Proceedings

for the

54th conference of the

South African Society for Agricultural Extension

"FACILITATION FOR DEVELOPMENT IN AGRICULTURAL EXTENSION IN THE NEW ERA (COVID-19 PANDEMIC)"

11 – 14 OCTOBER 2021

ASHANTI ESTATE, SONSTRAAL ROAD,

PAARL, WESTERN CAPE

SOUTH AFRICAN SOCIETY FOR AGRICULTURAL EXTENSION

PROCEEDINGS OF 54th CONFERENCE: ASHANTI ESTATE, SONSTRAAL ROAD PAARL, WESTERN CAPE PROVINCE, SOUTH AFRICA.

Published by the South African Society for Agricultural Extension.
Correspondence should be directed to:
The Secretariat,
SA Society for Agricultural Extension,
University of the Free State
Nelson Mandela Drive
Agricultural Building Room G119.11
Bloemfontein
9301
Free to members of the SASAE.

Convenor: SASAE Editorial Committee

FORWARD

The publication contains the papers presented at the 54th Annual SASAE Conference held at Ashanti Estate in Paarl, Western Cape from 11 to 14 October 2021. The Conference is the result of many dedicated volunteers: the reviewers, the best paper award judges and the organising committee. We wholeheartedly thank them all. We also wish to thank all the authors who submitted their work and the program participants for their contributions at the conference. We would also like to thank the Western Cape Department of Agriculture and SACNASP for their sponsorship and support during the conference.

We hope all of you had a fruitful and enjoyable time in Paarl.

TABLE OF CONTENTS

SASAE AWARDS: 2021

Awards Committee

Every year the Awards Committee of the SASAE Board sends out letters to Members to solicit nominations for Awards of the Board. During 2021 the Awards Committee proposed the following Awards to Members, which the Board approved:

1. AWARD CEREMONY

During the Gala Dinner of the Annual conference, we had an Award Ceremony where Members were awarded according to the criteria in the SASAE Awards Bylaws.

1.1. Silver Medal

A Silver Medal is awarded to a person (or a group of persons) who have made a special contribution in promoting Agricultural Extension. This year the Award was won by **Mmantoa Sinky Kgaphola (Mpumalanga)** and **Ineke Vorster (Gauteng).**

1.2. Bronze Medal

A Bronze Medal is awarded to a person (or group of persons) who have made a meritorious contribution in promoting Agricultural Extension. This year the Award was won by **Ngeletshedzo Superior Makhaga of the Eastern Cape Branch.**

1.3. Tim Bembridge Extension Management Award (Bronze)

A person who has demonstrated outstanding extension management is the recipient of this award. The recipient of the Award has made substantial management contributions towards Extension on a continuous basis. This year the Award was won by **Nkosinathi Motsoane (Gauteng)** and **Thulisile Mbilini (Eastern Cape).**

1.4. SASAE Floating Trophy for a Young Professional

A young Extension Officer (with ten years or less service) who has demonstrated a combination of service, leadership and participation in conferences relating to Agricultural Extension will qualify for this award. This year the Award was won by **Nagamso Mtamzeli-Cekiso of the Eastern Cape Branch.**

1.5. Loubie Loubser Floating Trophy

This Award is for the most active Branch of the Society. This year the **Eastern Cape Branch** won this Award.

2. POPULAR PAPER, SCIENTIFIC PAPER & BEST POSTER AT THE CONFERENCE.

During the conference, 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".**

The winner was **L. Qokweni (with co-authors M. Chimonyo & M.C. Marufu) from the Eastern Cape Branch.** The title of his paper was: ***"Differences in Burden of Gastrointestinal Nematode Infestations in Indigenous Foraging in Grassland and Forestland Vegetation Types".***

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

This year the winner was **T. Mokhesengoane (with co-authors H.C. Van der Westhuizen & J.A. Van Niekerk) from the Free State Branch** for the paper: ***"Stocking Rate of Extensive Land Reform Livestock Farmers During 2018/2019 Drought: Bloemfontein Grassland Biome Case Study.".***

During the Conference we had a Poster Session where a number of posters were displayed. There was a panel who adjudicated the posters to determine the **"Best Poster"**.

The winner was **C. Koelman from the Limpopo Province.** The title of their Poster was: **"*Take the Gap"***

3. HONORARY MEMBERSHIP

Honorary Membership is granted to persons who over a period of years have made an exceptional contribution towards the development and application of the science of Agricultural Extension and has rendered out of the ordinary inputs/services to promote the interests of the South African Society for Agricultural Extension. This year honorary membership was granted to **Mr Joseph Benjamin Stevens** for:

- his faithful and committed membership of SASAE for 42 years.
- his commitment, enthusiasm and dedication in which he served the SASAE over many years as council member and Chairman for the Central Branch for the years 2007 and 2008.
- his commitment, enthusiasm and dedication in which he served SASAE as the Secretariat for ten years.
- his participation as a journal article reviewer of SAJAE over many years and the final compilation of the journals for nine years. He also compiled the proceedings of conferences for nine years.
- his contribution as an extension officer in the Department of Agriculture where he specialized in extension for deciduous fruit farmers and smallholder owners up until he became regional manager for the Department of Agriculture. In addition, he informally trained different groups of farmers and was editor of the ward newsletters for ten years.
- his contribution in 19 publications and generation of knowledge towards the extension community.
- his pleasant and warm personality and the upholding of high ethical and professional standards, thereby setting an example to all involved in extension.

4. CASE STUDY COMPETITION

A new initiative in the form of a case study competition was launched at the 2019 SASAE conference. The different extension branches in South Africa were each requested to select four people between the ages of 20 to 35 years, who are attending the conference, and not presenting oral presentations to participate in a case study competition. This initiative was brought in to bring together students and young working people to demonstrate their investigative and problem-solving skills and to provide innovative solutions to practical problems. The winners for the case study competition are presented below:

First Place (Winners)	Second Place	Third Place
L. Mashamaite	A. Maajtie	G. Darries
MM. Mudau	O. Bedeni	J. Links
TR. Thobejane	R. Mokwele	R. Mathobela
	R. Murovhi	Y. Tema

OPENING SESSION

SCRIPTURES AND PRAYER: Mr Gavelin Darries

WELCOMING ADDRESS: Ms Mantombi Mbongo, President SASAE

Honourable MEC

HOD

Dr Mercy Akeredulo

Ms Joyene Isaacs

Our Farmers. Mr Mark Anthony Williams, Mr Kaashif Toefy and Ms Jacky Goliath

Delegates

It is with great pleasure to welcome you to this 54th SASAE Annual conference here at Paarl in the Western Cape. The Theme for this year is: **Facilitation for development in agricultural extension in the new era (COVID-19 PANDEMIC)**. Dear Colleagues, 2020 was a watershed year for the world which has impacted on all of us, whether as individuals or organisationally. As an organisation we also have scars that are a reminder of what we have been through and what we are going through now. Let's salute our heroes and heroines who have assisted us to weather this pandemic storm.

Ladies and gentlemen once again let me welcome you to our belated 54th conference which is been held in the year of Charlotte Mannya Maxeke - a remarkable woman in terms of her dedication as a woman forging ahead in untested waters. Untested because she never knew what will come out of her endeavours and forages. A woman who pioneered new ways of doing things in an unfamiliar environment, a woman who enable things to happen, who influenced the pace of change and its direction. Unheard of in those times from a woman, she engaged with relevant people, formed organisations to drive change and made linkages for other women to study. She was an embodiment of development facilitation in motion. How we need people like her today in this volatile times!

In the coming days, our academia friends, farmers, and other presenters will share with us the relevance of facilitation in our profession and share with us the tools for facilitating change in this COVID-19 era. Our Editorial team ensured that we have good quality papers, and the best 10 papers will be published in our Journal. I should mention that the papers that are being presented today were peer reviewed. This is one of the benefits of presenting in our conferences and it is done to encourage researchers to submit high quality papers.

In our endeavour to expedite and fast track development change, Dr Mercy Akeredolu (Virtual) from Senegal and Ms Joyene Isaacs will share with us multi stakeholder engagement perspectives as well as strategic partnership and networking capacitating skills. We will also hear from our farmers how best we can engage and better their production. We planned a panel discussion to stimulate thoughts and it will be facilitated by Dr Ngwenya. She will also facilitate our workshop on Thursday. Here members are expected to report back on the 5 key priorities they identified in 2019 in Kimberley.

I would like to acknowledge and welcome the presence of all delegates from different Organisations, Institutions of higher learning and the public sector.

With these few words and on behalf SASAE Board and its members, we WELCOME everyone, network and enjoy as much as you can during these 3 days.

Thank you

WELCOME TO WESTERN CAPE PROVINCE HOD: Dr Mogale Sebopetsa

(This Address Was Not Available at the Time the Proceedings was Produced).

OFFICAL OPENING OF THE 54TH SASAE CONFERENCE: Dr Ivan Meyer, MEC

(This Address Was Not Available at the Time the Proceedings was Produced).

KEYNOTE ADDRESS

Dr Mercy Akeredolu (Virtual)

(This Address Was Not Available at the Time the Proceedings was Produced).

SECOND KEYNOTE ADDRESS

Ms Joyene Isaacs

(This Address Was Not Available at the Time the Proceedings was Produced).

Page intentionally left blank

SECOND SESSION

TOP 5 ACADEMIC PAPERS

(Chairperson: Dr Jan Swanepoel)

THE EFFECT OF RECAPITALISATION AND DEVELOPMENT PROGRAMME ON AGRICULTURAL PRODUCTION OF LAND REFORM BENEFICIARIES IN THE EASTERN CAPE PROVINCE OF SOUTH AFRICA

Shiba, W.T.[1] and Aliber, M[2]

Corresponding author: Shiba, W.T; E-mail: wshiba@ufh.ac.za

ABSTRACT

Access to land is a key part of socio-economic development in South Africa. It can be used as a way of rectifying the injustice of the past and lessening the severity of poverty among beneficiaries. To address the issue of land reform, the Recapitalisation and Development Programme (RECAP) was introduced in 2009. The main objectives of this programme are to increase production, to guarantee food security, to create employment opportunities within the agricultural sector and to graduate small farmers into commercial farmers. The purpose of this was to analyze the impact of RECAP on land reform projects, focusing on the agricultural production in the Eastern Cape. Both primary and secondary data were used in the study, collected through farm/projects visits. The results indicated that the programme has made progress towards improving agricultural production on land reform beneficiaries, since its inception of RECAP. Through RECAP intervention, land reform beneficiaries gained technical skills.

Keywords: RECAP, Land reform, Eastern Cape, agricultural production, technical skills

1. INTRODUCTION

South Africa is still facing imbalance in land ownership in twenty-seven years into democracy as a consequence of the apartheid discriminatory practices that resulted in land being taken away from black people. A number of items of legislation were used to dispossess black people of their land and the most significant one was the Native Land Act of 1913 (Boudreaux, 2010).

From its inception in 1994, the democratic government in South Africa has envisioned land reform playing a critical role in addressing past injustices, promoting equity in asset ownership and access to opportunities, and rebuilding sustainable livelihoods in rural and urban areas. This vision was articulated by the African National Congress (ANC, 1992). The program's

[1] Department of Agricultural Economics and Extension, Faculty of Science and Agriculture, University of Fort Hare, South Africa, Private Bag X1314, Alice, 5700.

[2] Department of Agricultural Economics and Extension, Faculty of Science and Agriculture, University of Fort Hare, South Africa, Private Bag X1314, Alice, 5700.

main aims were to correct the inequalities of the past whilst improving the socio-economic economic status of its beneficiaries (Department of Land Affairs, 1997). The main objectives

of the land reform programme are to provide previously disadvantaged people access to agricultural land to improve their livelihood, food security, and quality of life. South Africa's land reform is divided into three sub-programmes namely: land tenure reform which aims to secure people's right to hold land, redistribution which uses land acquisition grants to assist previously disadvantaged people to buy land, and restitution which involves restoring land that was taken away as a result of apartheid practices back to rightful owners (Department of Land Affairs, 1997).

Land is one of the most basic needs in rural areas, as many people depend on access to land for their social and economic survival. According to FAO (2008) securing access land is of importance significant in improving the livelihood of rural people and enhancing their food-security. Therefore, correcting the inequality of land distribution is key in ensuring food security. According to Thiesenhusen (1989), land reform may lead to a decrease in agricultural production initially as a result of the drastic change of the production structure. However, in the long run, land reform can increase agricultural production, resulting in the improvement of the socio-economic position of the beneficiaries. Growth in agricultural production can reduce food prices and increase employment rates and opportunities in rural areas. For land reform to have a positive impact on the livelihood of the beneficiaries, the land concerned must be used productively. In countries like China, Cuba, India, Malaysia, Philippines and South Korea land reform programmes have been implemented to alleviate poverty (Besley & Burgess, 2000; Borras et al., 2006; Gordoncillo et al., 2003; Lim & Anthony, 2003).

Anseeuw and Mathebula (2005) pointed out that, most land reform projects have failed or are experiencing hardships, which has resulted in the reversal of the land reform objectives. Successful land reform projects can contribute in increasing agricultural productivity, alleviate poverty and enhance food security. However, much more than land is needed to improve the socio-economic status of beneficiaries. For instance, appropriate financial services are essential in rural areas to guarantee that sustainable development is achieved. To ensure that the land reform policy achieves its intended goal, input purchase, investments in resettlement, technical advice and other investments are crucial, and land only makes up a minor portion of the overall costs (Thomas & Van den Brink, 2006).

Since a number of land reform farms were unproductive, the Department of Rural Development and Land Reform (DRDLR) saw it fit to introduce the Recapitalisation and Development Programme (RECAP) in 2009. The main objectives of this programme are to increase production, to guarantee food security, to create employment opportunities within the agricultural sector and to graduate small farmers into commercial farmers (DRDLR, 2012).

The programme not only provides support to land reform beneficiaries, but also to emerging black farmers and to farmers in communal areas. The funding provided under this programme replaces all previous forms of land reform grant. Mentorship, co-management and share equity are the core principles of the programme. Cousins (2013) pointed out that the programme has targeted about 1807 distressed farms.

Since the inception of the RECAP in 2010, the government has invested a total of R3.32 billion to recapitalize 1459 farms (DRDLR, 2014). Through the programme, land reform beneficiaries and emerging farmers are provided with wide-ranging support through acquisition of mechanization, entrepreneurial support, infrastructure development, market access, production inputs and integrating into the value chain over a five-year period (Department of Rural Development and Land Reform, 2013).

Access to land is a key part of socio-economic development in South Africa. It can be used as a way of rectifying the injustice of the past and lessening the severity of poverty among beneficiaries. Van Zyl et al., (1996) argue that the success of land reform in South Africa should be assessed against its ability to correct land inequality, upgrade livelihood, food security, rural employment creation, and enhancing the quality of life of beneficiaries. Datar et al., (2004) stated that assessment of a programme is an elementary requirement for improving efficiency and performance. To this end, several programs have been designed and implemented since 1994. After twenty-seven years of implementing these programs, the question still remain whether land reform beneficiaries contribute on RECAP objectives. This study opt to analyze the effect of RECAP on land reform beneficiaries' agricultural production. The results from this study could be helpful to policy makers on choosing appropriate approach that could fulfil the intended objectives of RECAP.

2. OVERVIEW OF RECAPITILISATION AND DEVELOPMENT PROGRAMME

The Recapitalisation and Development Programme (RADP, henceforth abbreviated as RECAP) was launched in 2009 with the following objectives: (a) to increase agricultural production; (b) to guarantee food security; (c) to graduate small farmers into commercial farmers; (d) to create employment opportunities in the agricultural sector; and (e) to establish rural development monitors (rangers). The programme was designed to focus on struggling land reform farms acquired since 1994 that have received little or no support, but have potential to become successful, if assisted. These distressed farms were supposed to receive both technical and financial support from government (Department of Rural Development and Land Reform). Two strategic interventions, namely, strategic partnership and mentorship, have been adopted under the RECAP to ensure sustainability of assisted projects/farms.

Land reform is an important priority for the South African government and constitutes a critical component of the Comprehensive Rural Development Programme (CRDP). The land reform programme was intended to contribute to the CRDP's main objective of deracialising the rural economy, ensuring democratic, equitable land allocation and sustainable production discipline for food security.

Although the land reform programme has achieved some success, in terms of improving access to land and contributing to improved livelihood for beneficiaries, its sustainability has been questioned, both within and outside government circles. In particular, some of the transferred farms have not reached the desired levels of productivity while others are not operational at all. It was partially as a result of the above that the Recapitalisation and Development Programme (RECAP) was implemented in 2010 (DRDLR, 2011a; DRDLR, 2012b).

2.1. Operation of RECAP

RECAP was designed to focus on land reform farms acquired since 1994 that have received little or no support but have a potential to be sustainable. These farms, considered to be in distress, are offered technical and financial support. About 1807 distressed farms have been targeted for recapitalisation and development by 2014. The number of farms recapitalised from the inception of RECAP up to June 2012 was 640 and this is universe from which the sample for the implementation evaluation was selected. According to DRDLR (2013b), 1269 farms had been recapitalised by the end of the 2012/13 financial year. Two strategic interventions have been adopted under RECAP to ensure the sustainability of land reform projects. These interventions are strategic partnership and mentorship.

RECAP funding has no ceiling in terms of the amount of money that an individual farmer should receive. Farmers qualify for any amount, but the grants are approved using a bankable farm business plan, and the business plan is financed by RECAP for a period of five years (DRDLR, 2014). RECAP beneficiaries access their funds for a period of five years uninterruptedly and farmers receive their tranche of money in percentages. In the first-year RECAP funds 100% of the farm business plan; in the second year 80%; in the third year 60%; in the fourth year 40%; and in the fifth year 20%. Thereafter, RECAP funding of the farm business plan ceases (DRDLR, 2014).

2.2. Land Reform in South Africa

Land reform in post-apartheid South Africa has been implemented through three main programs: a) land tenure reform (which seeks to secure and protect land rights of farm workers, farm dwellers, and other vulnerable groups; b) land restitution (which pursues to restore the rights of or compensate people who were forcibly removed from their land after 1913), and c) land redistribution (which focuses on addressing inequalities in land ownership created by land dispossession and forced removals during colonial and apartheid eras). The objectives of these reforms as noted earlier include addressing inequality in land ownership, reducing poverty through productive use of land, and contributing to economic growth by generating income and employment. In recent years, the objectives of land reform have been linked to the broader agenda of rural development in which land reform and agrarian transformation are integral parts. The Comprehensive Rural Development Program (CRDP) sees land reform and agrarian transformation as central to creating “vibrant, equitable and sustainable rural communities” (DRDLR, 2009, p. 9).

2.3. Conceptual Framework

The conceptual framework serves to relate the important factors that contribute to the level of agricultural production on land reform projects beneficiaries benefiting from RECAP.

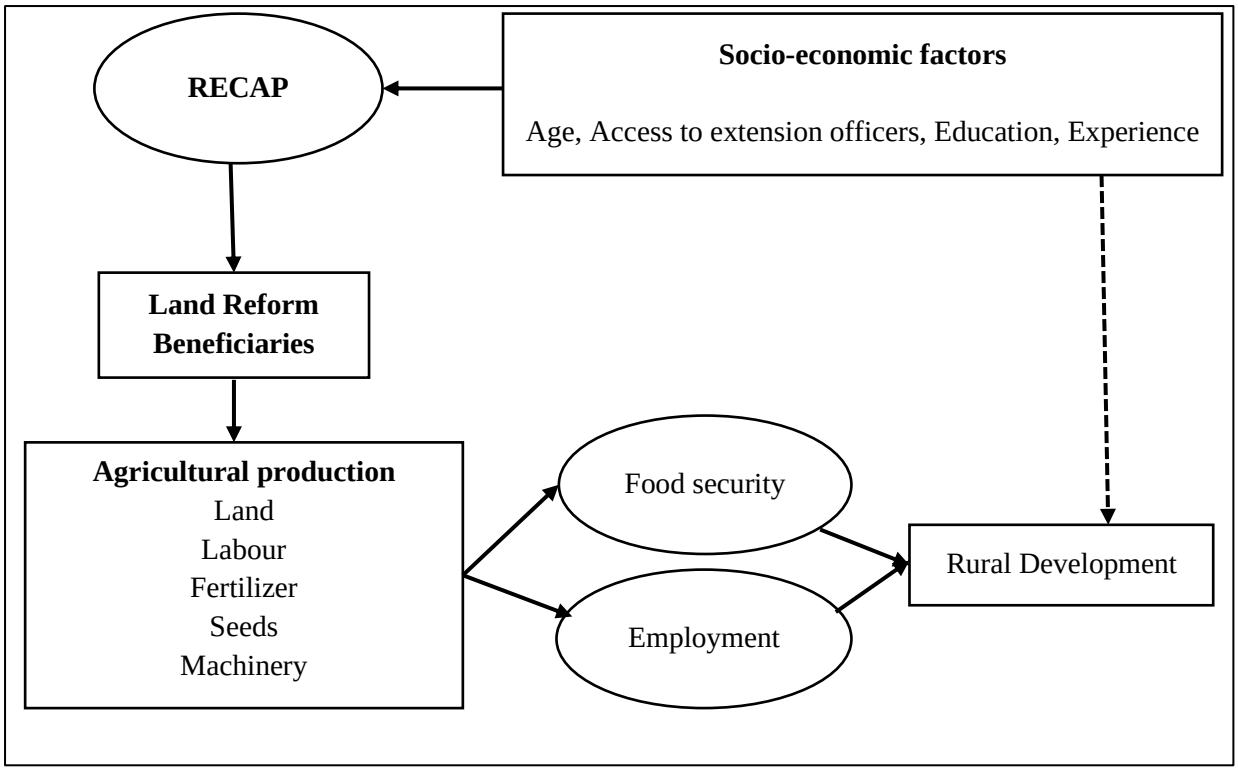


Figure 1: Conceptual Framework
Source: Author's own

3. METHODS AND PROCEDURES

This study used both primary and secondary data obtained from RECAP survey beneficiaries in six provinces of South Africa in 2016 and the Eastern Cape Province was part of the six provinces of the survey. The data was collected during a cross-sectional survey conducted in the Easter Cape, Free State, Gauteng, Kwa-Zulu Natal, Limpopo and North West. To collect the data, a structured questionnaire was administered to the land reform beneficiaries through RECAP. This study is limited into four districts municipality of the Eastern Cape Province namely; Amathole, Cacadu, OR Tambo and Ukhalamba districts. Where nine out of fourteen land reform beneficiaries from RECAP were visited.

3.1. Data collection procedure

The respondents/stakeholders were classified into various categories, depending on their roles and responsibilities, and a different data collection instrument was used for each category. The categories and types of data collection instruments were as follows (Business Enterprise, 2013).

- ✓ Project/farm management: A structured questionnaire was administered to the management (beneficiaries) of the farms/projects.
- ✓ Focus Groups (beneficiaries other than project managers): A checklist was used in cases where, in addition to the project manager, there were other beneficiaries.
- ✓ Strategic partners and mentors: Interviews with strategic partners and mentors were conducted using a checklist.
- ✓ Project officers: DRDLR officials responsible for RECAP project facilitation and coordination with strategic partners and mentors were interviewed using a checklist.

- ✓ Provincial leadership (provincial government officials): A checklist was used for interviews with DRDLR provincial managers (Directors and Deputy Directors) responsible for land reform and RECAP.
- ✓ National leadership (national government officials): A DRDLR official (Director) at the national level responsible for RECAP was interviewed using a checklist.

3.2. Project selection

Stratified sampling and purposive sampling were used to select the projects and respondents. The following criteria were identified for selecting the projects:

- ✓ Geographic distribution to ensure that regional climatic variations are taken into consideration and both urban and rural areas are included.
- ✓ Type of enterprise to ensure that both livestock and crop projects are included.
- ✓ Size of project to ensure that small and large projects are included in the sample.
- ✓ Stage of project to ensure that projects in all stages (planning, implementation and production) are included.
- ✓ Type of land reform program (SLAG, LRAD, SPLAG, PLAS, Commonage, and Restitution).

Table 1: Land reform projects selected in the Eastern Cape

District Municipality	Project Name	Area	Strategic Partner/Mentor	Enterprise
Amathole	Jojo Farming	Rural	University of Fort Hare	Poultry
	Portion 4 of Montra Farm	Urban	Farmer	Tomatoes
	Siyavuselela Agricultural Cooperative	Urban	Farmer	Tomatoes
Cacadu	Kommando Kraal	Rural	Bono (Pty) Ltd	Citrus (oranges)
	Nebraska	Rural	Bono (Pty) Ltd	Citrus (oranges)
Ukhalamba	Lanflo Project	Rural	Imbumba Beef Production (Pty) Ltd	Beef cattle, sheep
	Malibuye Farmers Trust	Rural	Imbumba Beef Production (Pty) Ltd	Beef cattle, sheep
	Vezemafa CPA	Rural	Imbumba Beef Production (Pty) Ltd	Beef cattle, sheep
OR Tambo	Magwa Tea Cooperative	Rural	None	Tea

Source: Author's own (2020)

4. RESULTS AND DISCUSSIONS

The objective of study was to analyze the impact of RECAP on agricultural production of land reform beneficiaries. Through RECAP intervention, land reform beneficiaries gained technical skills. In the districts, technical skills transferred were in cattle and sheep, citrus, tomatoes, and tea. The provincial government officials in the Eastern Cape are of the view that beneficiaries of RECAP have thrived in having their products integrated into the value chain. Since the inception of RECAP, in the Eastern Cape about 188 projects benefited, 3 380 beneficiaries, 125 farmers trained and spend about R427 million (DRDLR, 2015).

To study the impact of RECAP on production level, it crucial to look at the development before RECAP was implemented and compare them with the production development after implementation of RECAP. The agricultural production level of the sampled projects before and after RECAP are shown in Figure 2. The results indicate both crop and livestock production has increase from acquisition of farms to present. The results suggest that both crop and livestock production increase significantly after RECAP was applied.

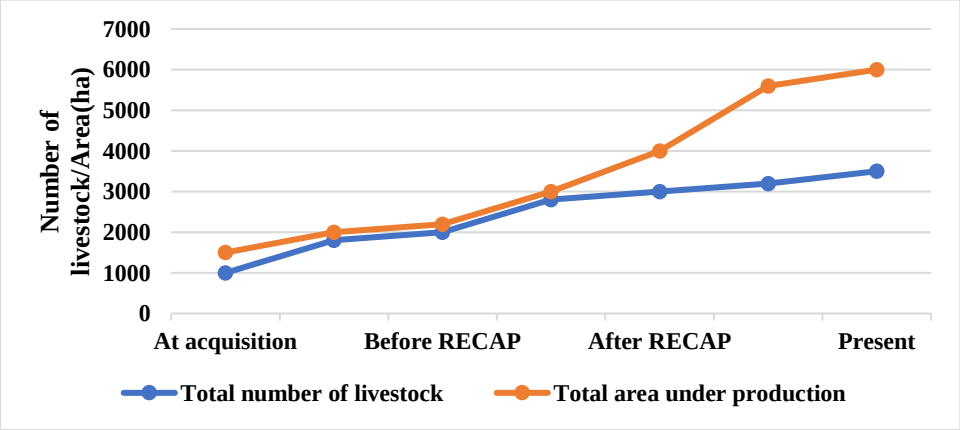


Figure 2: Agricultural production on RECAP farms from acquisition to present
Source: (Business Enterprise, 2013)

Figure 3 shows the growth numbers in livestock on RECAP beneficiaries of land reform in the Eastern Cape. The number of livestock numbers showed an increasing trend since acquisition of the farm and the increase in herd size continued after acquisition. The graph indicate that after the programme was implemented there is a upward trend in herd size of livestock, showing that RECAP has added on the existing herd size of beneficiaries in the province.

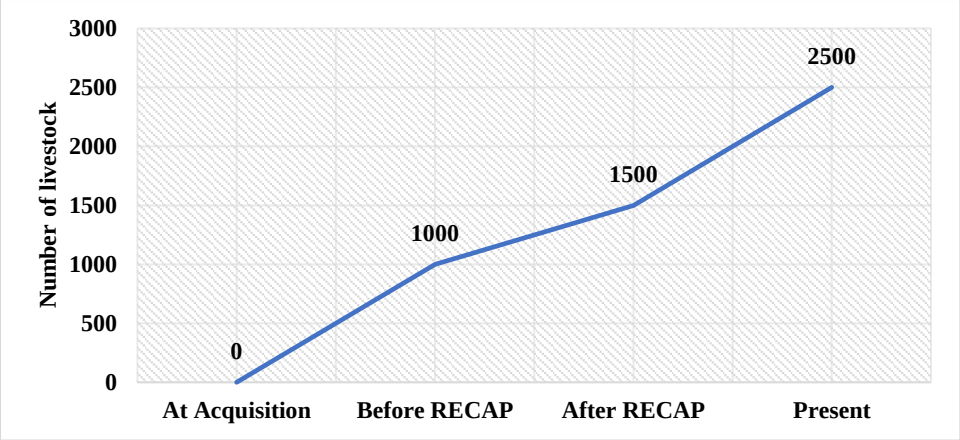


Figure 3: Growth in livestock numbers on RECAP farms
Source: (Business Enterprise, 2013)

Figure 4 depict the area under crop production on RECAP beneficiaries. The results indicate that crop production was stagnate before acquisition in the province. The RECAP has been able to address the stagnate growth resulting to an increase in area under crop production after the programme was introduced. Since then the Eastern Cape Province has experienced a sharp increase in area size under crop production.

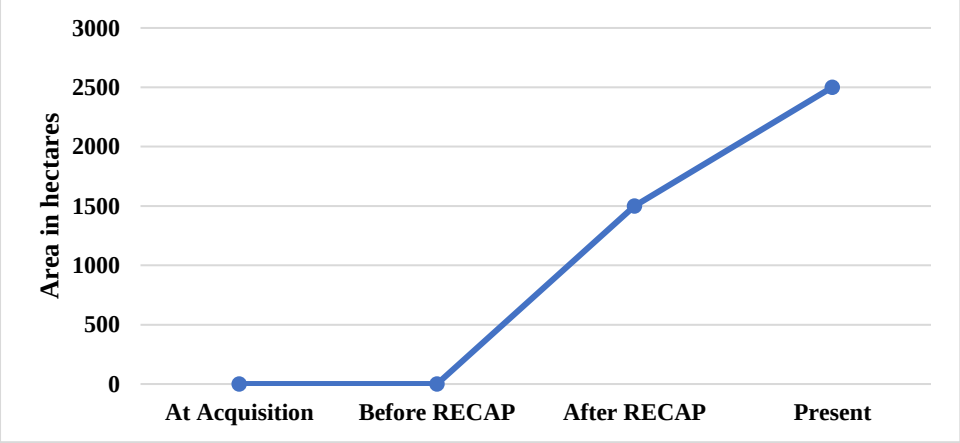


Figure 4: Growth in area under crop production
Source: (Business Enterprise, 2013)

Figure 5 present size information of the projects visited of RECAP beneficiaries. The results indicate that four projects beneficiaries have between 51 to 100 hectares of land. While four project beneficiaries have projects size of 21-50, 101-500, 1001-5000, and 5000+ hectares respectively.

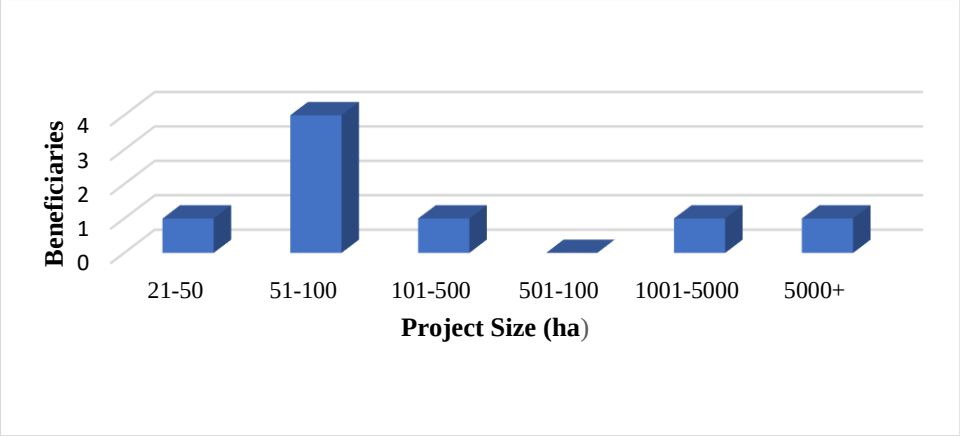


Figure 5: Size of projects visited in hectares
Source: Research findings 2020

Figure 6 shows the proportion of RECAP investment by enterprise. The results indicate that majority of RECAP beneficiaries through land reform are involve in livestock production (34%). Investment in citrus enterprise is (22%), followed by tomatoes enterprise (22%), and poultry enterprise (11%), and tea enterprise (11%) respectively. Indicating that livestock production is most common enterprise across the Eastern Cape Province.

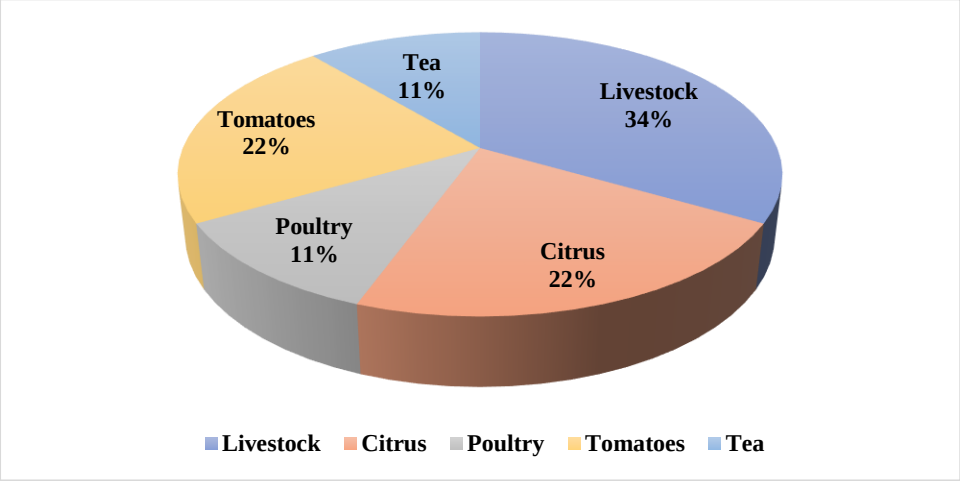


Figure 6: Proportion of RECAP investment by enterprise
Source: (Business Enterprise, 2013)

Figure 7 below indicates the land reform sub programme of RECAP projects. The results indicate that majority (5) of land reform sub programme are through Land Redistribution for Agricultural Development (LRAD), followed by Proactive Land Acquisition Strategy (PLAS) (4). Settlement Land Acquisition Grant (SLAG) have (2) beneficiaries, while Irrigation (IRRIG) and Restitution distributed one each respectively.

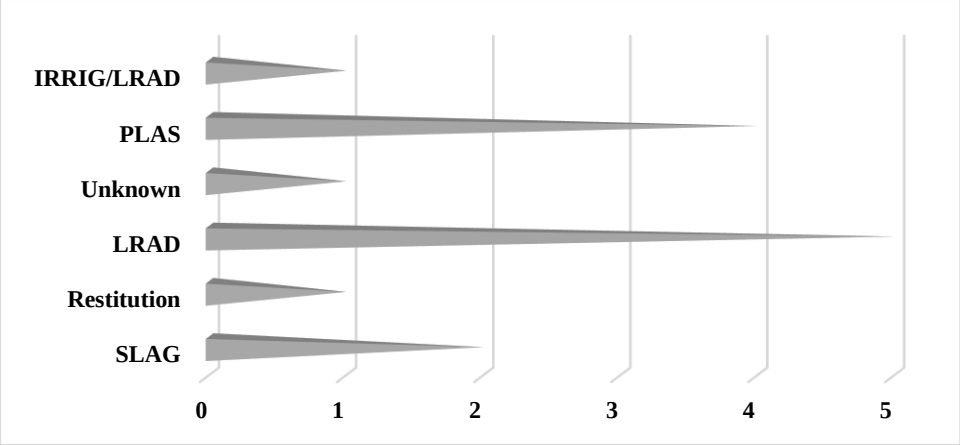


Figure 7: RECAP projects by land reform type
Source: (DRDLR, 2015)

5. CONCLUSION AND RECOMMENDATIONS

The main objective of the study was to analyze the effect of RECAP on agricultural production of land reform beneficiaries in the Eastern Cape. The study was conducted into four districts namely, Amathole, Cacadu, OR Tambo, and Ukhalamba districts respectively. The descriptive results (graphs) illustrated that there is upward trends. Meaning that after RECAP was implemented on land reform projects, overall production in terms of crop and livestock production has increased. The RECAP programme had a positive effect on agricultural production. This means the RECAP programme has made advancement towards achieving its goal to increase agricultural production. Livestock production was found to the most common enterprise within the districts. The study recommends that more funding must be available for land reform beneficiaries to assist with food security and youth unemployment across the province.

6. ACKNOWLEDGEMENTS

The authors like to express their gratitude to the Govan Mbeki Research Development Centre (GMRDC) for their funding and assistance provided in the course of carrying out this study.

7. REFERENCES

AFRICAN NATIONAL CONGRESS (ANC), 1992. Ready to govern: ANC policy guidelines for a democratic South Africa, adopted at the National Conference 28–31 May 1992.

ANSEEUW, W. & MATHEBULA, N., 2008. Land reform and development: Evaluating South Africa's Restitution and Redistribution Programmes. Kellogg's Foundation Research Paper No 2008/1, 67p. University of Pretoria.

BESLEY, T. & BURGESS, R., 2000. Land reform, poverty reduction, and growth: Evidence from India. The Quarterly Journal of Economics, 115(2'0: 389-430.

BORRAS, S., SATURNINO, M., & McKINLEY, T., 2006. "The Unresolved Land Reform Debate: Beyond State-Led or Market-led Models" International Poverty Centre Research Brief.

BOUDREAUX, K., 2010. Land reform as Social Justice. Institute of Economic Affairs, 30(1): 13-20.

BUSINESS ENTERPRISES, 2013. Implementation evaluation of the Recapitalisation and Development Programme (from inception in 2010 to 2012). Pretoria. The Presidency, Republic of South Africa.

COUSINS, B., 2013. Land redistribution, Populism and Elite Capture. New land reform policy proposal under microscope. The Journal of Helen Suzman Foundation, 70:11-19.

DATAR, A., STURM, & MAGNABOSCO J., 2004. Childhood Overweight and Academic Performance: National Study of Kindergartners and First-Graders. Obesity research, 12: 58-68.

DEPARTMNT OF LAND AFFAIRS (DLA), 1997. White Paper on South African Land Policy. Department of Land Affairs.

DEPARTMENT OF RURAL DEVELOPMENT AND LAND REFORM (DRDLR), 2009. The Comprehensive Rural Development Programme Framework. Pretoria, South Africa: DRDLR.

DEPARTMENT OF RURAL DEVELOPMENT AND LAND REFORM (DRDLR), 2010. Annual report 2009/10. Pretoria, South Africa: DRDLR.

DEPARTMENT OF RURAL DEVELOPMENT AND LAND REFORM (DRDLR), 2015. RADP grant and skills development schedule of standard terms and conditions: Mentorship arrangement. Pretoria, South Africa.

DEPARTMENT OF RURAL DEVELOPMENT AND LAND REFORM (DRDLR), 2011(a). Policy framework for Recapitalisation and Development Programme of the Department of Rural Development and Land Reform. Pretoria.

DEPARTMENT OF RURAL DEVELOPMENT AND LAND REFORM (DRDLR), 2012(b). Mid-term review of the Department of Rural Development and Land Reform. Pretoria.

DEPARTMENT OF RURAL DEVELOPMENT AND LAND REFORM (DRDLR), 2013(b). Unpublished documents. Pretoria.

FOOD AND AGRICULTURE ORGANIZATION (FAO), 2008. FAO STAT Online Statistics Service. Food and Agriculture Organization of the United Nation (FAO), Rome.

GORDONCILLO, P., ESCUETA, E., PENALBA, L. & JAVIER F., 2003. An Assessment of the Comprehensive Agrarian Reform Program and Its Impact on Rural Communities: A

Household (MICRO) Perspective. CARP Impact Assessment Studies. Volume 2. FAO-DAR. 85p.

LIM, J. & ANTHONY, Y., 2003. An Integration of the First Round of CARP Impact Assessment Studies, in CARP Impact Assessment Studies. Quezon City: Department of Agrarian Reform.

THIESENHUSEN, W.C., 1989. Searching for agrarian reform in Latin America. Unwin Hyman: Boston.

THOMAS, G.S. & VAN DEN BRINK, R., 2006. Land Redistribution in South Africa: Towards Accelerated Implementation. International Conference on Agrarian Reform and Rural Development. Organized by FAO and Government of Brazil Porto Alegre, Brazil, March 6-10.

VAN ZYL, J. KIRSTEN, J., & BINSWANGER, H.P., 1996. Agricultural Land Reform in South Africa. Cape Town: Oxford University Press.

STOCKING RATE OF EXTENSIVE LAND-REFORM LIVESTOCK FARMERS DURING 2018/2019 DROUGHT: BLOEMFONTEIN GRASSLAND BIOME CASE STUDY

Mokhesengoane, T.E.,[1] Van der Westhuizen, H.C[2] and Van Niekerk, J.A[3].

Corresponding author: Mokhesengoane, T.E; Email: mokhesengoane@gmail.com.

ABSTRACT

The study aimed to determine the average stocking rate among land reform beneficiary farmers specialising in livestock production, in order to establish differences between calving percentage, fodder availability and mortality rate of sampled farmers, and to compare forage scarcities of Land Reform farms with their neighbouring farms during the midsummer drought of 2018/2019 in the Bloemfontein area. The average stocking rate was 5.9 ha/LSU in comparison with the Departmental grazing capacity norm of 6 ha/LSU for rangeland in good condition. However, 31% of the sampled farms were found to be severely overstocked and the mortality rate on these farms, in relation to grazing capacity of 6 ha/LSU, was significantly higher ($P < 0.05$) than the mortalities on the other remaining farms. Natural available fodder was found to be heterogeneous, with 37.9% of the respondents observing their available fodder as worse than that of their neighbours. The total mortality of 176.77 LSUs was recorded for the 29 sampled farms. These findings will assist the local extension personnel to prevent future rangeland condition degradation, and to increase land reform farmers' productivity. The study concluded that training is paramount to farmers' development and further recommends more research undertakings.

Keywords: Stocking rate; land reform farmers; drought

1. INTRODUCTION

Stocking rate must be considered one of the most important determinants of ecological sustainability, sustainable livestock production, and economic returns for extensive livestock farming enterprises (Van der Westhuizen *et al.*, 2001; Van der Westhuizen *et al.*, 2018). Tenacious over-stocking is a major contributor to veld degradation. Nonetheless, to ensure sustainability of extensive livestock businesses and profitability, Forbes (1988) and Van der Westhuizen (2020) indicate that farmers must be in control of equating the animal forage requirements to seasonal forage production cycles and natural periods of forage scarcities. The grazing resources management decisions are heavily dependent on the temporary climatic variations in rainfall and temperature, leading to stocking rate adjustments. Over- and

[1] T.E. Mokhesengoane. PhD student at the University of the Free State and Agricultural Extension Practitioner: Free State Department of Agriculture and Rural Development, Bloemfontein, South Africa, Email: mokhesengoane@gmail.com, ORCID: 0000-0002-4492-7540

[2] Dr H.C. van der Westhuizen. Professional scientist: Range and Forage Science, Free State Department of Agriculture and Rural Development, Glen, South Africa, Email: mias@fs.agric.za

[3] Prof. J.A van Niekerk. Director, Centre for Sustainable Agriculture, Rural Development and Extension, University of the Free State, Bloemfontein, South Africa, Email: vNiekerkJA@ufs.ac.za

understocking are both detrimental to natural veld; overstocking results in severe defoliation, which cripples the natural veld recovery ability post-defoliation, whereas understocking causes mould on natural veld as a result of underutilization of grazable material, leading to a decline in both palatability and nutritional value. Thus, it is extremely essential to always strike a balance between available natural veld and livestock numbers.

The results of not equating large stock unit (LSU) numbers to forage availability are detrimental to natural veld. Substantial evidence by Du Preez and Snyman (1993) and by Mokhesengoane (2020) highlights that veld recovery ability post-severe defoliation is almost impossible, to the extent that seed germination and poor plant re-growth ability can result in a shift in the ecosystem state. Overstocking leads to detrimental removal of leaf area and thus retards the ability of plants to regrow. According to Mworia *et al.* (1997), rangeland recovery ability is heavily dependent on the grazing intensity level. The 1984 White Paper on Agricultural Policy highlighted the tremendous deterioration of natural rangelands in South Africa (Du Toit *et al.*, 1991).

However, according to O'Connor *et al*. (2010) and Sanbi (2014), farmers often manage livestock with the intent to realize production goals only and not to maintain biodiversity. Thus, Dankwerts and Tainton (1996) as well as Van der Westhuizen *et al.* (2018) reiterate that optimization of long-term forage production quality needs rangeland deterioration prevention. This study aims to determine stocking rate and calving percentage as well as get an indication of available fodder during the mid-summer drought of 2018/2019 on land-reform farms. The results of this study will assist local extension personnel in supporting Bloemfontein's extensive livestock land-reform farmers, to ensure ethical, sustainable livestock production and to mitigate catastrophic impacts of drought.

2. MATERIALS AND METHODS

2.1. Study area

The research was conducted on 29 land-reform farms in the magisterial district of the city of Bloemfontein in the central Free State, South Africa. Located at an average altitude of 1 395 m above sea level, it is a semi-arid environment with average annual rainfall of 548 mm. The natural vegetation for livestock grazing can be described as sweet grassveld of the grassland biome, with *Themeda triandra* as the most distinctive and well-distributed grass specie among other perennial grasses available for extensive livestock production (Acocks, 1988; Van der Westhuizen, 2003). Trees are extremely limited in plain variations of the topography, but dense stands can occur in veld areas and hill variations. According to the Department of Agriculture and Rural Development (2003), the grazing capacity for veld in a good condition is 6 ha per LSU. Unfortunately, the Departmental grazing capacity cannot be blindly applied, as veld condition varies considerably from farm to farm.

2.2. Methods

Twenty-nine land reform extensive livestock farmers, representing 30.8% of the total land-reform farmers in Bloemfontein, were randomly sampled from farmers who participated in the 2018-2019 mid-summer drought assessment. Commonage, communal and all farmers who

acquired their farms through private means were purposely excluded. The analysed data for this study was extracted from the following parts/sections of the 2018-2019 mid-summer drought assessment form: size of the grazing area, including the size of arable lands; livestock inventory part C1, highlighting current livestock on the farm; livestock inventory part C2, highlighting livestock mortalities due to drought, and the section where farmers described their available veld fodder comparing it to that of their neighbours. LSUs were calculated using metabolic body weights (Meissner *et al.,* 1983) for medium-framed beef cattle, mutton sheep and Boer goats, as these were the prevalent livestock types kept on the sampled farms. LSU is the equivalent of an animal with a weight of 450kg which gains 500g per day in weight on the pasture with the average digestible energy (DE) concentration of 55% (Meissner *et al*., 1983). Three per cent (3%) of the number of matured cows and bulls were calculated as bulls, since the form does not make provision for separating matured bulls from the cows. Among the studied farms, 51.7% had rain-fed arable lands, ranging from the minimum of 1 ha to 250 ha. These arable lands could not be planted for consecutive years preceding this study and were added to natural grazing areas of specific farms.

To investigate the research topic, a multi-methodological research approach was employed, namely qualitative and quantitative as well as farmers' observations. Stocking rate was calculated as a percentage of the LSUs that can be kept on the farm using a grazing capacity of 6 ha/LSU. Farmers were grouped into five different stocking rate groups. Analysis of variance (ANOVA) was used to compare the mean values and mean differences between stocking rate and mortalities as well as between calving percentage and fodder availability. Market information was also utilized to estimate the value of the financial losses. The rainfall data was collected from Bloemwater weather station and summarised as study area rainfall differences for a period of ten years.

2.3. Rainfall conditions

The South African Weather Services (SAWS) confirmed that summer rainfall areas in South Africa received below average rains for the 2017/2018 and 2018/2019 growing seasons. Furthermore, drought was already declared in parts of the country in 2018. The Bloemfontein local weather station report further confirmed that, for both 2017/2018 and 2018/2019, below average rainfall coupled with extreme high summer temperatures were recorded in the Bloemfontein area. Below average rainfall for September 2018 until the end of January 2019 for the study area, prior data collecting, also contributed to extremely dry conditions. During this period, the area only received 41% of rain in comparison with the long-term average, qualifying the study area as drought restricted.

