agriculture and agribusiness communities, and that leverages modern technologies for the storage and dissemination of knowledge and information.

2. **AEAS Community Members** encourage the continuous evolution of our public-sector institutions toward adoption of best practices, policies and regulations, with proactive administrative rules and programs to accelerate Africa's adoption (and creation) of CSA knowledge and technologies.

3. **National AEAS Actors** put in place knowledge management systems that ensure the timely generation of quality CSA content tailored to the divers needs and demands of the diverse actors in agriculture and rural development.

4. **AEAS Community Members** put in place appropriate tools and platforms for enabling all stakeholders to engage in knowledge management for CSA.

SCALING INNOVATION AND ENTREPRENEURSHIP THROUGH CSA

1. **AEAS Community Members** encourage African youth and women to seek exposure to the wider continent to identify intra-African trade and resource sharing opportunities, in particular, to help create markets and demand for local innovation and local entrepreneurial aspirations for without markets it is difficult to be innovative or entrepreneurial.

2. **National AEAS Actors** expand our thinking about how and where it is best to farm, to allow us not to

be mentally confined to older ways of thinking and to be flexible to adapt to changing circumstances on the continent in terms of land availability, and the need for accelerated production of food to keep up with our rapid population growth.

3. **African Governments and their Development Partners** promote systems of market development to enhance national and inter-regional trade to facilitate agribusiness and entrepreneurial development on the African continent.

This Declaration was adopted by the participants who attended the 3rd Agricultural Extension Week, 30 October to 3rd November, 2017 ***and endorsed at the AFAAS General Assembly in Durban on 3rd November, 2017.***

Organisers

agriculture, forestry & fisheries
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