Rainfall has obvious effects on herbaceous productivity and, as a result, rainfall timing is thus extremely important. Veld growths increased drastically in the Bloemfontein area from November until the end of February and, according to Van Der Westhuizen (2006), the average contribution to rangeland production for these four months is roughly 62%. However, the later process relied on effective rains during August, September and October, which is essential for the ending of the dormant season and contributes immensely to veld quality. Van den Berg (2019) states that, for the period between October and the end of February, the Bloemfontein area experienced below average rainfall for four out of the past five seasons (Figure 1). The

aforementioned five-month period is very important for efficient fodder-flow planning. The findings of Fynn and O'Connor (2000) as well as those of Baudoin *et al.* (2017) and Swemmer *et al.* (2018), respectively, state that the importance of rainfall on veld compositional change cannot be attributed to a single rainfall season, but also to the preceding seasons.

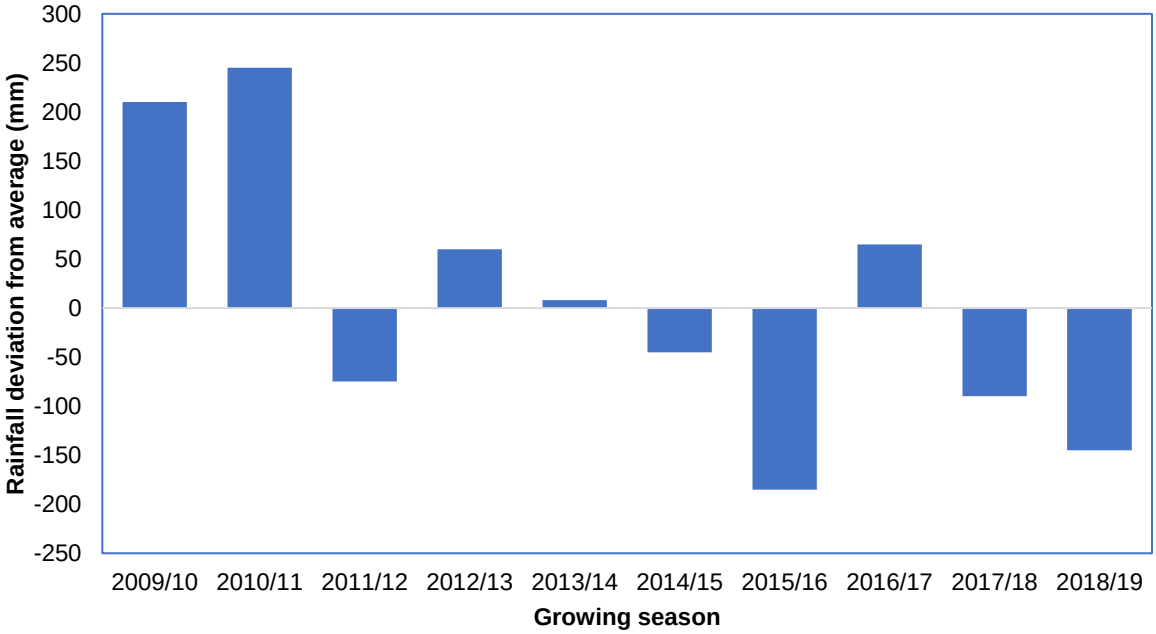


Figure 1: Bloemfontein rainfall differences report for a ten-year period from 1 October to 28 February (Van den Berg, 2019)

3. RESULTS AND DISCUSSIONS

The statistical analyses represent the decisions taken by 29 extensive land-reform livestock farmers sampled for the study, during the 2018/2019 mid-summer drought in the Bloemfontein area. The data are presented in Table 1.

Table 1: Descriptive statistical analyses regarding grazing area, number of large stock units kept, stocking rate, mortalities, and calving rate

	Grazing area, including arable lands (ha)	**Number of LSUs**	**Stocking rate (ha/LSU)**	**Mortalities (LSU)**	**Calving rate (%)**
Mean	514	87.1	5.9	6.1	32
Median	400	54.5	5.7	1.2	31
Std. deviation	446	82.5	6.8	11.2	24
Range	1566	311.3	37.5	55.7	83
Minimum	4	4.6	0.2	0	0
Maximum	1570	315.9	37.7	55.7	83
Total	14902	2526.8		176.8	

The results show that the average number of large stock units were 87.1 allocated to the average grazing area of 514 ha. This means that the average stocking rate of sampled Bloemfontein

livestock land-reform farmers was 5.9 ha/LSU during the 2018/2019 drought. According to these findings, the collective land-reform farmers' average stocking rate conceded with the departmental grazing capacity of the study area for veld in a good condition for an average production growing season. These findings correspond with the findings of Foster (2015), where a similar parameter was measured on an extensive commercial beef-farming unit in the Zastron area, south-eastern part of the Free State province in South Africa. However, standard deviations were large, indicating a big variation in stocking rate between the different sampled Bloemfontein land-reform livestock farmers. These findings are inconsistent with good veld management practices, as highlighted by Forbes (1988:p. 01) that the "farmers must be in control of equating the animal forage requirements to seasonal forage production cycles and natural periods of forage scarcities".

According to Cros *et al*. (2004) as well as Zuma-Netshyukhwi and Stigter (2016), even though there is consistency on vegetation types at farm level, the farmer has no control over prevailing weather conditions as they are dependent on the climatic conditions. However, the stocking rate is the main parameter that the farmer can control. Stocking rate was divided into different groups as indicated in Figure 2, while mortality rate was calculated as the percentage of mortalities on every farm in relation with number of LSUs that can be kept on the farm for veld in a good condition with a grazing capacity of 6 ha/LSU.

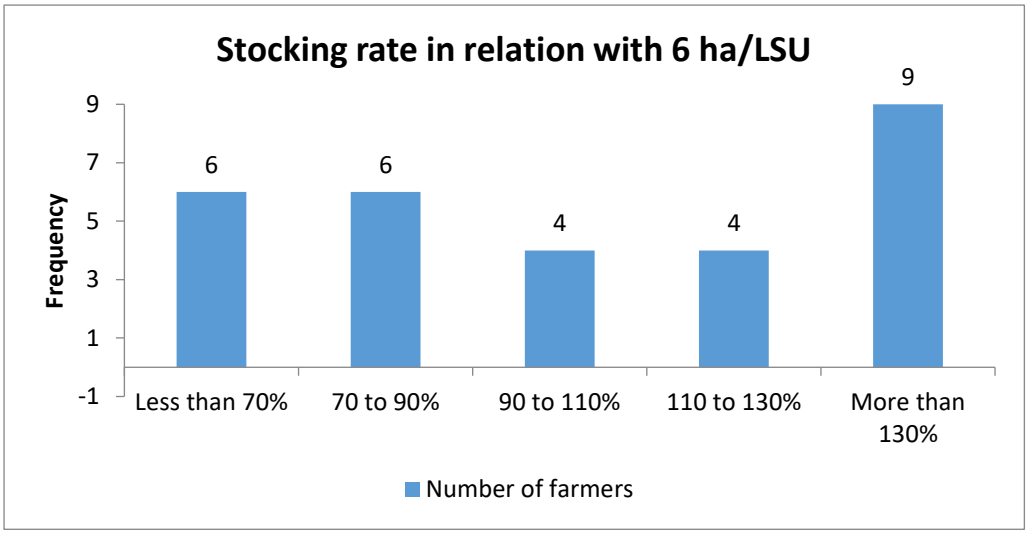


Figure 2**:** Histogram of stocking rate ranges in relation with veld in a good condition (6 ha/LSU) reported by the farmers**.**

Although the average stocking rate for land-reform livestock farmers in Bloemfontein was observed to concede with the recommended grazing capacity for veld in a good condition, six farmers (21%) reported exceptionally low stocking rates and nine farmers (31%) reported extremely high stocking rates. Four of the nine farmers with extremely high stocking rates reported stocking rates of more than 300% in comparison with veld in a good condition. These findings highlighted that 31% of the sampled Bloemfontein land-reform livestock farmers were totally overstocked, even during the drought/dry spell of 2018-2019. It is clear that these farms are not sustainable.

Table 2: Mean mortality rate as a percentage of the stocking rate at 6 ha/LSU as well as calving rate (± standard deviation)

Stocking rate	**Mortality %**	**Calving %**
More than 130% overstock	32.7 ± 50^{a}	32.7 ± 28.7
Rest of the farmers	5.7 ± 7.6^{b}	31.9 ± 22.4

[a & b] – Values in column with different superscripts differ significantly.

The mortality rate of the 31% of the sampled Bloemfontein land-reform farmers, who were totally overstocked, was also significantly higher ($P < 0.05$) in comparison with the other farmers, as illustrated in Table 2. On average, the mortality rate for these farmers was 32.7% of the optimal grazing capacity of 6 ha/LSU, while farmers with more moderate stocking rates on average only lost 5.7% of LSUs. Key to note was the fact that no relation between stocking rate and calving rate could be found from data as reported by the farmers.

Average calving rates were, however, exceptionally low and comparable to the results of Van der Westhuizen *et al* (2020) of 32% obtained with very little or no rangeland management inputs. This trial was executed over a five-year period on the Glen experimental farm of the Free State Department of Agriculture and Rural Development in the Bloemfontein district. The authors highlighted the essential role of sustainable rangeland management in drought and the impact on mitigation, where reproduction of beef cattle was significantly higher during a dry season with sustainable rangeland management in comparison with a normal year, with no rangeland management inputs.

All respondents in this study were requested to make a comparison of their available natural fodder with that of their neighbours, by mere observation, to assess if there was general uniformity on available forage.

Table 3: Respondents' forage scarcity in comparison to that of their neighbours, average stocking rate as well as average mortality rate during drought/dry spell of 2018-2019

Forage in relation with neighbours	**Frequency**	**Percentage (%)**	**Stocking rate (%)**	**Mortality rate (%)**
Better	12	41.4	88	6.5
Same	6	20.7	147	14.0
Worse	11	37.9	378	22.4
Total	29	100.0		

In the study, 41.4% of the respondents, which is the biggest portion of the sampled group, observed that their available fodder was better than that of their neighbours; 20.7% of the respondents observed that their available fodder was similar to that of their neighbours, and 37.9% of the total respondents, which is the second biggest portion of the sampled group, observed that their available fodder was worse than that of their neighbours.

Although not significant, a clear trend was found between available fodder and stocking rate, as well as available fodder and mortality rate, as reported by respondents. The average stocking

rate of the farms with less fodder available than their neighbours (378%) contributed to both forage shortages and higher mortality rates (22.4%). These findings clearly point out that there was no uniformity in terms of available fodder between the respondents. However, even though it is essential to note that livestock management systems might differ from one farmer to the next, the 37.9% is not simply a fraction of the respondents and, as a result, a close monitoring and more detailed assessment of production systems and stocking rates for land-reform livestock farmers in Bloemfontein is recommended. Nonetheless, the average calving rate on farms with less fodder available during the drought was significantly higher ($P < 0.05$) at 45% in comparison with the rest of the farms with an average calving rate of 25%. In practice, these findings might suggest that farmers with higher livestock production skills, unfortunately possess lower fodder management skills, which might be a serious threat to sustainable extensive livestock production.

Drought/dry spell drastically reduces the availability and nutritional value of the available fodder for livestock grazing. Nonetheless, literature consistently agrees with the fact that the lack and poor quality of natural fodder in extensive livestock farming systems increase the susceptibility of livestock to diseases, leading to subsequent livestock deaths. A total livestock mortality of 176.8 LSUs for sampled farmers (Table 1) was recorded during the period of this study. This equates to R 1 760 920.87 based on average class B2/B3 beef carcass price for November 2018 of R42.39/kg, which is an enormous financial loss incurred by farmers when converted to monetary value. On average, each farmer from the total sampled group lost 6.1 LSUs, as observed in Table 1. This means that, on average, each farmer incurred R 60 766.65 financial losses. The losses varied from old cows/ewes/does to offspring. However, the older breeding stock accounted for more than 80% of the entire losses. The loss of breeding stock is a major setback in livestock farming, since it can take years to rebuild the breeding stock.

4. CONCLUSION AND RECOMMENDATIONS

4.1. Conclusion

Bloemfontein land-reform farmers' average stocking rate indicated positivity in comparison to the departmental stocking rate norm of 6 ha/LSU, at the time when rainfall data indicated successive years of below average rainfall and when a significant proportion of the sampled farmers observed their natural fodder availability as worse than that of their neighbouring farms. It is thus concluded that the positive relationship is spurious. The stocking rate of 21% of the respondents was exceptionally low, resulting in a loss of income for these farmers, while 31% of the respondents' stocking rates were extremely high, which will contribute to rangeland degradation, unsustainability, and poverty. Mortality rates of livestock was also high for the farmers who were severely overstocked, and they lost on average 32.7% of livestock that can be kept on the farms in optimal conditions, during the 2018/2019 drought. The fact that rangeland condition was not evaluated could further indicate that stocking rate of the vast majority of farmers is too high for sustainability. According to Van der Westhuizen (2003), the grazing capacity for rangelands in moderate condition (50%) is roughly 8 ha/LSU for cattle and 9.5 ha/LSU for sheep for the study area.

In terms of available fodder, 38% of the respondents reported fodder shortages, with available fodder less than on neighbouring farms. On average, the farmers with fodder shortages were severely overstocked during the drought and livestock mortalities for this group of farmers was 22%. As a result, the continued viability of these farming operations is in jeopardy. Calving rates, as reported by farmers, were also exceptionally low, with an average of 32% and a standard deviation of 24%. According to Van der Westhuizen *et al.* (2020), low calving rates can be classified as the main financial driver in terms of profitability for extensive livestock farming systems.

Due to climate change and global warming, the effect of the correct stocking rates will play a major role in the sustainability of Bloemfontein's extensive land-reform livestock farmers. Imprudent grazing management practices, especially pertaining to veld, already under stress prior to the onset of drought, is one of the most important contributing factors to the devastation caused by the drought (Coleman, 2017). Dry years, particularly when they occur in succession, can reduce perennial plant cover and reduce the number of animals the veld is able to support (Van der Westhuizen *et al.*, 2018). It is recommended that livestock numbers be reduced during extended drought periods. Stocking rates, according to grazing capacity as well as the timely adjustment of stocking rates during droughts is essential to promote sustainable utilisation of natural veld, and subsequently to ensure sustainable productivity on extensive livestock farming systems.

Bembridge (1986) and Mokhesengoane (2020) emphasized the importance of educational programmes both on the formulation of veld management programmes and veld assessment for farmers. Education of farmers on rangeland management, livestock reproduction performance and economics has a major role to play in their decision-making process when managing their rangelands. Farmers, extension personnel and rangeland scientists have a major role to play in this regard, in order to reduce or prevent future rangeland degradations.

4.2. Recommendations

It is recommended that the extension personnel of the Bloemfontein ward office develop systems to closely assess and monitor livestock production systems, and veld management programmes utilized by land reform livestock farmers to narrow 38% of the respondents, who observed their available fodder as worse than that of their neighbours.

It is also recommended that these personnel must arrange intensive training on rangeland degradations and stocking rate alignment with natural forage scarcity periods for their land-reform livestock farmers.

5. ACKNOWLEDGEMENTS

The authors are grateful for the contribution of Mr Johan van den Berg, a senior Climatologist and Manager Specialized Crop Insurance at Santam Crop Insurance, for his guidance and enormous contribution in this study about long-term rainfall pattern analyses.

6. REFERENCES

ACOCKS, J.P.H., 1988. *Veld types of South Africa. Memoirs of the Botanical Survey of South Africa*. Pretoria: Government Printer.

BEMBRIDGE, T.J., 1986. 'n Uitdaging vir landbouvoorligting. *Journal of the Grassland*, vol. 3:159-163.

BAUDION, M., VOGEL, C., NORTJE, K. & NAIK, M., 2017. Living with drought in South Africa: Lessons learnt from the recent El Niño drought period. *International Journal of Disaster Risk Reduction*, 23:128-137.

COLEMAN, A., 2017. Always manage grazing with drought in mind. *Farmers Weekly*, 7 June 2017.

CROS, M.J., DURU, M., GARCIA, F. & MARTIN-CLOUAIRE L,R., 2004. Simulating management strategies: The rotational grazing example. *Agricultural Systems*, 80:23-42.

DANKWERTS, J.E. & TAINTON, N.M., 1996. Available biomass and carrying capacity. Range management: Optimizing forage production and quality. *Bulletin of the Grassland Society of Southern Africa*, 7(1):36-50.

DEPARTMENT OF AGRICULTURE, 2003. Free State Province. Map compiled by Farming Information Section.

DU TOIT, P.F., AUCAMP, A.J. & BRUWER, J.J., 1991. The national grazing strategy of the Republic of South Africa: Objectives, achievements and future challenges. *Journal of the Grassland Society of Southern Africa*, vol. 8:126-130.

DU PREEZ, C.C. & SNYMAN, H.A., 1993. Organic matter content of a soil in a semi-arid climate with three long-standing veld conditions. *African Journal of Range and Forage Science*, vol. 10:108-110.

FORBES, T.D.A., 1988. Researching the plant-animal interface: The investigation of ingestive behavior in grazing animals. *Journal of Animal Science* (66):2369-2379.

FOSTER, L.A., 2015. The profitability and production of a beef herd on transitional Cymbopogon – Themeda veld receiving three different levels of lick supplementation. D. Tech Agric. thesis. Central University of Technology Free State, pp. 15-16.

FYNN, R.W.S. & O'CONNOR, T.G., 2000. Effect of stocking rate and rainfall on rangeland dynamics and cattle performance in a semi-arid savanna, South Africa. *Journal of Applied Ecology*, 37:491-507.

MEISSNER, H.H., HOFMEYR, H.S., VAN RENSBURG, W.J.J. & PIENAAR, J.P., 1983. *Classification of livestock for realistic prediction of substitution values in terms of a biologically defined Large Stock Unit. Technical Communication no. 175*. Pretoria: The Government Printer.

MOKHESENGOANE, T.E., 2020. Land reform farmers stocking rate pattern during extended dormancy season: Bloemfontein grassland biome case study. MSA mini-dissertation, University of the Free State, Bloemfontein, South Africa. 53 pp.

MWORIA, J.K., MNENE, W.N., MUSEMBI, D.K. & REID, R.S., 1997. Resilience of soils and vegetation subjected to different grazing intensities in a semi-arid rangeland of Kenya. *African Journal of Range and Forage Science*, vol. 14:26-31.

O'CONNOR, T.G., KUYLER, P., KIRKMAN, K.P. & CORCORAN, B., 2010. Which grazing management practices are most appropriate for maintaining biodiversity in South African grassland? *African Journal of Range & Forage Science*, 27(2):67-76.

SANBI, 2014. Grazing and burning guidelines: Managing grassland biodiversity and livestock production. Compiled by Lechmere-Oetel, R.G. South African National Biodiversity Institute, Pretoria, 42 pp.

SWEMMER, A.M., BOND, W.J., DONALDSON, J., HEMPSON, G.P., MALHERBE, J. & SMIT, I.P.J., 2018. The ecology of drought – A workshop report. *South African Journal of Science*, 114(9/10):1-3.

VAN DEN BERG, J., 2019. Long term rainfall pattern analysis report for the Bloemfontein area. Santam Crop Insurance.

VAN DER WESTHUIZEN, H.C., 2003. Die gebruik van degradasiegradiënte vir weiveldevaluering in 'n semi-ariede gebied. Ph.D. thesis, University of the Orange Free State, Bloemfontein, South Africa. 444 pp.

VAN DER WESTHUIZEN, H.C., 2006. Weiveldevaluering vir optimale hulpbron benutting. *Nguni J.*, 2006:13-33.

VAN DER WESTHUIZEN, H.C., 2020. Volhoubare veldbestuur and soet veld gebiede. *Veeplaa*s December 2020.

VAN DER WESTHUIZEN, H.C., MOHLAPO, T.D., DE KLERK, J.D., MAJOLA, S.E., SNYMAN, H.A. & NESER, F.W.C., 2020. Reproduction performance of beef cattle before and after implementing a sustainable grazing system in a semi-arid grassland of southern Africa. *South African Journal of Agricultural Extension*, 48(1):112-121.

VAN DER WESTHUIZEN, H.C., SNYMAN, H.A. & FOUCHÉ, H.J., 2018. Sustainable veld management guidelines for the Free State. *Glen Research Periodical FSDARD*, 1:27-59.

VAN DER WESTHUIZEN, H.C., SNYMAN, H.A., VAN RENSBURG, W.L.J. & POTGIETER, J.H.J., 2001.The quantification of grazing capacity from grazing and production

values for forage species in semi-arid grasslands of southern Africa. *African Journal of Range & Forage Science*, 18(1):43-52.

ZUMA-NETSHIUKHWI, G.N.C. & STIGTER, C.J., 2016. An extension approach to close the gap between suppliers and users of agro meteorological services in the south-western Free State of South Africa. *South African Journal of Agricultural Extension*, 44(2):84-98.

USING ACTION RESEARCH TO DEVELOP A DROUGHT ADAPTATION STRATEGY

Conradie, B.I.[1] and Kerry, C.L.[2]

Corresponding author: Conradie, B.I; Email: Beatrice.Conradie@uct.ac.za

ABSTRACT

The drought in the Karoo is the worst in a lifetime across the region and thereby demands a response from the extension service. An Action Research (AR) lens is used to describe the process of formulating an adaptation programme that responds to the crisis. The study describes the initial planning steps and the data analysis that constituted the first Action Research cycle of an ongoing programme in the Karoo. At the end of the AR first cycle competing climate change scenarios emerged and were reflected on, and the study presents the way forward as the planning stage of the next AR cycle. This study offers a route map for other practitioners working on similar climate adaptation programmes.

Keywords: Arid conditions, action research, adjustment to drought

1. INTRODUCTION

The Karoo covers the arid western half of South Africa. Low and erratic rainfall limits agriculture to low-intensity sheep and goat farming. This sheep industry provided the financial bedrock for the Cape Colony in the 18th and 19th centuries (Beinart, 2018) but its development fell behind the rest of the province during the first half of the 20th century due to a lack of technical progress (Conradie et al., 2009). Other reasons for the stagnation include drought and overgrazing, decaying infrastructure caused by a decline in commercial farming, and more recently predation (Conradie et al., 2013; Conradie and Nattrass, 2017). In 2002 the region's livestock numbers were the lowest in a century and farmers are now financially more vulnerable than ever (Conradie and Landman, 2015). These farmers are low on the government's list of priorities (Nattrass and Conradie, 2015) and defenceless against adverse weather which they consider to be just as big a threat as predators (Conradie and Piesse, 2016; Wustro and Conradie, 2020).

The potential financial devastation of the drought places a significant burden on extension staff to disseminate sound advice that will support rational decision making and will foster the correct mental models to achieve transformative change in the sector. What this would entail is an important question to ask since most of the climate change adaptation literature focus on policies and perceptions (including farmers' perceptions of how the weather has changed in their area) but offers little guidance on adaptation practices. Kania et al. (2018) emphasised the importance of power dynamics and relationships to facilitate transformative change. In this instance the extensionists' role is to promote sustainable agriculture by encouraging farmers to change farming practices. The implicit nature of the latter makes it difficult to think about new

[1] Associate professor in the School of Economics and Director of the Sustainable Societies Unit in the Centre for Social Science Research at the University of Cape Town.

[2] Independent Monitoring and Evaluation Consultant, 8 Greenwood Road, Pietermaritzburg

interventions generally, and this gets more challenging if the requirement adjustments are more complex.

This study uses Action Research as an analytical framework to describe our emerging practice on how to formulate an appropriate climate adaptation message for the Karoo. The programme is very new and still not fully formalised, but much work has gone into it and it has already delivered many useful insights. Action Research is well suited to the problem at hand because it emphasises process while at the same time being sufficiently flexible to accommodate the tentative nature of programme initiation.

The technique is described in Section 2. Section 3 presents a brief history of the programme and the data analysis which constitutes most of the action undertaken during the first AR cycle. The main results are presented in and reflected on in Section 4 and 5. Section 6 introduces the next AR cycle by presenting the way forward and the paper concludes with some lessons for practitioners writing about practice.

2. ACTION RESEARCH

Hobson et al. (2013) described Action Research as an iterative process that alternates between planning, action and reflection (Figure 1), a familiar sequence in the work life of an extension practitioner. Any intervention begins with "finding out" which collates existing data to define a problem. With the problem clarified, suitable goals can be set to steer clients' existing actions and invoke new responses. These decisions generate an extension programme that could involve choices on, for example, what meetings to hold and which information to share. Once "things start to happen" on farms (actions), outcome data will flow (e.g., farm financial performance) which need to be reflected on. Initially, the extensionist will simply "watch and listen" and then "think about and discuss" the emerging data with colleagues. At the end of the process of reflection, he or she might come to a different insight about the nature of the challenge at hand, which could result in a completely different programme triggering a new AR cycle of "making things happen", "watching and listening" and "thinking and discussing".

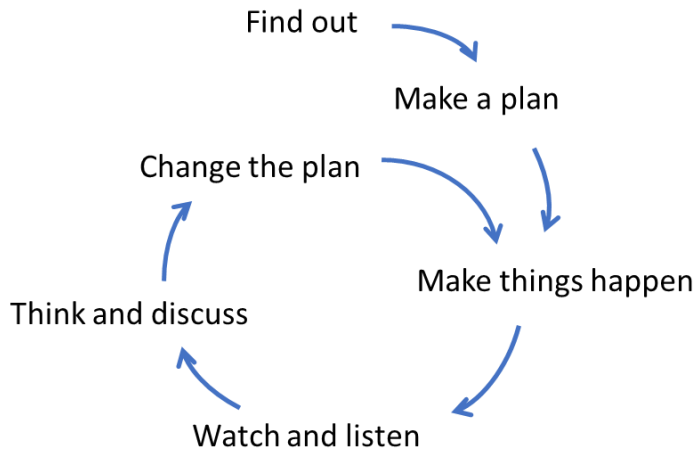


Figure 1: Steps in the action research process (Source: Hobson et al., 2013)

Action Research is not the same as Monitoring and Evaluation (M&E), but AR can be a very useful informal precursor to formal M&E because it gathers knowledge and insight that will

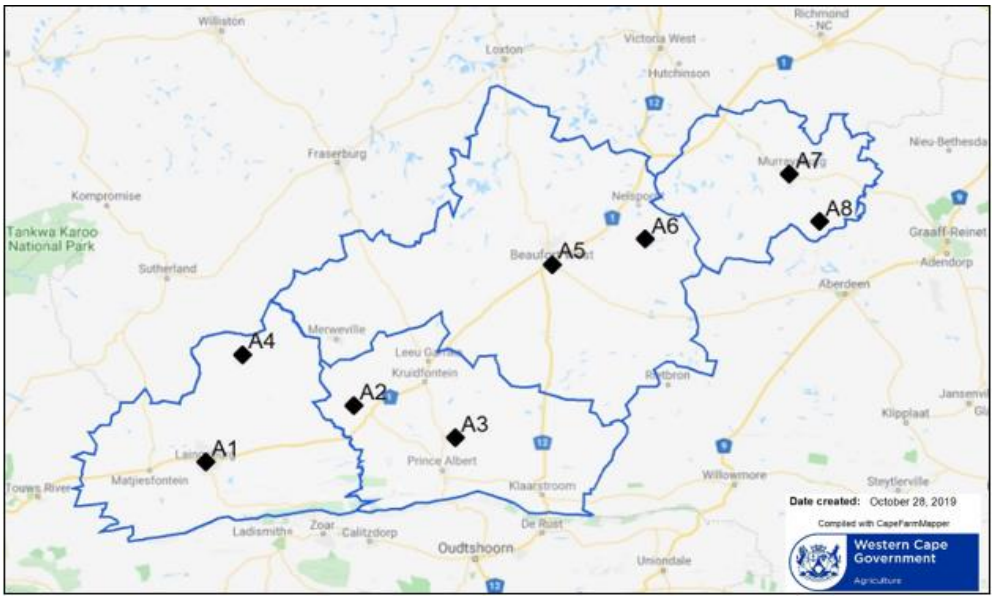
improve the M&E design when the programme matures enough to justify formal monitoring and evaluation. According to Hobson et al. (2013) monitoring is the formal collection and analysis of data while a project is ongoing and evaluation is the periodic, retrospective (external) formal evaluation of its performance.

3. FINDING OUT ABOUT THE DROUGHT IN THE KAROO

This study's context is the current drought[3] in the Central Karoo District Municipality. Interest in this area goes back to the mid-2000s when a district-level total factor productivity analysis of the Western Cape found consistently poor performance across the Karoo (Conradie et al., 2009; Conradie et al, 2013). In response to serious predation problems we established a research project in 2011 to measure its effect on sheep farms (Nattrass and Conradie, 2015; Nattrass and Conradie, 2018; Nattrass et al., 2019). The predation project generated the Karoo Management Survey, a four-wave panel dataset of representative farm financials for 52 operations for the period 2012 – 2015. Earlier waves of this dataset were used to record profitability and measure productivity (Conradie and Landman, 2015; Conradie and Piesse, 2015) and more recently the whole four wave panel was used to identify success factors for this production system (Conradie, 2019).

The 2019 analysis revealed that total factor productivity is closely related to weather conditions, but in the field, we found that farmers were vague about grazing conditions and that very few (<1/3) kept rainfall records. On reflection it is not so easy to translate rainfall into grazing capacity and *vice versa* because the Karoo's dwarf shrub vegetation evolved to cope with highly erratic rainfall so that the relationship between the two is not always linear.

One way of simplifying the vegetation rainfall relationship is to summarise rainfall into a grazing index using Du Toit's (2010) method. Du Toit's index calculates a moving average annual total figure from monthly data subjected to linear depreciation over a 12-month period.



[3] The drought was ongoing at the time of writing this article (February 2021). It began in 2013 in some parts and in 2015 in other parts of the study region and 2019 was the driest year on record at several locations (Conradie and Theron, 2019). By the end of the 2020/21 rainfall season carrying capacity is still not fully recovered despite relatively good rains in certain parts of the study area (Milton, pers. Comm).

Straight line depreciation is used, which means that if a farm received 20mm of rain six months ago, only 10mm will count towards the current month's index. Each index is site-specific. This makes it possible to interpret current conditions, including the duration and depth of an ongoing drought, against the historical data for the specific site, which avoids generalisations. Du Toit (2010) defines the start of the drought as the point at which the index falls below the 10th percentile of grazing index values on record and declares a drought to be over when the grazing index rises above the 50th percentile of data on record. The main advantage of this index is that is mimics the local vegetation's ability to accumulate rainfall over long periods and it main disadvantage is that it is not yet underpinned by firm scientific data. Two other important advantages are that median monthly values preserve the appropriate seasonal pattern and history for each site. See Conradie and Theron (2019) for an analysis of the history at the eight sites indicated in Figure 2. In Figure 3 this data was converted into the number of dry months per decade in the period since 1940. Also see the appendix.

Figure 2: Distribution of sites for which grazing indices are available in the Central Karoo (Source: Conradie and Theron, 2019)

Figure 3 shows many more dry months during the 1940s, 1950s and 1960s than in the period since 1980, although conditions deteriorated markedly during the most recent decade. However, between 88% and 100% of the dry months recorded in the decade following 2010 occurred since January 2015, in other words quite recently.

This data has several implications. Firstly, Figure 3 reveals that there is incredible spatial variability across the eight sites that are located within a radius of 150 kilometres in what is often considered a homogenous area. The first lesson for extension staff working on climate change is to be on the lookout for spatial variation and to ensure that there is enough local weather data available to allow a proper location-specific assessment of changing trends. A lack of temperature data is the main concern. Secondly, it is sometimes quite difficult to summarise weather data in a way that farmers find useful, but this must be done if the extensionist has any ambition to use an evidence-based approach to influence their clients' behaviour. A third implication of Figure 3 is that recent rainfall patterns created a biased mental model amongst the current generation of farmers, most of whom have only ever operated under normal or above normal rainfall conditions. One of the most urgent extension challenges is to point out, explain and correct this mental bias. Fourthly, it is important to see this data for what it is and not for what we want it to be. In a study of changing climate trends in the Boland, Jury (2020) found a dramatic decline in surface runoff in a catchment of the Du Toitskloof Mountains that is attributable not to lower rainfall but to higher evaporation due to higher temperatures. Figure 3 reflects only rainfall and no temperature effects incorporated yet and it is a high priority to work out how the local vegetation responds to a given rainfall regime at higher temperatures. This is a task for plant ecologists and not something extension staff can do on their own. But while the research is ongoing, the extensionist can begin to sensitise his / her clients about the potentially negative effects of rising temperatures for example by sharing summaries of daily minimum and maximum temperatures data and encouraging selected farmers to begin keeping temperature records in addition to rainfall records.

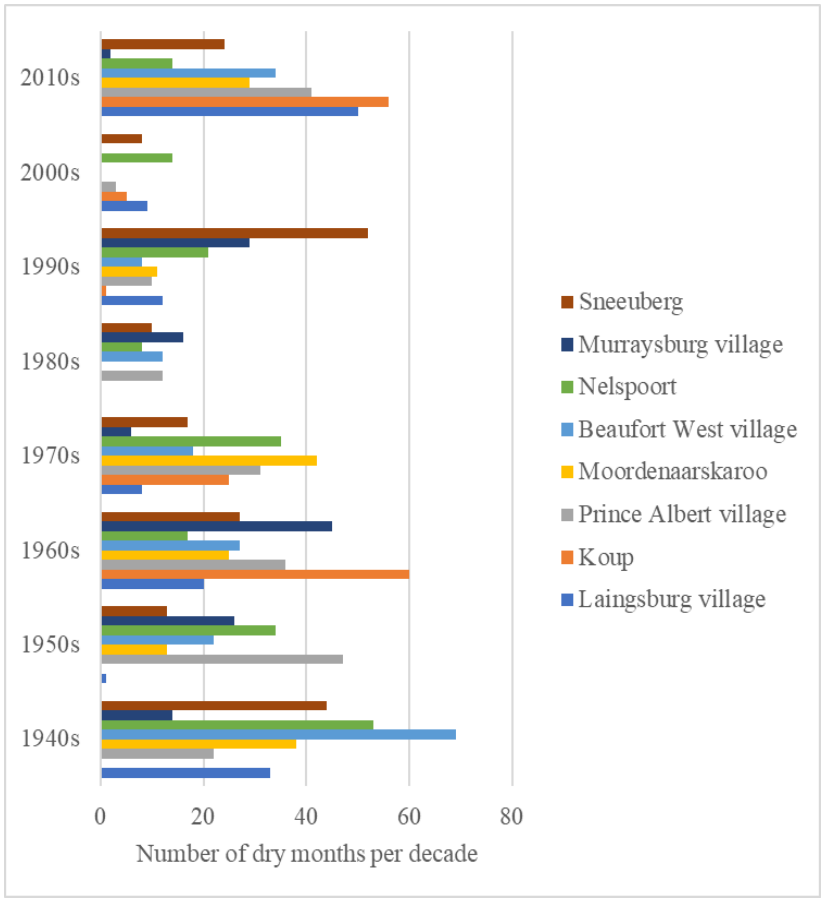


Figure 3: Number of dry months per decade at selected sites in the Central Karoo (Source: Conradie and Theron, 2019)

Despite the strong evidence of cyclicality in Figure 3 the extensionist must not lose sight of other data out there including of the possibility that the current drought is the first sign of the climate change predicted for the Karoo. The current South African drought is not the only recent example of a severe southern hemisphere drought. The “Big Dry” or “Millennium Drought” of Australia (1996-2010) peaked in 2002, which was one of the warmest and driest years on record in that country (Bureau of Meteorology, 2015). Despite good rains in 2011 and 2012, Australians expect further droughts and expect exceptionally wet seasons to disappear almost altogether, which has severe implications for rainwater harvesting and groundwater resources. Southern hemisphere droughts are associated with El Nino events, a phenomenon of elevated sea temperatures in the Pacific and Indian oceans (Rouault, 2015). As global temperatures rise, El Nino events will get stronger and droughts more frequent, here and in Australia.

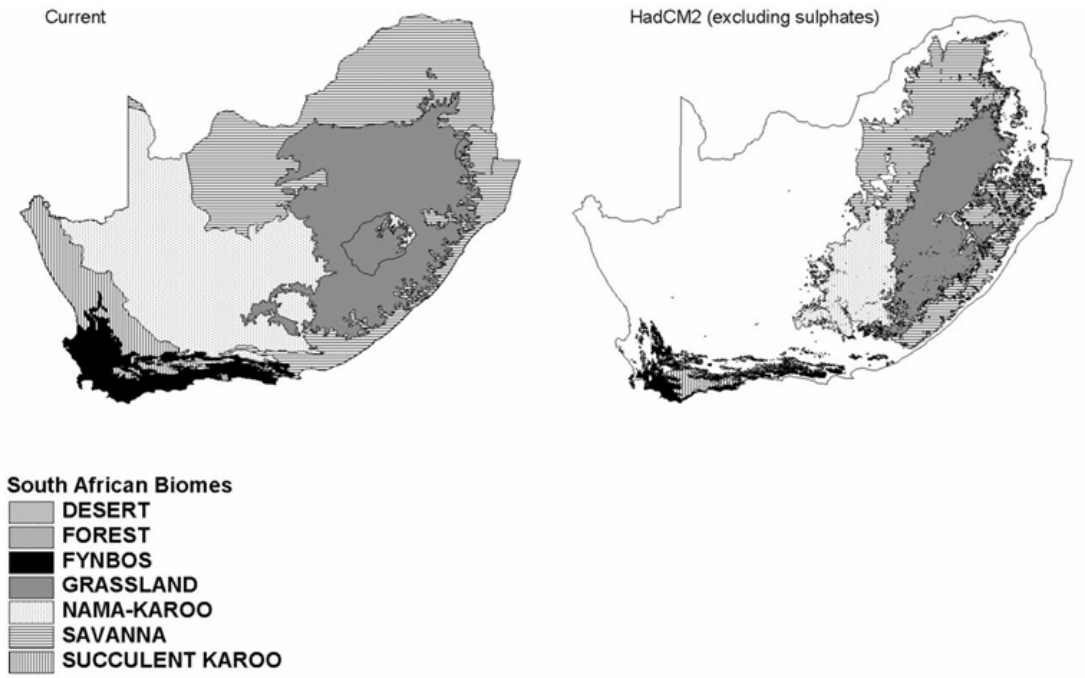


Figure 4: Predicted changes in the distribution of South African biomes, 1990 vs. 2050 *(*Source: Midgley *et al,* 2001*)*

Climate change has been predicted to have a dramatic effect on the distribution of South Africa's major plant biomes by 2050 (Midgley et al., 2001). The left-hand panel in Figure 4 represents conditions as surveyed in the late 1990s while the right-hand panel reflects predictions for 2050. The white portion of this map represents hotter and drier conditions than have been experienced in South Africa to date. This uncertainty applies to most of the historical domain of the Nama Karoo Biome, which is predicted to end up beyond its historical distribution on new lands in the Transkei and Free State and to shrink to a third of its original size. The Fynbos Biome is expected to shrink by 60% while Namaqualand's Succulent Karoo Biome will migrate from the northwest coast to the southeast coast and shrink by >80% due to rising temperature and more erratic rainfall. These shifts mean that it will be too hot and dry for these vegetation types to persist where they were found thirty years ago, and this will have implications for the profitability of the farming systems supported on this vegetation.

4. COMPETING MENTAL MODELS

The data reviewed in Section 3 represent the product of the initial AR cycle. The information can be summarised as two competing climate scenarios (Table 1) with separate extension strategies. Scenario 1 based on Figure 3 concludes that the current drought is cyclical and that rainfall conditions will revert to "normal". Scenario 2 based on Figure 4 and the evidence presented by Jury (2020), assumes that the current drought is the beginning of a permanent change in rainfall. These trains of action are deliberately presented as mutually exclusive to illustrate just how much farmers' mental models will have to change to respond effectively to climate change.

Table 1: Plans and trains of action by climate scenario 44

	Scenario 1	**Scenario 2**
Find out	Cyclical drought	Climate change
Overall objective	To facilitate farmers' survival through the bad cycle To maintain flocks	To enable farmers to use land differently
Main strategy	Feed livestock	Switch to other livelihoods
Extension officer's actions	Promote efficient feed plans Measure efficiency	Facilitate alternative mental models Retrain farmers for more profitable enterprises Monitor and evaluate progress in new endeavours
Farmers' actions	Buy feed Improve feed (and farm) efficiency	Lower stocking density Switch livelihoods Change succession plans Exit the farm in this generation
Land Care's actions (examples)	Deliver drought relief	Implement PES schemes for climate change mitigation
Other parties' actions (examples)	Do sheep research Investigate veld restoration Recruit and coordinate donations Maintain viable communities	Facilitate climate mourning Create spaces in which farmers can develop new mental models of what it means to live in the Karoo Re-deploy farmers who no longer want to farm Provide bursaries for farm children to train for other livelihoods Change curriculums at agricultural schools Generate more accurate data on probable climate change
Questions for reflection (examples)	Is the farming system maintaining productivity with its current feeding strategy? What are the different ways in which people have responded to the drought? Do some plans work better than others?	Who wants to exit? Which alternative livelihood is the most profitable? What are the main constraints and opportunities to alternative livelihoods? What are the indicators of success in new ventures?

	Which changes at the farm level had the biggest positive effect on productivity?	

In Scenario 1 we argue that if the current drought falls within normal parameters, it is a temporary disaster to which the appropriate response is cost minimisation and resource conservation. The most important asset to protect is the rangeland and from society's perspective the best way to protect it is to allocate public funds for disaster relief. From the farmer's perspective the best strategy is to feed livestock, as cost effectively as possible. Extension input should revolve around improving farm efficiency and implementing new cost-effective feeding programmes. Those in support roles should recruit, coordinate and deliver physical and knowledge resources that will contribute towards these objectives. Land Care features as important protector of the natural resource and distributor of relief funds.

The optimal strategy changes radically if the current drought is seen as evidence of climate change (as in Scenario 2). In this case land use must adjust, and the extension message must switch from intensification to extensification and diversification. Farmers should be warned about taking on too much debt to wait out the drought. Leaving agriculture should be encouraged and facilitated while farmers still have some assets left to support the move. The most important goal should be to get clients do adjust their mental models of what it means to live and work in the Karoo. Kania et al. (2018) argued that mental models need to be updated across the whole system because agriculture needs to be supported with appropriate technology development, subsidies and networks of influence. In the process like-minded individuals at every level should reach out to each other to reinforce each other's visions. Conversely no amount of policy change will have an impact on how people live and work in the Karoo, if those involved cannot imagine doing something other than farming with sheep and goats in that area. A good extension strategy will expose farmers a combination of intelligible climate data and to other livelihoods like eco-tourism.

There are several exciting possibilities for the Karoo when considering options for Scenario 2. Amongst the region's assets count several nature protected areas, intact biodiversity on farmland (Drouilly et al., 2018), scenic landscapes and proximity to Cape Town's international transport hub (Reed and Kleynhans, 2009). There are examples of marginal farms that have been converted into highly successful tourism destinations or nature restoration projects. One such example is Canyon Farm in Namibia, located at the top of the Fish River Canyon, which offers accommodation to the passing Canyon trade. Another example is N/a'ankusê Wildlife Rehabilitation Centre that offers wildlife rehabilitation training and predator relocation services in conflict situations. Closer to home there are the possibilities of snout-to-tail cooking schools photography workshops, trail running and adventure camping. Converting surplus accommodation into holiday stays will be easy, but extensive training will be needed to help the Karoo's farm families to identify tourism opportunities and develop those for the market.

To deliver on this vision service providers must reinvent themselves, for example, extensionists must specialise in nature-based tourism and equip themselves to work as small-business incubators and even as life coaches. Land Care must stop focussing on drought relief and do

more on ecosystem restoration and on developing markets for ecosystem services such as carbon sequestration. Agricultural schools and colleges must broaden their curricula to pick up these subjects and develop other nature-based livelihoods, including meat and wool processing, guiding and professional hunting. Introducing these topics at school is probably the best way to future-proof agricultural communities. Private donors should be solicited for training and internship opportunities instead of for feed and boreholes, and according to Kania et al. (2018) this is where the social capital networks built around changed mental models become effective in leveraging more appropriate policies and resource flows.

Kiem and Austin's (2013) view immediate short run "social" relief should always be combined with developing longer-term solutions in the form of more profitable alternative livelihoods. These authors make a valid point, but here a dichotomy is useful for the purpose illustrating the shifts from "business as usual' that will be needed to accommodate the possibility of climate change. It is quite important that parts of the public sector do not undermine or contradict what other parts of the public sector is trying to do. For example, if the extension service is trying to entice farmers off unsustainable farms, providing fodder subsidies to those same farmers will undermine the message that it is time to go.

5. INFERRING WHAT FARMERS THINK FROM WHAT THEY DO

Karoo farmers' actual responses to the drought reveal that Scenario 1 is still the dominant mental model in this community. During the early part of the drought, 2012 to 2015, most observations in the Karoo Farm Management dataset had a cost entry for feed purchases. In good times these amounts are targeted at stud rams and finishing of slaughter animals, but as conditions deteriorated the emphasis shifted to maintenance diets. Partitioning the sample by whether there is a drought[4] in effect or not, 60% of the observations refer to "good" conditions with the balance reflecting behaviour under drought conditions. In a drought feed costs rise by 72% per hectare and 58% per sheep. The probability on the t-test reveals that the per-hectare difference is only indicative, while the per-sheep difference is statistically significant. In contrast the stocking density figure does not respond to rainfall differences, which indicates that during the early part of the drought farmers were holding out for better times. Table 2 also reveals how quickly feed expenses can wipe out gross margin. The difference of +R23.75 per hectare in a good year to -R7.40 per hectare in a dry year is highly significant. The data in Table 2 are in constant 2015 Rand and there was no public drought relief available at the time.

Table 2: Farmer behaviour and farm performance by level of drought, Central Karoo, 2012-2015 (n = 208 pooled)

Variable	**Unit**	**High or normal rainfall[1] n=127**	**Low rainfall[2] n=81**	**Probability[3] on t-test**
Income	R/ha	91.61	80.40	0.2961
Feed cost	R/ha	9.90	17.07	0.0547*
	R/sheep	79.93	126.56	0.0154**
Stocking density	ha/ sheep	12.3	12.2	0.8969

[4] This time a drought is defined as receiving less than 80% of long-term rainfall in a year.

Gross margin	R/ha	23.75	-7.40	0.0001***

[1] High rainfall is defined as >120% of median annual rainfall. Normal rainfall is defined as 80-120% of expected precipitation

[2] Low rainfall is defined as < 80% of median annual rainfall

[3] *** signify $p \leq 0.01$, ** signify $p \leq 0.05$ and * signifies $p \leq 0.10$

The Western Cape Department of Agriculture has been monitoring grazing conditions systematically since the early 2000s and began providing drought relief on a small scale in May 2016. In the three subsequent financial years the Department has spent R303 million on drought relief across the province, and presumably most of it in the Central Karoo. This figure is in constant 2020 prices and district-level data was not available. This relief was mostly distributed via bi-monthly vouchers and was scaled by size of operation. Each farming enterprise was eligible for a portion of the energy requirements for 30 large stock units (LSU) in every round. Aliber's (2019) size classification determined the subsidy rate. Subsistence operations of less than 30 LSU qualified for a subsidy rate of 90% on 30 LSU, i.e. for 27 LSU's worth of feed. Small scale farms with flocks of 30-50 LSU qualified for 80% of 30 LSU and farms with more than 50 LSU received a subsidy rate of 70% on 30 LSU. In practice this meant that the smallest 29% of large-scale *bona fide* farms in the region (with an average holding of 375 sheep per farm) had 43% of their feed requirements covered, while the next 40% (whose average flock size is 702 sheep) only had 21% of their feed requirements covered (Conradie, 2019b). For the largest 30% of farms in the region the drought relief cap implied an effective subsidy rate of only 11%, which arguable is too low to influence allocation decisions[5]. By February 2019 the parts of the Central Karoo to the east of the N12, between Beaufort West and Klaarstroom, and north of the Great Escarpment were downgraded from "critical", which qualifies for drought relief, to "very dry" or "dry", for which drought relief falls away. Despite dire conditions in parts of the region drought relief was discontinued across the region for most of 2020 due to a lack of funds and only became available again in December 2020. This erratic provisioning makes it extremely difficult for farmers to integrate the relief effectively with their own resources leading to an inefficient allocation of these scarce public funds at the farm level. The funding was not accompanied by any extension input to direct efficient use of the allocated funds on the farm. More work needs to be done on the government's side to improve the assurance of delivery and increase the notice period to farmers and work out an extension message on how drought relief is best integrated with other fodder sources. In the Northern Cape – were almost no public drought relief was forthcoming in the period 2019 to 2020 – farmers self-organised to add value to private fodder donations. The success of these strategies, or not, also deserves to be documented.

Despite the many shortcomings, there is evidence that the public drought relief provided by the Western Cape Department of Agriculture was a worthwhile investment. According to the Abstract of Agricultural Statistics, the value of all mutton and wool sales during the period 2016-2018 amounted to R49 364.4 million nationwide (DAFF, 2019). This figure is also in

[5] A subsidy rate of 40% is substantial and it is still an open question how it affected behaviour and productivity.

constant 2020 prices. According to the 2007 Agricultural Census, the Western Cape's share of the country's small stock holdings was 14.5% and the Central Karoo accounted for 48% of provincial holdings (StatsSA, 2010a, b). It means that the Department spent roughly R303 million to safeguard about R3 432 million worth of output, which seems a reasonable return on public investment. The return on investment on private spending and private donations is not known and probably will never be due to limited farm records. Anecdotally we know that financial resources are being depleted rapidly. Tenants have given up or renegotiated their leases, often to a zero rate. Land that lies fallow create opportunities for rich (often foreign) investors to set up game farming enterprises, which will artificially price land reform projects out of the market. This is bad for social justice. It also causes stress and ill health (Conradie et al., 2019). Unfortunately, there is no systematic data on the success of the various strategies, but we do know that the drought and climate changes is now considered more important by farmers than predation (Wustro and Conradie, 2020).

During the last major drought, of the 1960s, when population pressure was lower, flocks were moved from the Karoo onto grazing in other parts of the country, facilitated by subsidies on rail transport. Major infrastructure development projects in the region provided temporary work for local farmers whose farmers were temporarily taken over by parents and grandparents while the younger generation went out to work. Distressed farms could be refinanced by the Agricultural Credit Board and the government funded a stock removal scheme that paid a cash stipend for a voluntary prescribed reduction in livestock numbers. Official records show that this scheme reduced aggregate livestock holdings by 30% between 1965 and 1971, which allowed a 17% recovery in productivity in the period to 1976 (Conradie et al., 2008). Since 1976 livestock numbers have declined at 4% per year until 2007, when less than a third of the 1976 livestock holdings remained in the Central Karoo. Over the past ten years livestock numbers have stabilised but not recovered (Statistics South Africa, 2020).

Few of these historical remedies are currently available. Railway networks have been dismantled and freight subsidies no longer exist. There is less grazing available outside the Karoo due to more widespread droughts and more farm development in these areas. The Agricultural Credit Board no longer exists. The Western Cape Department of Agriculture's drought relief programme is an anomaly in the country. Unemployment is high and public works programmes tend to be reserved for previously disadvantaged South Africans, who are even poorer than these white farmers. Few Karoo farms can still support multi-generational families and due to a dramatic decline in land productivity, the number of family farms have declined sharply, which raised the cost of education dramatically. Although generous private donations make up for some of these shortfalls, Karoo farms are probably more vulnerable now than they were at the end of the previous twenty-year drought cycle in the 1960s.

6. LOOKING FORWARD INTO THE NEXT ACTION RESEARCH CYCLE

At this preliminary stage, the AR framework fits only loosely with the evolution of our drought extension strategy for the Karoo. The drought intervention came out of "watching and listening" on a different issue (predation). That cycle of observation and reflection led to the insight that the drought might be more important than predation in the minds of farmers. Our new interest in drought was initially too vague to be called a strategy but was nonetheless the

first step in the drought AR cycle. In step 2 instead of a concrete intervention the plan that emerged in the first cycle was to continue listening and to do some analysis that could serve as input into a subsequent intervention. Initially "making things happen" involved discussing the results of productivity research with farmers and much more "watching and listening" has gone on since 2015. This includes observing our own positionality on the issue of the drought and drought relief, reinterpreting earlier observations and data on how farmers responded to the early part of the drought, and gathering new anecdotal data on what they have been doing since 2016. Peripheral data was also gathered of other role players' actions. Most of this data sits in memory and "field notes".

Looking forward to the second cycle, we are armed with the two drought mitigation scenarios developed in Table 1, rich climate data and measures of farm performance over the past eight years. As extensionists we lack understanding of how the drought affected the veld and farmers have lost many of the principles of scientific rangeland management as they scrambled to respond to predation in the period since 2006. The vision for the future is to focus on more scientific rangeland management as drought (and climate change) mitigation strategy. Earlier work has shown that this aspect of farming in the Karoo is the least likely to attract private extension inputs (Conradie, 2016) and therefore it particularly demands a response from the public extension service, including universities.

The communication plan is multifaceted and includes both farmers and other key role players. There are many people working on ecological change whose information urgently needs to reach farmers. For example, the National Research Foundation's South African Environmental Observation Network have students measuring drought mortality and canopy dieback on a research farm near Prince Albert. Mortality differs between species but as much as 70% of some long-lived species has had some individuals die (Milton, personal communication). Milton anticipates big changes in vegetation composition when the drought breaks but warns that this has not happened yet despite good rains in November 2020 which was enough to recruit some bushman grass but no shrubs. She concludes that since 2014 "we have seen only deterioration in protected and grazed veld". This is a difficult message for farmers who are desperate for the drought to be over and will resume heavy stocking at the first subjective signs of recovery. For these farmers it is important to monitor recovery very carefully so that their stocking decisions can be made according to data and not emotion. Since the monitoring systems being used by plant ecologists is too tedious for farm applications, it will require careful negotiation with scientists and farmers to find a compromise that is still scientifically valid and yet practical for farm use.

After presenting clients with Scenario 2 (climate change) we should "watch and listen" for what they intend to change and check later if these changes actually transpire. If it is possible to identify farmers who already believe that the current drought is the beginning of climate change, their behaviour should be in line with Scenario 2 rather than Scenario 1. This could offer valuable lessons about sustainable adjustment to everyone else. In this round it is important to "watch and listen" in particular for strategies of extensification and their impact on farm (or rural nonfarm) livelihoods.

To take our input in the Karoo farmers forward, survey work could be combined with a two-day workshop aimed at generating new farming models, which can be discussed and later formally assessed for productivity impacts and profitability outcomes. These events would create the opportunity to build trust and social networks that could feed up to organised agriculture as more focussed lobbying goals that are more appropriate for the likely future climate conditions. By participating in the event, the farmer would expose himself to Action Research in which he is asked to document and evaluate his own plan in order to come up with a new approach that might get him closer to the objectives for his farm and family. If this can be achieved, extension will have achieved a meaningful adjustment to the drought (whether cyclical or due to climate change) that could be replicated in other parts of the country and the region.

7. CONCLUSION

This paper reports on the first attempt to formally "think about and discuss" the evolving drought "strategy". Discovering the two competing climate scenarios and using those to generate competing theories of change falls halfway between "finding out" and "making a plan" in the Action Research cycle. The plan for this analysis was to find out what farmers' actions reveal about their perspectives on the drought. The answer is quite clearly that most people considered the drought to be cyclical in the beginning, and it is possible that many still believe this. If the drought is permanent, as climate change predictions signal that it could be, operating as if it is cyclical could have a devastating financial effect for farmers, and demands a new extension plan. At the moment the plan for the second cycle has two main branches which are to build networks with plant ecologists working on the effects of the drought and to foster discussions with farmers about the implications of emerging climate data. The main responses to listen for are scientific results on carrying capacity and new rangeland management models and how farmers respond to these problems. There needs to be cross pollination between these two types of discussions and therefore it is important for the extensionist to spend enough face time in both domains to build trust with both stakeholder groups and to keep reflecting on how the process evolves It is therefore equally important that the extension team writes about these experiences and talk about what they mean.

8. REFERENCES

ALIBER, M. 2019. How we can promote a range of livelihood opportunities through land redistribution. Working paper 58, Programme for Land and Agrarian Studies, University of the Western Cape, South Africa. [Accessed: 26/02/2020]. http://repository.uwc.ac.za/xmlui/handle/10566/4654?show=full

BEINART, W., 2018. An overview of themes in the agrarian and environmental history of the Karoo since c. 1800. *African journal of range & forage science*, *35*(3-4), 191-202.

Bureau of Meteorology (Australia) 2015. Recent rainfall, drought and Southern Australia's long term rainfall decline. [Accessed 8/02/ 2020] http://www.bom.gov.au/climate/updates/articles/a010-southern-rainfall-decline.shtml

CONRADIE, B., 2019a. Designing for successful land reform for the extensive grazing sector. South *African Journal of Agricultural Extension*, 47(2): 1-12.

CONRADIE, B., 2019b. Land use and redistribution in the arid west: The case of Laingsburg magisterial district. *Agrekon* 58(3): 281 – 291.

CONRADIE B., THERON, S. 2019. Grazing indices for the Karoo. Working paper 442 of the CSSR, University of Cape Town.

CONRADIE B., PIESSE, J., STEPHENS, J. 2019. Efficiency, vulnerability and land use change in the Karoo region of South Africa. *Environmental Development.* https://doi.org/10.1016/j.envdev.2019.07.003

CONRADIE, B., NATTRASS, N., 2017. The robustness of self-report data on predation: A comparison of two Karoo surveys. *African Journal of Agricultural and Resource Economics* 12(3): 217-229.

CONRADIE, B.I., PIESSE, J., 2016. Ranking perceived risk to farmers: How important is the environment? *African Journal of Agricultural and Resource Economics* 11(4): 263-276.

CONRADIE, B.I., LANDMAN, A.M., 2015. Wool versus mutton in extensive grazing areas. South *African Journal of Agricultural Extension* 43(1):22-31

CONRADIE, B., PIESSE, J., 2015. Productivity benchmarking of free-range sheep operations: Technical efficiency, correlates of productivity and dominant technology variants for Laingsburg, South Africa. *Agrekon* 54(2):1-17.

CONRADIE, B., PIESSE, J., THIRTLE, C., VINK, N., WINTER, K., 2013. Explaining declining total factor productivity in the Karoo districts of the Western Cape, 1952 to 2002 *Agrekon* 52(S1): 1-23.

CONRADIE B., PIESSE J., THIRTLE, C., 2009. What is the Appropriate Level of Aggregation for Productivity Indices? Comparing District, Regional and National Measures. *Agrekon* 48(1): 9-20.

CONRADIE, B., PIESSE, J., THIRTLE, C. (2008) Total Factor Productivity at the District Level for the Western Cape, 1952 - 2002: Data and Methods. Working paper 50, Research papers Kings College London.

DEPARTMENT OF AGRICULTURE, FISHERIES AND FORESTRY, 2019. Abstract of Agricultural Statistics. Pretoria.

DROUILLY, M., CLARK, A., O'RIAIN, M.J., 2018. Multi-species occupancy modelling of mammal and ground bird communities in rangeland in the Karoo: A case for dryland systems globally. *Biological Conservation*, *224*, 16-25.

DU TOIT J.C.O., 2010. An analysis of long-term daily rainfall data from Grootfontein, 1916 to 2008. *Karoo Agri* 10(1): 1–12.

HOBSON, K., MAYNE, R., HAMILTON, J. 2013. Step by step guide to monitoring and evaluation. Programme for Monitoring and Evaluation for Sustainable Communities. [Accessed 12 /02/2020]. https://www.geog.ox.ac.uk/research/technologies/projects/mesc/guide-to-monitoring-and-evaluation-v1-march2014.pdf

JURY, M.R, 2020. Climate trends in the Cape Town area, South Africa. *Water SA* 46(3), 438-447.

KANIA, J. KRAMER, M., SENGE, P. 2018. The water of systems change. [Accessed 26/02/2020] http://efc.issuelab.org/resources/30855/30855.pdf

KIEM, A.S., AUSTIN, E.K., 2013. Drought and the future of rural communities: opportunities and challenges for climate change adaptation in regional Victoria, Australia. *Global Environmental Change*, *23*(5):1307-1316.

MILTON, S. 2021. Renu-Karoo Veld Restoration and resident ecologist, Prince Albert.

NATTRASS, N., CONRADIE, B., STEPHENS, J., DROUILLY, M. 2019. Culling recolonizing mesopredators increases livestock losses: Evidence from the South African Karoo. *Ambio. https://doi.org/10.1007/s13280-019-01260-4*

NATTRASS, N., CONRADIE, B., 2018. Predators, livestock losses and poison in the South African Karoo. *Journal of Cleaner Production* 194(1): 777-785.

NATTRASS, N., CONRADIE, B., 2015. Jackal Narratives: The politics and science of predator control in the Western Cape, South Africa. *Journal of Southern African Studies* 41(4): 753-771.

ROUAULT, M. 2015. El Nino threatens southern Africa with another drought. Posted 11 November. [Accessed 8 Feb 2020.] http://theconversation.com/el-nino-threatens-southern-africa-with-yet-another-drought-50491

REED, L.L., KLEYNHANS, T.E., 2009. Agricultural land purchases for alternative uses—evidence from two farming areas in the Western Cape province, South Africa. *Agrekon*, *48*(3), 332-351.

STATISTICS SOUTH AFRICA, 2020. Census of commercial agriculture, 2017: Western Cape: Production statistics for selected products, Report 11-02-02 (2017). Pretoria.

STATISTICS SOUTH AFRICA, 2010a. Census of commercial agriculture, 2007: Financial and production statistics. Report 11-02-01 (2007). Pretoria.

STATISTICS SOUTH AFRICA 2010b. Census of commercial agriculture, 2007: Western Cape: Production statistics for selected products, Report 11-02-02 (2007). Pretoria.

WUSTRO, I., CONRADIE, B. 2020. How stable are farmers' risk perceptions? A follow up study of one community in the Karoo. *Agrekon* 59(1) 30-45.

Appendix 1: Severity of the drought in number of dry months per decade for selected rainfall stations in the Central Karoo

Location	**1920s**	**1930s**	**1940s**	**1950s**	**1960s**	**1970s**	**1980s**	**1990s**	**2000s**	**2010s**	**% of the last decade's dry months since 2015**
Laingsburg village	46	10	33	1	20	8	0	12	9	50	98%
Koup					60	25	0	1	5	56	88%
Prince Albert village			22	47	36	31	12	10	3	41	100%
Moordenaarskaroo		21	38	13	25	42	0	11	0	29	100%
Beaufort West village	32	49	69	22	27	18	12	8	0	34	100%
Nelspoort	29	21	53	34	17	35	8	21	14	14	100%
Murraysburg village		37	14	26	45	6	16	29	0	2	100%
Sneeuberg		0	44	13	27	17	10	52	8	24	100%

(Source: Conradie and Theron, 2019

LIVELIHOOD ANALYSIS OF GASELA COMMUNITY IN AMAHLATHI LOCAL MUNICIPALITY OF THE EASTERN CAPE PROVINCE

Mkhungela, M.N.[1] and Khwidzhili, R.[2]

Corresponding author: Mkhungela, M.N; Email: mabutomkhungela@yahoo.com

ABSTRACT

The study was conducted to distinguish the livelihood activities that need sustainable development intervention in the Gasela rural community. A sample survey procedure was done on seventy-seven community household heads population. A sample size of sixty-five was randomly selected. It was found that cabbage, spinach, and potatoes were the most crops produced by the community. Wattle forest was used for cooking, housing, and kraal fencing. The households were affected mostly by pests, diseases, environmental stresses, and weather-related shocks. These sources of vulnerability are cited to limit sustainable crop production. Therefore, the recommendations were interventions for the sustainable production of cabbage, spinach, and potatoes. A further recommendation was to investigate the alternative resource for wattle that will provide the same livelihood outcomes for the Gasela rural households when biological control of this invader species is being implemented.

Keywords: livelihood activities, sources of vulnerability, sustainable development intervention.

1. INTRODUCTION

Livelihood is the means of securing physiological survival needs and other physical essentials at a primitive level. The poverty category begins below this level. The vast bulk of poverty, both absolute and relative is found in the developing countries (Baulch & Hoddinott, 2000). South Africa is an example of a country where poverty is prevalent with the most unequal societies having persistent high levels (World Bank & Statistics SA, 2018). The Eastern Cape Province is the second-largest and poorest in South Africa (Adekunle, 2013). The primary goal of the 2030 Agenda for sustainable development recognizes the ending of poverty in all its forms. To attain this, the Agenda realizes the strategies that build the economy, address social needs, tackle climate change, and protect the environment as key. One such strategy is that of sustainable development.

There are only drafts and guidelines that are delineating South Africa's intentions towards sustainable agriculture (Khwidzhili & Worth, 2017). Hence, there is a need to approve policies on this. The Gasela community in the Amahlathi Local Municipality was established through the land redistribution process in the year 2001. According to Kepe and Cousins (2002) when

[1] M.N. Mkhungela. Scientific Technician at Dohne Agricultural Development Institute, Private Bag X15, Stutterheim, 4930. Tel. 043 0683 04004; Email: mabutomkhungela@yahoo.com.

[2] R.H. Khwidzhili. Lecturer at University of Mpumalanga, P/Bag X11283, Nelspruit, 1200. Tel. 013002 0144; Email: Humphrey.khwidzhili@ump.ac.za

land, resource rights, and income are secured, people are more likely to invest efforts and resources in conservation and land-use practices that meet the needs of the present, without compromising the ability of future generations to meet theirs. The Eastern Cape Agricultural Economic Transformation strategy (2016-2021) is informed by the overarching Rural Development Framework Policy directive outcome 7. The strategy ensures that life quality, services, livelihoods, and income are improved in rural communities. However, the programs implemented to solve the problems of poverty and food insecurity are continuously failing to produce the desired results (Musemwa, 2013).

The study was to examine the characteristics of the Gasela community livelihood with intentions to distinguish forms of livelihood activities that need sustainable development intervention. A sample size of sixty-five was randomly selected. It was found that cabbage, spinach, and potatoes were the most crops produced by the community. Wattle forest was used for cooking, housing, and poles for kraal fencing and selling. The households were affected mostly by pests, diseases, environmental stresses, and weather-related shocks. Therefore, the recommendations are interventions for the sustainable production of these most produced crops and investigations of the alternative resources for wattle that will provide the same livelihood outcomes for the community.

2. OBJECTIVES AND PURPOSE OF THE STUDY

The main objective of the study was to determine how the rural community within the vulnerability context develops livelihood strategies to achieve the desired livelihood outcomes.

The purpose was to identify the different types of livelihood assets and activities used by household categories to support their livelihood. Further to determine institutions, policies, and processes that influence community livelihood strategies. Lastly to provide livelihood outcomes that suggest entry points for sustainable development approach at the micro and macro-economic level.

3. METHOD

A survey method was chosen with the purpose to sum the community characteristics and make general statements about the study population using information obtained from the sample (Yin & Heald, 1975). The method is a personal interview survey in the respondent's home. The qualitative and quantitative methods were both used to collect information on human behaviour and numerical data respectively. The mixing method of qualitative and quantitative research presents a comprehensive discussion on the theoretical, methodological, and practical issues (Brannen, 2017). A semi-structured questionnaire was used to collect data from sixty-five randomly selected household heads. The data was collected in October 2019.

The information, which was collected through a questionnaire included demographic information, vulnerability context, livelihood assets, institutions, policies, processes, livelihood strategies, and livelihood outcomes. The interviews were voluntary and participants were told of their rights to decline to answer the questions that were uncomfortable to answer.

4. RESULTS

The results present the different types of livelihood assets and activities used by household categories to support their livelihood. Further the results cover institutions, policies, and

processes that influence community livelihood strategies. Lastly, included the livelihood outcomes that suggested the entry points for sustainable development approach at the micro and macro-economic level.

4.1. Human Capital

Human capital is a productive capacity of an individual, both inherited and acquired through education and training (Goodwin, 2003). The choices and options to develop strategies of sustainable livelihood are widened by an increase of this capital (Kanel & Niraula, 2017). The education level was found to enable the Gasela rural community to make informed decisions on livelihood activities that support their livelihood. The education level of respondents is summarised in Table 1.

Table 1: The education level of respondents

Education level of respondents	**Frequency**	**Percentage**
Never been to school	11	16.9
Grade R to Grade 8	36	55.4
Grade 9 to Grade 12	18	27.7

4.2. Natural Capital

The study covered only renewables that were used by the Gasela rural community. Land, water, and forest were used to support livelihood. It is the pattern that rural households in low- and middle-income countries create employment using livelihood assets (Berchoux *et al*., 2020). Hence the Gasela rural community used land, water, and forest for livelihood activities. The main natural capital the households had access to is shown in Table 2.

Table 2: Main natural resources the households had access

		No of households	**Percentage**
Land	No	0	0
	Yes	65	100
Water	No	5	7.7
	Yes	60	92.3
Forest	No	6	9.2
	Yes	59	90.8

The land was used to produce crops such as watermelons, beans, green pepper, potatoes, pumpkin, onion, beetroot, spinach, cabbage maize, and carrots. The main crops produced were cabbage, spinach, and potatoes. Cabbage, spinach, and potatoes are the most produced crops in rural communities in the Eastern Cape Province (Perret *et al.*, 2000). Table 3 are crops produced by households.

Table 3: Crops produced by the households

		Households		**Percentage**
Watermelons	No	62		95.4

	Yes	3		4.6
Beans	No	55		84.6
	Yes	10		15.4
Green Peppers	No	60		92.3
	Yes	5		7.7
Potatoes	No	32		49.2
	Yes	33		50.8
Pumpkin	No	53		81.5
	Yes	12		18.5
Onion	No	46		70.8
	Yes	19		29.2
Beetroot	No	45		69.2
	Yes	20		30.8
Spinach	No	32		49.2
	Yes	33		50.8
Cabbage	No	27		41.5
	Yes	38		58.5
Maize	No	46		70.8
	Yes	19		29.2
Carrots	No	52		80.0
	Yes	13		20.0
None	No	48		73.8
	Yes	17		26.2

The reasons for households to produce crops were for consumption; consumption and feeding livestock, and consumption and selling. The research participants who produced crops for consumption and selling constitute 68.8%. Raleting and Obi, (2015) support the findings that the rural communities produce crops for both sale and consumption. Figure 1 presents the household reasons for producing crops.

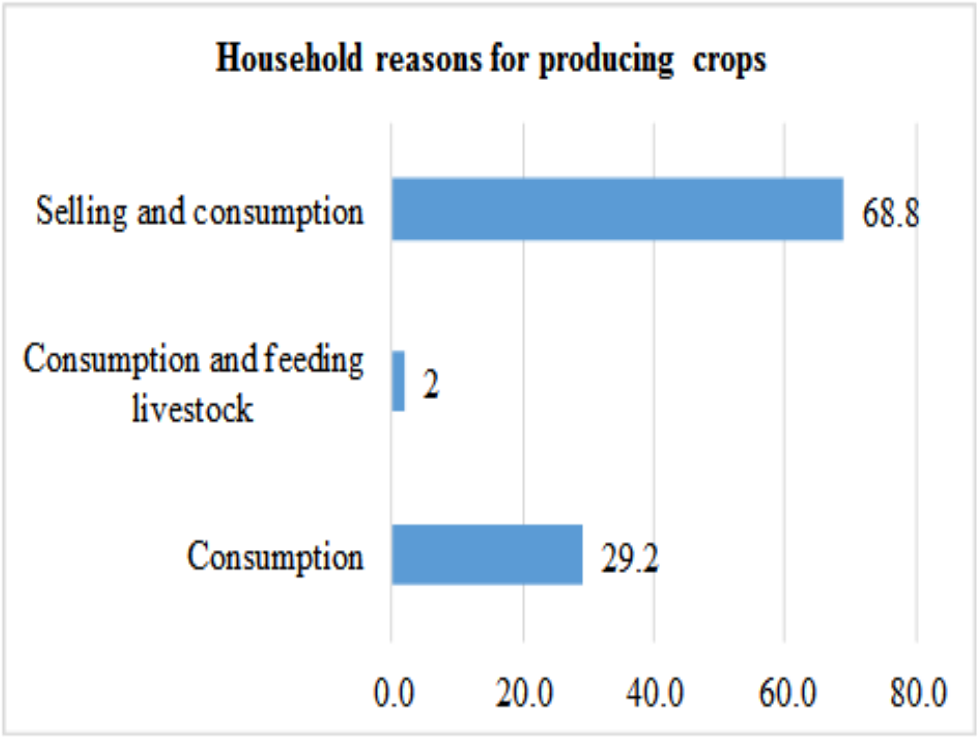


Figure 1: Household reasons for producing crops

The range of activities of the community was based on the natural capital. Such activities were collection and gathering in the forest, food cultivation, non-food cultivation, and lastly livestock keeping and pastoralism. Activities of the community are summarised in Table 3.

Table 3: Natural resource-based activities of respondents

Natural resource-based activities		**Percentage**
Collection and gathering in the forest	No	3.1
	Yes	96.9
Food cultivation	No	40
	Yes	60
Non-food cultivation	No	98.5
	Yes	1.5
Livestock keeping and pastoralism	No	56.9
	Yes	43.1

The wood produced from wattle was used for cooking, making fires, housing, and poles for building kraals, and selling. The study supports Johnson and Bryden, (2012) that the majority of the rural community uses firewood as the primary energy source for livelihood activities. The use of the forest by the community is shown in Table 4.

Table 4: Uses of forest resources by households

Uses of wood	**Frequency**	**Percentage**
Cooking and making fire	7	11

Housing and making livestock kraals and selling	58	89

4.3. Physical capital

The households accessed water through the community piped water, household piped water, delivered by the municipality, river, and other (nearby farm reservoir). The majority of the Eastern Cape rural communities access drinking water through groundwater supply (Lehloesa & Muyima, 2000). Even though the source of water accessed by the Gasela rural community was groundwater, the scarcity remains a challenge. The water scarcity indicates a burden on rural women as they have to walk more distances in search of water (Sigenu & Pelser, 2009). The access to water resources by households is presented in Table 4.

Table 4: The access of water resource by households

Access of water	**Frequency**	**Percentage**
Community piped water	14	22
Household piped water	1	1.5
Delivery by municipality	12	18.4
River	2	3.1
Other (nearby farm reservoir)	36	55

Water was used for consumption, washing, bathing, and irrigation. The Water Poverty Index (WPI) of Amahlathi local municipality falls at 51 (Cullis, 2005). The WPI of 100 is considered a perfect score however, South Africa falls below that hence it stands at 52 (Lawrence *et al*., 2002). Integrated Water Resources Management (IWRM) is recommended for the Gasela community with such a low WPI. The IWRM encompasses different stakeholders at different levels using water resources to manage water to achieve sustainable development goal targets of the 2030 agenda. The use of water resources by households is shown in Table 4.

Table 4: Uses of water resource by households

Uses of water	**Frequency**	**Percentage**
Consumption, washing, and bathing	21	32
Consumption, washing, bathing, and irrigation	44	68

The rural community needs the types of equipment and machinery that are economically affordable, environmentally safe to be used locally to produce crops. The types of manual implements used by the participants to produce crops were spade and hoe; and others combined spade, hoe, and rake. The results support Phezisa, (2016) that manual implements are most used by the household to produce crops from home gardens. A tractor was used by relatively few research participants. Adekunle, (2014) highlights the limitation that the lack of machinery makes most of the rural communities rely on labour-intensive crop production. Table 5 indicates the implements and machinery used to produce crops.

Table 5: Implements and machinery used to produce crops

Implements and machinery used to produce crops	**Frequency**	**Percentage**
Spade, hoe	38	58
Spade, hoe, rake	13	20
Tractor	14	22

4.4. Financial Capital

The Gasela rural community creates financial capital from different sources such as employment, farming, off-farm activities, forest products, pension, and child grants. The unemployment rate was relatively high when compared to the Eastern Cape Provincial unemployment of 37.4% in the first quarter of 2019. The Gasela rural community can improve financial capital through support services that include agricultural and entrepreneurship, networking, and financial education. According to Hamdan, (2019) entrepreneurship offers a means to overcome present challenges through sustainable development. Table 6 illustrates the principal occupation of the research participants.

Table 6: Principal occupation of the research participants

Principal occupation	**Frequency**	**Percentage**
Employed	8	12
Unemployed	35	54
Self-employed	2	3
Pension and child grant	20	31

4.5. Social capital

The majority of the research participants know each other and that enables the community to act collectively. Conversely, the productive results in the community were not created mostly by components of social structure. The structural social capital of the community was poor hence 98.2% were not members of any organization or social group and 9.8% being members of Ilima. Bebbington, (1997) emphasizes the importance of civil society actors in improving agriculture, livelihoods, and resource use.

4.6. Institution, Policies, and Processes

The Ilima is a government project grant that helps vulnerable communities to increase agricultural production. The research participants that were participating in this project were 9.8%. South African agricultural policy on conserving natural resources promotes sustainable resource use. Nevertheless, no organization was found to promote sustainable resource use in the Gasela community. The social process indicated no interactions that could improve the livelihood quality. Bachke, (2019) emphasizes that membership to organizations has been used to improve market access, access to information, and capacity to increase production. Table 7 shows the membership of the research participants to an organization or social group.

Table 7: Community membership to an organization or social group.

Membership to an organization or social group	Frequency	Percentage
Yes	6	9.2
No	59	90.8

4.7. Livelihood strategies

The livelihood strategies are a set of economic actions influenced by social context to source the location of internal and external resources. The rural community commonly follows a traditional livelihood strategy by adopting two widely known adaptations such as intensification of agricultural production and diversification of income sources. There was no agricultural production intensification practiced by the research participants. However, the diversification of income sources was a phenomenon hence there were combinations of off-farm and on-farm activities, revenue generated from crops, livestock, and forest. Diversity is an intrinsic attribute of many rural livelihood strategies (Warren, 2002).

4.8. Livelihood outcomes

The sources of vulnerability found in the community were weather-related shocks, pests, and disease shocks, economic shocks, seasonal stresses, environmental stresses, idiosyncratic shocks, and structural shocks. The three main sources of vulnerability with the highest percentages were pests and diseases, followed by environmental stresses, and lastly, weather-related shocks. As per Dhanush *et al.*, (2015) climate change changes the stages and rates of pathogen development, and host resistance, ultimately resulting in changes in the physiology of host-pathogen interactions. Thus to alleviate the effects of pests and diseases Heeb *et al*., (2019) cite Climate-Smart Pest Management (CSPM) which reduces pest-induced crop losses, improves the ecosystem, reduces greenhouse gas emissions. The abiotic and biotic stresses were the second-highest sources of vulnerability experienced by the Gasela rural community. Amongst the abiotic stress mentioned by the research participants was the drought that caused the planted seeds not to germinate and seedlings to perish because of water stress. Drought caused some research participants not to participate in crop production.

Biotic stresses mentioned by the research participants were moles in potatoes and aphids in cabbages. According to Hanawalt, (1922) moles eat mostly earthworms, centipedes, millipedes, slugs, and snails with no interest in vegetables. In addition, *Pocket Gophers* are burrowers that create mounds on the soil, in the same way that moles do, and feed on vegetables (Hafner, 2004). Therefore, it might be inaccurate that the moles are biotic stress in potato production when *Pocket Gophers* are responsible for vegetable damages. The recommendations were that further research is conducted to identify accurately the pests responsible for potato damages in Gasela rural community gardens. Aphids were mentioned as another biotic stress on vegetable production. The cabbage aphid, *Brevicoryne brassicae* (L.) leads to a significant reduction in the percentage of epicuticular wax, dry weight, sugar, amino acids in cabbages (Khattab, 2007).

The *Green Peach Aphid* is a major pest of *brassica* vegetables and a vector of more than a hundred viruses (Ahmed *et al*., 2018). It was further recommended that research be conducted to accurately identify the type of aphids that are responsible for cabbage damages in the Gasela

community gardens. Plants develop specific mechanisms that enable them to withstand the damaging effect of environmental stress (Chelli-Chaabouni, 2014). Hence the use of crops with identified stress-responsive genes and overexpression within sensitive crop species are recommended to withstand environmental stress (Ahanger *et al*., 2017). Figure 1 indicates the Gasela community's sources of vulnerability.

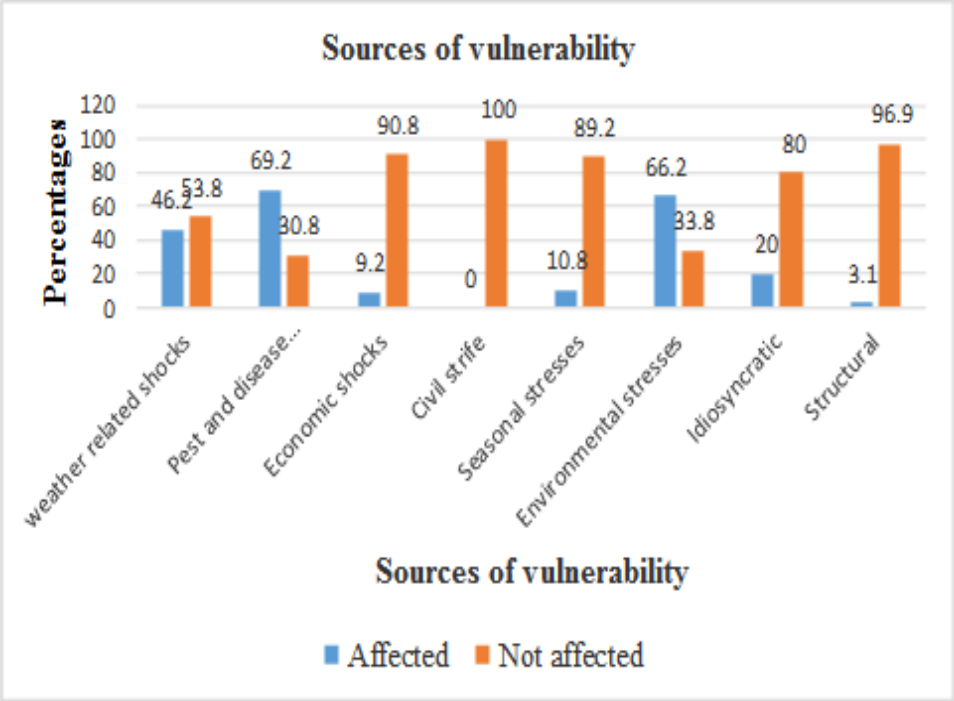


Figure 2: Sources of vulnerability

The environment in South Africa is characterized by shocks with a significant percentage of households being affected and that threatens the daily sustenance (Carter & Maluccio, 2003). The frequency of the sources of vulnerability experienced by the Gasela community on yearly basis was fifty-five with 84.6% of people being affected. The main abiotic stress experienced by the research participants was the drought that led some of the community members to a coping strategy by not participating in crop production. The Eastern Cape Province is highly vulnerable to drought and determinations to reduce the impact should be a major research effort (Mdungela *et al*., 2018). Appropriate risk management strategies such as prevention, mitigation, and coping are recommended to manage shocks. The major shocks to be managed in the Gasela community are pests and diseases, environmental stresses, and weather-related shocks.

Figure 3 illustrates the frequency of shocks and the percentage of the affected people in the community.

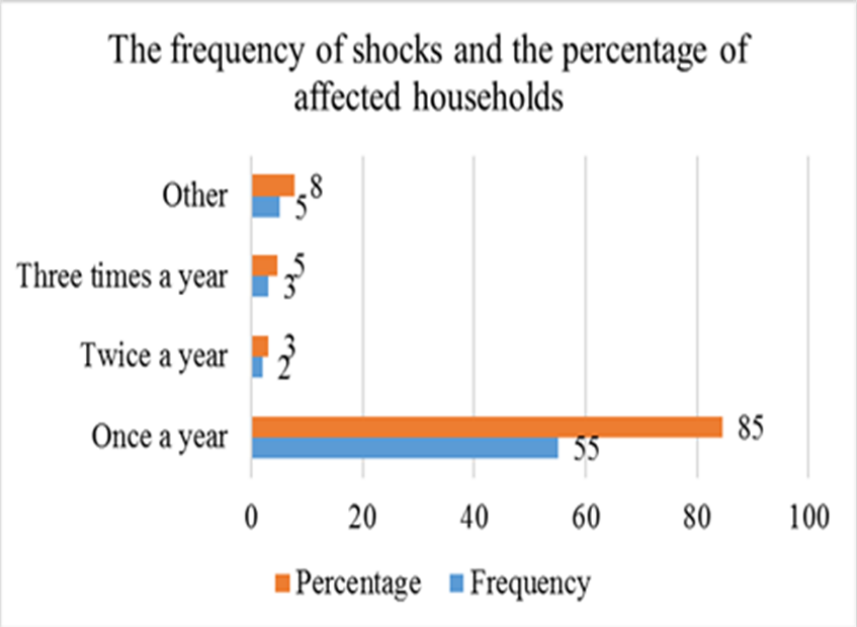


Figure 3: The frequency of shocks and the percentage of affected households

5. CONCLUSION AND RECOMMENDATION

Livelihood analysis of rural communities is important because these communities have the potential to produce or reduce natural resources by their action or inaction. This, in turn, can result in significant effects on the micro and macro economy. The study was to determine how the rural community within the vulnerability context develops livelihood strategies to achieve the desired livelihood outcomes. The intention was to provide livelihood outcomes that suggest entry points for a sustainable development approach at the micro and macro-economic levels. Crop production was the main livelihood activity in Gasela rural community. The most produced crops were cabbage, spinach, and potatoes. The wattle forest was used to collect firewood, poles for building houses and livestock kraals, and selling. Crops were produced for consumption, feeding livestock, and selling. The Gasela rural community was affected mostly by three main sources of vulnerability which were weather-related shocks, pests and diseases, and lastly by environmental stresses. These sources of vulnerability were cited by research participants as limiting crop production. Thus the study recommends the IWRM for weather-related shocks existing in Gasela rural community. To alleviate the effects of pests and diseases CSPM is recommended to reduce pest-induced crop losses, improve the ecosystem, and reduce greenhouse gas emissions. The number of gaps that will benefit these findings and enhance this study is:

- To assess soil and water suitability for sustainable production of cabbage, spinach, and potatoes in the Gasela rural community.
- To conduct Cost-Benefit Analysis (CBA) for sustainable production and marketing of cabbage, spinach, and potatoes in the Gasela rural community.
- To determine the type of pests and diseases of cabbage, spinach, and potatoes to improve their control and management in Gasela rural community.

- To investigate the alternative resources for wattle that will provide the same livelihood benefits when biological control of this species is implemented in the Gasela rural community.

6. REFERENCES

ADENKULE, O. O., 2014. An investigation of challenges facing home gardening farmers in South Africa: A case study of three villages in Nkokonbe municipality Eastern Cape Province. *Journal of Agricultural Science*, *6*(1), 102.

AHANGER, M. A., AKRAM, N. A., ASHRAF, M., ALYEMENI, M. N., WIJAYA, L. & AHMAD, P., 2017. Plant responses to environmental stresses—from gene to biotechnology. *AoB Plants*, *9*(4).

AHMED, N., CHAMILA DARSHANEE, H. L., FU, W. Y., HU, X. S., FAN, Y. & LIU, T. X., 2018. Resistance of seven cabbage cultivars to green peach aphid (Hemiptera: Aphididae). *Journal of economic entomology*, *111*(2), 909-916.

BACHKE, M.E., 2019. Do farmers' organizations enhance the welfare of smallholders? Findings from the Mozambican national agricultural survey. Food Policy, 89, p.101792.

BAULCH, B. & HODDINOTT, J., 2000. Economic mobility and poverty dynamics in developing countries. The Journal of Development Studies, 36(6), 1-24.

BEBBINGTON, A., 1997. Social capital and rural intensification: local organizations and islands of sustainability in the rural Andes. Geographical Journal, pp.189-197.

BERCHOUX, T., WATMOUGH, G.R., JOHNSON, F.A., HUTTON, C.W. & ATKINSON, P.M., 2020. Collective influence of household and community capitals on agricultural employment as a measure of rural poverty in the Mahanadi Delta, India.Ambio, 49(1), pp.281-298.

BRANNEN, J. (Ed.). 2017. Mixing methods: Qualitative and quantitative research. Routledge.

CARTER, M. R. & MALUCCIO, J. A., 2003. Social capital and coping with economic shocks: an analysis of the stunting of South African children. World Development, 31(7), 1147-1163.

CHELLI-CHAABOUNI, A., 2014. Mechanisms and adaptation of plants to environmental stress: a case of woody species. In Physiological mechanisms and adaptation strategies in plants under changing environment (pp. 1-24). Springer, New York, NY.

DHANUSH, D., BETT, B. K., BOONE, R. B., GRACE, D., KINYANGi, J., LINDAHL, J. F. & SMITH, J, 2015. Impact of climate change on African agriculture: focus on pests and diseases. Copenhagen, Denmark: CGIAR Research Program on climate change, Agriculture and Food Security (CCAFS). [Viewed 09 June 2021]. Available online at: www.ccafs.cgiar.org.

GOODWIN, N. R. (2003). Five kinds of capital: Useful concepts for sustainable development (No. 1434-2016-118878).

HAFNER, M. S., DEMASTERS, J. W., SPRADLING, T. A. & REED, D. L., 2003. Cophylogeny between pocket gophers and chewing lice. Tangled trees: phylogeny, cospeciation, and coevolution. University of Chicago Press, Chicago, p. 195-220.

HAMDAN, A.M.M., 2019. Entrepreneurship and economic growth: An Emirati perspective. *The Journal of Developing Areas*, *53*(1).

HANAWALT, F. A., 1922. Habits of the Common Mole: Scalopus aquaticus machrinus, (Rafinesque).

HEEB, L., JENNER, E., & COCK, M. J. (2019). Climate-smart pest management: building resilience of farms and landscapes to changing pest threats. Journal of Pest Science, 92(3), 951-969.

JOHNSON, N.G. & BRYDEN, K.M., 2012. Energy supply and use in a rural West African village. Energy, 43(1), pp.283-292.

KANEL, K. R., & NIRAULA, D. R. (2004). Can rural livelihood be improved in Nepal through community forestry? Banko janakari, 14(1), 19-26.
KHATTAB, H. (2007). The defense mechanism of cabbage plants against phloem-sucking aphid (Brevicoryne brassicae L.). Australian Journal of Basic and Applied Sciences, 1(1), 56-1362.

KHWIDZHILI, R. H., & WORTH, S. H. (2017). Evaluation of policies promoting sustainable agriculture in South Africa. South African Journal of Agricultural Extension, 45(2), 73-85.

LAWRENCE, P.R., MEIGH, J. & SULLIVAN, C., 2002. *The water poverty index: an international comparison*. Keele, Staffordshire, UK: Department of Economics, Keele University.

LEHLOESA, L. J., & MUYIMA, N. Y. O. (2000). Evaluation of the impact of household treatment procedures on the quality of groundwater supplies in the rural community of the Victoria district, Eastern Cape. Water SA, 26(2), 285-290.

MDUNGELA, N. M., BAHTA, Y. T., & JORDAAN, A. J. (2017). Farmer's choice of drought coping strategies to sustain productivity in the Eastern Cape Province of South Africa. Book Series Frontiers in Sustainability, 1(1), 73-89.

MUSEMWA, L., ZHOU, L., NDHLEVE, S., & AGHDASI, F. (2013). Factors affecting household access to enough food in the Eastern Cape Province of South Africa. Journal of development and agricultural economics, 5(3), 84-91.

PERRET, S. R., CARSTERNS, J., RANDELA, R., & MOYO, S. (2000). Activity systems and livelihoods in Eastern Cape Province rural areas (Transkei): Household typologies as socio-economic contributions to a Landcare project (No. 1737-2016-140363).

PHEZISA, B. (2016). A situational survey of Siyazondla homestead food production program and food security, poverty alleviation in selected communities of Nkonkobe local municipality of the Eastern Cape (Doctoral dissertation, University of Fort Hare).

RALETING, P. M., & OBI, A. (2015). An analysis of institutional factors influencing vegetable production amongst small-scale farmers in six vegetable projects of the Nkonkobe Local Municipality. Journal of Agricultural Science, 7(6), 184.

SIGENU, K. and PELSER, A., 2009. Rural women and water scarcity: challenges and strategies in the Eastern Cape, South Africa.Journal for, p.69.

WARREN, P. (2002). Livelihoods diversification and enterprise development. An initial exploration of concepts and issues. Livelihood support program (LSP) working paper, 4.

WORLD BANK. (2018). Overcoming poverty and inequality in South Africa: An assessment of drivers, constraints, and opportunities. South Africa Poverty and Inequality Report.
YIN, R. K., & HEALD, K. A. (1975). Using the case survey method to analyze policy studies. Administrative science quarterly, 371-381.

AN ASSESSMENT OF THE EFFECTIVENESS OF EXTENSION SERVICES IN THE OVERBERG AND WEST COAST DISTRICTS, WESTERN CAPE PROVINCE

Carelsen, R[1]., Ncube, B.[2]and Fanadzo, M[3]

Corresponding Author: Carelsen, R; Email: recardoc@elsenburg.com.

ABSTRACT

Extension services are usually one of the first respondents to assist farmers during disaster periods such as droughts. However, multiple organisations and institutions respond with different support services to smallholder farmers during disaster periods with minimum coordination, rendering such services ineffective. This study aimed at assessing the effectiveness of public and private extension services in supporting smallholder farmers in Overberg and West Coast Districts in the Western Cape. The study was part of a bigger Water Research Commission funded project that was looking at drought impacts on smallholder farmer livelihoods, with the focus being on the 2015-2018 drought. A total of 24 extension officers and managers participated in the study. Questionnaires were used to collect data such as age group, gender, education levels and other variables for quantitative data. Quantitative data was used to tabulate and graph the results. The results showed signs of growth and improvement in extension services. The public extension services were more advanced in achieving the Norms and Standards as well as the Extension Recovery Plan requirements when compared to the private sector and non-governmental organisations. The private sector and non-governmental organisations, therefore, need further investment for them to be able to comply with the legal framework for agricultural extension workers. The findings indicated that the passing of new laws and the implementation of the Norms and Standards for Agricultural Extension Services and Extension Recovery Plan enhance the effectiveness of extension services, especially in the public domain. It is therefore recommended that the South African government empower and promote rigorous public-private partnerships aiming at improving extension service delivery with adequate coordination.

Keywords: smallholder farmers, extension and advisory services, effectiveness, drought

1. INTRODUCTION

The development of the South African smallholder farmers is advocated in multiple legislative documents such as the 1995 White Paper on Agriculture, the 1998 Agricultural Policy in South Africa discussion document, the 2001 Strategic Plan for South African Agriculture, the 2011 National Development Plan, the 2016 National Policy on Extension and Advisory Services,

[1] Western Cape Department of Agriculture, Private Bag X1 Elsenburg, 7607, South Africa

[2] Centre for Water and Sanitation Research, Department of Civil Engineering and Surveying, Faculty of Engineering & the Built Environment, Cape Peninsula University of Technology, Bellville 7535, Cape Town, South Africa

[3] Department of Agriculture, Faculty of Applied Sciences, Cape Peninsula University of Technology, Private Bag X8, Wellington 7654, South Africa

and the 2004 Comprehensive Agricultural Support Programme (CASP). Government interventions aim at rectifying the injustices of the past and at fostering the development of rural communities (Aliber & Cousins, 2013; NPC, 2011). As Theron (2018) points out, this development of the smallholder farmers and rural communities is the main responsibility of extension services although the roles of extension services may vary from servicing a few thousands of white commercial farmers to servicing millions of black farmers (Tshuma, 2014; Pienaar, 2013; DAFF, 2016) with different needs and resources. During disaster periods such as droughts it is critical that information (about for example, the climate and drought support) be communicated to the masses of farmers within a short space of time, hence the need of strong linkages with farmer groups such as farmers' associations. Clearly, the literature compiled a mountain of evidence reporting the failure of extension service to successfully implement the tasks of creating an enabling environment for the smallholder farmers to prosper (Sonwa et al., 2016; Gillespie & Mitchell, 2016; van Niekerk, 2012; Greenberg, 2013). Additionally, contributing factors that seem to add to the challenges encountered include climate change and climate change events such as floods and droughts.

Although extension services are usually one of the first respondents to assist farmers during disaster periods such as droughts, multiple organisations and institutions were however not able to provide adequate support services to smallholder farmers during disaster periods due to poor coordination, hence the ineffectiveness of such services (AgriSA, 2016). Some of the challenges faced by the country extension services, as cited in the literature, include for instance, the presence of poorly trained or skilled extension staff, the lack of resources facilitating the access to transport and to information and communication technologies (ICT's), that follow top-down approaches of technology transfers (Khwidzhili & Worth, 2019; Fanadzo & Ncube, 2018; Hart and Aliber, 2012). Furthermore, another challenge has to do with the diversity occurring within the different extension approaches implemented by both the private and public sectors since private sectors aims at delivering natural science advisory services while the public sector delivers extension science advisory services (Terblanchè, 2013).

The realization of the South African government that the smallholder sector is one of the main contributors towards the rural economic development that includes food security and job creation resulted in a change of direction for extension services. New laws, rules and legislation that were translated into the Norms and Standards for Agricultural Extension Services were introduced within the national framework labelled the Extension Recovery Plan (ERP). Since then, different documented Norms and Standards contained in the national framework known as the ERP became the new legal requirements for agricultural extension and advisory officers to perform their duties. The ERP basically guides or regulates the implementation of the Norms and Standards through five objectives known as pillars (DAFF, 2011; Liebenberg, 2015; Lukhalo, 2017; Mmbengwa et al., 2012).

Given the reported failure of extension services, this study aimed at assessing the effectiveness of public and private extension services in supporting smallholder farmers in Overberg and West Coast Districts in the Western Cape. The study was part of a bigger Water Research Commission funded project that was looking at drought impacts on smallholder farmer livelihoods, with the focus being on the 2015-2018 drought.

2. METHODOLOGY

The Overberg and West Coast Districts were selected as the study areas, because of their agricultural background and dryland production practices. The two districts contribute to the capital of small grain producers of South Africa and are therefore, known as our country's bread basket (Zwane, 2019; Barends, 2016; Smidt, 2018). Secondly, dryland producers are hardly hit by climate change events like droughts (Fanadzo et al., 2021). Furthermore, Overberg district is known for its deciduous fruit exports while West Coast district is known for its citrus and rooibos tea exports (Overberg District Municipality [ODM] 2018; Hendriks, 2014; Department of Rural Development and Land Reform [DRDLR], 2017; West Coast District Municipality [WCDM], 2018).

To be able to achieve the objectives assigned to this study, a sample of twenty-four extension officers and managers from both the public and private sector participated in the study. Questionnaires were used to collect data such as age group, gender, education levels and other variables for quantitative data. Quantitative data was used to tabulate the results. The results for the effectiveness of extension services were then assessed against the Norms and Standards for Agricultural Extension Services and Extension Recovery Plan Framework.

3. RESULTS

3.1. The summary of socio-economic characteristics of the extension officers in the study area.

Table 1: Age groups of the extension service respondents (n=24)

	Extension officers	
Age group	**n**	**%**
20–30 years	7	29
31–40 years	7	29
41–50 years	6	25
Older than 50 years	4	17
Total	**24**	**100**

The results in Table 1 revealed that more males were employed as extension officers in the study area than females were, with 70% males and 30% females. With respect to the age group of the extension officer respondents in the study area, the findings in Table 1 show that both the 20-30 years and 31-40 years age groups were represented by 29% (n=7) followed by the next group 41-50 years with 25% (n=6) while the age group with the least participants is the one comprising older generation of 50 years and above with 17% (n=4).

Table 2: Education level of the extension officer respondents (n=24)

	Extension officers	
Education level	n	%
B degree (NQF 7)	8	33
Honours (NQF 8)	3	12

Masters (NQF 9)	9	38
Doctorate (NQF 10)	1	5
Other - Diploma	3	12
Total	24	100

Table 2 extrapolates the level of education of the extension officer respondents. Of the respondents, 38% (n=9) have NQF level 9 qualifications, followed by 33% (n=8) with NQF level 7 qualifications. The respondents holding NQF level 8 and those holding the Diploma were each represented by 12% (n=3) while there was only one respondent holding a NQF level 10 qualification. The results further indicate that 58% (n=14) of the respondents received study bursaries while those who did not receive any bursary were estimated at 48% (n=10).

Table 3: Extension officers' employment sector (n=24)

Employment sector	**Extension officers**	
	n	**%**
Public sector	19	79
Private sector	3	13
NGO	2	8
Total	**24**	**100**

Table 3 shows the number of extension officers that are employed by the different sectors. As the findings indicate, the greater proportion or majority of the respondents (79%, n=19) are employed by the public sector, those working in the private sector are equivalent to 13% (n=3) while the least number of respondents 8% (n=2) are employed by Non-government organizations (NGO).

The number of extension officer respondents that are registered with a professional body such as the South African Society of Agricultural Extension (SASAE) and the South African Council for Natural Scientific Professions (SACNASP) are equally divided at 50% (n=12) for both the public and the private sector.

Table 4: Experience years of the extension officer respondents (n=24)

Period of extension service	**Extension officers**	
	n	**%**
1–5 years	11	46
6–9 years	5	21
10–19 years	5	21
More than 20 years	3	12
Total	**24**	**100**

As Table 4 indicates, 46% (n=11) of the respondents have been working in the sector for less than 5 years, those groups with 6-9 years and 10-19 years of work experience are estimated to

21% (n=5) each, while the group with the most years of experience was less dominant with only 12% (n=3) of the respondents.

3.2. Extension officers' access to Information and Communication Technologies

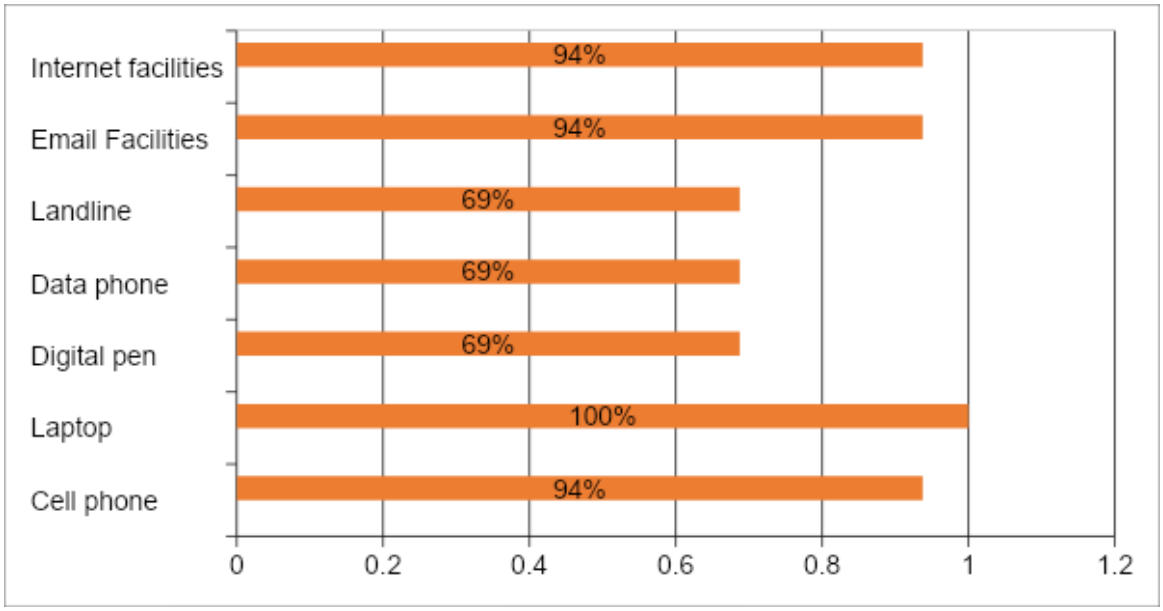


Figure 1: Extension service respondents' access to IT equipment

As the findings in Figure 1 reveal, none of the extension officers from both NGOs and private sector had access to a digital pen and data phone, while those from the public sector were 7 (29%). According to the findings, 50% extension officials all from the public sector have access to a digital pen and data phone. Extension officials used the smart pen and data phone to complete site visits forms during their visits to farmers. The data captured during visits becomes immediately available to managers to view and thus serves as a monitoring tool and keep extension officers accountable to farmers.

As the findings further reveal, all the respondents have access to laptops. Extension officers appear to be digitally connected through the Internet, e-mail facilities and cell phones at 94% each. Public extension officers utilizing the digital pen and data phone during farm visits were estimated at 69% each. Landlines are also included in IT equipment used by some extension officers in the study area with a percent equivalent to 69% as well.

4. DISCUSSION

4.1. The demographic characteristics of the respondents

The demographic characteristics of the extension officers determine their desirable extension clientele to be serviced by them (Moyo & Salawu, 2018). The results have shown that of all the respondents, less than 30% were females. This suggests that more male farmers will be serviced by the current extension crop when compared to female agriculturists. This result is not surprising because the South African agricultural sector has a history of limiting the involvement of female in the farming industry (Tshuma, 2014).

In addition, studies that were recently conducted in the Overberg District found that more male farmers were supported by extension services (Bastian et al., 2019; Jepthas & Swanepoel, 2019). Nonetheless, the results of the different age groups appear to be more desirable in farming sector because of the positive impact and influence of some age groups on farming. For example, the age groups 20-30 years (represented by 29% in this study) and 31-40 years (equivalent to 29% in this study) representing the younger generation were identified to be more vibrant and capable of delivering a robust extension service that is more effective. Moyo & Salawu (2018) attest to this as well by stating that the 24 – 40 years category of extension workers is more productive and capable of effectively imparting knowledge and skills to farmers. Additionally, the younger generation are more digital oriented and have the ability to quickly adapt to the changing environments that surround the agricultural sector. During disaster periods such as droughts communication skills through social media and other digital platforms or sources become crucial needs or a priority for extension workers who have to distribute reliable information to farmers within a short space of time. On the other hand, the elder extension officers 41-51 years (25%) and those older than 50 years (17%) have a role to play in terms of mentoring and coaching the younger extension officers (Moyo & Salawu, 2018).

4.2. Comparison of achieved extension services with the pillars of a National Framework

Drawing on the National Framework for ERP (DAFF, 2011), the effectiveness of extension services is assessed. The ERP is a government tool that aims at revitalising the extension service of South Africa and also to some extent at restoring the dignity of the country's extension crop (Khwidzhili & Worth, 2019). The minimum criteria for agricultural extension and advisory services, also known as the Norms and Standards for Agricultural Extension Services (DAFF, 2005) form the basis of the National Framework for ERP, a framework which is constitutive of five strategic objectives, referred to as pillars. Thus, those pillars include the following:

(i) Ensure visibility and accountability of extension
(ii) Promote professionalism and improve the image of extension
(iii) Recruit extension personnel
(iv) Reskill and reorientate extension workers
(v) Provide ICT infrastructure and other resources

4.2.1. Pillar One: Ensuring the visibility and accountability of extension

Pillar One seeks to identify the responsible extension officer that needs to service a specific extension clientele within a certain location (DAFF, 2011). In this study, extension officers were not assigned to a certain area hence them not being accountable to the farmers.

However, this situation has left farmers astray during disasters like droughts. Farmers need to be supported by extension staff to be able to access government services such as drought relief support. The WCDoA addresses this objective through for instance the implementation and/or distribution of the agricultural information and management system that entails a digital reporting system to be used by extension officers when conducting farm visits. However, in

this study, it was ascertained that 12 extension staff officers did not have data phones or digital pens.

4.2.2. Pillar Two: Promoting professionalism and improve the image of extension

Long periods of drought have the ability to threaten human lives especially the most recent event of the 2015-2018 drought that almost left the City of Cape Town with nothing. Highly skilled frontline staff such as extension officers are needed to come to the rescue of communities with professional skills and advisory support that can support farmers and rural communities to cope with the drought and adapt to the changing environment. This calls for extension staff to specialise in one or different disciplines. Climate Change events such as droughts require new innovative thinking when responding to such events. Professionalism also has the ability to restore the dignity of extension officers.

Extension officers need to acquire new skills to be able to effectively manage and respond to the masses of clients during disasters. Since membership of professional associations is paramount for practitioners, scientists, policymakers and managers to be successful and productive (Bennett & Ramsden, 2007; Davis & Terblanchè, 2016) the South African Society of Agricultural Extension (SASAE) and the South African Council for Natural Scientific Professions (SACNASP) play a pivotal role in facilitating the benefits or outcomes of such memberships and relationships. For example, SASAE is a voluntary association that promotes science and agricultural extension to its members. SACNASP recognises agricultural extension as a science and allows extension staff to register as practitioners (Mmbengwa et al., 2009). According to the findings in this study, 7 male (equivalent to 29%) and 3 (12%) female extension officers belonged to SACNASP while only two (8%) females belonged to SASAE. Furthermore, the findings show that uniforms were issued to all public extension staff to improve the image of extension.

4.2.3. Pillar Three: Recruiting extension personnel

Liebenberg (2015) highlighted the fact that the effectiveness of extension services is influenced by the ratio of extension officers to clients. The ERP recommends an extension-to-farmer ratio of 1:400 for crop producers, 1:500 for livestock producers and 1:500 for mixed farming (DAFF, 2011). The continuous increase in extension clientele from food security initiatives driven by the government including new land reform beneficiaries (Lukhalo, 2017) makes it difficult for the government to reach the target set by the ERP. Climate Change events also have an impact on the number of extension clients, because the extension officer needs to provide advisory services to more people in the household in order to transfer knowledge on water saving techniques and other climate adaptation strategies. The findings have also indicated that more male extension officers (17 or 71%) than females (7 or 29%) were employed. The sector demonstrates a willingness to invest in young extension officers that can adapt to a changing working environment. The findings have shown that the youth respondents were from the private sector (2 or 8%), the NGOs (1 or 4%) and from the public sector (5 or 21%). All of the young respondents have between one to five years of work experience in the extension field. These findings suggest that the agriculture sector has been recruiting extension personnel which is as well constitutive of young people.

4.2.4. Pillar Four: Reskilling and re-orientating extension workers

One of the main gaps identified in the literature are the poor development, training and technical skills of extension staff (Cousins, 2010; Fanadzo, 2012; Fanadzo & Dube, 2018) that renders the current status of extension services ineffective and/or incompetent. Henceforth, this was the reason for Pillar Four of the ERP that attempts to address the human capital status of extension workers in South Africa. The successful implementation of Pillar Four, resulted in the improvement of the human capital status of extension staff in the study area. Study bursaries were allocated to extension staff to enrol in institutions of higher learning to improve their qualifications, knowledge and skills. Improved qualifications of extension staff together with acquired knowledge and skills give a guarantee that they positively impact the level of service delivery to extension clients (Mmbengwa et al., 2009; Landini & Davis, 2019).

The human capital development of the extension service providers in the study area was as well assessed. The results indicate that 24 extension staff members that were interviewed belonged to different sectors with 3 (12%) being from the private sector, 2 (8%) from NGOs and 19 (79%) from the public sector. With respect to education level of extension officers, although, the male extension officers held more post-graduate qualifications, the findings revealed that the female extension staff was more educated than the male staff with one female holding a Doctoral degree. Furthermore, with 9 (37%) Master's degrees, 11(46%) Bachelor's degrees and 3 (12%) Diplomas the extension staff from the study area were characterised as well-educated. Public extension staff was empowered through the ERP that allows a total of 9 (37%) males and 5 (21%) females being awarded with study bursaries. Given these educational levels and bursary arrangements to improve the qualifications and knowledge of extension staff continuously, it would be reasonable to describe the extension staff as educated and as capable of delivering an effective extension service to clients.

4.2.5. Pillar Five: Providing ICT infrastructure and other resources

Information and Communication Technologies were identified as enabling tools that enhance the efficiency and effectiveness of extension services (DAFF, 2011). Through the ERP, extension managers and organisations were empowered to create favourable environments for extension staff to explore the digital world and improve communication techniques with farmers during disaster periods. Mass media (social media) and drought portals were created to distribute more reliable information to farmers and facilitate communication during the recent drought. The tools and equipment required to improve the effective delivery of extension services include for instance, an information technology package (laptop, printer, cell phone, memory stick). The results indicate that 6 (25%) officials did not have access to official cell phones, while 18 (75%) had; and 2 officials (8%) did not have access to laptops whereas 22 (92%) did. The same results apply for landline telephones. Only 1 (4%) official had no access to both email facilities and the Internet, while 23 (96%) officials did have access to email facilities.

5. CONCLUSION AND RECOMMENDATIONS

The idea of categorising extension services as ineffective or unproductive becomes irrelevant within the study area, namely Overberg and West Coast Districts. The findings have shown that extension services appear to be more efficient and effective, especially during disaster periods like droughts, thanks to the successful implementation of the Norms and Standards as well as the ERP. Moreover, the public sector proved to be more compliant in all five pillars of the ERP when compared to the public sector's and NGO's implementation of extension services. The private sector and NGOs need further investment if they are to comply with the legal framework for agricultural extension workers. It is therefore recommended that the South African government empower and promote rigorous public-private partnerships aiming at improving extension service delivery with adequate coordination.

6. REFERENCES

AGRI SA. 2016. *A raindrop in the drought. Report to the Multi-stakeholder task team on drought*. Retrieved from http://www.nstf.org.za/wp-content/uploads/2016/06/Agri-SA-Drought-Report_Cs4.pdf [Accessed 13 August 2019].

ALIBER, M. & COUSINS, B. 2013. Livelihoods after land reform. *Journal of Agrarian Change*, 13(1):140-165.

BARENDS, V. 2016. Developing a sustainable carbon calculator for smallholder farming systems in Western Cape, South Africa. Masters thesis, Stellenbosch University.

BASTIAN, R.M. SWANEPOEL, J.W. & VAN NIEKERK, J.A. 2019. Effectiveness of the implementation of the mechanisation programme for emerging farmers in the Overberg and Eden districts of the Western Cape. *South African Journal for Agricultural Extension*, 47(2):58-71.

BENNETT, R.J. & RAMSDEN, M. 2007. The contribution of business associations to SMEs: strategy, bundling or reassurance? International Small Business Journal, 25(1): 49-76.

COUSINS, B. 2010. What is a 'smallholder'? PLAAS, University of the Western Cape, Working Paper, 16.

DAVIS, K.E. & TERBLANCHÈ, S.E. 2016. Challenges facing the agricultural extension landscape in South Africa, Quo Vadis? *South African Journal for Agricultural Extension*, 44(2):231-247.

DEPARTMENT OF AGRICULTURE, FORESTRY AND FISHERIES (DAFF), 2011. National Framework for Extension Recovery Plan. Pretoria.

DEPARTMENT OF AGRICULTURE, FORESTRY AND FISHERIES (DAFF), 2005. *Norms and Standards for Extension and Advisory Services in Agriculture*. Pretoria: Government Printer.

DEPARTMENT OF AGRICULTURE, FORESTRY AND FISHERIES (DAFF), 2016. *National Policy on Extension and Advisory Services*. Pretoria: Government Printer.

DEPARTMENT OF AGRICULTURE, FORESTRY AND FISHERIES (DAFF), 2016. *Overberg District: Rural Development Plan. Integrated development planning summary (2017/2018*). Retrieved on the 4th of April 2019, from http://www.ruraldevelopment/gov.za./phocadownload/SPLUMB/Dev_Plans2017/Western_Cape/Overberg%20RDP%20Summary%20March%202017.pdf.

FANADZO, M., NCUBE, B., FRENCH, A. & BELETE, A., 2021. Smallholder farmer coping and adaptation strategies during the 2015-18 drought in the Western Cape, South Africa. *Physics and Chemistry of the Earth, Parts A/B/C*, p.102986. https://doi.org/10.1016/j.pce.2021.102986

FANADZO, M. AND NCUBE, B., 2018. Challenges and opportunities for revitalising smallholder irrigation schemes in South Africa. *Water SA*, 44*(*3):436-447.

FANADZO, M. & DUBE, E. 2018. Recognising the differences between farmers key to smallholder development. *Water Wheel*, 17(6):12-15.

FANADZO, M., 2012. Revitalisation of smallholder irrigation schemes for poverty alleviation and household food security in South Africa: A review. *African Journal of Agricultural Research*, 7(13):1956-1969.

GILLEPSPIE, W.A. & MITHCHELL, F.J. 2016. Measuring the effectiveness of extension for small-scale sugarcane growers: A case study. Retrieved from https://sasae.co.za/conferences/proceedings-of-conference-2016/ [Accessed 14 June 2019].

GREENBURG, S. 2013. The disjunctures of land and agricultural reform in South Africa: Implications for the agri-food system'. PLAAS Working Paper 26. Institute for Poverty, Land and Agrarian Studies, August 2013.

HART, T. & ALIBER M. 2021. *Inequalities in agricultural support for women in South Africa. Human science research council: policy brief.*

HENDRIKS, M. 2014. Connecting small-scale farmers in Grabouw, South Africa to formal markets: An assessment of the key constraints. Masters thesis, Wageningen University.

JEPTHAS, G. SWANEPOEL, J.W. 2019. Implications of the environmental impact assessment regulations on the agricultural sector in the Overberg District in the Western Cape for emerging farmers. *South African Journal for Agricultural Extension*, 47(2):128-139.

KHWIDZHILI, R.H. & WORTH. S. 2019. Evaluation of South Africa's public agricultural extension in the context of sustainable agriculture. *Afr. J. Agric*, 47(1):20-35.

LINDINA, F. & DAVIS, K. 2019. Extension officers' perception of extension and innovation in South Africa. *"The Challenge: Successful Land reform in South Africa and the Role of Extension Advisory Services". Proceedings of the South African Society for Agricultural Extension Conference,* 9–11 July 2019, Kimberley. Retrieved from https://sasae.co.za./proceedigs-2019/ [Accessed 21 January 200].

LIBENBERG, F. 2015. *Agricultural advisory services in South Africa*. Working Paper 241722, University of Pretoria, Department of Agricultural Economics, Extension and Rural Development. DOI: 10.22004/ag.econ.241722

LUKHALO, T. 2017. An expenditure review of the agricultural extension system in South Africa. Masters thesis, University of Pretoria.

MMBENGWA, V., GROENEWALD, J., VAN SCHALCKWYK, H.D. & SEBOPETSA, M. 2012. An evaluation of the quality of government extension services in West Coast District of Western Cape Province, RSA. *OIDA International Journal of Sustainable Development*, 4(12):113-126.

MMBENGWA, V., GROENEWALD, J., VAN SCHALCKWYK, H.D. & SEBOPETSA, M. 2012. An evaluation of the quality of government extension services in West Coast District of Western Cape Province, RSA. *OIDA International Journal of Sustainable Development*, 4(12):113-126.

Mmbengwa, V.M., Gundidza, M., Groenewald, J.A. & van Schalkwyk, H.D. 2009. Factors affecting extension workers in their rendering of effective service to pre post-settled farmers in government initiated and supported farming small, micro and medium enterprises. *South African Journal of Agricultural Extension, 38:1-14.*

MOYO, R. & SALAWU A. 2018. A survey of communication effectiveness by agricultural extension in the Gweru district of Zimbabwe. *Journal of rural studies 60:32-42. Development*, 4(12):113-126.

NATIONAL PLANNING COMMISSION (NPC). 2011. *National Development Plan. Vision for 2030.* Republic of South Africa, Pretoria. Retrieved from https://www.salga.org.za/SALGA/%20Municipal%20Managers%20Forum/Documents/National%20Development%20Plan%202030.pdf [Accessed 14 August 2019].

OVERBERG DISTRICT MUNICIPALITY (ODM). 2018. *Draft Integrated Development Plan Review.* Retrieved from https://www.odm.org.za/draft-idp-review-2018-2019 [Accessed 5 May 2020].

PIENAAR, L. 2013. Typology of smallholder farming in South Africa's former homelands: Towards an appropriate classification system. Masters thesis, Stellenbosch University.

SMIDT, H.J. 2018. The use of information and communication technology by emerging commercial farmers in their development in the Western Cape, South Africa. Masters thesis, Stellenbosch University.

SONWA, D.J. DIEYE, A., MZOURI, E.E., MAJULE, A., MUGABE, F.T. OMOLO, N., WOUAPI, H. OBANDO, J. BROOKS, N. 2016. Drivers of climate risk in African agriculture. Climate and Development, 9(5):383-398.

TERBLANCHÈ, S.E. 2013. Agricultural extension training needs of the non-government advising sector in South Africa. *South African Journal for Agricultural Extension*, J41:94-106.

THERON, J.G. 2018. Evaluation of an instrument for the assessment of farming operations to enhance commercialisation. *"Synergising Agricultural Extension Services towards the Commercialisation of Smallholder Producers". Proceedings of the South African Society for Agricultural Extension Conference*, 5–7 June 2018, East London. Retrieved from https://sasae.co.za/conferences/conferences-2018/ [19 July 2019].

TSHUMA, M.C. 2014. Understanding the small-scale agricultural sector as a precondition for promoting rural development in South Africa. *African Journal of Agricultural Research*, 9(31):409-2418.

VAN NIEKERK, J.A. 2012. Redefining the role of the extension agent in commercializing South African agriculture. An Eastern Cape case study. PhD thesis, University of the Free State.

WEST COAST DISTRICT MUNICIPALITY (WCDM). 2018. *Integrated development plan 2017-2022. Review 1.* Retrieved from http://westcoastdm.co.za/wp-contnet/uploads/2018/05/WCDM-IDP-2017-2022-Review-1-3.pdf

ZWANE, E.M. 2019. Impact of climate change on primary agriculture, water sources and food security in Western Cape, South Africa. *Jamba: Journal of Disaster Risk Studies*, 11(1):1-7.

FOURTH SESSION

BACKYARD TO BOARDROOM: THE ROLE PLAYED BY AGRICULTURAL EXTENSION

Bornman, M.E[1] and Lubuku, D.C[2]

ABSTRACT

One of the goals of an Agricultural Extension Officer is to assist farmers to progress from one level to the next level in their farming enterprise in order to generate income and better their livelihood. This goal was achieved in the RM Agribusiness that over past eighteen (18) years have progressed from a backyard garden to a profitable commercial business. The business succeeded even during the difficult times of the COVID 19 pandemic during 2020. The role of the Agricultural Extension Officer, bringing together a team of experts to support the farmers to grow, and the willingness of the farmers to accept and implement advice will be explained. Lessons learned during this process will be shared.

Keywords: Extension officer; linkage; marketing; organizational arrangements.

1. INTRODUCTION

Agricultural Extension also known as Agricultural Advisory Services is the application of scientific research and new knowledge to agricultural practices through farmer education. It plays a crucial role in boosting agricultural productivity, increasing food security, improving rural livelihoods and promoting agriculture as an engine of economic growth.

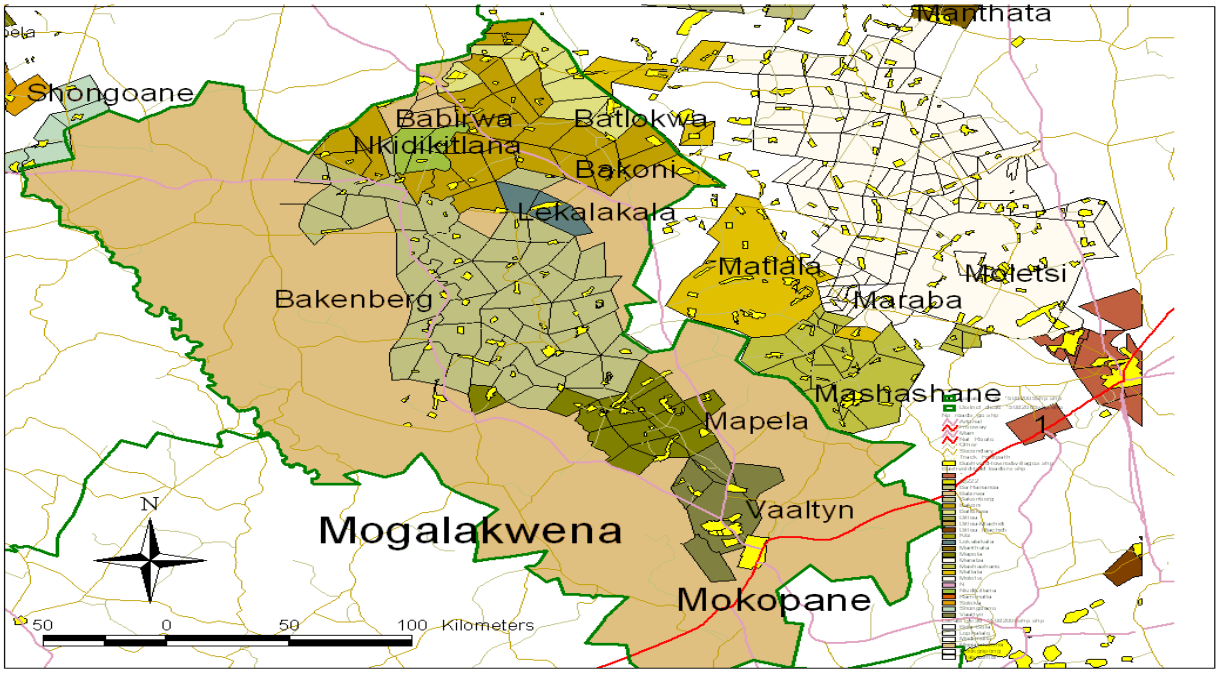
The purpose of this paper is to show case how agricultural extension assisted a farmer (Me Caroline Chokoe or RM Agribusiness) to progress from a backyard garden to a profitable commercial business. Attention will be given to the important role of the Agricultural Extension Officer and the importance of support of other components in the Department to ensure that the farmers can grow and reach their potential. One of the key aspects will be the ability of the Extension Officer to communicate and build solid networking systems.

Information was gathered by conducting one to one interview with: Me. Chokoe (the owner of RM Agribusiness), the extension officer and other colleagues who supported the farmer.

Me. Caroline Chokoe established RM Agribusiness in 2003 as a backyard garden. It is situated in the Ga Mathapo village in the Mogalakwena Local Municipal area of Waterberg District in Limpopo Province (Municipalities.co.za). Through the support of dedicated extension staff and with some financial support from the Department of Agriculture and Rural Development and other donors the farmer has progressed from her back yard garden to an eight (8) ha production unit.

[1] M.E. Bornman. Deputy Director: Limpopo Department of Agriculture and Rural Development. Private bag x Modimolle, 0510. Tel 014 717 4949. Email: bornmanm@agric.limpopo.gov.za

[2] D.C. Lubuku. Deputy Director: Limpopo Department of Agriculture and Rural Development. Private bag X 2455 Mokopane, 0600. Tel 015 491 5148. Email: lubukudc@agric.limpopo.gov.za



DEPARTMENT OF AGRICULTURE

2. RM AGRIBUSINESS.

RM Agribusiness started as a back yard garden project in 2003 by Me. Chokoe. She started by producing vegetables for home consumption. Production was of such a nature that she was able to sell some produce to her neighbors.

She discovered that not only does she have "green fingers" when it comes to growing vegetables, but that she also loves doing it. Thus the yearning to expand the backyard garden to make it a profitable business. At first she produced in her own backyard and in the backyard of her neighbor. She then obtained more land from the local authority and are currently producing vegetables successfully on 8ha; she has access to another 2 ha which will be put under production in the near future. There is a strong borehole (drilled and equipped by ESKOM funding) that enable her to use drip irrigation system.

She has also obtained an "inflatable water storage tank", with a capacity of 35,000L. Water from the borehole are stored in this facility, to be utilized in times when water table are low. This will ensure that cultivation can take place throughout the year.

The vision of the company is: "… to become the most preferred vegetable produce enterprise by maintaining our reliability of providing excellent vegetables and fruits through PRIDE, DETERMINATION & RESILIENCE". (Chokoe, M, 2019)

The long term objectives include:

- To increase the companies', turn over by 10 percent by the end of business of the financial year,
- Maximize profit by working more efficiently,
- Improve company financial management by implementing financial management systems,
- Ensure the sustainability of the company,

- Product development: Increase product range and quality of products,
- To have satisfied customers,
- Ensure business growth of 15% every year.

The project is mainly producing tomatoes, cabbage, green peppers and Sweet piquante pepper (commonly known as pepper dew).

When the business started in the backyard the overflow was marketed in the local community. As the business grew the local community remained one of the target markets. In the words of Me. Chokoe: "We value our communities, and they always remain our target market."

The business started operating with its focus on potential customers as its target market – therefore producing for what the market needed to ensure that produce will sell. This is an important lesson for many projects.

Seedlings are obtained from commercial nurseries. One is a nursery in Tzaneen and the other one close to the town of Mokopane. Commercial fertilizer is used and applied as fertigation. Sometimes manure from the animal kraal is used. Plants are watered on a well-designed schedule to optimize water usage and maximum growth of plants.

Currently the project is producing for existing customers over and above the local communities.

Peppadew are produced for Mufama investments on contract, tomatoes are supplied to the Pretoria Fresh Produce Market weekly.

Furthermore, sub-contracting for the company that is supplying food to twenty-one (21) local schools in the Matlala circuit, as part of the Department of Education feeding scheme. Cabbage are supplied to the contractor who collect the cabbage and deliver it to the schools.

Local community members buy on a daily basis from the farm gate.

During Christmas time high volumes of vegetables are needed and the project has scheduled their planting time to make sure enough produce will be available to meet the demand.

The farmer also contributed to the increase in sales due to the increase of trust of the existing customers and the positive responses of the marketing efforts. "Initially we were mostly dealing with smaller companies and could only be trusted for smaller work in bigger enterprises. Our quality did improve over the period we have been in business and our clients developed more trust in us. Over the period of our existence, we have been involved in multiple marketing strategies and we believe they have contributed to the growth." (Chokoe, M, 2019)

It is important to note the production decrease during the winter season and that natural phenomena like heat waves and hailstorms can damage crop negatively.

During discussions with the local economist, when business plans were developed, the farmer identified the following as their strength:

- Experienced and competent employees (2 females for vegetable production and 2 young men to assist with cattle on permanent basis and 2 - 6 casual workers are employed during planting and harvesting time)
- After sale service and quality service from suppliers of inputs and equipment to the project.

- RM Vegetables are seen as reliable supplier of products by its clients.
- Thorough knowledge of the business was build up over time.

Weakens that were identified are:

- Limited working capital.
- A need for quality management systems
- Shortage of machinery
- Lack of long-term contracts

Opportunities that presented itself:

- Political changes have contributed to the success of many SMME's
- Growth opportunities to have access to more land, produce more vegetables and enlarge the production of vegetables
- Black woman owned

Threats:

- Recession
- Unexpected heat waves

3. IMPACT OF COVID 19

Covid 19 has impacted negatively on the farming enterprises as well. Me. Chokoe managed to overcome this by identifying new markets.

She sub-contracted for service provider who supplied cabbage to the schools under the School-feeding scheme. Due to lockdown the feeding schemes was temporally stopped. This meant that the harvest on the land will go to waste and there would be no income. She explored the local market in the village and was successful in this regard. Due to fact that transport to town was big problem during lockdown, more and more local people bought from her. Many of the local community members are now regular customers.

When the feeding scheme was re-instated, she started to supply cabbage again to the sub-contractor.

The project had peppadews on the land, when the COVID restriction came in. Unfortunately, they lost this crop because the factory to whom they supplied was closed due to the restrictions and could not take in any produce. The harvest had to be ploughed back in the soil as compost.

The farmer applied for the COVID19 fund that was offered as stimulus package by National Department of Agriculture, Land Reform and Rural Development. The project received voucher to the value of R50 000.00. Funds were used to purchase paprika seedlings, fertilizer and chemicals. A market was secured in Brits for dried Paprika.

She was also able to maintain all the workers on the project. Since they were seen as essential workers, they could come to assist on the project.

4. THE ROLE OF THE AGRICULTURAL EXTENSION OFFICER

The norms and standards for Extension and Advisory Service in Agriculture state the following: "In general, extension refers to a systematic process of working with farmers or communities to help them acquire relevant and useful agriculture or related knowledge and skills to increase farm productivity, competitiveness and sustainability. In practice it is a continuum, ranging from the narrow technology transfer that brings changes in farming practices without taking into account the overall societal perspectives, to advisory, education and human development where it takes on critical public priority issues"

(NDA 2005 p5).

Dr. J.B. Stevens commented that "… many extensionist still believe in their role as that of teaching or telling instead of creating an environment where people form effective linkages in order to help themselves." (SASAE Journal, 2009. p59). This is in reference to the important role that extensionist play and the following dimensions of his/her roles (Oakley, 1991):

- **Structuring:** The identifying of partners and the forming of internal cohesion and solidarity in some form of structure which brings people together and that will encourage continued involvement. Once the different capacities of each individual in the system is recognized the respective responsibilities and objectives will fall into place.
- **Facilitation:** This role is to empower the partners to take action and by so doing, strengthening their participation. This will include acquiring specific technical skills, gaining access to resources, etc.
- **Linking:** Assist in developing linkages between people with similar contexts and who are facing similar needs.
- **Animation:** Encouraging participants to express their challenges in their own words and to help them understand that they can contribute in bringing about change.
- **Intermediary:** The fine art of bringing relevant people together and help them establish linkages and then to move away and let them proceed with the work at hand.
- **Withdrawal:** Empowering people and then to let them go and to ensure that they take responsibility for the specific action.

In the case of RM Agri business, the local Extentioner has walked the road with the farmer. At first only to give guidance on production in the backyard. When the farmer indicated her intention to expand, the official brought in a team of specialists to assist. The agricultural economist spent many hours with the farmer to determine what her vision is for the project and what she wanted to achieve. With this information he was able to draw up a comprehensive business plan for the project with which the farmer could apply for funding from various sources. The soil scientist and crop specialist from the Mogalakwena Municipal office was also brought on board. Soil samples were taken and analyzed to ensure that correct fertilization is done to enhance production. The team of Limpopo Department of Agriculture and Rural Development (LDARD) worked together to assist the farmer to grow and they are still assisting.

Me. Chokoe were also taken on exposure visits to nearby projects that are in vegetable production enterprise. The Extentioner encouraged her to read and learn on her own, which she is indeed currently doing.

Due to the success of RM Agri Business, Me. Chokoe has been requested by the local Extentioner to mentor new entrants into the world of vegetable production. She is mainly mentoring young aspirant farmers. She has also avail her farm for regular farmer's days and exposure visits from neighboring municipalities who are bringing farmers to observe.

It is extension practices like these that open up the world of farming to not only other farmers but to other officials as well.

The Extension Officer also assisted the farmer to register the workers under UIF and to have the enterprise registered for COIDA.

5. FUTURE PLANS

The project has started to engage livestock as well. Currently there are 55 sheep and 25 goats. The plan is to produce Lucerne under irrigation in order to ensure extra feed for the livestock.

RM Agri business has also registered as a service provider on Governments' central database. Currently the business has been contracted by LDARD to deliver ploughing services to identified farmers.

6. ACHIEVEMENTS

Over time Me. Chokoe has grown from backyard to thriving business which is now registered as a legal entity and paying taxes.

She was awarded many accolades, including:

- 2003: Best Female Farmer in Waterberg District: Back yard production
- 2007: Best Female Farmer in Waterberg District: Informal market
- 2016: Best Female Farmer in Waterberg District: Commercial
- 2016: Runner up Best Female Farmer: Limpopo Province: Commercial
- 2009: Winner Nestle National Nutrition award

Me. Chokoe has embraced all learning opportunities that crossed her path. She received training in development of business plan, planting of seedlings and the laying of dripper lines. She is computer literate and able to send and receive information by means of email, do research using the internet etc.

7. LESSONS LEARNED

Extension service is a two ways process: information is given and the recipient need to accept and implement it. This truth is made clear from the words of Me Chokoe who said "I wouldn't be where I am if it was not because of the advice I got and used from the Extension Officers".

Extension Services succeed if the farmer is willing to take and implement the advice provided.

It is important to be flexible at all times. COVID 19 has taught all that one has to adapt and be creative in your day-to-day activities.

Extension Officers (especially in rural areas) should be equipped with a state of the art knowledge base to ensure that their presence brings positive results in production and yield of agricultural produce - because in most cases they are the only source of information to the farmers.

8. CONCLUSION

With the help of an Extension Officer combined with the farmer's commitment and hard work; it is possible to move from backyard garden subsistence farming to commercial farming. And be successful even in troubling times such as the COVID pandemic

9. REFERENCES

ACRON, J. 2009 Thabazimbi *Local Economic Development Strategy*. Stellenbosch.

BORNMAN, M.E; NEALER E.J; STEVENS J.B. 2009. (titel) *South African Journal of Agricultural Extension, Volume 38 (1): (Bl nommers).*

CHOKOE M. 2019. *Business Plan R.M. Agribusiness (Pty) Ltd.* Mokopane

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA). 2018. *SHEP Handbook for Extension Staff (place of puglication and by who)*

LDA (LIMPOPO DEPARTMENT OF AGRICULTURE). 2014. *Strategic Plan 2015/16 – 2019/20.* Polokwane: Review printers

NDA (NATIONAL DEPARTMENT OF AGRICULTURE). 2005. *Norms and Standards for Extension and Advisory Services in Agriculture*. Pretoria

Municipalities.co.za map. (Viewed on 3 April 2018) Available from: http://municipalities.co.za/maps

OAKLEY, P. 1991. *Projects with People: The practice of Participation in rural development.* Geneva. International labour Office.

EFFECTIVENESS OF ADVANCED TECHNOLOGY TRANSFER DURING COVID-19 ON SMALLHOLDER FARMERS IN SOUTH AFRICA: A REVIEW

Ngqulana, A.,[1] Christian, M.,[2] Mdoda, L.[3] and Jiba, P[4].

ABSTRACT

Majority of rural people in South Africa depend on agriculture for survival. Over the past years, government policy interests have been directed in reducing poverty through farmer support programme. Among other things is the introduction of new and advanced farming techniques to increase production. Again, the COVID-19 pandemic is causing everyone to revisit the global norms that have been the backlog for the last century. Advance agricultural technology transfer can play an imperative role in improving agricultural productivity, especially in South Africa during this current pandemic. The study made use of qualitative synthesis to assimilate the retained studies for full-text review of the study. Evidence suggests that farmers who are empowered with digital information (advanced technology) have a high probability of increasing their yields, farm returns, and resilience against shocks (Covid-19). This seeks to assess sources of information on improved agricultural technology, to understand the effectiveness of new technology on smallholder farmers and lastly to address the challenges of extension officers during covid-19 regulations. The study recommends that policymakers and government must venture into empowering the national extension system through both conventional and non-conventional technologies (ICT, mobile phones), given the cost-effectiveness and their impact on the farmers' acceptance decisions.

Keywords: Advanced technology, Covid-19, Effectiveness, Smallholder farmers

1. INTRODUCTION

The current global focus and derive for under-developed countries is to adopt the fourth industrial revolution and effectively global food system, the agriculture sector must improve labour productivity to meet the increasing demand for food and move towards utilization of digital technologies, thus explore in more alternatives for automation and mechanization. Dhebibi *et al.* (2020) mentioned that most African countries have failed to meet the requirements for a successful agricultural revolution and many smallholder farmers in developing countries remain in dark regards to improved farming practices. According to Collier and Dercon (2009), the economies of scale that are linked to technology are probably

[1] Lecturer at the Elsenburg Agricultural College: Department of Agricultural Extension and Production, Department of Agriculture: Western Cape Private Bag X1 Elsenburg, 7607. E-mail: ngqulana1@gmail.com

[2] Senior Lecturer/Researcher at the North West University: Department Agricultural Economics and Extension, P/Bag x 2046, Mmabatho, 2735. E-mail: mzuyanda1990@gmail.com and; ORCID: 0000-0003-4446-0298

[3] Senior Lecturer/Researcher at University of KwaZulu Natal: Department of Agricultural Economics, Agricultural Management and Agribusiness, P/Bag X1314, Scottville, Pietermaritzburg, 3200. E-mail: MdodaL@ukzn.ac.za; ORCID: 0000-0002-5402-1304.

[4] PhD Candidate/Researcher at the North West University: Agricultural Economics and Extension, P/Bag x 2046, Mmabatho, 2735. E-mail: phiwejiba@gmail.com; ORCID: 0000-0003-0648-7254

the most disputed but most misunderstood area in the engagement on the qualities of the smallholder sector.

The widely used advanced technology transfer (thus information systems) in agriculture are mass media and mobile phone applications, particularly in providing information from agriculture, marketing of food and agricultural products, as well as in supporting farmers' decision-making initiatives. Sikundla et al. (2018) specified that mobile phone application effectiveness by farmers is based on enabling information entrance amongst growers, agricultural extensionists and distant realization and subsequently offer communiqué links uniform in inaccessible situations, thereby supporting the attainment of the growers breathing in far-flung regions. Abdul & Bashir (2019) added that the usage of information systems (such as mobile phone applications) has transformed the traditional methods of agriculture and enhanced agriculture productivity and sustainability. Khou & Suresh (2018) and Huq et al. (2017) specified that there is a rapid huge base for farmers using social media tools in the form of mobile phone application for technology transfers for fetching better ways of sharing agricultural information which has made a vast world impact, especially during COVID-19 pandemic. As a result, the extraordinary digital revolution has facilitated the global drive for development with technological progress which has assisted smallholder farmers in decreasing prices, ease information asymmetry, infrastructural deployment consequential in improved access to agricultural information, and bridging the information gap between large and smallholder farmers (James & Versteeg, 2007; Mwalupaso et al., 2019). Additionally, mobile phone applications have played imperative roles in the driving enhancement of smallholder productivity, employment, and economic growth (Azinne et al., 2020).

The major challenge for policymakers to increase productivity in the agricultural sector especially during COVID-19 pandemic. The current system of technology transfer presents important deficiencies related to the lack of means in the extension institutions, such as the SASAE, to the lack of coordination between the various actors of the technology transfer system, particularly the profession and research, and the lack of a targeted transfer strategy that considers the specificity of regions and the socio-demographic and economic characteristics of farmers. The main research questioned addressed in this article are what are the sources of information on improved agricultural technology, how is the effectiveness of new technology on smallholder farmers and what are the challenges faced by extension officers during covid-19 regulations.

2. METHODOLOGY

2.1. Approach

Review studies have emerged as one method of addressing research questions and have been widely accepted in many disciplines, especially developmental studies (Okoli, 2015). Systematic literature review (SLR) is one of the most preferred models of this kind. As a result, this study also follows the SLR process outlined by Okoli (2015). This paper is based on a literature review to relate the sources of information on improved agricultural technology, the effectiveness of new technology on smallholder farmers and the challenges faced by extension officers during covid-19 regulations. Existing literature, policies, administrative records, and

government reports provided information for this study. The study followed the following steps: formulated the research question, conducted literature search, determining criteria for inclusion, did the screening of studies for inclusion, synthesis of information from the literature and writing.

2.2. Literature search and inclusion

To cover as much literature as possible, this research looked at three popular and reliable literature databases. These included Scopus, Web of Science and Science direct (Zhang, Xu, Zhang, Wang, He & Zhou, 2020). In addition, Google and Google scholar were also used.

2.3. Synthesis of literature

A qualitative synthesis of the literature was followed in this study to assimilate the retained studies for full-text review. Following similar review studies (e.g. Okeke *et al*., 2015; Machete & Shale, 2015), the study applied thematic analysis to develop themes related to the research objectives.

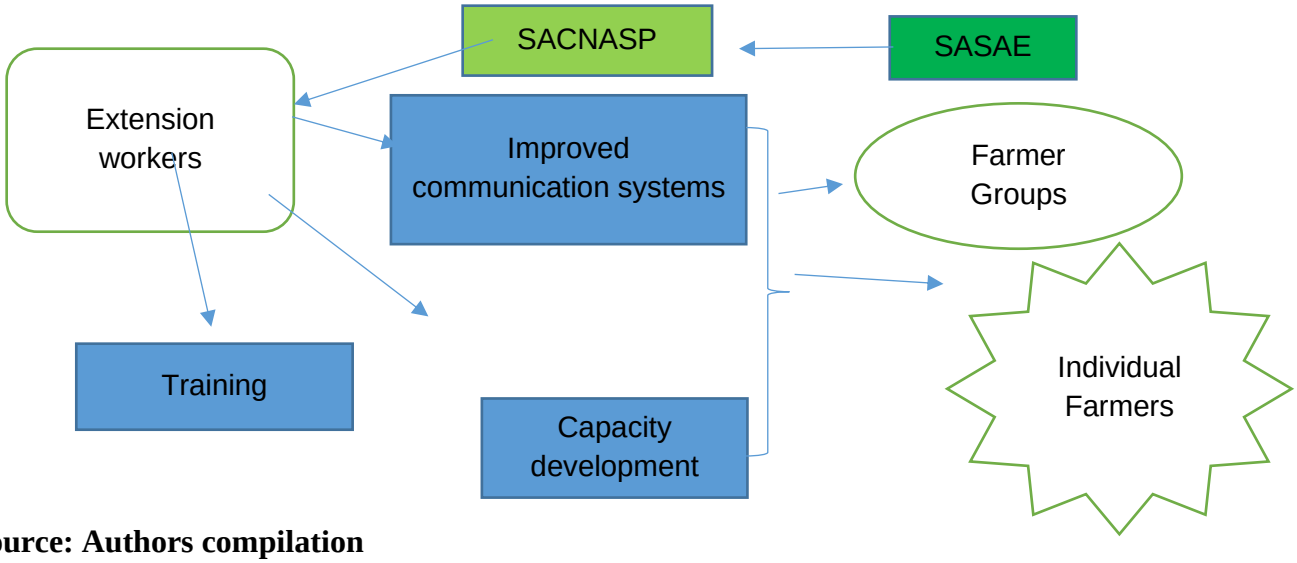
3. FINDINGS

3.1. Synthesis of literature reviewed

3.1.1. Public extension service delivery model in South Africa

In South Africa, the state provides all extension support services to smallholder farmers, which is like other developing countries. These services are offered free of charge as social welfare, which makes government bear all the costs (Koch & Terblanché, 2013). However, the recent economic plunge, coupled with bureaucratic inefficiencies in the agricultural sector, has led to the government reducing its investment in extension provision services. According to Afful & Lategan (2014), the limited funding for extension services has aggravated the administration of the sector, leading to poor service delivery to smallholder farmers who rely on the government for extension services.

Furthermore, funding is at the centre of several institutional challenges currently facing the administration of extension services. These include the low extension worker to farmer ratio, which currently stands at 1:1500, the laying off of skilled and experienced workers, poor essential support, like transport, and the inadequate supply of inputs and information (Hlatshwayo & Worth, 2016; Nkosi, 2017).



Source: Authors compilation

3.2. Review the use of information sources on agriculture

Information is processed and planned data for meaning full purpose which could be in different forms or sources of information. Information is an essential factor in the practice of farming, and it is the basis of extension delivery (Uwandu *et al*, 2018). Agricultural information is defined as the various sets of information and communications that are relevant to agricultural production activities of farmers and such contribute to the betterment of farming activities as well as enhancing productivity (Tadesse, 2008). Agricultural information, as advised by Agbamu (2006) is defined as all published or unpublished knowledge in all aspects of agriculture.

It is important in all angles of the agriculture sector from planning to production level in the farm. According to Adio *et al*. (2016), agricultural information should be available to scientists particularly extension officers to engage in agricultural development and food production, this requires different sources of information at the right time to make a wise decision. According to Vidanapathirana (2019), agricultural information is an important factor that interacts with other production factors which can be improved by relevant, reliable, and useful information. Agricultural information is very important and necessary because the information had been defined as gentleman's collected knowledge in all subjects, in all forms and from all fonts that could help users who are farmers to improve and develop them intellectually on their activities and enhance their productivity.

Information is very useful and important if it is within the hands of the farmers because it means empowerment through control over their resources and decision-making processes. Having an effective and efficient transfer system of important information and technology services facilitates the farmers' perilous role in decision-making towards improved agricultural production, processing, trading, and marketing (Vidanapathirana, 2019). Agricultural information creates awareness among farmers about agricultural technologies for the adoption of advanced technologies. The characteristics of a good information source are relevance, timelessness, accuracy, cost-effectiveness, reliability, usability, exhaustiveness, and aggregation level.

3.3. Information sources in agriculture

3.3.1. Agricultural extension

This is the most trusted and used source of agricultural information. Agricultural extension is the primary delivery system for information to farmers in South Africa and Africa (Raidimi & Kabiti, 2019; Stevens & Van Heerden, 2016). Danso-Abbeam et al (2018) argue that agricultural extension is the most trusted source of transfer technology, supports rural adult learning, assists farmers in problem-solving and getting farmers actively involved in the agricultural knowledge and information system. In developing countries context, Agricultural extension assists through knowledge and application of this knowledge on the farm. This type is the most recognized type of dissemination of practical information to farmers, including on improved seeds, soil quality, tools, water management, crop protection, agricultural practices, and livestock. Agricultural extensions are the middlemen between research institutes and farmers as they disseminate research findings and scenarios to farmers (Adio, 2016).

Agricultural extension provides a source of information on new technologies for farming communities which when adopted can improve production, incomes, and standards of living. Extension service providers make an innovation known to farm households, act as a catalyst to speed up adoption rate and control change and attempt to prevent some individuals in the system from discontinuing the diffusion process. Through extension services, farmers' problems are identified for further investigation and policy direction.

3.3.2. Radio and Television

Advancement in technology has brought about new communication channels which are either separate or facilitated communication devices. Farmers do access agricultural information using radios and television. Mtenga (2018) argued that radio and television are the potentials for knowledge dissemination to farmers cheaply and easily. Radio and television stations have an excessive latent of being able to reach more people and farmers at a given time because dissemination is made possible through satellites and antennas (Wahab 2015). Moreover, conversion from radio and television transmissions has made the accessibility and reachability of radio and television frequencies wider. Radio and television broadcasts are known to reach most rural areas. However, this type is not most used as an agricultural extension due to network challenges and finance in purchasing them by farmers, especially in remote areas.

3.3.3. Mobile phones and newspapers

Oppose to radio and television, mobile phones and newspapers are a source of information used in agriculture. Since the e-agriculture community was established, several agricultural organisations have commenced e-agriculture actions and newspapers, either on a large or on a small scale as a source of information in agriculture. Sekabira & Qaim (2017) state that since 2000, mobile phones and newspapers have been largely accepted in most developing countries, and studies have revealed that the use of these sources has enhanced farmers' market access and farm returns. Additionally, the mobile phone has also empowered farmers to communicate from local to administrative levels regarding the agricultural trade, information exchange, and marketing of their farm commodities (Rahman et al., 2020).

3.3.4. Farmer to farmer

This is another source of information that is widely used in disseminating information. This is whereby farmers with much information share the information with other farmers intending to improve their farm operations and farm returns. Smallholder farmers rely on farmer-to-farmer information, as they cannot afford other sources due to poor infrastructure and finance.

3.4. Improvement of skills labour productivity

Smallholder farming is the driver of various economies in Africa even though their potential is sometimes not brought forward (Aaron, 2012). Most of these farmers tend to rely on cheap family labour for production (Ntshangase, 2014). They rely on traditional methods of production, which has lowered the level of productivity significantly. This may be a result that, farmers also tend to use local cultivars, which have low yield potential (Yakomo, 2020). This points directly to policymakers on how to design and plan different strategies or policies to increase production and productivity using advanced and farmer-friendly technologies (Yakomo, 2020). In developing countries including South Africa, improving the livelihoods of rural farm households through agricultural productivity would continue to be a mere wish if the rate of agricultural technology adoption remains very low.

Therefore, there is a need for small-scale farmers to adopt the proven agricultural technologies to enhance production as well as productivity and thereby improving the living condition of the rural poor farmers, respectively. The use of improved agricultural technology could inspire the changeover from the presently low productivity, peasant, and subsistence farming to commercial farming, which is to be able to produce on surplus. This may include the use of genetically modified seeds or varieties and the use of improved machinery. These improved varieties offer new opportunities for farmers because of their unique characteristics, such as shorter periods of growth, higher yield, and greater tolerance to major stresses, increased protein contents and tasting better than the traditional cultivars/varieties. The adoption of these improved varieties is very vital since it is becoming more obvious that traditional subsistence smallholding farming systems can no longer meet the needs and expectations of rising demand for food (Awotide et al., 2016). Based on the recent literature reviewed and development projects, the use of mass media and information and communication technologies (ICT) are widely recommended for raising awareness, knowledge and subsequently contributing to the development of potential positive impact on the farmer's livelihoods and wellbeing in a short period (Dhehibi et al., 2020).

According to Yokamo (2020), the adoption and effectiveness of this improved technology in rural communities depends on several factors which include the nature of technology, awareness about the technology, risk aversion, institutional constraints, lack of human and financial and lack of infrastructure. These have necessitated constant research to ensure the use of improved technologies by farmers and their staff to improve production. The generated new information and technologies from research get to the farmers through extension services. The extension agents need communicate the results through various channels and effective communication, which will lead to improved knowledge and skills that will subsequently improve production (Maduka, 2020).

3.5. Challenges that are faced by extension officers in delivering services to farmers during the COVID-19 pandemic.

The important challenges faced by agricultural extension officers according to SA News, (2020), Auditor General (2020), Parliament of SA (2021), GFRAS (2020) are as follows:

- A ban on traveling and limited mobility within areas reduced farmer's access to agricultural inputs such as fertilizers, seeds, and farm equipment. This will deter agricultural productivity and subsequently farmer's livelihoods.
- Transport availability proved to be the major stumbling block during the pandemic. In many instances, extension workers cannot move around and reach out to farmers for agricultural advice.
- Most farming communities in South Africa lack internet access, as a result, they could not have access to information even that of the relief fund.

4. CONCLUSIONS AND RECOMMENDATIONS

The findings revealed that the delivery of agricultural extension services was adversely affected by the outbreak of COVID-19. While our synthesis lacked empirical evidence, it was evident that the travel restrictions and social distancing reduced farmer-extension worker physical interaction and possible farmer training. As a result, the productivity of farmers was hampered.

The study recommends that the use of social media groups for communication to share information about recent developments in the sector. It is further recommended that there must be development of online marketing strategies where people can make orders of various products and become booked for purchases or deliveries during a specified time range. The Department of Agriculture, Land Reform and Rural Development can develop a big data platform that will contain production and technical support to farmers.

5. REFERENCES

AARON, J. 2012. A framework for the development of smallholder farmers through cooperative development. *Department of Agriculture, Forestry and Fisheries. Republic of South Africa*, pp.1-8.

ADIO, E.O., ABU, Y., YUSUF, S.K. AND NANSOH, S. 2016. Use of Agricultural Information Sources and Services by Farmers for Improve Productivity in Kwara State. Lib. Phi. Pra. 1456. http://digitalcommons.unl.edu/libphilprac/1456.

AFFUL, D.B. AND LATEGAN, F.S. 2014. Small and medium-scale producers' use and credibility of information sources: implications for public extension's financial sustainability. *S. Afr. J. Agr. Ext.,* 42(1): 27-38.

AGBAMU, J.U. 2006. Essentials of Agricultural Communication in Nigeria. Lagos: Malthouse Press Limited.

AGHOLOR, A.I. 2012. The quality of extension education delivery among livestock farmers in central Eastern Cape. A case study of Nkonkobe Local Municipality. Unpublished Master's Thesis, University of Fort Hare, Alice.

AWOTIDE, B.A., KARIMOV, A.A. AND DIAGNE, A. 2016. Agricultural technology adoption, commercialization and smallholder rice farmers' welfare in rural Nigeria. Agr. Foo. Eco. 4(1): 1-24.

BEMBRIDGE, T.J. 1991. The practice of agricultural extension- a training manual. DBSA, halfway house. Case of farmers in Morogoro region of Tanzania. *Int. J. Edu. Deve. Inf. Com. Tec.*, 14(3): 252-266.

CHRISTOPLOS, I. 2010. Mobilizing the potential of rural and agricultural extension. Neuchâtel Group.

COLLIER, P. AND DERCON, S. 2009. African agriculture in 50 years: smallholders in a rapidly changing world.

CONRADIE, B.I. 2016. The implications of a weak public extension service for the productivity performance of Karoo agriculture. *S. Afr. J. Agr. Ext.*, 44(2): 99-109.
DANSO-ABBEAM1, G., EHIAKPOR, D.S. AND AIDOO, R. 2018. Agricultural extension and its effects on farm productivity and income: insight from Northern Ghana. Agr. Foo. Sec., 7: 74.

DHEHIBI, B., RUDIGER, U., MOYO, H.P. AND DHRAIEF, M.Z. 2020. Agricultural Technology Transfer Preferences of Smallholder Farmers in Tunisia's Arid Regions. https://www.mdpi.com/2071-1050/12/1/421

HALL, R. AND KEPE, T. 2017. Elite capture and state neglect: new evidence on South Africa's land reform. *Rev. Afr. Pol. Eco.*, 44(151): 122-130.

HLATSHWAYO, P.P.K. AND WORTH, S.H. 2016. Stakeholders' Perceptions about Visibility and Accountability of the State Agricultural Extension in Nquthu Area, KwaZulu-Natal Province, South Africa. *S. Afr. J. Agr. Ext.*, 44(2):174-185.
https://www.sciencedirect.com/science/article/pii/S0306919217303093.

KOCH, B. H. AND TERBLANCHÉ, S. E. 2013. An overview of agricultural extension in South Africa. *S. Afr. J. Agr. Ext.*, 41(1): 107-117.

LIEBENBER, G. F. 2015. Agricultural Advisory Services in South Africa. Discussion paper. University of Pretoria: South Africa.

MACHETE, F. AND SHALE, K., 2015. Classification of Unregulated Landfills by Waste Stream Analysis Method: A Case of Chief Albert Luthuli Local Municipality, Republic of South Africa. Afr. J. Sci. Tec. Inn. Dev., 7(6): 446–452.

MADUKA, O.A., 2020. Awareness, knowledge and utilization of improved pig production technologies among farmers in Abia State, Nigeria. Nig. Agr. J., 5(1): 119-124.

MAOBA, S. 2016. Farmers' perception of agricultural extension service delivery in Germiston region, Gauteng Province, South Africa. *S. Afr. J. Agr. Ext.*, 44(2): 167 –173.

MTEGA, W. P. 2018. The usage of radio and television as agricultural knowledge sources: The

NKOSI, N.Z. 2017. Level of Access to Agricultural Extension and Advisory Services by Emerging Livestock Farmers in uThungulu District Municipality, KwaZulu-Natal Province. Unpublished Master's Thesis. University of South Africa.

NTSHANGASE, M.G. 2014. Analysis of marketing channels used by smallholder crop farmers in Vryheid (Abaqulusi) Municipality, Kwazulu-Natal. MSc thesis, University of Fort Hare, South Africa.

RAHMAN, S., HAQUE, E. AND AFRAD, S.I. 2020. Utility of Mobile Phone Usage in Agricultural Information Dissemination in Bangladesh. Eas. Afr. Sch. J. Agr. Lif. Sci., 3(6): 154-170.

RAIDIMI, E.N. AND KABITI, H.M. 2019. A review of the role of agricultural extension and training in achieving sustainable food security: a case of South Africa. S. Afr. J. Agric. Ext., 47(3): 120 – 130.

SEKABIRA, H. AND QAIM, M. 2017. Can mobile phones improve gender equality and nutrition? Panel data evidence from farm households in Uganda. Available:

SIKWELA, M.M. 2013. The impact of farmer support programmes on market access of smallholder farmers in the Eastern Cape and KwaZulu-Natal provinces, South Africa. PhD Thesis. Unpublished dissertation University of Fort Hare Alice, South Africa.

TADESSE, D. 2008. Access and Utilization Agricultural Information by Resettler Farming Household: The Case of Metema Woreda, North Gender, Ethiopia, Unpublished MLS Thesis p.7. Retrieved 6/6/2012 from ww.ethopia.org/context/pdf.

UWANDU, C.N., THOMAS, K.A. AND OKORO, C.M. 2018. Utilization of Agricultural Information Sources and Adoption of Animal and Crop Technologies among Farming Households in Imo State, Nigeria. J. Agr. Ext., 22(1): 143-155.

VIDANAPATHIRANA, N.P. 2019. Agricultural information systems and their applications for development of agriculture and rural community, a review study.

WAHAB, A. 2015. Signal processing of information for digital broadcasting. Case Study: Nigeria and Kenya Signal processing of information for digital broadcast: Case study of Nigeria and Kenya,

YOKAMO, S., 2020. Adoption of Improved Agricultural Technologies in Developing Countries: Literature Review. *Int. J. Sci. Foo. Agr*., 4(2), 183-190.

ZHANG, D., XU, J., ZHANG, Y., WANG, J., HE, S. AND ZHOU, X., 2020. Study on sustainable urbanization literature based on Web of Science, Scopus, and China national knowledge infrastructure: A scient metric analysis in Cite Space. J. Cle. Pro. 264: 121537.

AN ASSESSMENT OF THE EXTENSION AND GOVERNMENT SUPPORT SERVICES IN COMMUNAL LIVESTOCK PRODUCTION IN THE MHLONTLO LOCAL MUNICIPALITY OF THE EASTERN CAPE PROVINCE, SOUTH AFRICA.

Ntweni, S.[1] and van der Westhuizen, C[2]

Corresponding Author: Ntweni, S; Email: siya.ntweni@gmail.com

ABSTRACT

Livestock farming is a critical component of rural economies. Rural development initiatives must take into cognisance the potential contribution of livestock as a strategy to alleviate poverty. However, communal livestock farming is hindered by several constraints. Improvement in extension and government support services could be beneficial to livestock owners. A study to assess the extension and government support services was conducted by interviewing 60 farmers in the Mhlontlo Local Municipality using a structured questionnaire. A significant portion of the study sample had low educational levels with only 15% having university qualifications. The interviews were conducted in isiXhosa. The ratio of male to female was 0.83 to 0.17. The mean age was 57.7±13.96. The sources of information most frequently used by farmers were extensionist (92%), farmer association (83%), Department of Agriculture (48%) and television (30%). Market and credit advice, animal health, pasture management, production planning and weather services were important information provided by the extension staff. Intervention from the Department of Agriculture included feed, veterinary services, dip, and drugs for vaccination. Poor meetings attendance by farmers undermines the work of extension. Lack of trust in the extension programs was highlighted as a major reason for farmer's reluctance to implement advice from extension services.

Keywords: Mhlontlo Local Municipality, Communal livestock farming, extension, and support services.

1. INTRODUCTION

In South Africa, Goni, Skenjana & Nyangiwe (2018), Coetzee, Montshwe & Jooste (2005) and Meissner, Scholtz & Palmer (2013) mentioned that about 70% of agricultural land is suitable for livestock production. In developing countries, particularly in the Southern African regions, livestock production is a crucial aspect of communal agriculture (Schwalbach, Groenewald & Marfo, 2001). It plays a critical role in the economy of South Africa, particularly in rural areas (Ngqulana, 2017). According to Rocha, Starkey & Dionisio (1991), communal livestock owners

[1] S.Ntweni. Master's student at the Central University of Technology, Free State, Department of Agriculture, Private Bag X20539, Bloemfontein, 9300. Email Address: siya.ntweni@gmail.com.

[2] Carlu Van der Westhuizen, Lecturer at the Central University of Technology, Free State, Department of Agriculture, Private Bag x20539, Bloemfontein, 9300.

keep animals for subsistent purposes such as meat and milk consumption and as a source of income. For rural farmers, livestock represent a form of investment that can be converted to cash quickly and are kept for their provision of animal traction, manure, cash sales and many other socio-economic functions (Rocha *et al*., 1991; Musemwa, Mushenje, Chimonyo & Mapiye, 2010; Goqwana, 2008). Powell, Pearson &Hiernaux (2004) and Peden, Tadesse, Misra, Amed, Ayalneh, Herreo, Kiwuwa, Kumsa, Mati, Mpairwe, Wassenaar & Yimegnuhal (2009), reported that livestock production is useful because it compliments cropping activities in that it provides manure, which is necessary for the maintenance of soil fertility, draught power needed for cultivation, transport, cash, and food. This cash is often used for various reasons which include purchasing of inputs for cropping reasons, payment for the education of children, purchasing medical remedies for sick animals, remuneration for workers, etc. (Muchenje, Dzama, Chimonyo, Taats & Strydom & 2008).

In the Eastern Cape, the occurrence of drought dictates that the people of this province depend on livestock and their products for livelihoods (Musemwa *et al.,* 2008). For this reason, the Integrated Sustainable Rural Development Strategy (2004) identified agriculture, especially livestock production as the most viable means to improving food security in the rural communities and thereby eradicating poverty in the poor rural areas. According to the National Livestock Statistics (2019), the Eastern Cape is the highest in livestock, namely cattle (24%), goats (38%) and sheep (29%) of the total livestock numbers in South Africa. Moreover, many of these livestock come from the communal lands.

However, communal livestock farming is hindered by several constraints. Numerous studies have reported similar constraints under communal farming. These constraints include diseases, overgrazing, scarcity of water (due to drought), theft, inadequate and lack of information about the available markets, veld fires, lack of credit, limited money to buy inputs, poor management practices, lack of institutional support (Coetzee *et al*, 2005), poor infrastructure, lack of information, etc. Some of these constraints are production related. These include poor animal husbandry, slow growth, high mortality rates, low conception rates, delays of mating, long inter lambing and calving periods and low slaughter weights (Mahlako, 2018). The fact that much research has found that high livestock numbers are kept in the Eastern Cape indicates that there is a great potential to improve production in the province and thereby reduce poverty. Improvement in extension and government support services could be beneficial to livestock owners. In light of the above, the current study was undertaken to assess the extension and government support services in the study area.

2. MATERIALS AND METHODS

2.1. Study site

This study was undertaken in the Mhlontlo Local Municipality which falls under the OR Tambo District Municipality of the Eastern Cape Province. The municipality covers an area of 2826 Km^2

and has a population density of 66, 6 people per m^2. In 2015 the municipality had 193000 people which constituted 0, 4% of the South African population, with a population growth of -0, 52% (Mhlontlo Local Municipality, 2017). The municipality is largely dominated by Xhosa-speaking people with more than 80% residing in rural villages and less than 10% living in informal urban settlement (Mhlontlo Local Municipality, 2017). The Municipality consists of more than 80000 households and with 26 wards. Subsistent agriculture dominates the municipality.

2.2. Sampling method and data collection

A convenient sampling technique was employed to select participants who kept livestock in the study area. A sample of 60 farmers was selected and interviewed using a structured questionnaire. The questionnaire consisted of open and close-ended questions. Interviews were individual and researcher administered. The advantage of interviews administered by the researcher is that the researcher was able to get detailed information from the farmers. Over and above the demographic details of the sampled farmers, other important aspects that were investigated were extension support, veterinary services, land ownership, herd information and other government support provided to the farmers. Considering that most farmers were not conversant in English in which the questionnaire was designed, interviews were conducted in isiXhosa.

2.3. Data analysis

The data obtained from the questionnaire were coded and captured in Microsoft Office Excel and analyzed using the Statistics Package for Social Sciences Program.

3. RESULT AND DISCUSSION

3.1. Demographic details

Most of the participants were males who represented 83.3% of the total participants. The majority of female farmers were widows who inherited livestock from their deceased husbands. These findings are consistent with the general perception that communal livestock farming is dominated by males. Mahanjana and Cronje (2000) and Mthi, Nyangiwe, Thubela, Nyalambisa, Madyibi & Yawa (2020) reported similar results. The average age was 57.7±13.96. This study agrees with Katikati (2017) who reported an average age of 57.63±13.44 in the selected districts of the Eastern Cape. While exact reasons for the high mean age are unclear, it can be possibly attributed to the economic crisis imposed by political uncertainty that engulfed the country in 2008 which led to massive retrenchments of workers and the recent outbreak of Covid-19 that is devastating the world. Migrant factory and mine workers returned home and focused on farming while youths were emigrating to find opportunities in the cities (Mthi *et al.*, 2020).

Table 1: Demographic details of the farmers

Respondent details	Number of respondents (n)	Percentage (%)
Gender		
Male	10	83.3
Female	50	16.7
Age		
25-35	3	5
36-49	19	31.7
50-69	23	38.3
70-89	15	25
Education level		
No education	27	45
Primary education	12	20
Secondary education	12	20
Tertiary education	9	15
Marital status		
Single	6	10
Married	35	58.4
Divorced	2	3.3
Widowed	15	25
Separated	2	3.3

Most of the farmers had very low education, with fewer farmers indicating that they had a college or university education. Musemwa, Chahwiza, Sikuka, Fraser, Chimonyo & Mzileni *(*2007), stated that education is important in farming as it plays a role in the success of the farming business by influencing decision-making. The high percentage of farmers with no education is attributable to the average age of the farmers.

The majority (58.3%) of the farmers indicated that they were married, followed by 25% of the farmers who are widowed, while the remaining percentage was accounted for by other options from table. Mthi *et al.,* (2020) reported similar results in the Eastern Cape. The reason for high percentage in married farmers may be attributed to the average age and the dominant age group of the farmers. The option of divorce occupied the lowest number (3.3%). This low percentage in divorce may be ascribed to traditional beliefs that do not recognise divorce as a method of ending marriages within the amaMpondomise tribe from which all participants come. Marital status is an important phenomenon in rural areas. Married people receive more respect than their unmarried counterparts (Mahlombe, 2018). Single farmers constituted 10% of the study. These farmers (single) largely came from the youth age group in the study.

3.2. Important source(s) of information

Respondents were asked to state their source(s) of information and how they obtained that information. The responses of the farmers to these questions are presented in the following table and discussed thereafter.

Table 2: Sources of agricultural advice for the farmers in the Mhlontlo Local Municipality

Source of advice	Number of responses (n)	Percentage of responses (%)
Research institutions	2	1.3
Extensionist	56	35.7
Print media	10	6.4
Farmer association	50	31.8
Commonage meeting	2	1.3
Internet	8	5.1
Television	18	11.5
Nampo	3	1.9
Local agricultural shows	4	2.3
Other farmers	4	2.3
	Total:157	**Total: 100**

The table above clearly shows that 35.7% responses rated extension officer as the most important source of information for the farmers in the MLM. The farmer association which all respondents were members of was considered as the second most important source

The low percentage of farmers that used research institutions as their source of information may be ascribed to the low educational levels reported earlier. Understanding that scientific research is difficult to the uneducated rural and commercial farmer, the task of extension services must be to bridge the gap that exists between research and farmers.

Farmers were further requested to state the frequency of their interaction with the extension officers. Eighty-nine percent indicated that they met with the extension officer more than once a month, 5.3% once a month, 3.5% every two months and 1.8% twice a quarter. Farmers who met extension officer twice a quarter and every two months mentioned the poor state of the roads and poor network signals as some of the reasons the extension officers raised as preventing them from meeting the farmers more than once a month. Extension officers visited farmer in groups. Group visits (workshops) make it easy for extension officers to dissipate information to a large audience using limited resources and time. These results agree with Sebeho (2017) and Mahlako (2018) who rated extension officers and the Department of Agriculture as the most important sources of information for communal farmers. However, not all farmers frequently attended meetings, and this undermines the work of extension.

3.3. Type of agricultural information offered by the extension officer (s)

The type of information provided to the farmers is summarised in table 3 below.

Table 3: Type of agricultural information offered to the farmers by the extension staff and Department of Agriculture, Land Reform and Rural Development

Type of information	**Number of responses (n)**	**Percentage of responses (%)**
Market advice	54	23.5
Credit advice	18	7.8
Production planning	49	21.3
Pasture management	34	14.8
Assistance with weather services	19	8.3
Animal health	56	24.3
	Total: 230	**Total: 100**

Animal health was ranked as the most important information from agricultural extension (24.3%), followed by marketing advice (23.5%), production planning (21.3%), pasture management, (14.8%), weather services assistance (8.3%) and credit advice (7.8%). The above results address the contention of Raidimi and Kabiti (2019) in their review of the role of agricultural extension to food security who stated that agricultural extension must advise farmers about knowledge which is critical for farmers to adapt their operations to changing climatic conditions. Moreover, the above authors stated that success of farming is determined by access to markets and an increased production and further insisted that agricultural extension must address these factors.

Thus, it is apparent that the extension staff in the study area aligned its program to address these factors. While key information about credit was provided, it is clear that this information does not give the intended results as farmers continue to be excluded from financial assistance by formal institutions. Some of the farmers who applied for a loan from banks and other key financial institutions were not granted the loan on the basis that they did not have corresponding collateral which would be claimed by these institutions should the farmers fail to repay. The present results concur with Isaga (2018) who reported that only 1.9% of farmers in Tanzania used loans from banks to finance their farming business. In the same study, Isaga (2018) further attributed poor access to credit from formal financial institutions by smallholders to a lack of education and collateral possessions by the farmers. The general perception about education is that farmers can make informed financial decisions which are desirable by banks to facilitate the granting of the loan.

3.4. Infrastructure

When farmers were asked to state constraints that they faced, poor road infrastructure was mentioned by most of the farmers. It is evident that government did little to improve roads. Good

roads allow access to remote areas and are perceived as an important factor that encourages investment and marketing. Under circumstances where the condition of roads is poor, marketing is affected. Poor road network results to increased transport costs. According to the farmers, bad roads militated them from visiting state the veterinary during rainy weather as the area has gravel roads.

3.5. Government intervention on animal Health

Eighty-two percent of the farmers (n=49) were making use of the state veterinary technician. It was important to find out where these farmers sought advice when their animals are sick. Figure 1 below displays the sources of animal health advice for farmers that in the study area.

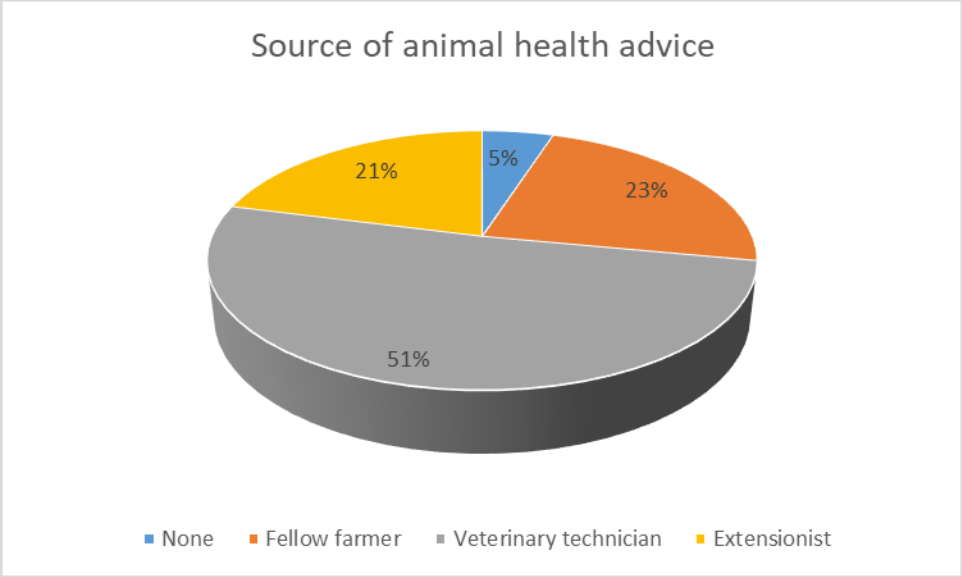


Figure 1: Sources of animal health advice

The number of responses in figure 1 were 96 responses. Thus, other farmers did not use only one source of advice for animal health. The majority of the farmers (n=49) used state veterinary technician (51%), while others sought advice from other farmers (23%), extensionist (21%) and only an insignificant number (5%) not seeking any advice.

In the study sample, 93% of farmers vaccinated their animals. Farmers who did not vaccinate animals either complained of the high cost of medicines or were old and did not have anyone to take their animals to a vaccination center for a state vaccination program. These results are similar to those of Katikati (2017) where 88.3% of respondents vaccinated their animals and 11.7% did not. The state carried out the vaccination program twice a year. Nowers, Nobumba, & Welgemoed (2013) stated that vaccination programs in communal farming are mostly carried out by the state. Figure 2 below demonstrates the diseases that farmers vaccinate against.

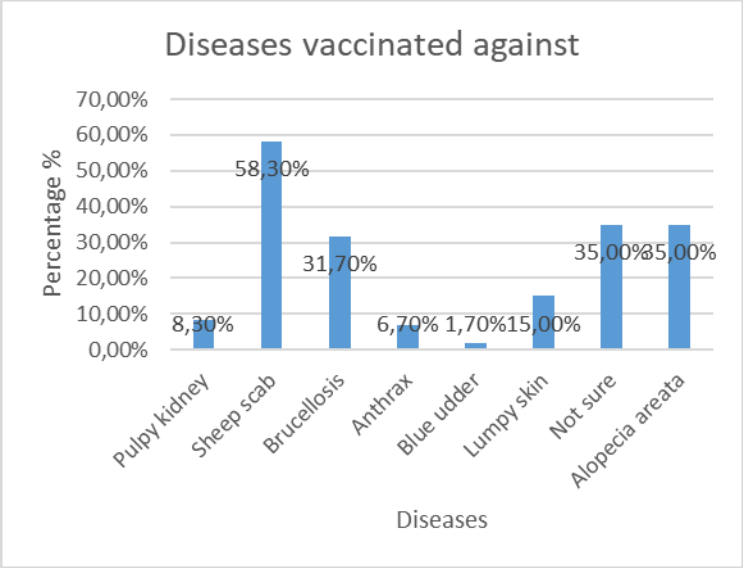


Figure 2: Types of diseases against which animals are vaccinated.

Responses varied when farmers were asked when they vaccinate their animals. Thirty-one farmers (52%) followed a health management program, 58.3% of respondents (n=35) vaccinated only when a need arises and 10% of the respondents (n=6) vaccinated anytime.

3.6. Provision of animal feed by government

Provision of feed followed typical communal farming routine. Communal farmers struggle to buy feed for their animals. In most cases, because of the high cost of feed, they prefer to feed animals during natural disasters like drought because the DALRRD normally intervenes in such instances. Farmers were asked how they ensured fodder availability throughout the year. The results indicate that 56.7% of respondents planted pastures in the cropping fields, 18.3% kept crop remains in storerooms and 25% depended squarely on provision by DALRRD.

The typical pattern in communal areas is that livestock depend on natural resources for their nutritional requirements. This practice prevails in communal areas due to a high cost of feed. 95% of respondents provided extra feed for their animals during drought. Table 3 below demonstrates major types of feed that farmers provide to their animals during feed scarcity.

Table 4: Major types of feed provision in the study area

Type of feed	**Number of responses (n)**	**Percentage of responses (%)**
Lucerne	52	31.0
Maize	57	33.9
Crop residue	45	26.8
Rested veld	14	8.3
Total	168	100

According to Makapela (2008), supplementary feeding results in improved milk production which is necessary for lactating animals. The present work agrees with a study by Mthi *et al.*, (2020) who identified crop residue as important supplementary feed in communal farming areas. It was, however, essential to determine the source(s) of the supplementary feed. Figure 3 below illustrates the sources of feed.

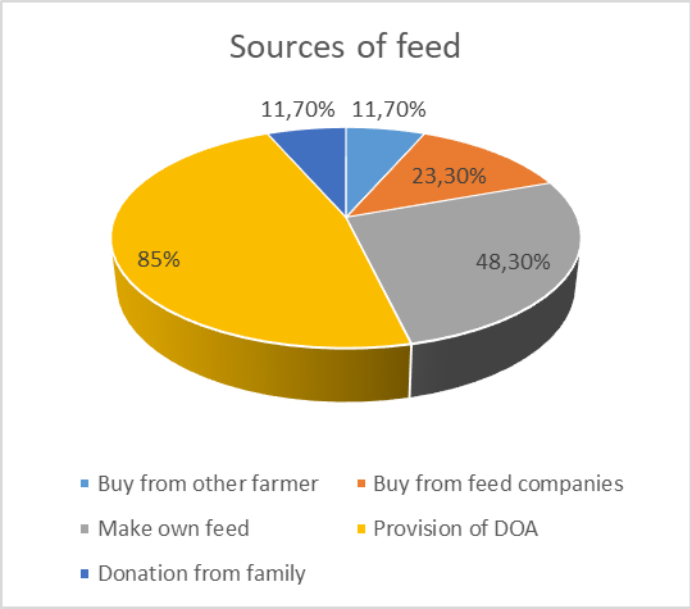


Figure 3: Indication of the sources of feed in the study area

It can be deduced that most farmers (85%) depended on the provision of feed by the department during natural disasters. Only 11.7% (n=7) of respondents bought feed from other farmers. These other farmers are crop producers who do not keep livestock and sell their produce at cheaper prices compared to a formal feed market price. 48% of farmers (n=29) made their own feed from crops planted both in the cropping fields and in gardens of their allocated residential land.

4. CONCLUSION

Livestock keeping is confronted by numerous constraints in the Mhlontlo Local Municipality. Programs to improve production in the area have been introduced by government. Some of these programs include extension services, feed and animal medical remedies provision and state veterinary services. However, it appears that government has done little to improve road infrastructure which is a key factor that influences marketing. Poor roads increase transaction costs during marketing. For this reason, it appears that farmers will continue to struggle to exploit formal marketing opportunities which are possible when roads are properly constructed and maintained. Communal farmers in the study area do not have adequate financial resources to maintain roads and depend on government. Government must improve roads condition to ensure an increased possibility for formal marketing.

Despite the key and massive extension advice provided to the farmers, they appear to lack confidence and trust in extension and as a result, they find it difficult to implement advice from

extension staff. According to the researcher's interaction with the farmers, this poor trust in extension originates from the swine flu in 2007 for which farmers were not remunerated as promised. The failure by government to compensate farmers led to farmers losing trust in extension programs even when these programs are genuine.

While government in the past has made efforts to encourage farmers to exploit formal wool markets by improving wool production through a ram exchange program, farmers in the study area did not benefit from this program due to lack of organized farmers groups. Recent attempts to organize farmers associations are applaudable. Due to a disorganized association, farmers did not benefit from the ram exchange program.

The study advises farmers to properly organise and coordinate their farmers association or co-op to benefit from other government initiatives such as the Ram Exchange Program of the Department of Agriculture and Rural Development aimed at promoting key traits which are necessary to improve the quality of their livestock to ensure marketability and better wool growth for those farmers who are engaged in sheep farming.

5. ACKNOWLEDGEMENT

The researchers would like to acknowledge financial support from the National Research Foundation and the Central University of Technology, Free State. Without their assistance, this study would not be possible.

6. REFERENCES

COETZEE, L., MONTSHWE, B.D. & JOOSTE, A. 2005. The marketing of Livestock on communal lands in the Eastern Cape Province: constraints, challenges, and implications for the extension services. *South African Journal of Agricultural Extension, 34:81-103.*

GONI, S., SKENJANE, A & NYANGIWE, N., 2018. The status of livestock production in communal farming areas of the Eastern Cape. *Applied Animal Husbandry and Rural Development*, 11:34-40.

GOQWANA, W.M., MACHINGURA, C., MDLULWA, Z., MKHARI, R., MMOLAENG, O. & SELOMANE, A.O., 2008. A facilitated process towards finding options for improved livestock production in the communal areas of Sterkspruit in the Eastern Cape Province, South Africa. *African Journal of Range and Forage Science*, 25(2):63-69.

INTEGRATED SUSTAINABLE RURAL DEVELOPMENT STRATEGY (ISRDS) (2004). http://www.info.gov.za/otherdocs/2000/isrds.pdf.

ISAGA, N., 2018. Access to bank credit by smallholder farmers in Tanzania: A case study. *Africa Focus*, 31(1): 241-256.

KATIKATI, A., 2017. Assessment of production practices of emerging cattle farmers in the selected districts of the Eastern Cape, South Africa. Master's thesis. Central University of Technology, Free State, Bloemfontein.

MAHANJANA, A.M. & CRONJÉ, P.B., 2000. Factors affecting goat production in a communal farming system in Eastern Cape region of South Africa, *South African Journal of Animal Science,* 30 (2):149-154.

MAHLAKO, S.R., 2018. Assessment of the Eastern Free State small scale farmers management of sheep production. Master's thesis. Department of Agriculture, Central University of Technology, Free State, Bloemfontein.

MAHLOMBE, C., 2018. The role of agricultural development projects in poverty reduction in the OR Tambo District Municipality of the Eastern Cape Province, South Africa. Master's thesis. University of Pretoria. Pretoria.

MAKAPELA, M.J., 2008. An overview of the management practices for wool production amongst the communal farmers of the Hewu district in the Eastern Cape. Master's thesis. Nelson Mandela University, Gqebera.

MEISSNER, H., SCHOLTZ, M. & PALMER, A., 2013. Sustainability of the South African livestock sector towards 2050. Part 1: worth and impact of the sector. *South African Journal of Animal Science*, 43(3):282-297.

MHLONTLO LOCAL MUNICIPALITY, 2017. *Mhlontlo IDP Review*. Available online: http://.mhlontlolocalmunicipality.gov.za. [Accessed 14 April 2019].

MTHI, S., NYANGIWE, N., THUBELA, T., NYALAMBISA, N., MADYIBI, Z. & YAWA, M., 2020. Cattle production and breeding practices in communal farming system in the Eastern Cape Province, South Africa. *Applied Animal Husbandry and Rural Development.* Volume 13:42-54.

MUCHENJE V., DZAMA K., CHIMONYO M, RAATS J.G. & STRYDOM P.E, 2008. Meat quality of Nguni, Bonsmara and Aberdeen Angus steers raised on natural pasture in the Eastern Cape, South Africa. *Meat Science,* 79:20-28.

MUSEMWA, L., CHAGWIZA, C., SIKUKA, W., FRASER, G., CHIMONYO, M & MZILENI, N., 2007. Analysis of cattle marketing channels used by small scale farmers in the Eastern Cape Province, South Africa, *Livestock Research for Rural Development* 19 (9):131.

MUSEMWA, L., MUSHUNJE, A., CHIMONYO, M. & MAPIYE, C., 2010. Low cattle market off-take rates in communal production systems of South Africa: Causes and mitigation strategies. *Journal of Sustainable Development in Africa* 12:209–226.

MUSEMWA, L., MUSHUNJE, A., CHIMONYO, M., FRASER, G., MAPIYE, C. & MUCHENJE, V., 2008. Nguni cattle marketing constraints and opportunities in the communal areas of South Africa: review. *African Journal of Agricultural Research,* 3:239–245.
National Livestock Statistics (NLS), 2019. Department of Agriculture, Land Reform and Rural Development, Pretoria, South Africa.

NGQULANA, T.C., 2017. Constraints and opportunities in communal production development in Nyandeni Local Municipality, Eastern Cape, Province. Master's thesis. University of Pretoria, Pretoria.

NOWERS, C.B., NOBUMBA, L.B. & WELGEMOED, J., 2013. Reproduction and production potential of communal cattle on sour veld in the Eastern Cape Province, South Africa, *Applied animal husbandry & rural development 6*:48-54. [Available at] www.sasas.co.za/aahrd/.

PEDEN, D., TADESSE, G., MISRA, A.K, AWAD AMED, F., ASTATKE, A., AYALNEH, W., HERRERO. M., KIWUWA, G., KUMSA, T., MATI, B., MPAIRWE, D., WASSENAAR. T & YIMEGNUHAL. A., 2009. *Livestock and water for human development.* IN: Molden, D. et al., Comprehensive assessment of water management in agriculture. p. 485-514. Oxford (UK): Oxford University Press.

POWELL J M, PEARSON R.A. & HIERNAUX P.H., 2004. Review and interpretation. Crop-livestock interactions in the West African Drylands. *Agronomy journal,* 96: 469-483.

ROCHA, A., STARKEY, P. & DIONISIO, A.C., 1991. Cattle production in smallholder Farming Systems in Southern Mozambique. *Agricultural systems,* 37:55–75.

SCHWALBACH, L.M., GROENEWALD, I.B. & MARFO, C.B., 2001. A survey small scale cattle farming system in the North West Province of South Africa. *South African Journal of Animal Science,* 32(4):230–237.

SEBEHO, M.A., 2017. Perceptions and attitude of farmers and extensionists towards extension delivery in the Free State Province, South Africa. Master's thesis. University of Pretoria, Pretoria.

RAIDIMI, E.N., & KATIBI, H.M., 2019. A review of the role of agricultural extension and training in achieving sustainable food security: a case of South Africa. *South African Journal of Agricultural Extension,* 47(3):120-130.

THE EFFECT OF THE FOOD INSECURITIES IN FARMING AND NON-FARMING HOUSEHOLDS: LESSON LEARNT FROM HOUSEHOLDS IN THE FRANCIS BAARD DISTRICT MUNICIPALITY, NORTHERN CAPE PROVINCE OF SOUTH AFRICA.

Shushu, M.N

(This Article Was Not Available at the Time the Proceedings was Produced).

ANALYZING THE DELIVERY OF PUBLIC AGRICULTURAL EXTENSION SERVICES TO RURAL HOUSEHOLD'S DURING COVID-19: A CASE STUDY OF IDUTYWA, EASTERN CAPE SOUTH AFRICA

Christian, M., Jiba, P., Loki, O., Khobai, H. and Luvhengo, U.

Corresponding author: Jiba, P; Email: phiwejiba@gmail.com

ABSTRACT

There is a growing concern that covid-19 pandemic will have dire consequences on agri-extension service delivery. This is regrettable because agricultural extension and advisory services play an indispensable role in building producer's capacity to maintain good agricultural practices. In addition, agricultural services are a major factor to improving income and welfare of rural households. This study analysed the delivery of public agricultural extension services to rural household of Idutywa, Eastern Cape. Primary data were collected from 75 participants. Descriptive and inferential statistics were used to analyse data. Results revealed that there is generally lack of access to extension services by households in the study area. Above all, the findings showed that access to agricultural extension services is influenced by limited movements, cellphone data, household size and limited number of farmers for training in different significant intervals. However, cellphone data was significant influencing the extension services but has a negative coefficient estimate. Based on the control and treated variables, the Average Treatment Effect Treated from Kernel, Nearest Neighbours, Radius matching methods were found to be negative which means that if farmers did not receive the program during the pandemic, the performance and yields were going to be very poor and low. In conclusion, E-extension becomes very important as an innovative way of working with extension workers and famers. Framing needs to be led by information and communications technology (ICT), furthermore it should turn into a demand driven vocation. The study recommends that extension officer should be empowered with modern tool to deliver need-based agricultural extension services in the future.

Keywords: Households, Covid-19, Access to Public Extension Services, logit model

1. INTRODUCTION

The purpose of this study is to analyse the delivery of public extension services during Covid-19 in the Eastern Cape rural households. The research consists of background, statement of the problem, objectives of the study, theoretical and conceptual framework, research methodology, results and discussion, conclusion, and recommendations**.**

1.1. Background of the study

Flu related outbreaks continue to be a threat on economies and public health all over the world (Jones et al., 2008). Evidence suggests that there has been 6 flu related pandemics in the past 120 years (1889, 1918, 1957, 1968, 2009 and 2020). Before the 2020 outbreak, the "spanish flu" was

regarded as the most severe outbreak which occurred during a period of 1918 to 1919 and led to about 1million deaths. Most recently, May 2009 saw the emergence from Mexico of H1N1 (commonly known as swine flu) virus capable of human-to-human transmission. Highly transmissible, yet ultimately mild, it rapidly spread around the world, infecting 74 different countries in all six continents within five weeks. The rate of spread of the pandemic was far more rapid than previously observed, enabled by high volumes of international air traffic (Verikios et al., 2011).

In January 2020, WHO (2020) declared coronavirus (COVID-19) the worst outbreak that the world has ever experienced. SARS-Cov-2 (the virus that causes COVID-19) is the latest member of coronavirus family affecting humans. This type of virus is mainly found on humans and other mammals such as pangolins. In humans, the clinical symptom of this virus includes common cold. Since this virus is a new challenge to human, there is no pre-existing immunity in humans and as such, everyone is susceptible to it. According to National Institute of Communicable Disease (NICD) (2020), elderly and people of any age who have underlying medical condition are more vulnerable to coronavirus. Coronavirus is transmitted via droplets and fomites (contact with contaminated surfaces).

The first case of COVID-19 was firstly reported in December 2019 in Wuhan, China (WHO, 2020). Since then, the virus has been spreading very fast across the world, affecting 210 countries, and claiming close to 500 000 lives as of May 2020 (WHO, 2020). Because of the absence of specific vaccines for COVID-19, many countries such as South Africa have chosen "lockdown" as a strategy to slow down the spread and to protect their populations. This approach aims to reverse epidemic growth, reducing case numbers to low levels by social distancing the entire population, closing schools and universities and halting all non-essential economic activities (NICD, 2020).

1.2. Problem statement

During lockdown, people were urged to stay at home and to go out only to meet the most urgent needs like buying food (SA government, 2020). As much as this was a necessary and legal step to contain the spread of the virus, the reality is that it impacted the food supply chain (UN, 2020), access to markets and agricultural extension services (Muvhuringi, 2021). In his first address on covid-19, President Ramaphosa (2020) indicated that agriculture will be part of the essential services. However, prohibition of public gathering meant that the provision of agricultural extension services such as farmer trainings, agricultural input distribution, field visits, field schools and district agricultural shows would not be feasible. This was very unfortunate for rural households as farmer trainings and agriculture extension services are critical in improving the quality and quantity of agricultural products.

This study analyses the extent to which the delivery of extension services impacted rural households in the Eastern Cape. In doing so, the findings of this study will not only assist policymakers in formulating effective policies but also can provide insights into the preparation

efforts to similar infectious diseases in the future. To date, no study has empirically analyzed the delivery of extension services during CVID-19 and its impacts on rural households in Eastern Cape.

2. LITERATURE REVIEW

2.1. Conceptual framework

The study has investigated the determinants of public extension services delivery. Figure 2 illustrates the conceptual framework of this study. According to literature, different factors determine access of extension services by rural households. These factors are broadly categorised into demographic, socio-economic and institutional.

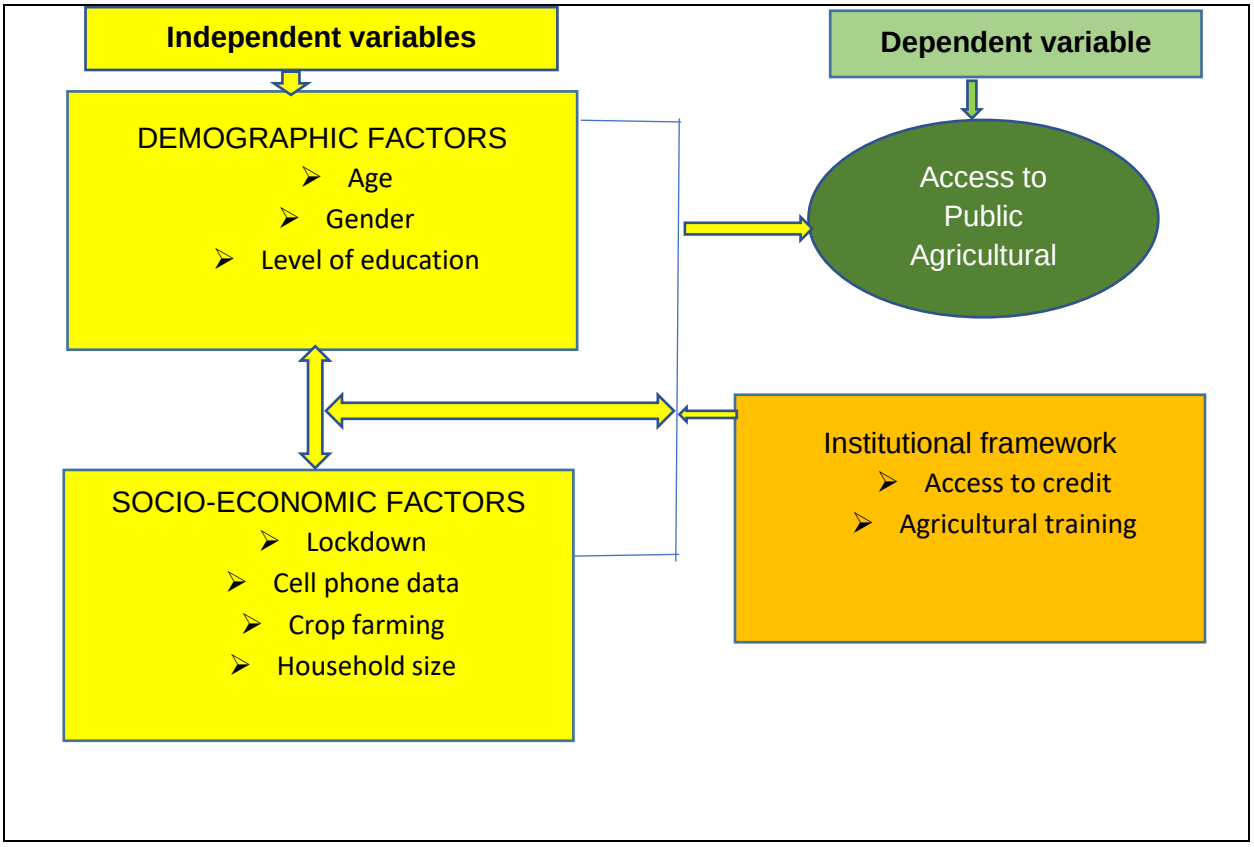


Figure 1: Framework showing determinants on access to extension services.
Source: Authors own framework (202)

2.2. Agricultural extension in South Africa

In South Africa, the state provides all extension support services to smallholder farmers, which is like other developing countries. These services are offered free-of-charge as social welfare, which makes government bear all the costs (Koch and Terblanché, 2013). However, the recent economic plunge, coupled with bureaucratic inefficiencies in the agricultural sector, has led to the government reducing its investment in extension provision services. According to Afful and

Lategan (2014), the limited funding for extension services has aggravated the administration of the sector, leading to poor service delivery to smallholder farmers who rely on the government for extension services. Furthermore, funding is at the centre of several institutional challenges currently facing the administration of extension services. These include the low extension worker to farmer ratio, which stands at 1:1500, the laying off of skilled and experienced workers, poor essential support, like transport, and the inadequate supply of inputs and information (Hlatshwayo and Worth, 2016; and Nkosi, 2017).

The challenges mentioned above coupled with poorly formulated extension policies, rigid approaches and a lack of monitoring and evaluation by the State, have in one way or another, contributed to the poor performance of the sector (Williams *et al.,* 2008; Maoba, 2016). Evidence of this poor performance can be seen in the low output of smallholder farmers, who largely depend on government-supplied extension services (Sikwela, 2013), and this has led to many criticisms of the government-led extension service, for example, Hall and Kepe (2017).

The background of agricultural and advisory services is different from any other African country. Its foundation and premise are a result of both colonialism and the apartheid era. This study explored the background narratives of three authors depicting different events of the origin and maker of extension in South Africa. Similarly, to the agricultural sector, the early history of the agricultural extension services in South Africa is twofold. Liebenberg (2015) in a discussion paper entitled *Agricultural Advisory Services in South Africa*, narrates that extension services in South Africa date back to the reconstruction years that followed from 1902, when scientists were imported from England. The then government employed these scientists to assist in the development of local agriculture by conducting research and disseminating it to farmers. He continues to say that in 1907 the advice and guidance from these English scientists were not always successful due to them being unfamiliar with the local agricultural conditions. This necessitated the South African government to send scientists to study abroad and come back to advance white farmers in South Africa. Bembridge (1991) in his book entitled: *The practice of Agricultural Extension - A training manual*, asserted that the establishment of Teko Agricultural College in the Eastern Cape in 1905 was the start of extension services in South Africa. The next five years would see the appointment of agricultural demonstrators teaching improved cultivation methods to smallholder farmers. The year 1929 saw the establishment of an agricultural technical services structure, followed in 1930 by the opening of Fort Cox Agriculture College in the former Ciskei which is in the East of the Eastern Cape.

Koch and Terblanché (2013), posited that the first century since the founding of Agricultural extension services in South Africa will be in the year 2025. In other words, these authors suggest that extension services in South Africa started in 1925. The reason/s that contributed to this ambiguity about the origin of extension services in South Africa is unclear; however, one idea that might have led to this is dualistic nature of the agricultural sector that came about with the colonial regime. Bembridge (1991) explores the events that took place among the black farming community, while Liebenberg (2015) gives an overview of the technical support given to white

farmers in South Africa. Koch and Terblanché (2013), reflect on the overall extension structure, diversity (black and white) and challenges encountered by agricultural extension in South Africa since its foundations. However, although these authors have different narratives about how extension came to be in South Africa, what is common among them is that extension started in the 20th century in South Africa. Also, when the new government came into power in 1994, it sought to restructure completely the agricultural system and advisory services to what is seen today.

3. MATERIALS AND METHODS

3.1. Description of study area

The Eastern Cape is the second largest province of the nine provinces of South Africa. It also has the third highest population with approximately 6 620 100 people and is among the poorest provinces in the country (Statistics South Africa, 2020). This study was conducted in the villages of Ngqamakwe. Ngqamakhwe is located 10 km from the town of Butterworth which falls under Mnquma Local Municipality in the south-eastern part of the province between East London and Mthatha.

3.2. Research approach

This study adopted a pragmatic research approach which is also referred to as mixed methods. According to Shorten and Smith (2017), mixed methods refer to a research approach that includes both qualitative and quantitative data on the same study. This research approach is used to obtain a better comprehension of the interrelations and variances between quantitative and qualitative data (Shorten and Smith, 2017). It gave the participants an opportunity to share their experiences throughout the research.

3.3. Sample and sampling technique

The target population of the study was farming household residents of Idutywa in Eastern Cape. A sample of 75 respondents were randomly selected and interviewed for this study. Five villages (15 from each) were randomly selected.

3.4. Data collection

This study will use primary data. Data for this study were collected via an internet survey. An online semi-structured questionnaire consisting of both open-ended and close-ended questions was used. This data collection method was chosen due to the prevailing issue of Covid-19, considering social distancing regulation. The questionnaire was sent to random household respondents in Ngqamakhwe using social media (WhatsApp, Telegram and Facebook). The respondents were requested to indicate their village, and results showed that responses were equally distributed in the five villages. Given that the study used a rapid online survey approach to obtain data, it should be stressed that the sample is not the representative of the entire Province. Be as it may, the

information is useful to provide the understanding of extension services rendered during the ongoing COVID-19 pandemic.

3.5. Data analysis

The data from the questionnaires was coded and captured into a computer using Microsoft Excel spreadsheet. Thereafter, the data was analysed using STATA computer program. Both descriptive and inferential statistics were utilized for the analysis of data.

3.5.1. Descriptive statistics

Descriptive statistics such as frequencies, percentages, minimum and maximum values, etc. were used to describe the socio-economic attributes of the rural households. Descriptive statistics assist to describe and understand the features of a specific data set by providing summaries about the sample and measures of the data.

3.5.2. Inferential statistics (Binary logistic regression model)

To assess the determinants of access to extension services, the binary logistic regression model was used. The binary logistic regression model is used when the outcome variable has two possible values, and it permits for the addition of power terms and explicit interaction (Sperandei, 2014). The binary regression model is useful in analysing data where the researcher is interested in finding the likelihood of a certain event occurring. In this study, the logistic model is preferred because of its comparative mathematical simplicity and fewer assumptions in theory. Furthermore, logistic regression analysis is more statistically robust in practice and is easier to use and understand than other methods.

Logit (Pi) =In $\left(\frac{Pi}{1-Pi}\right)$ = α + β1X1 +…+ βkXk + Ui

In $\left(\frac{Pi}{1-Pi}\right)$= Access to extension services

Pi = Probability that a household will have access to extension services

1 − P = Probability that a Household does not have access

α and β = Estimated parameters

X = Explanatory variable

Ui = Error Term

4. RESULTS AND DISCUSSION

4.1. Socio-Economic Factors of Sample Households

Table 1 presents the descriptive statistics for the socio-economic characteristics of households. The results showed that most participants in the study were male (57%). In all the five villages, participants were youth with an age range between 18 to 44 years. A large portion of respondents had either a tertiary (45.3%) or secondary (34.67%) level of education. This is not surprising, given the fact that the study was conducted using online survey, which were likely to be filled by

educated persons and are likely to have internet access, own smart phones, belong to social media platforms and understand the questions without any assistance.

Most of the respondents were household heads, presiding over a household comprising about two (2) to fifteen (15) members of the family on average. Only 21 percent of respondents were salary earners, with a range of R600 to 18400 monthly income. Other main sources of income included farming, self-employed and government grants. This is in line with Stats SA finding that most of the youth is unemployed (StatsSA, 2020).

The results from Table 1 showed that the mean average of farming experience is 9 years and ranged between 1 and 27 years. Most of experienced household heads, were able to get more productivity of crops by timely sowing of crops, avoid flood irrigation hence saving water and balanced use of fertilizers on account of their experience even in the absence of extension visitors.

The results indicated that every household had access to land, either for crop or livestock production. Table 1 also indicated that the households in the study area own between 0.12ha to 2.5ha of land with a standard deviation of 0.64ha. Similar findings that were reported by Christian *et al*. (2019) that at the provincial level, 85% of rural households in the Eastern Cape have access to arable land, whilst 75% have access to shared grazing land.

Table 1: Socio-economic characteristics of households

Characteristic	**Description**	**Frequency**		**Percent**	
Gender	Male	**43**		**57.33**	
	Female	**32**		**42.67**	
Level of education	Primary	**15**		**20**	
	Secondary	**26**		**34.67**	
	Tertiary	**34**		**45.33**	
Employment status	Yes	**16**		**21.33**	
Member of coop	Yes	**32**		**42.67**	
		Mean	**Std dev.**	**Min**	**Max**
HH Monthly income	Rands	4194.2	3356.3	600	18400
Household size	Number of persons	6.65	2.97	2	15
Prohibition of movements	Land in Ha	0.74	0.64	0.12	2.5
Age	Age (years)	29.12	6.967	18	44
Farming experience	Years of involvement	9.41	5.38	1	27

Source: Survey, 2020

While all the surveyed households have access to land, cultivation was limited to homestead gardens. This can be attributed by the prohibition of movements that has been reported above. There were farmers who did not participated at all in crop production (3%). Almost every household head indicated that they are involved either on livestock (96%) or crop (97%) or the combination of the two (69%). This is in line with Christian et al., (2020) findings that majority of households in the study area practice mixed farming. The results are shown in Figure 2.

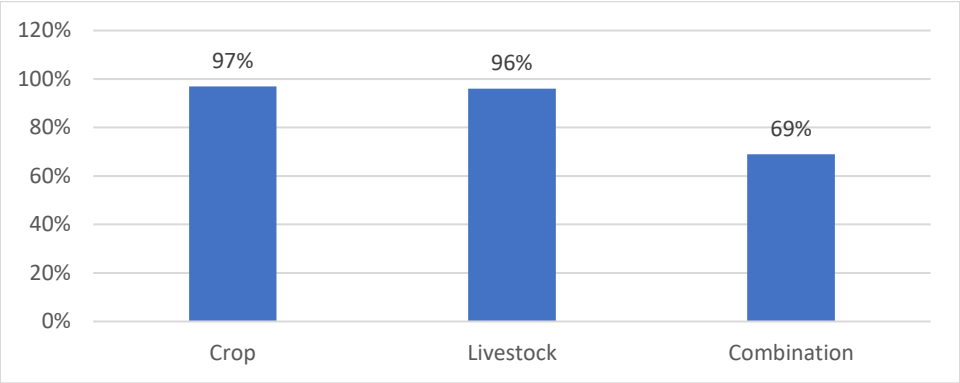


Figure 2: Farming in the study area
Source: Survey, 2021

4.2. Delivery of Agricultural Extension During Covid-19 in the Study Area

4.2.1. Access to extension service

In South Africa, agricultural extension services are the most common forms of public sector support for knowledge diffusion and learning. The concept of extension services sector involves agricultural experts, who teach improved methods of farming in both livestock and cropping enterprises, demonstrate innovations, organise farmer meetings and markets. Among other things, access to agricultural extension services has been an issue in rural Eastern Cape for years. The results in Figure 3 indicate that of the surveyed households, (61.33%) had no access to extension services during covid-19 pandemic. Again, from the survey, there was little mention of extension delivery with respect to input supplying and marketing related services.

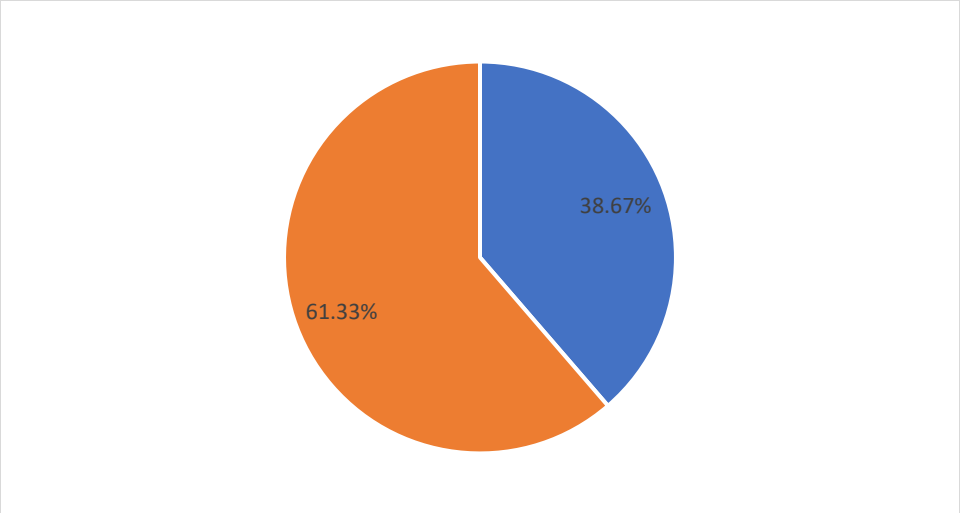


Figure 3: Access to extension services during covid-19
Source: Survey, 2021

4.2.2. Information needs

As seen in Table 1, seeking information on marketing and farm related credit are the highest while fertilizer application and storage recorded the lowest.

Table 2: Information needs of farming households.

Information need	**Frequency**	**Percent (%)**
Fertilizer application	38	50.67
Marketing of produce	62	82.67
Storage	22	29.33
Farm related credit	59	78.67

Source: Survey, 2021

Table 3: Factors affecting farm yields.

Logit regression				Number of obs = 75		
				LR chi2(11) = 22.94		
Log likelihood = -29.862282				Prob > chi2 = 0.0283 Pseudo R2 = 0.2775		
Access to extension officers =0, No=1)	**Coef.**	**Std. Err.**	**z**	**P>z**	**[95% Conf.**	**Interval]**
Household size	.1899646	.0899507	2.11	0.035	.0136645	.3662648
Gender	-.1242723	.3958282	-0.31	0.754	-.9000912	.6515367
Age	.0070563	.0280549	0.25	0.801	-.0479302	.0620429
Material status	-.1795293	.2020639	-0.89	0.374	-.5755673	.2165088

Marketing distance	-.1294232	.5555363	-0.23	0.816	-1.218254	.9594079
Cell phone data	-1.75193	.7119812	-2.46	0.014	-3.147387	-.3564725
Education	.1642027	.259255	0.63	0.526	-.3439277	.6723332
Limited number of farmers for trainings	.8220865.	.4139518	1.99	0.047	.0107559	1.633417
Employment status	.337616	.4863236	0.69	0.488	-.6155607	1.290793
Storage need	.1335915	.4778287	0.28	0.780	-.8029355	1.070118
Fertilizer application	.5747642	.3987534	1.44	0.149	-.2067781	1.356306
Access to extension officers	.0871878.	.4147174	0.21	0.833	-.7256433	.9000189
_constant	.1171056	1.341711	0.09	0.930	-2.5126	2.746811

Source: Based on STATA processing of field data, 2021

Surprisingly, only four out of 13 explanatory variables that are significant from the above table which are household size, credit need, land size and limited number of farmers for trainings. However, cellphone data was significant influencing the farm performance but has a negative coefficient estimate. This means that it was less likely to receive treatment by 1.75193 if they do not have enough cell phone data as recorded in table 3.

Table 4: Impact of lack of extension services during covid-19. PSM

Output variable	**n. treat.**	**n. contr.**	**Kernel Matching Method**		
			ATT	**Standard error**	**t-value**
Access to extension	57	16	-295.489	1962.781	-0.151
		Nearest Neighbours Matching Method			
			ATT	**Standard error**	**t-value**
Access to extension	57	11	-829.035	1092.450	-0.759
		Radius Matching method			
Access to extension			**ATT**	**Standard error**	**t-value**
	57	16	-520.672	1363.682	-0.382
Model Summary			Number of observations =75 Matches requested =5 Treatment model =Logit		

Source: Based on STATA processing of field data, 2021

Table 4 shows the results from the covariate balancing tests both before and after matching. Based on the control and treated variables, the Average Treatment Effect Treated from Kernel, Nearest Neighbours, Radius matching methods were found to be negative. Therefore, we can conclude that

if they did not receive the program, the performance per farmer would be reduced by 295.489, 829.035 and 520.672, respectively recorded.

5. CONCLUSION AND IMPLICATIONS FOR EXTENSION DELIVERY IN THE FUTURE

This study aimed at analyzing the extension service delivery in times of covid-19 in the Eastern Cape. Covid-19 clearly affected residents across the country and even worse to rural residents. The findings indicated that there is still a quite several households that do not have access to extension services in Idutywa. Factors such as household size, cellphone data, limited movements, and limited number of farmers for training. However, cell phone data was significant influencing the yields but has a negative coefficient estimate. The results from propensity score matching on Average Treatment Effect on Treated further indicated that farmers really need the program despite covid-19 pandemic.

Findings from this study confirms the need for empowering extension workers with modern technologies to meet the needs of households. The study also recommends private-public partnership in extension service delivery.

6. ACKNOWLEDGEMENTS

The authors are grateful to all those who participated in the data collection and analysis. We are grateful to Dr Ikechi Agbugba for his comments in earlier drafts of this article.

7. REFERENCES

AFFUL, D.B. AND LATEGAN, F.S. 2014. Small and medium-scale producers' use and credibility of information sources: implications for public extension's financial sustainability. *South African Journal of Agricultural Extension*, 42 (1): 27-38.

AGHOLOR, A.I. 2012. The quality of extension education delivery among livestock farmers in central Eastern Cape. A case study of Nkonkobe Local Municipality. Unpublished Master's Thesis, University of Fort Hare, Alice.

BEMBRIDGE, T.J. 1991. The practice of agricultural extension- a training manual. Dbsa, halfway house.

CHRISTOPLOS, I., 2010. Mobilizing the potential of rural and agricultural extension. Neuchâtel Group.

CHRISTIAN, M., JIBA, P. AND MDODA, L., 2020. Factors Influencing Rain-Fed Agricultural Land Abandonment in Mnquma and Mbashe Municipalities, Eastern Cape. International Journal of Recent Technology and Engineering. 9(2): 2277-3878.

CHRISTIAN, M, LUVHENGO, U, KHOBAI, H, AND AGBUGBA, IK., 2020. Reviewing land access livelihood diversification strategies and factors influencing wellbeing of rural households in mnquma, Eastern Cape: implications to extension agents. S. Afr. J. Agric. Ext. 48(2): 113 - 125.

CONRADIE, B.I. 2016. The implications of a weak public extension service for the productivity performance of Karoo agriculture. *South African Journal of Agricultural Extension*, 44(2): 99-109.

HALL, R. AND KEPE, T. 2017. Elite capture and state neglect: new evidence on South Africa's land reform. *Review of African Political Economy*, 44(151): 122-130.

HLATSHWAYO, P.P.K. AND WORTH, S.H. 2016. Stakeholders' Perceptions about Visibility and Accountability of the State Agricultural Extension in Nquthu Area, KwaZulu-Natal Province, South Africa. *South African Journal of Agricultural Extension*, 44(2), 174-185. [Accessed: 18/10/2020].

JONES K.E., PATELN.G. LEVYM. A., STOREYGARD, A., BALK, D, GITTLEMAN J.L., DASZAK P. 2008. Global trends in emerging infectious diseases. Nature 451, 990-993.

KOCH, B. H. AND TERBLANCHÉ, S. E. 2013. An overview of agricultural extension in South Africa. *South African Journal of Agricultural Extension*, 41(1): 107-117.

LIEBENBERG. F. 2015. Agricultural Advisory Services in South Africa. Discussion paper. University of Pretoria: South Africa.

MAOBA, S. 2016. Farmers' perception of agricultural extension service delivery in Germiston region, Gauteng Province, South Africa. *South African Journal of Agricultural Extension* 44 (2):167 –173.

NATIONAL DEPARTMENT OF HEALTH, SOUTH AFRICA. MINISTER OF HEALTH UPDATE [Twitter] 2020. https://twitter.com/HealthZA/status/1242507959852302336?s=19 (accessed 24 March 2020).

NATIONAL DEPARTMENT OF HEALTH, SOUTH AFRICA. Latest confirmed cases of COVID-19 (23rd March2020). https://sacoronavirus.co.za/2020/03/23/latest-confirmed-cases-of-covid-19-23rd-march-2020/ (accessed 24 March 2020).

NICD.2020. COVID-19 Weekly Epidemiology Brief Week 18, 2020 www.nicd.ac.za

NKOSI, N.Z. 2017. Level of Access to Agricultural Extension and Advisory Services by Emerging Livestock Farmers in UThungulu District Municipality, KwaZulu-Natal Province. Unpublished Master's Thesis. University of South Africa.

SIKWELA, M.M. 2013. The impact of farmer support programmes on market access of smallholder farmers in the Eastern Cape and KwaZulu-Natal provinces, South Africa. PhD Thesis. Unpublished dissertation University of Fort Hare Alice, South Africa.

WHO. WHO Director-General's opening remarks at the media briefing on COVID-19-11 March 2020. https://www.who.int/dg/speeches/detail/whodirector-general-s-opening-remarks-at-the-media-briefing-on-covid-19--- 11-march-2020 (accessed April 23, 2020). 2

WHO. Coronavirus disease 2019 (COVID-19) situation reports. https:// www.who.int/emergencies/diseases/novel-coronavirus-2019/situationreports (accessed April 23, 2020).

WHO. 2020. Coronavirus disease (COVID-19) Pandemic. https ://www.who. int/emerg encie s/disea ses/novel -coron aviru s-2019. Accessed 10 April 2020.

DIFFERENCES IN BURDEN OF GASTROINTESTINAL NEMATODE INFESTATIONS IN INDIGENOUS DOES FORAGING IN GRASSLAND AND FORESTLAND VEGETATION TYPES

Qokweni, L.,[1] Marufu, M.C.[2] and M. Chimonyo, M[3]

Corresponding author: Qokweni, L; Email: qokweni.luxolo@gmail.com

ABSTRACT

Gastrointestinal nematode (GIN) infestations remain the main challenge to small ruminants' health, productivity and reproductive performance, and can lead to a substantial economic loss globally. A longitudinal study was conducted to assess the effect of vegetation type, season and parity on the burden of GIN in Xhosa lob-eared does foraging in grassland and forestland. Body condition score (BCS), packed cell volume (PCV), FAMACHA score and faecal egg counts (FEC) were determined in Xhosa lob-eared does (n = 165) during the cool-dry, hot-wet and post-rainy seasons in grassland and forestland. Faecal samples were collected from the rectum and analysed using the modified McMaster technique. There was a significant association between vegetation type and season on the recorded BCS, BW, FEC, PCV and FAMACHA scores. Does in the forestland (3.5± 0.09) had higher (*P<0.05)* BCS as compared to those in grasslands (3.3 ± 0.11). Higher FEC *(P<0.05)* were observed in does in grasslands (1.5 ± 0.03) compared to those in forestlands (1.4 ± 0.03). Body condition scores, FEC and FAMACHA scores were significantly higher in the hot-wet season than cool-dry and post-rainy seasons, while PCV was significantly higher during the cool-dry compared to hot-wet season in forestlands. Strongyles and *Strongyloides* eggs were higher in the grasslands than forestlands during the hot-wet season. Controlling of GIN in goats, therefore, requires an integrated control strategy that should be based on vegetation type.

Keywords: Does, Indigenous goats, Prevalence, Strongyle eggs, Vegetation Type

1. INTRODUCTION

Indigenous Xhosa lob-eared goat breeds have been part of the resource-limited farmers' assets in developing countries for many years to improve food security, income generation, savings and socioeconomic welfare (Devendra, 2013). These goats contribute largely to supply animal protein for resource-limited households (Wodajo *et al*., 2020). Indigenous Xhosa lob-eared goats adapt

[1] L. Qokweni. Senior Agricultural Advisor at Department of Rural Development and Agrarian Reform, P/Bag X5002, Mthatha, 5099, E-mail:qokweni.luxolo@gmail.com, Orcid:0000-0003-0088-9017.

[2] C.M. Marufu.Senior Lecture at University of Pretoria. Department of Veterinary Tropical Diseases, University of Pretoria, P/Bag X04, Onderstepoort, 0110, E-mail: chrismunya@gmail.com, Orcid: 0000-0003-4784-6153.

[3] M. Chimonyo. Head of department at University of KwaZulu-Natal: Animal and Poultry Science, University of KwaZulu-Natal, P/Bag X01, Scottsville 3209, Pietermaritzburg, E-mail: chimonyo@ukzn.ac.za, Orcid: 0000-0002-3244-0444.

well to various agro-climatic conditions and vegetation types, and are tolerant to diseases and parasites. Goat productivity is generally low in developing countries due to various limiting factors. These factors include high prevalence of diseases and gastrointestinal parasites, poor quality and quantity of feed and low levels of management (Mpofu *et al.,* 2020; Qokweni *et al*., 2020).

Gastrointestinal nematodes (GIN) infestation remains the main limiting factor to goat productivity (Zvinorova *et al*., 2016; Mpofu, *et al.,* 2020, Qokweni *et al*., 2020). Epidemiology of GIN in goats varies with climatic conditions, vegetation type, season and management practices (Giday *et al.,* 2018; Qokweni *et al.,* 2020). In Southern Africa, the most common GINs affecting goats are strongyles including *Haemonchus contortus, Trichostronglylus colubriformis, Teladorsagia circumcincta* and *Nematodirus spp* (Zvinorova *et al*., 2016). Infestation with GIN's is associated with great economic losses and huge impact on goat productivity affecting weight gain, meat quality and milk production and leading to mortality particularly in kids (Zvinorova *et al*., 2016; Hassan *et al.,* 2019). These nematodes reduce feed conversion efficiency, impair fertility and increase costs related to treatment and mortality in infested goats (Taylor *et al.,* 2007; Roeber *et al*., 2013).

Natural vegetation plays a significant role in goat production through provision of forage. Vegetation types found in Southern Africa include forestland, grassland, desert, shrublands, savanna, woodlands, and tundra (Dixon *et al*., 2014, Qokweni *et al*., 2020). Forestlands and grasslands are the most common vegetation types that contribute greatly to goat farming (Dixon *et al*., 2014). Grassland is a vegetation type that is dominated by grasses and lack of trees whilst forestland is characterised by the dominance of various species of trees (Qokweni *et al*., 2020). Vegetation type affects nutrition, immunity of goats, worm cycle and stocking density (Kumar *et al*., 2013; Giday *et al.,* 2018). Tree and shrub species found in forestland are rich in polyphenolic compounds, which have been reported to reduce gastrointestinal parasitic burden (Max *et al*., 2003; Evitayani *et al*., 2004). Goats browsing in forestlands tend to have lower GIN loads, since the chances of picking infective larvae from shrubs and trees are reduced compared to grasslands (Qokweni *et al.*, 2020). Studies conducted by Marume *et al*. (2012) highlighted that goats fed with *Vachellia* leaves had a marked decreased in faecal larval count and low worm counts at necropsy. Goats foraging in grasslands are characterized by higher GIN infestation due to exposure to infective larvae on pasture and thus are constantly being reinfected in cyclical fashion (Qokweni *et al.,* 2020). For sustainable goat production system, it is essential to determine differences in burden of GIN infestations and performance of Xhosa lob-eared does foraging in grassland and forestland vegetation types.

Higher GIN loads in goats can be exhibited by high faecal egg counts, high Faffa Malan Chart (FAMACHA) score, low packed cell volume (PCV), and reduced body weight and condition. The PCV is a measure of the circulating volume of erythrocytes in blood and an indicator of the severity of anemia and thus GIN infestation in goats. The normal range of PCV in goats is estimated to be from 22-38% (Onzima *et al*., 2017). Faecal egg counts determined using the modified McMaster

technique are a common veterinary practice for the diagnosis of internal parasitism and have been used as the direct indicator of the level of GIN infestation (Zvinorova et *al.,* 2016). The FAMACHA score system is the clinical assessment of the colour of a goat's eye conjunctival mucous membrane using FAMACHA chart to determine level of anemia (Van Wyk and Bath, 2002). There is, however, no information on the interaction between vegetation type, season and parity on packed cell volume, FAMACHA scores and faecal egg counts in indigenous goat does reared in grassland and forestland. Does are mostly retained goat class in the flock for breeding purposes and constitute more than 70% of the flock (Rotimi *et al.,* 2017).

Moreover, study conducted by Dey *et al*. (2020) reported that does are more susceptible to nematodes than other goat classes. Comprehensive knowledge on seasonal variation on PCV, FAMACHA scores and FEC in goats is the prerequisite to design effective GIN control strategy for each vegetation type. It is necessary to assess the effect of vegetation type, season and parity on PCV, FAMACHA score and FEC in indigenous goat does foraging in grasslands relative to those in forestlands. Such information capacitates goat farmers in developing effective GIN control programs based on vegetation type. Vegetation type-specific measures to control GIN in Xhosa lob-eared does that take in to account the seasonal variations in infestation and does' physiological status are required to enable resource-limited farmers to overcome this production challenge in their flocks. Therefore, the objective of the study was to assess the effect of vegetation types on the prevalence and loads of GIN in indigenous Xhosa lob-eared does foraging in grasslands and forestlands. It was hypothesized that the GIN burden will be influenced by season and vegetation type.

2. MATERIAL AND METHODS

2.1. Study site

The study was conducted with goat farmers in two communities of Mbizana local municipality in Alfred Nzo district in the Eastern Cape Province of South Africa. Communities which participated in the study were Khanyayo representing forestlands and Mpetsheni representing grasslands (Qokweni *et al*., 2020). These communities were selected based on vegetation type, keeping goats and their willingness to participate in the study and on the assurance of availability of the goats throughout the study period. Farmers from these communities are well known to raise goats and other livestock species that include cattle, sheep, chicken and pigs. Alfred Nzo district lies 30^{o} 50"83$^{'}$ S and 28^{o} 58'97' E at an altitude of 1055 m above sea level. The average maximum and minimum mean annual temperatures are 24 ^{o}C and 8.5 ^{o}C, respectively. The district receives an annual rainfall range between 750 and 1100 mm per annum; the rainy season is between October and March. Vegetation in Alfred Nzo district is mostly temperate and transitional forest with scrub and some pure grassland vegetation (Agriculture Geo-Referenced Information System, 2017).

Alfred Nzo district has a fragmented topography and consists of a wide-ranging ecotone between the grassland and forestland with *Vachellia* species. Mpetsheni community that falls under grassland is dominated by the following grass species *Richardia humistrata, Eragrostis plana, E.*

chloromelas, Sporobolus africanus, Aristida congesta, Aristida juniformi, Cynodon dactylon, Themeda triandra, Eragrostis curvula and *Cybopogon plurinodis*. The dominant tree species at Khanyayo community which falls under forestlands are *Sclerocarya birrea, Caddra rudis, Hereto rigida, Cussonia spicuto* and *Vachellia karroo* (Acocks, 1988*)*. In the sour grasslands, forages have low nutritive value (20-50 g/kg crude protein) and largely unpalatable during cool-dry season than during hot-wet seasons. Forages in forestlands composed of trees and shrub species that remain palatable and nutritious throughout the year such *Acacia karroo*.

2.2. Experimental does and their management

In each community, goats are kept in groups of 5 to 65 goats per households. A total of 165 South African indigenous Xhosa lob-eared does (n =80 for grassland and n=85 for forestland) where used for this study. Age of does was between 1-5 years of age and was verified using the dentition estimation method by counting the number of permanent incisors erupted on the lower jaws of the mouth (Stevens and Houston, 1989. The body weight of sampled does in grasslands ranged between 14 and 50 kg (averaging 35.4 ± 1.30) while those in forestlands were between 18 and 58 kg (averaging 37.1 ± 1.95). Does were selected based on health status and showing no signs of diseases prior to study commencing by experienced state veterinarian. These does were dosed against gastrointestinal parasites using 1.9% (m/v) Albendazole and 99% (m/m) Levamisole hydrochloride before the commencement of the trial. The does from Mpetsheni community were freely grazed in natural grasslands during the day whilst does in Khanyayo community browsed in natural forestlands as from 1000 to 1800 hours and penned at night (Qokweni *et al*., 2020). The experimental does had not been treated against GIN for at least six weeks prior to data collection. Once in the season experimental does received a single oral dose of broad-spectrum anthelmintic to clear GIN infestation and no supplementary feed were provided during sampling period of September to April. Data was collected in the cool-dry, hot-wet and post-rainy season on both grasslands and forestlands vegetation type.

2.3. Blood collection

Blood samples were collected from each experimental Xhosa lob-eared doe once in the cool-dry, hot-wet and post-rainy seasons between 0600-0900 hours. The study complied with the standards required by the Animal Research Ethics Committee of the University of KwaZulu-Natal (Reference Number: 1434/018D). For each doe, blood was collected from the jugular vein using a 21-gauge needle attached to a 5 ml syringe and immediately transferred into a blood tube containing ethylene diamine tetra acetic acid (EDTA) for PCV determination. The blood samples were stored in a cooler box with ice pack and transported at 4 ºC to the laboratory of Animal and Poultry Science of University of KwaZulu-Natal in Pietermaritzburg for analysis.

2.4. Faecal collection

Fresh faecal samples were collected once in the morning between 0600 and 0900 hours in cool-dry, hot-wet and post-rainy seasons. Faecal samples were collected directly from the rectum of

each experimental doe by means of a lubricated and gloved hand. Each faecal sample was placed in a sealable plastic sample bag on which was labelled the study site, goat's identification number, and date of collection. The faecal samples were transferred directly at the same day of collection in an airtight cooler box containing ice to the laboratory of Animal and Poultry Science of University of KwaZulu-Natal in Pietermaritzburg and then stored at 4 ^{o}C for a maximum of 48 hours before analysis.

2.5. Measurements

2.5.1. Body weights and body condition scoring

For each Xhosa lob-eared doe, body weight (BW) and body condition score (BCS) were measured in the morning from 0600 to 0900 hours once in the cool-dry, hot-wet and post-rainy seasons. Body weight was estimated using goat weigh-band (Asefa *et al*., 2017). A goat weight band is a specially marked tape used to estimate the live weight by conversion of the measurement of the heart girth of a doe. The girth measurement is taken by placing a tape around the doe's girth. The tape encircles the goat just caudal to the withers dorsally and just caudal to the elbows ventrally. The BCS was assessed visually and by palpation using the five-point scoring system with score 1= being emaciated, 2=thin, 3=average, 4=fat and 5=obese (Ghosh *et al*., 2019).

2.5.2. Packed cell volume

Packed cell volume (PCV) was measured using the micro-haematocrit method. The stored EDTA blood samples were used for the determination of PCV. Blood was drawn into non-heparinized micro haematocrit capillary tubes (1.40 x 1.60 x 75 mm, Lasec Pty Ltd Cape Town, South Africa) by capillary action, one end of the capillary tube was sealed before centrifugation in a micro-haematocrit centrifuge (MSE, London, Great Britain) for 3 m at 12 000 rpm. A haematocrit reader was used to determine the PCV which was the volume of erythrocytes expressed as a percentage of the total volume of whole blood.

2.5.3. Faecal egg counts

Faecal egg counts (FEC) were determined using the modified McMaster technique with a saturated solution of 40% sugar solution having specific gravity of 1.27 as the floatation medium per sample. Two grams of faeces were mixed with 58 ml of saturated sugar solution. The number of nematode eggs per gram (EPG) of faeces was obtained by multiplying the total number of eggs counted in the two chamber squares of the McMaster slide by the dilution factor of 50 (Hanse and Perry, 1994). The McMaster technique detection limit is 50 eggs per gram of faeces.

2.5.4. FAMACHA scoring

The Faffa Malan Chart (FAMACHA) scoring system was used to determine the severity of parasite infestation by opening the lower eyelid of each doe and comparing the colour of the conjunctiva with a five-point scale (1-5) where 1-2 indicate no anaemia, 3 mild anaemia and 4-5 severe anaemia (Van Wyk and Bath, 2002). This was conducted at the same frequency as sampling each

season and just before collection of samples from each doe. For the accuracy of eye scoring, there was a veterinarian and experienced animal health technician.

2.6. Statistical analyses

Data was checked for normality using the PROC UNIVARIATE of SAS (2016). To normalise data faecal egg count and body weight change were transformed using Log_{10} (x+1). Data were analysed using the generalized linear models for repeated measures of Statistical Analysis System (2016) to assess effect of vegetation type, season, age, parity and their first order interactions on the FAMACHA score, PCV, FEC, BCS and BW. The means and standard error of the faecal eggs counts of each GIN species were computed using PROC MEANS of (SAS, 2016). The chi-square test was used to determine associations between loads of parasite and vegetation type, season, age and parity (SAS, 2016).

3. RESULTS

3.1. Effect of vegetation type, season, parity and age on body weight changes

The effect of vegetation type on performance of does across the cool-dry, hot-wet and post-rainy seasons is depicted in Figure 1. Vegetation type, season, age, parity and their two-way interaction significantly ($P<0.05$) affected body weight chances of does. Generally, does foraging in forestlands had higher body weight gain ($P<0.05$) than those in the grasslands across the seasons. During cool-dry season does from forestland gained ($P<0.05$) more weight than those in grassland. Does on both vegetation types were observed to experience body weight loss ($P>0.05$) during the hot-wet season.

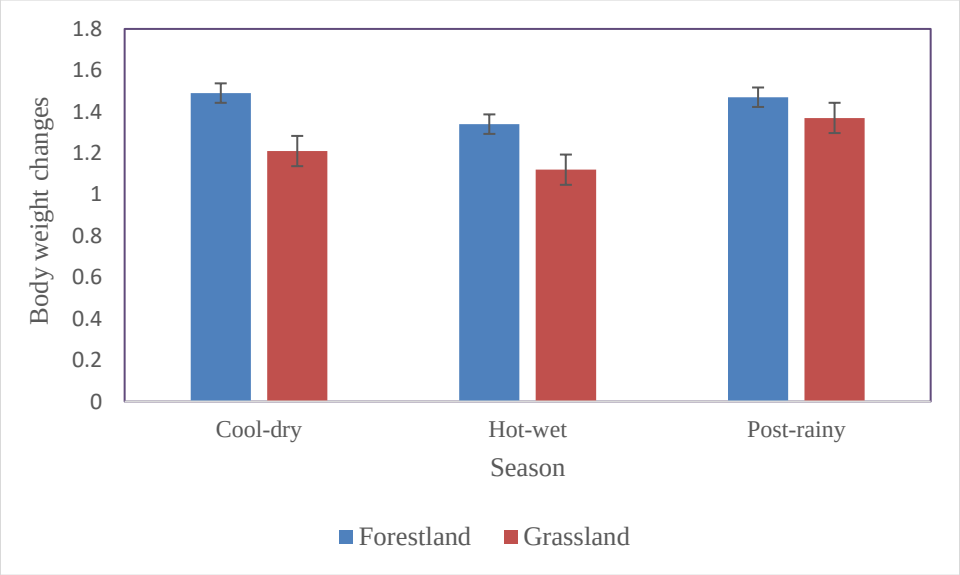


Figure 1: The overall effect of vegetation type on body weight change of does across the seasons.

3.2. Effect of vegetation type and season on faecal egg counts, packed cell volume (PCV), FAMACHA scores (FS) and body condition score (BCS)

Effect of vegetation type, season and their interaction on FEC, PCV, FS and body condition scores in does are shown in Table 1. The interaction between vegetation type and season on body condition score (BCS) was significant ($P < 0.05$). Higher ($P < 0.05$) BCS were observed in does in the forestland during the hot-wet and post-rainy seasons and lower ($P<0.05$) BCS in the cool dry season than for does in the grasslands. Season significantly affected mean egg count (MEC) with hot-wet season having higher ($P < 0.05$) MEC than cool-dry season in both the grassland and forestland does. There was significant ($P<0.05$) association on the interaction of vegetation type and season on mean PCV. The mean PCV values were affected by season and vegetation type with significantly ($P<0.05$) higher levels in the cool-dry compared to the hot-wet season in forestland type. Higher ($P<0.05$) mean PCV levels were recorded in the post-rainy season on both vegetation types. The mean FAMACHA score was affected by season and vegetation type with significantly ($P<0.05$) higher scores in the hot-wet than cool-dry season in forestland types. There was a significant ($P<0.05$) association on the interaction of vegetation types and seasons on BCS. Higher ($P < 0.05$) BCS was recorded in hot-wet than post-rainy season on both vegetation types.

Table 1: Effect of vegetation type and season on the FEC, PCV, FS and BCS of indigenous does.

Vegetation type	Season	LogFEC	PCV	FS	BCS
Grassland	Cool-dry	1.3 ± 0.49^{c}	19.7 ± 2.01^{c}	2.9 ± 0.12^{d}	3.3 ± 0.11^{b}
	Hot-wet	1.5 ± 0.03^{a}	27.1 ± 1.37^{a}	4.2 ± 0.13^{a}	3.3 ± 0.11^{b}
	Post-rainy	1.4 ± 0.02^{b}	28.4 ± 0.96^{a}	3.7 ± 0.11^{b}	3.1 ± 0.09^{c}
Forestland	Cool-dry	1.2 ± 0.53^{a}	24.5 ± 2.27^{b}	3.4 ± 0.14^{c}	3.0 ± 0.10^{c}
	Hot-wet	1.4 ± 0.03^{b}	20.9 ± 1.41^{c}	4.2 ± 0.13^{a}	3.5 ± 0.09^{a}
	Post-rainy	1.4 ± 0.01^{b}	25.7 ± 0.81^{b}	3.7 ± 0.09^{b}	3.3 ± 0.07^{b}

[abcd] Values of the same parameter in the same column with different superscripts are significantly different ($P < 0.05$). FEC: faecal egg count, PCV: packed cell volume, FS: FAMACHA score and BCS: body condition score.

3.3. Effect of vegetation type and parity on FEC, PCV and FAMACHA scores

Interaction of vegetation and parity on FEC, FAMACHA scores and PCV in does foraging in grassland and forestland types are shown in Table 2. Faecal egg counts were significantly affected by vegetation type and parity with higher ($P < 0.05$) FEC in does on first parity compared to those on fourth parity in forestland. Significant association ($P < 0.05$) of vegetation type and parity on FAMACHA scores were only observed in does in the fourth parity and above. Packed cell volume was affected by parity and vegetation types with significantly higher PCV levels observed in mature compared to young does in forestland.

Table 2: Least square means (± standard errors) on the effect of vegetation types and parity on $log_{10}(x+1)$ FEC, PCV and FAMACHA scores in does foraging in grassland and forestland

Parity	Grassland			Forestland		
	FEC	**FAMACHA scores**	**PCV**	**FEC**	**FAMACHA scores**	**PCV**
1	1.24 ± 0.10^{d}	3.45 ± 0.22^{c}	28.18 ± 1.39^{a}	1.38 ± 0.15^{e}	3.50 ± 0.25^{c}	22.25 ± 1.63^{b}
2	1.35 ± 0.06^{d}	3.67 ± 0.11^{c}	25.23 ± 1.11^{a}	1.45 ± 0.06^{d}	3.98 ± 0.11^{c}	22.44 ± 1.07^{b}
3	1.18 ± 0.09^{d}	3.68 ± 0.17^{c}	27.40 ± 1.88^{a}	1.25 ± 0.07^{d}	3.75 ± 0.14^{c}	25.97 ± 1.57^{b}
>4	1.17 ± 0.13^{d}	3.61 ± 0.17^{c}	22.06 ± 1.77^{b}	1.09 ± 0.09^{d}	3.48 ± 0.14^{c}	25.60 ± 1.50^{a}

^{abcd} Values of the same parameter in the same row with different superscripts are significantly different ($P < 0.05$). FEC: faecal egg count, PCV: packed cell volume.

3.4. Prevalence of gastrointestinal parasites

There were four GIN egg types that were identified from the does in the grassland and forestland vegetation type as presented in Table 3. These GI nematodes eggs were Strongyles, *Strongyloides*, *Nematodirus* and *Trichuris.* There was a significant association (P <0.05) between the prevalence of strongyles, *Strongyloide*s, *Nematodirus* and vegetation types. The highest (P <0.05) egg counts of strongyles, *Strongyloide*s and *Nematodirus* were recorded in the grassland than in forestland vegetation type. There was no significant (P >0.05) difference in the prevalence of *Trichuris* in does between the vegetation types.

Table 3: Prevalence (%) of gastrointestinal parasites of does rear in grassland relative to those in forestland

Parasites	Grassland (%)	Forestland (%)	χ^2 value	Significance
Strongyles	62.5	48.2	4.62	*
Strongyloides	65	32.9	23.1	**
Nematodirus	46.3	21.2	14.9	**
Trichuris	17.5	17.7	0.00	NS

* P < 0.05; ** P<0.01, NS: not significant (P > 0.05).

Table 4 indicates the transformed ($\log_{10}[x+1]$) seasonal changes in egg counts and standard error of strongyles, *Strongyloides, Nematodirus* and *Trichuris* in the grassland and forestland vegetation types. The interaction of vegetation type and season was significantly associated with the prevalence of strongyles and *Strongyloides.* The highest (P <0.05) egg counts of strongyles and *Strongyloides* were recorded in the hot-wet season while the lowest (P <0.05) were recorded in the cool-dry season for on both vegetation types. Does in the grassland recorded higher (P <0.05) egg counts of strongyles, *Strongyloides* and *Nematodirus* than those in the forestland. There was no significant association between vegetation type and season on the prevalence of *Trichuris* egg counts.

Table 4: Season changes in the mean ± standard error log-transformed faecal egg counts of gastrointestinal nematodes

Parasites	Grassland			Forestland			
	Cool dry	Hot wet	Post rainy	Cool dry	Hot wet	Post rainy	Significance
Strongyles	0.27 ± 0.05^{a}	0.57 ± 0.05^{a}	0.04 ± 0.04^{d}	0.12 ± 0.06^{b}	0.37 ± 0.06^{a}	0.37 ± 0.05^{a}	*
Strongyloides	0.22 ± 0.05^{b}	0.37 ± 0.05^{b}	0.08 ± 0.05^{c}	0.17 ± 0.06^{a}	0.23 ± 0.06^{b}	0.18 ± 0.05^{b}	*
Nematodirus	0.14 ± 0.05^{c}	0.35 ± 0.05^{b}	0.18 ± 0.04^{a}	0.16 ± 0.06^{a}	0.37 ± 0.06^{a}	0.16 ± 0.05^{b}	*
Trichuris	0.01 ± 0.02^{d}	0.00 ± 0.02^{c}	0.11 ± 0.02^{b}	0.11 ± 0.04^{b}	0.00 ± 0.04^{c}	0.14 ± 0.03^{c}	*

^{abcd} Values in the same column with different superscripts are differ ($P < 0.05$)

4. DISCUSSION

This study was conducted to assess effect of vegetation type, season and parity on the burden of GIN in does foraging in the grassland relative to those in forestland. Understanding effect of these factors in the burdens of GIN capacitate farmers on the appropriate strategies to manage and control GIN infestation in goats. Forage quality and quantity of natural vegetation varies with season, management, soil characteristics and growth stage, thus resulting in seasonal variation in goat performance.

Generally, the loss in body weight gain of does during the cool-dry season in grassland in this study could be attributed to the fact that forage during this period are reduced quality, unpalatable and inadequate enough to meet nutritional requirements for maintenance in does. Study conducted by Chimonyo *et al.* (2000) indicated that during cool-dry season grasses contain lesser crude protein (CP) level that could possibly be as low as 3%. Negative body weight gain in does foraging in grassland without provision of supplementation was expected in the cool-dry season due to poor feed availability (Safari *et al*., 2010). Loss of body weight gain in both vegetation types during hot-wet season on both vegetation type was likely attributed to the higher gastrointestinal infestation due to conditions being conducive for nematode proliferation. These findings are similar to the early reports by Mpofu *et al.,* (2020) and Qokweni *et al*., (2020) who reported high loads of gastrointestinal nematodes during the hot-wet season.

The observed body weight gain during the post-rainy season in grassland, can be explained by the pasture availability in conjunction with unfavorable conditions for gastrointestinal nematode infestation in goats. Moreover, during the post-rainy season vegetation is still plenty and nutritious to meet nutritional requirements of does. Fodder trees and shrubs play an important role to alleviate feed shortages and nutritional deficiencies experienced during the cool-dry seasons in forestland. This is reflected by the body weight gain in does during cool-dry season in forestland and negative body weight gain in grassland. Study conducted by Idamokoro *et al.* (2016) reported that feeding goats with *Vachellia karroo* leaves improve animal performance, reduce worm burden and increase growth rate in kids. Marume *et al.* (2012) further indicated that goats foraging *Acacia karroo* had better body condition and were able to maintain level of productivity compared to those only fed hay. The difference in body weights performance and body condition scores in does from grasslands and those in forestlands could be the seasonal variation of forage nutrients availability (Egea *et al.,* 2018). Rogosic *et al*. (2006) further highlighted that most trees and shrubs have high CP in their leaves and less fiber compared to grasses. These observations indicate better nutrition and health status of does in forestland than of those in grassland.

The observed association of higher mean egg counts, higher FAMACHA scores and lower PCV levels in hot-wet season than cool-dry season corroborate with previous studies by Kaplan *et al*. (2004), Nadarajah *et al*. (2015) and Seyoum *et al.* (2018) that showed a positive correlation between faecal egg counts and FAMACHA scores in small ruminants. The low PCV levels during hot-wet season most likely indicate high burden of GIN in does. The findings of the present study that indicate high mean egg counts and lower mean PCV levels during hot-wet season might be attributed to the fact that gastrointestinal stronglyes such as *Haemonchus contortus* are voracious blood sucking parasites in goats (Kaplan *et al.,* 2004).

Study conducted by Brik *et al*. (2019) indicated that *Haemonchus contortus* can suck approximately 0.05mL of blood per day in an animal. These results emphasized that GIN infestation is the real challenge in goat farming for resource-limited farmers. The high loads of faecal egg counts observed in this current study during hot-wet season can be also explained by the climatic variables of Alfred Nzo district in the Eastern Cape Province which is characterised by average minimum and maximum temperatures of 8.5-24 ^{o}C and annual rainfall ranges between 750-1100 mm that provide favourable climatic conditions for larva development and survival (Qokweni *et al*., 2020).

Higher FEC, FAMACHA scores and lower PCV observed in this present study in does in the first parity compared to those does in the third and fourth parity on both vegetation types agrees with May *et al*. (2017) who reported that cows in the first parity had higher FEC compared with cows in the third and fourth parity. This situation could be attributed to the fact that does in the third and fourth parity have developed a stronger immunity against GIN. The differences in the infestation rate of the younger does compared to the older does observed in the current study indicate that younger does were more susceptible to GIN infestation than older does. These findings corroborate with previous studies conducted by Zvinorova *et al*. (2016) and Qokweni *et al*. (2020) who reported higher susceptibility to GIN infestation in younger goats. The lower PCV levels were associated with higher mean egg counts for strongyles and *Strongyloides.*

The observed higher mean egg counts for strongyles and *Strongyloides* in the hot-wet season than in the cool-dry season on both vegetation types ($P<0.05$) were similar to those of Zvinorova *et al*. (2016), Yuan *et al*. (2019) and Mpofu *et al*. (2020) who also reported higher faecal egg counts in the wet season than dry season. The finding that faecal egg counts decline in the cool-dry season might be attributed to unfavourable climatic conditions during this period which inhibit the proliferation of worms. The lower mean egg loads of strongyles, *Strongyloides* and *Nematodirus* observed in goats from forestland than those in grassland can be attributed to the fact that other tree and shrub species found in forestland contain condensed tannins that could possibly reduce parasite loads in does. The finding agrees with that of Min *et al.* (2005) who reported that tannins appear to reduce the hatching of worm eggs and development. Tannin-rich plant species are capable of protecting dietary protein from degradation in rumen, which can increase the amino acid supply to both the abomasum and small intestinal resulting in an improved nutritional status of a goat (Min *et al.,* 2005). These results also agree with the findings of Xhomfulana *et al.* (2009) who observed low means egg counts for the Nguni steers fed on the *Acacia karroo*. The lower mean egg counts in does from forestland type might be attributed to the lower infective dose consumed by browsing goats as compared to grazing goats which consume larger amounts of nematode larvae questing on grass.

Development of strategic deworming program at the beginning of the cool-dry season and towards the end of the hot-wet season more precisely on grasslands vegetation type and also culling does with consistently high faecal egg counts and FAMACHA scores is essential. Deworming of does on first parity soon after kidding to prevent effects of lactation on faecal

egg counts and body condition scores may be warranted. Moreover, further investigation of browse species in the control of GIN in goats is essential.

5. CONCLUSIONS

Differences in burden of GIN was significantly associated with vegetation type, season and parity. In general, higher loads of GIN and FAMACHA scores were observed in the hot-wet than cool-dry and post-rainy season, resulting in lower body weights and body condition scores in does foraging in grasslands compared to those in forestlands. To ensure effective control strategies of GIN loads in goat farming enterprise, one should integrate PCV, FAMACHA scores and faecal egg counts based on vegetation type and season. Further studies can be conducted to assess nutritional related blood metabolites and some liver enzymes in goats foraging in grassland relative to those in forestland.

6. REFERENCES

ACOCKS, J.P.H., 1988. Veld types of South Africa, third ed. Botanical Research Institute, South Africa.

AGRICULTURE GEO-REFERENCED INFORMATION SYSTEM, 2017. Agro Meteorology-South Africa. Issue 20.

ASEFA, B., TESHOME, A. AND ABERA, M., 2017. Prediction of Live Body Weight from Heart Girth Measurement for Small Ruminant in Ethiopia: A Review Article. *International Journal of Agricultural Research, Sustainability and Food Sufficiency*, 4:193-201.

BRIK, K., HASSOUNI, T., ELKHARRIM, K. AND BELGHYTI, D., 2019. A survey of *Haemonchus contortus* parasite of sheep from Gharb plain, Morocco. *Parasite Epidemiology and Control, 3:1-6.* doi: 10.1016/j.parepi. 2019. e00094.

CHIMONYO, M., KUSINA, N.T., HAMUDIKUWANDA, H. AND NYOSI, O., 2000. Effect of work stress and supplementary feeding on body conformation, ovarian activity and blood parameter in Mashona cows in a smallholder farming system. *Asian-Australian Journal of Animal Science*, 13:1054-1058.

DEVENDRA, C., 2013. Investments on Pro-Poor Development Projects on goats: ensuring success for improved livelihoods. *Asian-Australasian Journal of Animal Sciences,* 26:1-18.

DEY, A.R., BEGUM, N., ALIM, M.A., MALAKAR, S., ISLAM, M.T. AND ALAM, M.Z., 2020. Gastrointestinal nematodes in goats in Bangladesh: Alarge-scale epidemiological study on the prevalence and risk factors. *Parasite Epidemiology and control,* e00146.doi:10.1016/j.parepi.2020.e00146.

DIXON, A.P., FABER-LANGENDOEN, D., JOSSE, C., MORRISON, J. AND LOUCKS, C. J., 2014. Distribution mapping of world grassland types. *Journal of Biogeography*, 41:2003-2019.

EGEA, A.V., BAKKER, M. L., ALLEGRETTI, L. I., PAEZ, S. A., GRILLI, D. J., GUEVARA, J.C. AND VILLALBA, J. J., 2018. Seasonal changes in feed intake, diet digestibility and diet composition by lactating and non-lactating goats browsing in a semi-arid rangeland of Argentina. *Grass Forage Science:* 1-14. *DOI: 10.1111/gfs.12393.*

EVITAYANI, L., WARLY, A., FARIANI, T.I. AND FUJIHARA, T., 2004. Seasonal Changes in Nutritive Value of Some Grass Species in West Sumatra, Indonesia. *Asian-Australasian Journal of Animal Sciences*, 17:1663-1668.

GHOSH, C.P., DATTA, S., MANDAL, D., DAS, A.K., ROY, D.C., ROY, A. AND TUDU, N.K., 2019. Body condition scoring in goat: Impact and significance. *Journal of Entomology and Zoology Studies*, 7:554-560.

GIDAY, K., HUMNESSA, B., MUYS, B., TAHERI, F. AND AZADI, H., 2018. Effects of livestock grazing on key vegetation attributes of a remnant forest reserve: The case of Desa'a Forest in northern Ethiopia. *Global Ecology and Conservation*, DOI10.1016/j.gecco.2018.e00395.

HANSE, J. AND PERRY, B., 1994. The Epidemiology, Diagnosis and Control of Helminth Parasites of Ruminants. (Handbook), *International Laboratory for Research on Animal Diseases* Press, Nairobi, Kenya. Electronic version available in www.fao.org/wairdocs/ILRI/x5492 E/x5492E00.HTM.

HASSAN, N.M.F., FARAG, T.K., EBU EL EZZ, N.M.T. AND ABOU-ZEINA H.A.A., 2019. Prevalence assessment of gastrointestinal parasitic infections among goats in Giza Governorate, Egypt. *Bulletin of the National Research Centre*, 43:127. https://doi.org/10.1186/s42269-019-0151-5.

IDAMOKORO, E.M., MASIKA, P.J. AND MUCHENJE, V., 2016. *Acacia karroo* leaf meal: A promising non-conventional feed resource for improving goat production in low-input farming systems of southern Africa. *African Journal of Range and Forage Science*, 33:1727-9380.

KAPLAN, R.M., BURKE, J.M., TERRILL, T.H., MILLER, J.E., GETZ, W.R., MOBINI, S., VALENCIA, E., WILLIAMS, M., WILLIAMSON, L.H., LARSEN, M. AND VATTA, A.F., 2004. Validation of the FAMACHA eye colour chart for detecting clinical anemia on sheep and goat farms in the southern United State. *Veterinary parasitology*, 123:105-120.

KUMAR, N., KRISHAN, T., ROA, S., VARGHESE, A. AND RATHOR, V.S., 2013. Internal parasite management in grazing livestock. *Journal of Parasitology Diseases*, 37:151-157.

MARUME, U., HUGO, A., CHIMONYO, M, MUCHENJE, V. AND DZAMA, K., 2012. Effect of dietary supplementation with *Acacia karroo* leaves of fatty acid profiles and consumer

sensory attributes of Xhosa lop-eared goats under artificial haemonchosis. *Animal Production Science,* 52:1099-1106.

MAX, R.A., BUTTERY, P.J., WAKELIN, D., KIMAMBO, A.E., KASSUKU, A.A. AND MTENGA, L.A., 2003. The potential of controlling gastrointestinal parasitic infections in tropical small ruminants using plants high in tannins or extracts from them. Pp. 115-125. In: proceedings of 3rd DFID LPP link project (R7798) workshop for small ruminant keepers. Izaak Walton Inn, Embu, Kenya, 4-7 February 2003.

MAY, K., BRÜGEMANN, K., YIN, T., SCHEPER, C. AND STRUBE, C., 2017. Genetic line comparisons and genetic parameters for endoparasite infections and test-day milk production traits. *Journal of Dairy Science,* 100:7330-7344.

MIN, B.R., HART, S.P., MILLER, D., TOMITA, G.M., LOETZ, E. AND SAHLU, T., 2005. The effect of grazing forage containing condensed tannins on gastro-intestinal nematodes parasite infection and milk composition in Angora does. *Veterinary Parasitology*, 151:105-113.

MPOFU, T.J., NEPHAWE, K.A. AND MTILENI, B., 2020. Prevalence of gastrointestinal parasites in communal goats from different agro-ecological zones of South Africa. *Veterinary World,* 13:26-32.

NADARAJAH, K., SCHOENIAN, S. AND KUHLERS, D.L., 2015. Gastro-intestinal Parasite (GIP) Infestation and its Associated Effects on Growth Performance of Bucks on a Pasture-based Test in Marylanda. *Sheep and Goat Research Journal*, 30:24-29.

ONZIMA, R.B., MUKIIBI, R., AMPAIRE, A., BENDA, K.K. AND KANIS, E., 2017. Between-breed variations in resistance/resilience to gastrointestinal nematodes among indigenous goat breeds in Uganda. *Tropical Animal Health and Production*, 49:1763-1769. Doi: 10.1007/s11250-017-1390-9.

QOKWENI, L., MARUFU, M.C. AND CHIMONYO, M., 2020. Attitudes and practices of resource-limited farmers on the control of gastrointestinal nematodes in goats foraging in grasslands and forestlands. *Tropical Animal Health and Production,* 52:3265-3273.

ROEBER, F., JEX, A. R. AND GASSER, R. B., 2013. Impact of gastrointestinal parasitic nematodes of sheep, and the role of advanced molecular tools for exploring epidemiology and drug resistance-an Australian perspective. *Parasites and Vectors*, 6:1-153.

ROGOSIC, J., PFISTER, J.A., PROVENZA, F.D. AND GRBESA, D., 2006. Sheep and goat preference for and nutritional value of Mediterranean maquis shrubs. *Small Ruminant Research,* 64:169-179.

ROTIMI, E.A, EGAHI, J.O. AND ADEOYE, A.A., 2017. Body characteristics of West African dwarf (WAD) goats in Bassa local government area of Kogi state. *World scientific news*, 69:179-189.

SAFARI, J., MUSHI, D.E., KIFARO, G.C., MTENGA, L.A. AND EIK, O.L., 2010. Seasonal variation in chemical composition of native forages, grazing behaviour and some blood metabolites of Small East African goats in a semi-arid area of Tanzania. *Animal Feed Science and Technology,* 164:62-70.

SAS, 2016. Statistical Analysis System User's Guide, Version 9.4. SAS Institute Incorporate Cary, North Carolina, USA.

SEYOUM, Z., GETNET, K., CHANIE, M., DERSO, S. AND FENTAHUN, S., 2018. Morbidity Parameters Associated with Gastrointestinal Tract Nematodes in Sheep in Dabat District, Northwest Ethiopia. *Bio Med Research International*, Article ID 9247439, https://doi.org/10.1155/2018/9247439.

STEVENS, V. AND HOUSTON, D.B., 1989. Reliability of age determination of mountain goats. *Wildlife Society Bulletin*, 17:72-74.

TAYLOR, M.A., COOP, R.L. AND WALL, R.L., 2007. *Veterinary Parasitology.* 3rd Ed., Blackwell Publishing Ltd., Ames, pp. 159-161.

VAN WYK, J.A. AND BATH, G.F., 2002. The FAMACHA system for managing haemonchosis in sheep and goats by clinically identifying individual animals for treatment. *Veterinary Research*, 33:509-529.

WODAJO, H.D., GEMEDA, B.A., KINATI, W., MULEM, A.A., VAN EERDEWIJK, A. AND WIELAND, B., 2020. Contribution of small ruminants to food security for Ethiopian smallholder farmers. *Small Ruminant Research*, 184:106064.

XHOMFULANA, V., MAPIYE, C., CHIMONYO, M. AND MARUFU, M.C., 2009. Supplements containing *Acacia Karroo* foliage reduce nematode burdens in Nguni and crossbred cattle. *Animal Production Science*, 45:646-653.

YUAN, W., LU, K., LI, H., LIU, J., HE, C., FENG, J., ZHANG, X., MAO, Y., HONG, Y., ZHOU, Y., LU, J., JIN, Y. AND LIN, J., 2019. Seasonal dynamics of gastrointestinal nematode infections of goats and emergence of ivermectin resistance in *Haemonchus contortus* in Hubei Province, China. *Acta Parasitologica*, 64:638-644.

ZVINOROVA, P.I., HALIMANI, T.E., MUCHADEYI, F.C., MATIKA, O., RIGGIO, V. AND DZAMA, K., 2016. Prevalence and risk factors of gastrointestinal parasitic infections in goats in low-input low-output farming systems in Zimbabwe. *Small Ruminant Research*, 143:75-83.

ZVINOROVA, P.I., HALIMANI, T.E., MUCHADEYI, F.C., MATIKA, O., RIGGIO, V. AND DZAMA, K., 2016. Breeding for resistance to gastrointestinal nematodes-the potential in low-input/output small ruminant production systems. *Veterinary Parasitology*, 225:19-28.

IMPACT ASSESSMENT OF COMMUNITY AND HOUSEHOLD FOOD GARDENS AND THE INFLUENCE ON LIVELIHOODS AND FOOD SECURITY: A CASE STUDY IN THE OVERBERG DISTRICT SUURBRAAK VILLAGE IN THE WESTERN CAPE, SOUTH AFRICA

Darries, G.S.[1]

ABSTRACT

This study investigated the impact of household and community food gardens and their impact on the household's livelihoods and food security in the Suurbraak community/village in the Overberg District/ Municipality. The study was conducted in the rural village of Suurbraak, in the Overberg Municipality, to comprehend the impact of the various household and community food gardens on household food security. Simple random sampling was utilised to acquire a study population of 30 responds/households, where interviews was dispensed. It was executed through personal interviews with the respondents in the Suurbraak community. Structured questionnaire was utilised and primary data was acquired and the data was investigated quantitatively and qualitatively with the Statistical Package for Social Science (SPSS) software. The findings from the data that was obtained is evident that the various food gardens don't impact Food security notably in the Suurbraak community, but their livelihoods has been positively impacted through the various One Home one Garden initiative launched by the Western Cape Department of Agriculture. Hence, the study acknowledges the research hypothesis stating that "Food garden initiatives in rural communities can contribute towards Food Security and can improve the livelihoods of communities and households. Household can get access to safe, nutritious food and can generate income from surplus produce. Thus, it's significant to conclude that in the Suurbraak Village, Overberg Municipality, the various social economic factors play a crucial role in the participation of household and community food gardens also in enhancing the livelihoods and food security status.

Keywords: Household food gardens (HFGs), Community Food Gardens (CFGs), Livelihoods, Food Security (FS)]

1. INTRODUCTION

The study was conducted to assess the impact of household and community gardens and the impact on livelihoods and food security in the Suurbraak community, Overberg Municipality in the Western Cape Province. The research was embarked on to the assess the role of household an community gardens in the community due to most rural communities are relying directly and indirectly upon agriculture or agriculture related activities for their daily food and income (Frayne & Pendleton 2009). The Millennium Development Goals (MDGs) was compiled by various leaders to eradicate and fight poverty in all the facets it occurs (United Nations, 2015). The various objectives for the past 15 years remained the structure for poverty

[1] Agricultural Advisor Agricultural Producer Support and Development (APSD), Department of Agriculture Western Cape Government, Address: Goulburn Centre, c/o Voortrekker Road and Goulburn Street, Goodwood. Email: gavilind@elsenburg.com

eradication. The sustainable Development Goals (SDGs), was designed to substitute the Millennium Development Goals (MDGs). To move forward in a sustainable manner towards 2030, it recognised and assessed indicators to summit unfavourable gaps and issues. According to the United Nations (2016) the SDGs were established to create harmony between the various pillars of sustainable development that include social and economic elements. According to the FAO et al (2019), globally around 821 million people are undernourished and are experiencing chronic food deprivation. This number is exacerbate by the current COVID-19 pandemic is human and health calamity compromising the food security and nutrition of millions of people globally (FAO, 2020). According to the FAO (2020), hundreds of millions of individuals globally were already enduring malnutrition and hunger before the pandemic emerged, therefore urgent intervention is required before a global food emergency could be experienced.

According to D'Haese et al. (2016) food security is a multidimensional occurrence and makes it very complex to define and comprehend Food Security. Food Security is when individuals (people) have access at all time to sufficient, clean and healthy nutrition food in order to live a healthy and active lifestyle (FAO et al., 2015). As said by Heather (2012) that community food gardens are customary sources of nutrition and food and are considered as crucial suppliers to livelihoods and food security of the various household and farming communities where most of their produce (vegetables and fruits) are mainly for consumption (Galhena, 2013). Community Food gardens (CFG) has fascinated various meaning and aims to various organizations and communities. Households partake in food gardens in attempt to admire the availability of land in order to develop adequate, safe and nutritious food (NDA, 2012). Rural households usually articulate reasons for partaking in food gardens that includes: well-being/health benefits, access to fresh food and the enjoyment of nature (Armstrong, 2016).

Nonetheless Koyenikan et al (2007) observed that individuals/households encounter in own production, enhancing the household's nutrition and health status social cohesion and also to generate income. Household food gardens (HFG) are commonly known as a paramount technique of additional food production system that are considered as a source of food for households (Frayne et al., 2009). According to Joseph (2012) South Africa is unique form the other countries SA try to maintain the ability to meet food requirements on a national level, comprehensive inequality and poverty signifying that seniority of the population in the country doesn't enjoy sufficient access to food.

In 2016 the Community Survey found that the Western Cape Province had the lowest percentage of household that didn't have sufficient money to purchase food in that 12 months at 13.2% in contrary to the national average of 19.9%. The 2015 General Household Survey postulates additional degree to this depiction: it discovered that 17.4% household in the Western Cape had inadequate access to food whilst 6.6% is severely inadequate access to food (WC GOV, 2015). Through the Western Cape Government: Agricultural Producer Support and Development Programme households are supported with the One Home One Garden initiative launched in 2020 by Minister Dr Ivan Meyer. The Programme provides support to various community and school programmes in the province to eradicate poverty and food insecurity.

2. METHODOLOGY

2.1. Description of the Study Area

Some of the major economic sectors within the area include social and community services, agriculture, forestry, hunting, wholesale and retail as well as personal services (StatSA, 2003) This area is predominantly rural with a population of approximately 241 414 people, 58 483 households and covers 3,454.78 km², which represents 20.4% of the district's total land area (StatSA, 2012). The study area Suurbraak is situated 24 km from Swellendam and 240 km from Cape Town. Suurbraak is situated in the Overberg District Municipality in the Western Cape Province. The population density of Suurbraak is 2252 people that speak predominantly Afrikaans. The Overberg District with the West Coast region, poverty rates were the second highest in the province in the year 2010. Thus, these elevated levels of poverty increase the dependents from governmental resources like basic services.

In the Overberg District the Western Cape Government Department of Agriculture and various other organisations, launched numerous projects in the district with the main aim to improve food security and the livelihoods of the communities and the households. In the year 2014, Suurbrak was the community identified by the Department of Agriculture where the aim for the year was Family Farming: Feeding the world, caring for the earth. On World Food day, in the community of Suurbraak 108 household and 7 community projects were established. The three areas that were targeted are Suurbraak, Buffelsjag and Rietvlei. However, Rietvleis projects wasn't established due to a lack of land and water resources. The main economic activities in the area are agriculture (Grain and Barley). The unemployment rate is high with associated social problems. Safety nets are the aid that various institutes use in reducing food insecurity in the various rural communities.

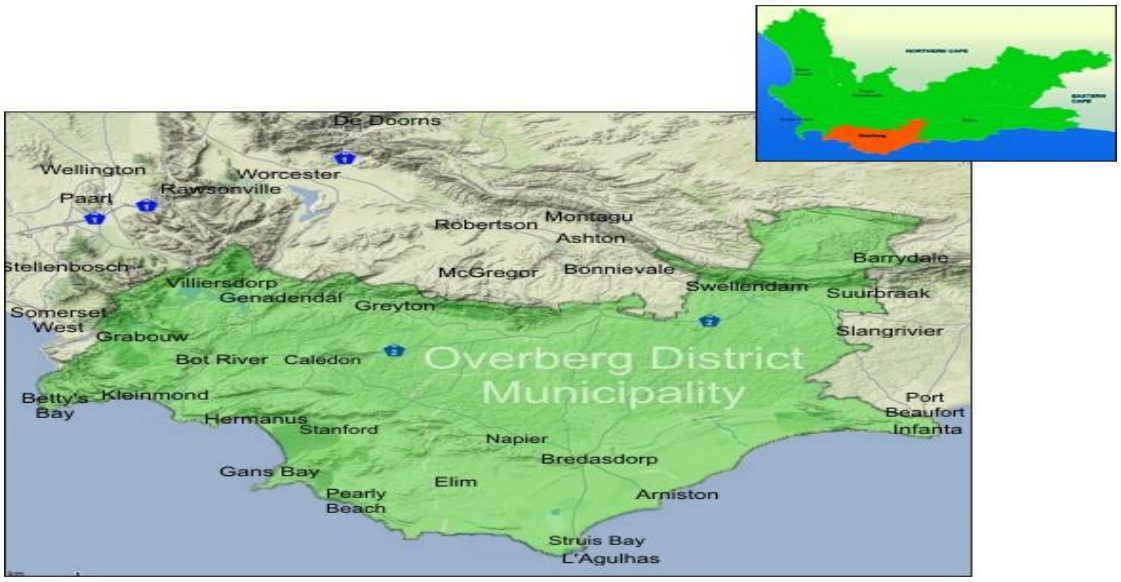


Figure 4: Map of the Overberg District Municipality (Suurbraak Community) (Source Western Cape Government, 2015)

2.2. Conceptual Framework

The various environmental aspects impact food systems in South Africa, aspects include: the depletion in soil fertility or productive assets of households and is frequently rural villages and climatic variabilities (Malan, 2015). The access to markets can be influenced by economical sound decisions in the countenance of opportunities and risks. It also comprises out if features of availability the access to food as well as the utilization thereof. It ties the various aspects with income and welfare of the individuals' that are productive, productivity as well as the various resources. Consequently, it supports direct production of access to food via additional resources and markets therefore the entitlements of people are redefined.

According to the Human Science Research Council HRSC (2004: 31) deprived households rely on government social grants as well as income salaries for survival. Environmental circumstances like climate change and political features like politics placed tremendous pressure on South Africa's food systems (Smith, 2014). The most current causes for poverty and food insecurity in the country contains the demands for wealth severe goods, elevated levels of unemployment, low request of unskilled workers that result in numerous individuals unemployed. Countrywide endeavors concerning food security resolves round the Millennium Development Goals (UN, 2015). The conceptual framework adopted for this study construct the relation amongst home and community gardeners and enhancement of the household situations. Household is affected by the various external and internal factors, the latter includes the various demographic like gender, age, education, farming experience, levels or income whilst the external includes agricultural advisory services, transactional cost and tenure security.

2.3. Ethical Consideration

According to Newman (2003:140), afore a person can be a subject she or he will be informed of the goals, methods, projected aids and impending endangers of the research. All the participants were thoroughly informed regarding the purpose of the study, also their rights to partake and that their participation is voluntary and the information they provide will remain confidential. The Researcher certified that the well-being and rights of the project beneficiaries that he worked with were safeguarded. The researcher adhered to the POPI Act of the Department by protecting the interest and identity of the project beneficiaries involved.

The researcher pledge confidentiality and anonymity of all the information provided by individuals to conduct the study. The researcher also guarantees transparency and honesty in relation to the research. The researcher ensures to conduct research in accordance with the ethical and professional regulations as quantified in the disciplinary of the University of the Free State.

3. RESULTS AND DISCUSSION

3.1. Gender involvement in Agricultural projects

Historically women in rural environments played a fundamental role in agriculture in order to enhance their living standard, through the production of agricultural produce (Kehler, 2001). According to Manuh (1998) thus this is more distinct in emerging countries like South Africa,

Nigeria and Ghana where more than 50% of females represent agricultural producers in the labour sector. According to a study that was conducted by Mushunje (2005) postulate that household head (sex) had an impeding impact on the capacity of the household to access income, assets like capital and land that directly develop the productivity of agriculture and livelihoods. The evaluation on gender on the various households was conducted from a sample of 30 household respondents for the purpose of this study the results are shown in the Figure 2 below.

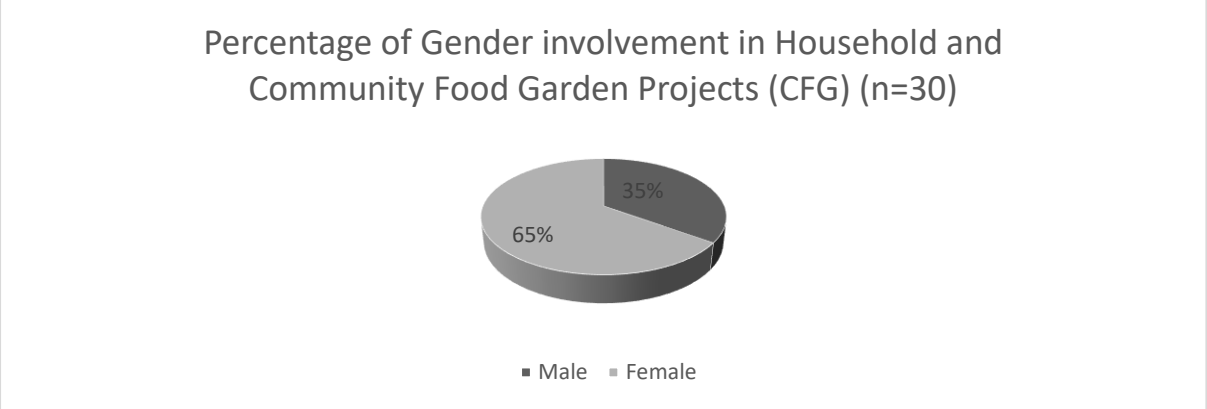


Figure 2: Percentage of Gender Involvement in HFG and CFG

The above Figure 2 results indicate that 65% of the households partake in household and community gardens whereas 35% are male that engage in food gardens. The universal results in this study reveal that females are dominantly engaging in food gardens for their daily livelihoods and food security. The logical finding could be that males travel to capitals to seek better job opportunities and improved salary wages. According to King and Ortmann (2006) they observed that male participants engaged lesser in agricultural activities because of their engagement in non-agricultural interest it can include the following activities like car maintenances, mining, brick production and manufacturing industries.

3.2. Age of the households that partake in Household and Community Gardens

According to Adhikari (2010) age is a fundamental feature that can ultimately regulate the participation of individuals in household activities, like household food gardening it can potentially imitate alterations in labour distribution over the span of life. Age might also entail the experience that the individuals have in order to manage the resources and ultimately the gathering of capital in the household (Kabubo-Mariari 2012). According to Maxwell et al. (2001) the age of an individual consequently can be regarded as one of numerous factors that can impact the decisions of a household or community to part-take in agricultural activities like household and community food gardens (CFG).

Table 1 demonstrate the distribution of the age groups of households' members that engage in household and community garden projects. Different age groups range from 16-20years and 21-25years and 31-35years that are regarded as youth in the country the three age categories combined is 35% among the participants that is the highest number of participants. The age group 36-40 has 10% individuals and the (41-50 years group) has 25% the age group (51-60

years) has 20% among the participants that are involved in food gardening. The age group (61-70 years and older) has the lowest percentage of participation rate.

Table 1: Age of Respondents of Suurbraak that Engage in Household and Community Food gardens (n=30)

Age Group/ Range	Number of Respondents	Percentage
16-20 years	1	5%
21-25 years	3	10%
31-35 years	6	20%
36-40 years	3	10%
41-50 years	8	25%
51-60 years	6	20%
61-70 years and older	3	10%
Total	30	100%

The high percentage of participation rate between the youth can be described that they are still committed to engage in the various activities like food garden projects also the impact it has on their livelihoods, whilst the low rate among the old group of age might be ascribed that they are not active as the youth and majority obtain social grants. According to Galrneau et al (2003) specified that youth/ younger individuals incline to be more eager to part-take and adapt than their counterparts and it's in line with this study's findings however, Banski (2003) findings are in contradiction with this study where he emphasised that youth across Africa migrate from rural to urban cities to seek ameliorate opportunities because most rural areas have less economic activities (Adhikari, 2005). Elder people are mostly incapable to perform keenly in the agricultural sector.

3.3. Educational Level of household respondents

According to the World Bank (2010) it has indicated that the level of educations (number of school years) per household attended, frequently impacts the overall economic activity preferences of such a household. Educational achievements of the household might result to potential responsiveness benefits of agricultural subsistence practices and official employment (Najafi, 2003). Najafi (2003) intensifies that the level of education impacts the literateness degree of households, which further influence their likelihood of being formal employed in addition, empowering them to make knowledgeable decisions that will influence their livelihoods progressively. Figure 3 demonstrate the educational levels of the Household in the Suurbraak Village.

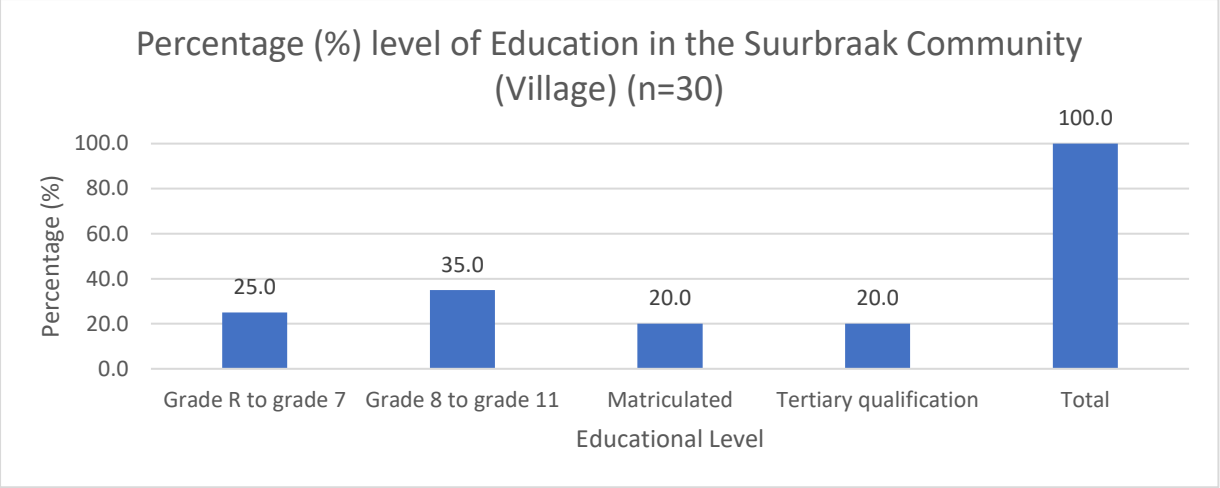


Figure 3: Percentage level of Education in the Suurbraak Community (n=30)

Figure 3 above display findings of the analysis on the level of education of the various households in the Suurbraak Village that participated in Household and Community Food gardens. There are ordinarily high levels of illiteracy in the community of Suurbraak. The results uncover that a total of 25% obtained a primary education (training) whilst 35% have received secondary training where 20% graduated from high school and a total of 20% have received tertiary education. A combined of 80% received primary and secondary training in education while a low 20% of the respondents received or are in the position of a tertiary qualification. The lack of motivation, a lack of amenities like schools and high levels of poverty validates the low literacy level findings in this study. Banmeke & Omoregbee (2009) documented those low levels of literacy are commonly amid rural residents and this is in line with this study findings.

These findings further observed that households that received tertiary education might also part-take in household or community food gardens as part community interacting whereas the argument of the World Bank (2008) are contradicting that states households that have acquired more years of training in school (education) would likely seek non-farm employment due to the monetary incentives.

3.4. Involvement of Participants in Food Security Projects (agricultural activities)

From the below Figure 4 it is noted that 90% of the participants said YES that they are involved in household food gardens and 10% answered NO. According to numerous Literature household gardens is defined as a piece of land that is being cultivated within the backyard or on the premises of the household and community food gardens are being cultivated in communal land persevered by the community (London-lane, 2004). Regardless of the fact that community food gardens (CFG) is considered as a livelihood source for numerous rural people, house hold food gardens is also a means through which participants livelihoods can be enhanced (Nell at al, 2000).

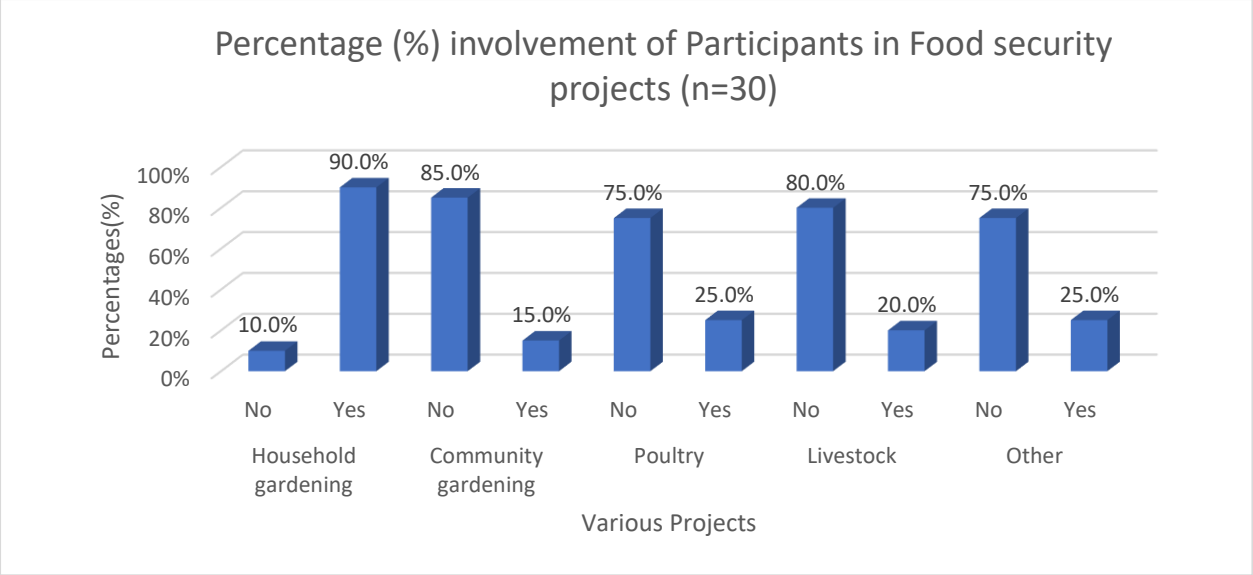


Figure 4: Percentage Involvement of Participants in Food Security projects (n=30)

Above Figure 4 demonstrate the findings of 90% of the participants are involved in household food gardens and 15% indicated that they were involved in community food garden projects. It might be due to different challenges they face like the distance for the community gardens to home and vice versa a lack of responsibility or internal groups' dynamics like conflict experience by community food garden participants. The findings also indicate that 25% of the participants that are involved in household and community gardens are farming with livestock (cattle and sheep). The ownership of livestock was utilised in the study as a determinant for household and community food garden involvement. Livestock is commonly used in rural areas as a source of food and income for several household livelihoods. According to Nqeni (2011) livestock such and sheep and cattle could be sold to provide households with cash in order to purchase agricultural inputs for the food gardens.

Therefore, this might impact the decisions of households to participate in food gardens. The production of livestock might aid as an alternate food security source as a substitution for livelihood however the results indicate that livestock have minority impact on the decision of households to contribute to food gardens.

3.5. Reasons for partaking in Food gardens

Household and community food gardens are a paramount venture in societies it has been seen as a crucial factor of creation of wealth midst the rural poor (Sotshongaye 2000). The production value of food gardens may considerably enhance the household food security level consequently rural communities' livelihoods. Household and community gardens have concerned various meanings respective like a food source, development of household food security status and nutrition, social cohesion and creation of income (Koyenikan et al 2007). The participants were asked to indicate by the six factors listed in the below Table 2 the various reasons they participate in food gardens delineated by (Koyenikan et al 2007).

According to the survey results in Table 2 (40%) respondents which is the majority indicated that they participate in food gardens for a daily source of dietary food. This could be as a result of the elevated levels of unemployment and the low incomes that the rural households experience. Only 5% indicated that they use the food gardens for a source of income. The second highest percentage of 25% respondents indicated that they partake in community and household gardens for social cohesion and involvement in the Suurbraak community. The findings coincide with a study conducted by Wakefield et al (2007) who observed that the involvement in household and community gardens result to an increase in access to food, enhance nutrition, boosted physical activity and better-quality of mental health.

Table 2: Reason for participation in Household and Community Food Gardens

Reason for participation in Household and Community Food Gardens	**Percentage Respondents (%)**
Source of Dietary food	40,0
Improve well-being and nutrition	15,0
Generation of income (money)	5,0
Social cohesion/Community involvement	25,0
Relaxation	5,0
Cost saving	10,0
Total	100,0

3.6. The impact of the Household and Community Food Gardens on the respondents Livelihoods after implementation

Various rural communities have been developing their community food gardens through hawking the surplus of their vegetable production to acquire household income. According to the Word Bank (2007) community gardens endorsed food security as per adult and youth contribution in the field of agriculture, household and community food gardens assist the defenceless to alleviate poverty in rural communities. Middleton (2009) indicated that household and community gardens is a means to cultivate food crops, herbs and various flowers with the assistance of neighbours and friends. It might also a setting to recouple with nature or to increase their physical workout. Community food gardens has promoted the various communities to foster social networks within the involvement of activities in the gardens. The participation if family and kinship in food gardening promotes interpersonal relations and social character of the individual members (Moyo and Tevera 2000). Furthermore, food gardens have also endorsed within family's intermarriages amidst families thus developing kinship and networks (Moyo and Tevera 2000).

Table 3: Household Consumption of Vegetables by respondents

Household Consumption of Vegetables by respondents	Frequency	Percentage (%)	Valid Percentage (%)
Several times a day	10	33,3	33,3
Once only in the day	6	20,0	20,0

Only a few times in the week	14	46,7	46,7
Total	30	100,0	100,0

Food gardens play a big role in the survival of many poor rural communities to distribute the various resources in turn to meet their basic needs daily and shared responsibilities. In the Suurbraak Village there is numerous community gardens like the Vegetable garden at the Crèche for daily consumption of vegetables for the learners. Participants were asked how many times per week did they consume vegetables form their food gardens after implementation According to Table 3 (33.3%) indicated that they consumed several times in the day and 20% only once in the day. The majority according to Table 3 indicated that 46.7% consumed vegetables from their gardens only a few times in the week. There are numerous reasons like season produce of vegetables, a lack of seeds, equipment or water that hinders the growth of the various vegetable gardens.

Table 4: The percentage impact of the Food gardens launched in Suurbraak Village

The percentage impact of the Food gardens launched in Suurbraak Village	**Number of times code applied**	**% of total participants (n=30)**	**% of participants who answered the question (n=28)**
Garden is used to supply fresh food to school children	1	3,3%	3,5%
Garden supplies household with fresh food	9	30,0%	28,57%
Save money on not buying vegetables	3	10,0%	10,71%
Part-time jobs/ projects	6	20,0%	21,42%
Full-time employment	8	26,6%	28,57%
Project too young to tell	2	6,6%	7,14%
Pension money	1	3,3%	3,57%

Numerous households revealed there is alteration in their daily life quality after the inauguration of the food garden projects in the Suurbraak Village. From their produce they gained access to various herbs and spices for their daily meals. Some of the respondents also have gained various skills through training and workshops which assisted the good management and methods to enhance their food gardens. Participants also specified that their team spirit has increased, a few financial transactions was successful and a decrease in crime since more time is spend on gardening activities. According to Middleton (2009) community and household gardens has developed to an assembly point for the configuration of clubs and it aids to decrease stress. In addition, community gardener participants enhanced social connections and interactions by sharing equipment and produce that enhance harmony in the communities like Suurbraak Village (Middleton, 2009).

Table 5: The impact of the Food gardens on the economic, well-being and social standards after implementation

The impact of the Food gardens on the economic, well-being and social standards after implementation	**Number of times code applied**	**% of total participants (n=30)**	**% of participants who answered the question (n=28)**
Economic benefits	8	26,7%	28,6%
Provide household with extra income	5	16,7%	17,9%
Sell surplus vegetables	4	13,3%	14,3%
Saved money by not buying vegetables	1	3,3%	3,6%
Improved health/ well-being	14	46,7%	50,0%
Physical benefits (No economic benefits)	5	16,7%	17,9%

Participants were asked whether there was an increase in either economic, wellbeing or physical benefits after the food garden projects were launched in the Suurbraak village. According to the survey below in Table 5 (n=28) 28.6% of the participants indicated that they received economic benefits by selling their household or community garden vegetables in the community or the nearby markets in order to generate income for their household livelihoods. According to Table 5 (17.9%) also indicated that they utilised the money they obtain from selling their surplus to provide the household with other food supplies and to pay the water bills etc. The other 14.3% of the participants indicated that they utilised their produce and the surplus they sold to make extra money. Table 4.7 indicate also that 50% of the participants indicated that their well-being has improved due to reason like frequent working their gardens and being actively involved in community projects. Table 5 also indicates that 17.9% of the participants indicated that they received physical benefits like being active and energetic by being involved in the various gardening activities.

Table 6: Percentage (%) of Vegetable consumption after project implementation

Percentage (%) of Vegetable consumption after project implementation	**Number of times code applied**	**% of total participants (n=30)**	**% of participants who answered the question (n=28)**
Vegetable consumption increased (intake)	14	46,7%	50,0%
Dependent on seasons and supplies	5	16,7%	17,9%

School children served vegetables with each meal	1	3,3%	3,6%
Did not have to buy vegetables	1	3,3%	3,6%
Garden supplies fresh vegetables	7	23,3%	25,0%
Consumption remained the same	2	6,7%	7,1%
Food garden is not yet sustainable	2	6,7%	7,1%
Consumption differs depending on climate each year	1	3,3%	3,6%
Consumption did not increase/ it decreased	5	16.7	17.9
Drought	1	3,3%	3,6%

The participants of Suurbaak were asked whether their vegetable consumption increased, decreased or deteriorated. Table 6 indicates that 50% indicated that their vegetable consumption increase it depends on the seasons and also the supply of fresh vegetables daily. The community gardens and crèche garden supplies the school learners with fresh vegetables daily so that their dietary needs can be met in order to live an active lifestyle and to boost their energy levels for concentration in class. According to Table 6 (7.1%) indicated that their consumption remained the same. Table 4.8 indicates that 17.9% consumption of vegetables decreased it could be due to reasons like a lack of water, climate and lack of funds in order to make the gardens sustainable. The lack of governmental support could also be some of the reasons where the accessibility of the Extension officers is limited. Table 6 also signifies that 3.6% indicated that their food gardens are being influenced by the drought that has impacted the Western Cape Province also 3.6% indicated that the climate also had a role in the sustainability of their food gardens.

4. CONCLUSION

Largely the outcomes indicated of the socio-economic features tested has an impact on the household's participation in food garden projects. The following features in the study proposed like gender, status of marriage, household income tested has an impact on the involvement of household in food garden projects. This is due to the participation of females that was indicated has a high probability of household food security. The findings also specify that households have social as well as other reasons like economic following their reasons involved in food security projects. The findings largely suggest that household's involvement in household and community food gardens as a main source of food and social cohesion. Food security in the Suuurbraak community in the Overberg District concurring the findings of the study indicated that household and community food gardens play a fundamental role in the development of rural household. Nonetheless, enhancing income of households by utilising food gardens that will result to great enlargement in their production of agriculture and reduction in household food insecurity.

Approaches that improve household revenue and applying of household and community gardens requires more responsiveness when it befalls in the reduction of household food insecurity. By means of household and community gardening the predicament of food insecurity could be addressed due to the fact that households partake in household food gardens

in order to add-on to their food bag. However, this can only occur when food gardens could be utilised as a strategy to assist with the food insecurity issues amidst rural residents. Readily available are benefits that is accomplished from engagement in activities on food, recreation and income generation. There are various limitations that exclude rural ass well urban households form partaking in food gardening like a lack of land, education and access to water etc. Household food gardens can be enhanced through the advancing of education levels of the various heads in households, including access to land particular in rural communities where access to land is limited. However, it requires joint powers of government, non-governmental organisations, municipalities, private enterprises (sectors) and households.

5. REFERENCES

AMSTRONG, D., 2016. A Survey of Community Gardens in Upstate New York: Implications for Health Promotion and Community Development. City Farmer, Canada's Office of Urban Agriculture

ADHIKARI, B. 2005, "Poverty, Property Rights and Natural Resource: Understanding Distributional Implications of Common Property Resource Management," Environment and Development Economics, 10, 7-31.

BANMEKE TOA, OMOREGBEE FE 2009. Rubber farmers' perceived factors militating against rubber production in Edo and Delta States of Nigeria. International Journal of Agricultural Economics and Rural Development, 2(2): 33- 39.

BANSKI, J. 2003. Transforming the functional structure of Poland's rural areas, Alternatives for European Rural Areas: Warszawa (PWE)

D'HAESE M, VINK N, NKUNZIMANA T, VAN DAMME E, VAN ROOYEN J, REMANT, STAELENS & D'HAESE (2016). Improving food security in the rural areas of KwaZulu-Natal province, South Africa: Too little, too slow. Development Southern Africa 30(4): 468-490.

FAO, IFAD AND WFP. (2015). The State of Food Insecurity in the World: Meeting the 2015 international hunger targets: taking stock of uneven progress. FAO, IFAD and WFP. https://doi.org/I4646E/1/05.15

FOOD AND AGRICULTURE ORGANIZATION (FAO), 2014. The state of food insecurity in the world 2014: Strengthening the enabling environment for food security and nutrition, Rome: FAO

FOOD AND AGRICULTURE ORGANIZATION (FAO), 2020. Policy Brief: The Impact of COVID-19 on Food Security and Nutrition, Rome: FAO Online Available at: https://www.un.org/sites/un2.un.org/files/sg_policy_brief_on_covid_impact_on_food_security.pdf [Accessed 22 July 2021].

FRAYNE, B. & PENDLETON, W. (2009). Urban Food Security in Southern Africa. Paper presented at the African Food Security Urban Network (AFSUN) Regional Policy Conference, 10–12 June. Ekurhuleni Municipality

FRAYNE, B., BATTERSBY-LENNARD, J., FINCHAM, R. AND HAYSOM, G., 2009 Urban Food Security in South Africa: Case Study of Cape Town, Msunduzi and Johannesburg. Development Planning Division Working Paper Series No.15, DBSA: Midrand.

GALHENA DH, FREED R & MAREDIA KM (2013). Home gardens: a promising approach to enhance household food security and wellbeing. College of Agriculture and Natural Resources (CANR), Michigan State University, East Lansing, USA.

JOSEPH H (ed). 2012. Community Food Security: A Guide to Concept, Design, and Implementation. Venice, CA: Community Food Security Coalition.

KABUBO-MARIARA, J. 2012. Forest dependence and household welfare: empirical evidence from Kenya.

KEHLER, JOHANNA (2001). Women and Poverty: The South African Experience. Journal of International Women's Studies, 3(1), 41-53.

KOYENIKAN, M. J. 2007. Perception of Home Garden Potential among Women in Edo South Ecological Zone, Nigeria. Retrieved, from http://www.sabinet.co.za/abstracts/genbeh/genbehv_n_a3.htm [Online] Available at: (Accessed 25 July 2021).

LONDON- LANE C. 2004. Livelihoods grow in gardens: Diversifying rural incomes through home gardens. Agricultural support systems division. Food and Agriculture organisation of the United Nations. Rome

MALAN, N. (2015). Urban farmers and urban agriculture in Johannesburg: Responding to the food resilience strategy, Agrekon, 54:2, 51-75

MANUH, T. 1998. Women in Africa's development: Overcoming obstacles pushing for progress. Nigeria. United Nations department of public information. Available From: www.un.org/geninfo/afree/b.paper/maineng.htm (Accessed 20 July 2021).

MAXWELL, D. 2012. Food security and its implications for political instability: a humanitarian perspective. http://www.fao.org/fileadmin/templates/cfs_high_level_forum/documents/FSImplications-Political_Stability-Maxwell.pdf Date of access 22 July 2021

MIDDLETON M. 2010. Reflections on spatial planning. Unpublished Internal working paper to RUF project, December 2010. Birmingham City University, Birmingham.

MIDDLETON, M. 2010. Reflections on spatial planning. Unpublished Internal working paper to RUF project, December 2010. Birmingham City University, Birmingham.

MOYO, P., 2013. Climate Change and Urban Food Security in South Africa: An overview. [Online]. Retrieved from: http://afesis.org.za/Sustainable-Settlements-Articles/climate-change-and-urban-food-security-in-southern-africa-an-overview-by-dr-philani-moyo [17 July 2021]

MUSHUNJE, A. 2005. Farm Efficiency and Land Reform in Zimbabwe. PhD Thesis, University of Fort Hare, Department of Agricultural Economics and Extension

NELL W. WESSELS B. MOKOKA J. MACHEDI S. 2000. A creative multidisciplinary approach ` towards the development of food gardening. Development debate and practice. Development Southern Africa. Vol 17, No 5. December 2000

NAJAFI, B., 2003. An overview of current land utilization systems and their contribution to agricultural productivity. Report of the APO Seminar on impact of land utilization systems on agricultural productivity. Productivity Organization, Islamic Republic of Iran Asian.

NQENI N, CHIMONYO M AND MAPIYE C. 2011. Farmers' perceptions of the causes of low reproductive performance in cows kept under low-input communal production systems in South Africa. Tropical Animal Health and Production 43: 315-321.

SMITH M. 2014. Household Food security: concepts and definition. An annotated bibliography. IFAD

SOTSHONGAYE A. MØLLER V. 2000. 'We want to live a better life like other people': Self-assessed development needs for rural women in Ndwedwe, KwaZulu-Natal. Development Southern Africa. Volume 17 no 1: Pp. 4-5

Statistics South Africa (2014). General household survey, Statistics South Africa, Pretoria. Online Available at: www.statssa.gov.za [Accessed 30 June 2021]

UNITED NATIONS. 2015. The Millennium Development Goals Report. Available: http://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf (Accessed 20 July 2021).

WAKEFIELD, S., YEUDALL, F., TARON, C., REYNOLDS, J., & SKINNER, A. 2007. "Growing Urban Health: Community Gardening in Southeast Toronto", Health Promotion International 22(2), 92-101.

WC GOV. (2015). A Situational Analysis of Food Security in the Western Cape: Phase 2, Western Cape Department of Agriculture, Western Cape Provincial Government, Report Prepare by GAB Consulting.

WORLD BANK, 2008. World Development Report 2008: Agriculture for Development, Washington DC: The World Bank

FACTORS INFLUENCING FARMER'S ACCESS TO EXTENSION SERVICES AND ITS IMPLICATION ON AGRICULTURAL PRODUCTION POST THE COVID-19 PANDEMIC IN THE EASTERN CAPE.

Loki, O.[1] and Christian, M.[2]

Corresponding author: Loki, O; Email: olwethuloki@yahoo.com

ABSTRACT

The study investigated factors influencing access to extension services and their implications to the agricultural performance of communal farmers post the Covid-19 pandemic. The study sought to distinguish the access to services farmers engaged in crop and livestock production at varying degrees. The study was conducted in Raymond Mhlaba local municipality, Eastern Cape, specifically in two communities, namely Ngcabasa and Phathikhala villages. Research activities included a formal survey conducted on 100 communal farmers and focus group discussions using the purposive sampling method. Descriptive statistics were used to give an overview of respondents, while t-tests and binary regression model were used to analyse inferential statistics. The main findings were that 70% of farmers had access to extension services in the study areas. The t-test showed that farmers who had access to extension had more farm income in both enterprises (crop and livestock) than their counterparts. Results from the binary regression indicated that farmers who had access to extension services were older, with less education, and those farming with livestock. The t-test showed that farmers who had access to extension services had more yield returns than their counterparts. The study concluded that access to extension services had a positive impact on the overall production activities of communal farmers in the two communities. Improved access to extension services can help farmers produce at an optimum level, particularly during the Covid-19 pandemic and its measures.

Keywords: Binary Logistic Regression, Communal Farmers, Covid-19 Pandemic, Extension Services

1. INTRODUCTION

Traditionally, agricultural extension was taught to rural peasant communities to understand farming activities better and improve farm production. The system was generally top-down (linear) from university classrooms to farmers until it was transferred to the Ministry of Agriculture (MoA). The lecturers were tasked to disseminate information and demonstrate to small farmers how to grow nutritious crops and rear livestock (Swanson, 2008). Today, agricultural extension services embody a professional body of agricultural experts, who teach improved methods of farming (livestock and cropping techniques), demonstrate innovations,

[1] African Greeneurs P.T.Y. (Ltd) Plot 116 Knopjeslaagte 385 JR, Centurion, 0158, Pretoria, South Africa, olwethuloki@yahoo.com, ORCID: 0000-0003-4187-3345

[2] North West University: Department of Agricultural Economics and Extension, P/Bag X 2046, Mmabatho, mzuyanda1990@gmail.com; ORCID: 0000-0003-4446-0298

organise farmer meetings and market (Makara, 2010; Conradie, 2016). In South Africa, agricultural extension services are the most common forms of public sector support for knowledge diffusion and learning, provided free of charge as social welfare. Despite this no-fee service extension, farmers appear to be struggling to access extension services (Nkosi, 2017). Catherine *et al.* (2012) posited that varied factors determine access to extension services by farmers; these can be broadly categorised into personal and household attributes, farm characteristics, socio-economic and institutional factors.

Education, Age and gender constitute the personal and household attributes. Ulimwengu and Sanyal (2011), Yusuf *et al*. (2011) and Kaur *et al*. (2014) sought to establish the relationship between education and access to extension services in most cases relate it to years of formal schooling. Bester (2008) found that education creates a favourable mental attitude for accepting new practices, especially information-intensive and management-intensive practices. Moreover, Tiwari *et al.* (2008) and Gebrehiwo (2017) found that among male heads, those with at least primary education are more likely to get visits from or initiate visits to providers of extension services. Catherine *et al.* (2012) found the effect of Age on extension access is found to be limited. However, Mniki (2001), Bester (2008) and Sikwela (2013) found Age to positively influence the adoption of technologies. Gender is another variable that forms part of the personal and household attributes. Tiwari *et al.* (2008) found that male-headed households with assets in the form of land and livestock are more likely to be visited or initiate visits to extension service providers.

Farm size, local rights area, number of livestock have been considered under farm characteristics. Akeredolu (2008) and Wright (2012) posited that farmer with larger land size and livestock holding are more likely to access agriculture-related information through different channels. The tenure rights, which is a proxy for the farm's location, has not been included in many extension studies. However, Martins *et al.* (2011) and Nkegbe *et al.* (2012) tested the significance of this variable in their adoption of technology studies and found it to exhibit a significant but negative correlation to accessing extension services.

The socio-economic and institutional factors include off-farm income, credit access, contacts with extension, group membership, distance to input store/market, and labour cost. Abdul-Hanan and Abdul-Rahaman (2016) argue that the effect of these variables on extension access is yet to be known. It is evident from the foregoing discussion that few studies have been conducted across the world on extension service access, and this result is scanty literature on the specific factors that influence access to modern agricultural extension services (Abdul-Hanan and Abdul-Rahaman, 2016). This is a serious gap that must be bridged if the problem of low access to extension services among farmers is to be addressed and agricultural productivity improved

Agriculture is among the engines for growth and development for many economies, particularly in sub-Saharan Africa (S.S.A.). Thus, achieving productivity growth in the agricultural sector is significant and a goal shared by the African Union (A.U.) and the United Nations (Hlatshwayo and Worth, 2016). Therefore, increasing agricultural production requires the dissemination of improved agricultural technologies. Inadequate extension services have been identified as one of the main limiting factors to the growth of the agricultural sector and

rural community development at large. With recent threats of the Covid 19 pandemic, more farmers require capital investment in agriculture and human capacity development to at least continue to make their living out of farming. It is on this basis that this study was undertaken; to provide empirical evidence on the factors influencing the accessibility of extension services to farmers and how this affect their overall agricultural production.

2. METHODOLOGY

2.1. Study area and data collection

The study was undertaken in two communities in what at the time was Nkonkobe Local Municipality, which later became the larger part of Raymond Mhlaba Local Municipality. The two communities were Ngcabasa and Phathikhala villages; the compelling reason for their selection was that the majority of households practice agriculture, as in both crop and livestock enterprises (Didiza, 2014). The study employed a quantitative research approach as this was important to provide a clear conclusion of the data collected.

2.2. Research Design, Criteria, Sampling Technique and Data Collection

This study employed a cross-sectional survey, where data collection was carried out at a single point in time in both provinces. The study objective guided the use of eligibility criteria, which comprised both the inclusion and exclusion methods. The two methods were used to formulate a criterion that farmers had to meet to be included in the study. The criteria were as follows; farmers' must/can/have:

a) Received support from varied sources, including the government, private sector and non-governmental organisations (N.G.O.s).
b) Practice farming for either business purposes or consumption and business
c) Access to farming land, either owning or leasing

The eligibility criteria eliminated household and smallholder farmers who were farming for social status from the sample. Following the eligibility criteria, a purposive sampling technique was employed to select farming households, given the absence of any sampling frame from which farmers could have been selected randomly

The size was represented by$N$, the farmers divided into strata (group) were represented by H. According to Ndoro *et al.* (2016), the size of the hth stratum is denoted asN_h:

$$\sum_{h=1}^{H} N_h = N \quad (1)$$

Proportional sampling refers to a design with a total sample size n such that

$$N_h = n\frac{N_h}{N} \quad (2)$$

and

$$\sum_{h=1}^{H} nb = N \quad (3)$$

A standardised questionnaire was developed comprising mainly closed-ended questions but also some open-ended questions. Where necessary, the responses to open-ended questions were coded to allow for their quantification. A total of 100 communal farmers were selected for the study.

2.3. Data analyses

2.3.1. Socio-economic characteristics

Frequency and percentages were used for the descriptive statistic to explain the relationship between farmers and access to extension services.

2.3.2. Binary logistic regression

A binary logistic model was used to identify what characteristics determine a farmer's access to extension services. The binary logistic regression model was chosen since it allows one to predict the impact of independent variables on a dependent variable. Ten independent variables were regressed against the binary variable (Extension Services), defined as follows: Where *yi* = access to extension services (represented by 1, 0). *yi* = 1 if farmer *i* had access to extension; *yi*= 0 if farmer *i* did not have access to extension services. The binary logistic regression model is shown in the equation below, following the approach by Gujarati [1992].

$$\text{Ln}\left\{\frac{(P(Y=1|x))}{1\text{-}P\,(Y=1|x))}\right\} = \alpha+\beta 1X1+\ldots+\beta nXn \qquad (4)$$

Where:

Ln = the natural logarithm function

P = probability of access to extension services

1-P= probability of not having access to extension services

α = constant of the equation

β = coefficient vectors of independent variables

X = Independent variables

2.3.3. T-tests

Comparative statistics in the form of a t-test were employed in this study to seek to understand further the impact extension services have on communal farmers. These tests were done on agricultural income of farmers who had access to extension services versus those who did not. The analysis looked at the differences in income margins in both enterprises (crop and livestock) and whether those differences could have happened by chance or as a result of having access to extension services.

2.4. Explanatory (independent) variables used in the model.

The study made use of Chi-square statistics to test the strength of association between categorical predictor variables as well as simple regression for the association between quantitative predictor variables and qualitative dependent variable. The study sought to build a statistical model to reduce explanatory variables until the most appropriate model that describes the data was predicted by employing this method.

Table 1: Relationships between the dependent and the explanatory variables

Dependent variable	**Measure**	
Extension services	1 = Access, 0 = No access	
Explanatory variable	**Measure**	**Expected outcome**
Age	Categorical – Years	+
Gender	Dummy; 1= male, 0 = female	+
Level of education	Categorical - 0 = no education, 1= primary , 2= secondary , 3= tertiary education	-
Employment status	Dummy- 1= employed, 0 = unemployed	-
Household size	Continuous – total number of household members	-
Agricultural income	Continuous – Rands	+
Livestock production	Dummy - 1 = Practice Livestock farming, 0 = do not practice home Livestock farming	-
Crop production	Dummy- 1 = practice crop production, 0 = do not practice crop production	-
Farming goals	Dummy- 1 HH consumption, 0 = Markets	+
Satisfaction with extension visits	Dummy – Yes = 1; No = 0	-

Source: field survey 2016

3. EMPERIAL RESULTS AND DISCUSSIONS

The section below looks at the sample characteristics and empirical results of the study, paying specific attention to the accessibility of extension services and how it influences the overall production of farmers.

3.1. Demographics information of farmers in the study area

Table 2 below shows the frequency and statistical distribution of demographic characteristics as these were important in explaining the relationship between farmers and access to extension services. The demographical information of the farmers will be discussed below, with the use of Table 2.

Table 2: Demographics of respondents at the two study sites

Explanatory variables	**Ngcabasa**		**Phathikhala**		**Average**
	n = 50	**%**	**n = 50**	**%**	**%**
Gender					

Male	21	42	35	70	56
Female	29	58	15	30	44
Age					
0-20	4	8	5	10	9
21-40	11	22	15	30	26
41-60	18	36	20	40	27
> 60	17	34	10	20	38
Education					
No education	7	14	15	30	22
Primary	13	26	15	30	28
Secondary	24	48	17	34	41
Tertiary	6	12	3	6	9

Source: field survey, 2016

As shown in Table 2, gender distribution stood at 56% for males, and 44% were female. Tiwari *et al.* (2008) found that male-headed households with assets in the form of land and livestock are more likely to be visited or initiate visits to extension service providers. The average age group was between >60 years with is in line with surveys that suggest the average Age of a farmer in Africa is 62 years old and higher than a farmer in the United States and some parts of Asia (StatsSA, 2016). Table 2 shows on average that most farmers (41%) had secondary education. Kaur *et al*. (2014) posited that this is good for basic literacy of N.P.K. and interacting with extension officers. Bester (2008) found that education creates a favourable mental attitude for accepting new practices, especially information-intensive and management-intensive practices.

3.2. Agricultural income

Agricultural income is an important indicator as it gives information on the viability of agricultural products produced by a farmer.

Table 3: Agricultural income

Communities	**Average Cropping income R/Year**	**Average Livestock income R/Year**
Ngcabasa	6 983	3 878
Phathikhala	10 509	2 333

Source: Field Survey 2016

Table 3 shows the average cropping and livestock income per year of farmers in both villages without differentiating those with access to extension services from those who don't. The average income per year presented results from farmers' sales to local households and neighbouring communities, even though 90% of the farmers indicated that their main farming objective was household consumption.

3.3. Land ownership

Table 4: Land ownership

Explanatory variables	**Phathikhala**	**Ngcabasa**
	%	**%**
Communal Own Lease	70 20 10	60 40 -
	mean	**mean**
Average land size Average farming experience	6.30 ha 11 years	4.23 ha 8 years

Source: Field survey 2016

Most farmers (70% in Phathikhala and 60% in Ngcabasa) practised farming on communal land. Moreover, the average land size was 6.30 ha in Phathikhala village and 4.23 ha in Ngcabasa. As shown in Table 4, on average, Phathikhala had farmers with farming compared to their counterparts in Ngcabasa.

3.4. Farming activities

The study employed descriptive statistics to overview the farming activities in the two communities in the Eastern Cape. In rural areas of the Eastern Cape, farmers are into different enterprises depending on their available resources. In this study, farmers were categorised into crop and livestock farmers.

3.4.1. Crop production and redistribution

Table 5 below shows the average of all crops grown by farmers in Ngcabasa and Phathikhala over the year and their distribution.

Table 5: Crop production distribution

Crop production	**Ngcabasa**			**Phathikhala**			**Average for both communities**		
Kg/year	Mean	%	Std. error	Mean	%	Std. error	Mean	%	Std. error
Amount produced	881.8	48	141.8	1690.6	50	566.5	1465.8	98	298.6
Amount consumed	485.3	48	99.6	1292.1	49	724.3	892.8	97	369.6
Amount sold	308.7	49	35.2	570.3	47	76.5	436.8	96	43.4

Amount fed to animals	48.8	49	6.6	86.2	49	15.0	67.5	98	8.3
Amount donated	44.7	50	7.0	93.7	49	20.7	68.7	98	11.0

As demonstrated in Table 5 the annual mean production for both communities was 1465.8 kg, on average, the household consumption was 892.8 kg a year, this indicates that farmers consume most of what they produce and only sell 436.8 kg. There is a variety of challenges facing farmers these include, among many others, market and storage facilities. Failure to access market and storage facilities has led farmers to donate their produce (68.7kg) and feed animals (67.5 kg).

3.4.2. Livestock distribution in the study area

Livestock remains an integral component of farming systems and contributes significantly to the overall agricultural sector in South Africa (Agholor, 2012). Goni *et al*. 2018 posited that Livestock farming in Eastern Cape Province is mainly farming cattle, sheep and goats. The mixed veld types of the province are an advantage for livestock farming, while the province generates the greatest number of livestock farming within the country.

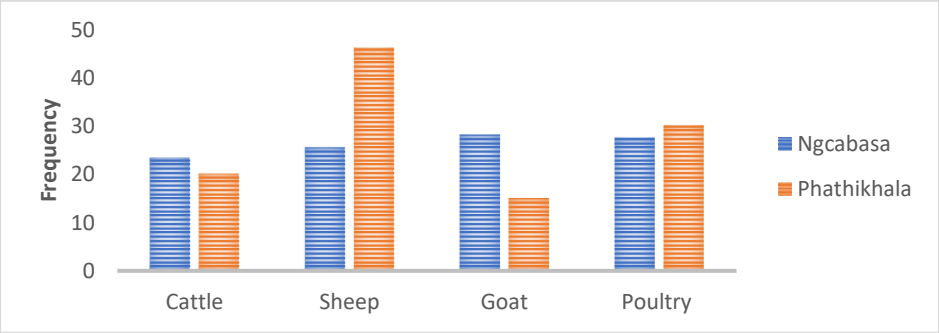


Figure 2. Livestock distribution

Ngcabasa had a higher proportion of farmers farming with cattle and goats, while in Phathikhala, most farmers were farming with sheep and poultry. All this distribution was influenced by the favourable climatic and environmental conditions of the respective areas.

3.5. Access to extension services in the study area

Table 6 presents results on the access to extension services in the two study areas.

Table 6: Farmers access to extension services in the study area

Explanatory variable	**Ngcabasa n = 50**	**%**	**Phathikhala n = 50**	**%**	**Average %**
	Access to Extension visits				
Access	34	68	36	72	70
No access	16	32	14	28	30

Frequency of Extension visits					
Weekly	2	4	5	10	7
Monthly	4	8	8	16	12
Quarterly	9	18	7	14	16
Annually	19	38	16	32	35
Quality of Extension services					
Very poor	15	30	12	24	27
Poor	9	18	16	32	25
Neutral	2	4	3	6	5
Good	4	8	4	8	8
Very good	4	8	1	2	5

Source: field survey 2016

The finding shows that on average 70% of farmers had access to extension services in the study areas. However, the main challenges cited by farmers was the frequency of extension visits and the quality of the services when the officials were on the site. The frequency of extension visits was inconsistent, and farmers (35%) indicated that visits occurred annually.

As shown in Tables 6, only 5% of farmers found extension to very good, the higher proportion on the quality of services received, was between poor (25%) and very poor (27%) and farmers were not satisfied with the quality of extension services. This is in line with the argument made by Makara (2010), Afful and Lategan (2014), Hlatshwayo and Worth (2016) and Maboe (2016) that the quality of extension officers was found to be poor and unsatisfactory in most rural areas of South Africa.

3.6. Empirical results of the Binary logistic model

Table 7 shows results from the binary logistic regression.

Table 7: Binary logistic regression

Explanatory variable	**Coefficient**	**Std. Error**	**Z**	**p-value**
Age	0.053	0.026	2.0175	**
Gender	−0.107	0.669	−0.1603	ns
Level of education	−0.789	0.471	−1.6747	*
Agricultural income	2.1e-05	2.4e-05	0.8510	ns
Employment status	0.699	0.727	0.9618	ns
Household size	0.191	0.179	1.0607	ns
Livestock farming	−1.557	0.729	−2.1373	**
Field cropping	1.378	0.835	1.6512	*
Farming goals	1.213	0.832	1.4587	ns
Satisfaction with extension visits	−1.307	0.685	−1.9091	**
_cons	−2.264	2.105	−1.0758	ns

Notes:
***, ** , * means significant at 1%, 5% and 10% levels of significance respectively, ns = not statistically significant
Number of observations =100
McFadden R-squared = 0.255395
Number of cases correctly predicted = 80.0%
Likelihood ratio test: Chi-square (10) = 24.0784 [p = 0.0074]

Source: Field survey 2016

As shown in Table 7, ten (10) explanatory variables were fitted in the binary logistic model, and five (5) variables influenced whether farmers have access to extension services. Age, education, home gardening, field cropping, and livestock production significantly influenced whether a farmer has access to extension services. The McFadden R-squared value is only 25%, however, the number of cases correctly predicted by the model is 80%, suggesting a reasonably powerful model (Greene, 2000). The likelihood ratio Chi-square test allows us to reject the all-slopes-zero null hypothesis below the 1% significance level (Gujarati, 2004).

3.6.1. Factors influencing access to extension services

3.6.1.1. Age of household

Table 7 indicated that Age of the household head was significant at 5%, and the coefficient was positive. This is to say the expected difference in the probability of y = 1 associated with Age increased by 5.3%, this implies that the older the farmer, the more likely they are to receive extension services. The hypothesis is that extension officers were more inclined to visit older farmers to improve their indigenous knowledge with new technologies (Agholor, 2012).

3.6.1.2. Level of education

The level of education was significant at 10%, but the coefficient was negative relative to the dependent variable. This indicates that the anticipated difference in the probability of y = 1 associated with the Level of education decreased by 78%, which suggests that the higher the level of education of the farmers, the more likely they do not see the need to use to extension service. The hypothesis was that educated farmers do not see the need for or use of extension officers with the view that they can use their knowledge (education) and do their farming (Kaur *et al.*, 2014)

3.6.1.3. Satisfaction extension with visits

Satisfaction with extension visits was a significant variable in determining access to extension services. The significant Level was at 10% and coefficient negative indicated an inversely proportional relationship between access to extension services and Satisfaction extension with visits. The anticipated difference in the probability of y = 1 associated with farmers' satisfaction extension with visits decreased by 30%. A study by Ganpat *et al.* (2014) posited that farmers' satisfaction with visits from extension officers could contribute positively to the overall production.

3.6.1.4. Livestock production

According to Table 7, practicing livestock production was significant at a 5% level to the accessibility of extension services. The coefficient was negative, indicating that the anticipated difference in the probability of y = 1 associated with livestock production decreased by 55%. Farmers who practice livestock production only are likely to have access to extension services. Akeredolu (2008) and Wright (2012) posited that farmer with more extensive livestock holding is more likely to access agriculture-related information through different channels.

3.6.1.5. Crop production

As shown in Table 7, crop production proved to be a significant variable in determining extension services access; its significance level to extension services was at 10%. The relationship was also directly proportional, indicating a probability of 37% increase in accessing extension services (y = 1). Furthermore, this shows that farmers who practised crop production appeared to use advice from extension officers.

3.7. Statistical test for difference of means on Agricultural annual income in the study area

Table 5 shows the results of the comparative statistics (T-test) employed in this study. These t-test were done on the agricultural income of farmers who had access to extension services and those did not. The results show that farmers who had access to extension services had higher margins on income received than those who did not, which was the case in both enterprises. Farmers in Ngcabasa were able to sell their cash crops and make money, although households had no reliable nor a stable market, they were able to make an annual income of R 11 067, while those who decided against the use of extension services made an annual income of R4 852. Farmers in Phathikhala who had access to extension services managed an average annual income of R10 480, while those who did not use extension services managed R10 271.

Table 8: Statistical test for difference of means of respondents in the study area

Explanatory variables	**Average annual income from crops (R)**		**t-test for difference of means**
	without extension	with extension	
Ngcabasa (n=35)	4 852	11 067	t Stat: -2.121 Prob (1-tail): 0.021
Phathikhala (n=22)	10 271	10 480	t Stat: 0.016 Prob (1-tail): 0.494
Average annual income (crops)	6 187	10 741	t Stat: -1.730 Prob (1-tail): 0.045
	Average annual income from livestock (R)		
	without extension	with extension	
Ngcabasa (n=49)	3 375	4 224	t Stat: -0.627 Prob (1-tail): 0.267
Phathikhala (n=39)	1 687	2 500	t Stat: -0.344 Prob (1-tail): 0.366

Average annual income (livestock)	2 893	3 333	t Stat: -0.365 Prob (1-tail): 0.358

Source: field survey, 2016

Farmers who practiced livestock farming were also investigated, and the findings suggested that with extension services, farmers were able to sell products like milk, meat and wool. In Ngcabasa, livestock farmers who used extension services had an average annual income of R4 224, and in Phathikhala, an annual income of R 2 500. Farmers who decided against extension services managed an average yearly income of R3 375 in Ngcabasa and R1 687in Phathikhala, respectively. More than 90% of households in both villages acknowledge the contribution the monetary returns have on their lives, highlighting that they use the money to buy groceries and other needs relevant to them. Less than 10% said that they save the money to buy seeds and pesticides for the next season.

3.8. Implication on Agricultural Production Post the Covid-19

The first case of COVID-19, a severe contagious respiratory disease, was reported in Wuhan, China, in December 2019 (F.A.O., 2020). The COVID-19 pandemic decimated humanity and brought the global economy to a halt. The South African Government declared the pandemic a national disaster in March 2020, and the country immediately went into a hard lockdown (level 5) until May 2020. During this period, normal supply of services were halted due to the preventive measures put in place to contain the spread of the Covid-19 pandemic (F.A.O., 2020

The outbreak generated extreme vulnerability in the agriculture sector; direct farmer access to extension services, trade, movement of farm produce to the markets and public gatherings were limited due to travel restrictions. The lockdown restriction started to ease towards the end of the year, however, production and supply of food had already been affected. Farmers in Phathikhala and Ngcabasa areas were severely affected by this outbreak, this hampered their livelihoods of vulnerable and increased proneness to hunger and food insecurity.

4. CONCLUSION

The study was inspired by the desire to understand what determines a farmer to receive extension services and the implications for agricultural production post the COVID-19 among communal farmers in Raymond Mhlaba Local Municipality Eastern Cape province. The study concluded that farmers had some form of access to extension services; however, many of these farmers were dissatisfied with the frequency of visits and quality of service from extension officers. Farmers felt that more could have been done to improve their farming activities if there was closer a close working relationship between them and extension officials.

From the regression analysis, farmers more likely to receive extension support appeared to be older, those with less education, and those farming with both crop and livestock enterprise. According to the T-test statistics, farmers who received extension received better agricultural income than those with no access to extension services. All this was achieved before the pandemic, however, post the outbreak, travel bans and many other restrictions imposed on people's movements seriously affected the production and supply of extension services and agricultural income.

5. REFERENCES

ABDUL-HANAN A, ABDUL-RAHAMAN A. 2016. Determinants of access to agricultural extension services: Evidence from smallholder rural women in Northern Ghana. A*sian Journal of Agricultural Extension, Economics & Sociology*. 9(3):1-8

AFFUL, D.B. and LATEGAN, F.S. 2014. Small and medium-scale producers' use and credibility of information sources: implications for public extension's financial sustainability. *South African Journal of Agricultural Extension*, 42 (1): 27-38.

AGHOLOR, A.I. 2012. The quality of extension education delivery among livestock farmers in central Eastern Cape. A case study of Nkonkobe Local Municipality. Unpublished Master's Thesis, University of Fort Hare, Alice.

BESTER, B.J. 2008. Summary: Agricultural Marketing and the importance of Agricultural Marketing. Unpublished Supplementary Lecture Notes for AGE121.

CATHERINE, R., GUUSH, B., FANAYE, T., ALEMAYEHU, S.T. 2012. Gender differences in access to extension services and agricultural productivity. ESSP Working Paper.

CONRADIE, B.I. 2016. The Implications of a Weak Public Extension Service for the Productivity Performance of Karoo Agriculture. *S. Afr. J. Agric. Ext*. Conradie Vol. 44, No. 2, 2016: 99 – 109.

DIDIZA, K. 2014. Integrated development plan of Nkonkobe Municipality, 2015 -2016

FOOD and AGRICULTURE ORGANISATION (F.A.O.). 2020. Extension and advisory services: at the frontline of the response to COVID-19 to ensure food security. Rome. https://doi.org/10.4060/ca8710en

GANPAT, W.G, WEBSTER, N., NARITE, N.K. 2014. Farmers' Satisfaction with Extension Services in the Organization of Eastern Caribbean States. *Journal of International Agricultural and Extension Education*, 21 (3) 49-62.

GONI, S., SKENJANA, A. and NYANGIWE N. 2018. The status of livestock production in communal farming areas of the Eastern Cape: A case of Majali Community, Peelton. *Applied Animal Husbandry & Rural Development*, 11, 34-40.

GEBREHIWO, K.G. 2017. The impact of agricultural extension on farmers' technical efficiencies in Ethiopia: A stochastic production frontier approach. *South African Journal of Economic and Management Sciences*, 20(1), 1-8

GREENE, W.H. 2000. Econometric analysis, (4th ed.). Prentice Hall, Upper Saddle River, New Jersey: Prentice-Hall.

GUJARATI, D.N. 2004. Essentials of Econometrics, (3rd Ed.). McGraw-Hill International

HLATSHWAYO, P.P.K. & WORTH, S.H. 2016. Stakeholders' Perceptions about Visibility and Accountability of the State Agricultural Extension in Nquthu Area, Kwazulu Natal Province, South Africa. *S. Afr. J. Agric. Ext.* Vol. 44, No. 2, 2016: 174 –185.

KAUR, J., SHEHRAWAT, P.S, P.S. PEAR, Q.J.A. 2014. Attitude of farmers towards Privatisation of Agricultural Extension Services. *Agricultural Science Digest* 34(2):80-86.

MAOBA, S. 2016. Farmers' perception of agricultural extension service delivery in Germiston region, Gauteng Province, South Africa. *South African Journal of Agricultural Extension* 44 (2):167 –173.

MAKARA, N.M. 2010. An investigation of the role and impact of the extension services in the massive food programme introduced at Zanyokwe irrigation scheme of the Amahlathi local municipality in the Eastern Cape. Master's Thesis. University of Fort Hare Alice.

MARTINS O., OBARE G., SALASYA. B. 2011. What factors influence the speed of adoption of soil fertility management technologies? Evidence from Western Kenya. *Journal of Development and Agricultural Economics* 3(13):627-637.

MNIKI, S. 2009. Socio-economic impact of drought induced disasters on farm owners of Nkonkobe Local Municipality. Unpublished Master's Thesis, University of the Free State, Bloemfontein, South Africa.

NKEGBE PK, SHANKAR B, CEDDIA GM. 2012. Smallholder adoption of soil and water conservation practices in Northern Ghana. *Journal of Agricultural Science and Technology*. 2:595-605.

NKOSI, N.Z. 2017. Level of access to agricultural extension and advisory services by emerging livestock farmers in uThungulu district municipality, Kwa Zulu-Natal Province. Master's Thesis. University of university of South Africa.

STATISTICS SOUTH AFRICA (STATS SA). 2016 Community Survey, Statistical release / Statistics South Africa. Pretoria: Statistics South Africa.

SWANSON, B. 2008. Global review of good agricultural extension and advisory service practices. Rome: Food and Agriculture Organization of the United Nations.

TIWARI, K.R., SITAULA, B.K., NYBORG, I.L.P. AND PAUDEL, G.S., 2008, 'Determinants of farmers' adoption of improved soil conservation technology in a middle mountain watershed of central Nepal', *Environmental Management* 42(2), 210-222.

ULIMWENGU, J. AND SANYAL, P. 2011. Joint estimation of farmers' stated willingness to pay for agricultural services. International Food Policy Research Institute, Discussion paper 01070.

YUSUF, D.E., OMOKORE, D.F. AND MUSA, M.W. 2011. Socio-economic and Institutional Factors Influencing Farmers' Perception of Privatisation of Agricultural Extension Services in Kaduna State Nigeria. *Journal of Agricultural Extension*, 15(2) 84-89.

FACILITATING CHANGE IN INDIVIDUALS, GROUPS AND ORGANISATIONS: CONSTRAINTS TO TECHNOLOGY ADOPTION BY COMMUNAL LIVESTOCK FARMERS

Molieleng, L.M[1]., Fourie, P.J.[2] and Nwafor, I.C.[3]

Corresponding Author: Molieleng, L.M; Email: molielenglerato1@gmail.com

ABSTRACT

The importance of adopting modern technologies in agriculture especially in a changing climate cannot be underestimated in Africa. This study was carried out in three (3) municipalities in the communal areas of Lejweleputswa district of the Free State province in South Africa to investigate the constraints to technology adoption by the communal farmers in the study region. To better understand this, issues such as the current status of livestock production in the region, type and species of livestock reared, livestock management systems and practices, communication effect, etc. were deliberated. Data was collected using a mixed methods questionnaire approach where open and closed-ended semi-structured design questions were administered to 53 communal livestock farmers. Thereafter, data was coded in Microsoft Excel ver.365 and then exported to the Statistical Package for Social Sciences (SPPS) version 26 for analysis. Results showed that the majority (57%) of livestock communal farmers in the study areas are between the ages of 50-70 years, are predominantly males (83%) and are engaged in semi-intensive system of livestock management (66%). Current technological innovations (72%) especially information sharing, up-to-date training (84.9%) and confusions about the most effective livestock management system to adopt (37%) were amongst the most prevalent constraints expressed. Strategies that prove to enhance the adoption of technology (especially amongst the aged) in communal areas should be employed to address these constraints and fortify farmers with relevant skills for sustainable and profitable farming practice.

Keywords: Communal farmers, Technology, Adoption

1. INTRODUCTION

Livestock production is one of the major components of agricultural activity and productivity in South Africa and in other developing countries (Mamabolo & Webb, 2005). Almost 84% of the 122.3 million hectares of South Africa's land surface are suitable for raising livestock, particularly cattle, sheep, goats and equines (Ramsay *et al*., 2006). Despite the abundantly available agricultural land, communal livestock farmers are still plagued with constraints to

[1] LM. Molieleng. Department of Agriculture, Central University of Technology, Free State, Private Bag X20539, Bloemfontein 9300, South Africa

[2] Prof. PJ. Fourie. Department of Agriculture, Central University of Technology, Free State, Private Bag X20539, Bloemfontein 9300, South Africa

[3] Dr. IC. Nwafor. Centre for Applied Food Sustainability and Biotechnology (CAFSaB), Central University of Technology, Free State, Private Bag X20539, Bloemfontein 9300, South Africa

profitable production such as lack of education, lack of feed, poor breeding methods, medication, poor management of natural resources, etc. According to Mphinyane & Terblanché (2006), the rate of technology adoption is directly associated with the level of education of farmers as well as information seeking behaviour of farmers. It is a known fact that most of our farmers are illiterate and this becomes a stumbling block to technology adaptation (Kunene & Fossey, 2006).

2. PROBLEM STATEMENT

The importance of adopting modern technology in agriculture, especially in a changing climate, cannot be underestimated in Africa. Previous studies by Kijima *et al*. (2011) agreed that agriculture modernisation increases productivity. De Janvry & Sadoulet (2002) also pointed out that agricultural technology can help reduce poverty through direct and indirect effects. The communal livestock farmers in Lejweleputswa district of the Free State, South Africa are confounded with numerous constraints. A few of these constraints include lack of marketing opportunities, lack of proper animal health care services and poor technological adoption. These constraints expose farmers, their households and communities to high risk of food insecurity, poverty, and very few livelihoods improvement options.

A better understanding of the specific factors that limit the development of communal farmers is crucial in order to effectively prepare policies, development strategies, programmes and models aimed at supporting and enhancing the transition of communal farmers into commercial farmers. At present, there is insufficient reliable information which focuses on the reasons for the poor adoption of technology and poor livestock productivity by the communal farmers at Lejweleputswa district, hence this study.

3. HYPOTHESIS

This study hypothesized that:

i. Illiteracy, inadequate market support structures, poor infrastructure, livestock health issues, and low technological input mostly contribute to low livestock productivity of farmers living in communal areas in Lejweleputswa district.
ii. Training communal farmers and introducing new technologies and advanced agricultural methods will increase production.

4. PROCEDURE

The study was conducted in Lejweleputswa district municipality of the Free State province in South Africa. Three municipalities were visited for this study, which are Matjhabeng municipality, Masilo municipality and Tswelopele municipality. Data was collected using a mixed methods questionnaire approach by administering both open and closed-ended semi-structured design questions to 53 communal livestock farmers in the study area. Due to covid-19 lockdown regulations data was mostly collected through group interviews with respondents. One-on-one interviews were also conducted telephonically as follow up to communal farmers to express their opinions. Questions relating to and addressing all the components of the research hypothesis were posed. Before the commencement of the research, a pilot study was conducted to test the reliability of the questionnaire.

4.1. Data analysis

Data was coded in Microsoft Excel® ver.365 spreadsheet and then exported to the Statistical Package for Social Sciences (SPPS) version 26 (IBM SPPS, 2019) for statistical analysis.

4.2. Statistical technique

Descriptive statistics such as frequencies, percentages, mean, standard deviation and standard errors were used to achieve the objectives.

5. RESULTS

5.1. Socio-economic characteristics of communal livestock farmers

Table 1 presents a summary of the socio-economic characteristics of the respondents. The results shows that all respondents were African farmers and the majority were between the ages of 51-60 years (32%, freq= 17), while a handful were above 20 years. This shows a lack of participation in livestock farming from the youth. Most respondents were male (83%, freq =44). The low participation of females can be attributed to the fact that most women stay at home doing domestic chores or some are employed full time elsewhere.

The majority of respondents possess little or no formal education (39.6%, freq= 21), while (28.3%, freq =15) were uneducated and could therefore hardly read or write properly in English or their native languages. The arithmetic ability of respondents was surprisingly high, stating that most farmers have the ability to understand and calculate numbers (67.9%, =freq 36). The results further revealed that the maximum number of years the respondents mentioned they have been farming is 50 years (1.9%, freq= 1), while the minimum was between 6 months – 5 years (34%, freq =18) this showed that many respondents were still new in the livestock production industry.

The average size of land in communal areas of Lejweleputswa district municipality is 402 ha and the results revealed that most respondents rear their livestock in communal land /commonages. The majority of respondents (73.6%, freq= 39) farm in municipality communal land and 5.7% (freq= 3) of respondents stay in their own land and/ rented land, which is common in livestock farming for additional grazing. Only 1 (1.9%) respondent obtained land through the law of restitution. On average the same land was shared by 40 farmers (41%), and 11-20 farmers (6%, freq =3) were the least number of people sharing the same piece of land. The communal land tenure system is a form of land tenure where land is held by a group of people through shared rules, and where their land administration systems are informed by and practised in terms of shared values and customary systems (Anim & Van Schalkwyk, 1996).

Table 1: Socio-economic characteristics of communal livestock farmers in Lejweleputswa district municipality

Factor	Variable	Response frequency	Percentage	Total number of respondents
Ethnic origin	African	53	100	53
	White			
	Coloured			
	Indian			
Gender	Male	44	83	53
	Female	9	17	
Age	21 -30	5	9	53
	31-40	4	8	
	41-50	12	23	
	51-60	17	32	
	61-70	13	24	
	71-80	2	2	
	80+	0	0	
Language proficiency	Sesotho	20	37.7	53
	English, Afrikaans and Sesotho	24	45.3	
	English, Tswana. Afrikaans and Sesotho	9	17.0	
Level of education	Uneducated	15	28.3	53
	Below matric	21	39.6	
	Matric	13	24.5	
	Graduate	1	1.9	
	Post graduate	3	5.7	
Years of farming experience	0-5 years	18	34	53
	6-10 years	16	30	
	11-20 years	6	11.3	
	21-30 years	6	11.3	
	31+ years	7	13.2	
Land ownership	Own land	3	5.7	53
	Municipal/commonage	39	73.6	

	Land affairs land	9	17	
	Restitution	1	1.9	
	Rented land	1	1.9	
Number of farmers on a piece of land	5-10 farmers	13	25	53
	11-20 farmers	3	6	
	21-30 farmers	10	19	
	31-40 farmers	5	9	
	41+	22	41	

5.2. Livestock species

Table 2 illustrates that most respondents farm with cattle (=n 41), the highest breed being Bonsmara and Brahman, followed by pigs (n= 24) using the duroc, Landrace and Large white breeds. Respondents reasoned that they keep Bonsmara because of its good adaptable characteristics and their ability to withstand drought and thrive in the area. This results differ from the finding of Mthi *et al*. (2017) who conducted a study on characteristics of small-scale sheep production systems in communal areas of the Eastern Cape province. These authors found that the most dominant species in that area were sheep (71.8%), poultry (12.9%), cattle (7.7%), goats (4.4%), dogs (1.3%) and pigs (0.6%). Kosgey, (2004) reported that most farmers in the tropics perceived that crosses between breeds were less favourably than indigenous breeds for a range of traits. Conversely, Ashfaq *et al*. (2020) stated that the average productivity of exotic and exotic cross breeds of cattle is higher than that of the indigenous breeds.

Respondents have different reasons for rearing livestock which varied across households needs. Figure 2 below revels that most of the respondents kept livestock to meet daily living expenses (32%, freq =17), followed by business purposes (30%, freq= 16), (15% freq=8) investment for emergencies and (13%, freq = 7) for culture and rituals. The reasons are closely similar to the results reported by Goni *et al*., (2018), where 42% and 30% of farmers kept livestock to earn income and for family support, and only 3% of them kept livestock for animal traction and household consumption.

Table 2 shows that 66% (freq =35) of the respondents were practising semi-intensive farming system as opposed to 22.6% (freq =12) who were practicing intensive and 11.3% (freq= 6) extensive farming system. Similar results were reported by (Munzhelele, 2015) that 75% of farmers used the intensive or semi-intensive management principles to rear their pigs.

Table 2: Livestock species farmed by communal farmers in Lejweleputswa district municipality

	N	Minimum	Maximum	Sum	Mean		Std. Deviation
Livestock species	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Number of cattle	41	2	140	665	16.22	3.974	25.448
Number of sheep	7	2	65	161	23.00	8.006	21.182

Number of goats	9	2	48	216	24.00	5.560	16.681
Number of pigs	24	1	75	415	17.29	3.424	16.776
Number of poultry	6	5	500	673	112.17	78.997	193.503

5.3. Livestock management practices

Table 3 shows that livestock management activities performed by communal farmers in the study region and the seasons when they were applied. The study revealed that the prevalent management practices were de-horning (78.6%, freq= 22), which was practiced mostly in winter; castration (90.3%, freq= 28), which was done by most respondents throughout the year; and de-worming (100%, freq= 32), practiced throughout the year. De-worming, ear-tagging and treating sick animals was ranked the top most management activity practiced by all respondents throughout the year (100%). Many farmers use castration as a tool to improve meat quality in livestock species such as pigs, sheep, and cattle (Needham *et al*., 2017). Katikati, (2017) also reported that farmers' managerial thinking and incorporating different management activities is connected to farm profitability.

Table 4: Livestock management practices performed by communal farmers in Lejweleputswa district municipality

	Percentage of respondents per seasons/ periods					
Management practices	**Winter**	**Summer**	**Spring**	**Autumn**	**Throughout the year**	**Total**
De-horning	78.6				21.4	28
Castration		6.5		3.2	90.3	31
De-worming					100	32
Ear-tagging					100	40
Branding	58				41.7	24
Vaccination		2.3			97.7	44
treating sick animals					100	46

5.4. Constraints faced by communal livestock farmers in adopting modern technology

Adopting modern technologies in communal areas is not an easy task because of many barriers which exceed the under listed. These barriers include poor educational status, inadequate farm experience, limited land size, lack of farm input/financial resources, infrequent contact with agricultural Extension Officers and non-exposure or lack of access to media.

5.4.1. Status of extension services

Agricultural extension plays a role in improving farmers' productivity and income, thereby reducing poverty and increasing food security. The majority of respondents (54.7%, freq =29) reported that they have access to government extension officers, while 45.3% (freq =25) said that they have limited or no access to extension officers. As illustrated in figure 1, 71.4% (freq= 20) of the respondents claimed they don't require any service from extension officers at all.

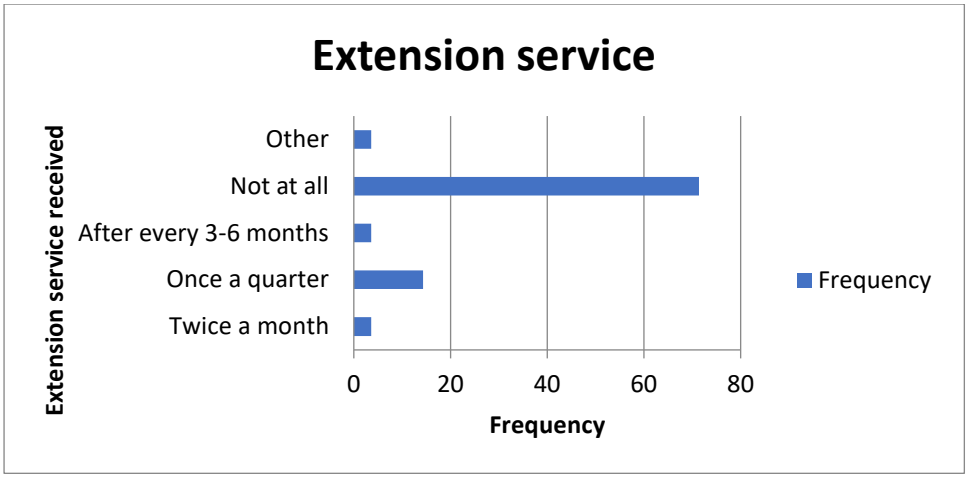


Figure 1: results of extension service received by communal livestock farmers in Lejweleputswa district municipality.

5.4.2. Infrastructural deficit

Infrastructure is an important aspect of livestock commercialization. During data collection in the study area the inspection evidenced that the majority of respondents had combination of kraals (livestock enclosures), loading zones and chutes as the main equipment available in the communal areas (20%, freq= 10). Some of the respondents reported that they do not have tools house and medication rooms (2% freq= 1) on their farms. According to the results recorded by (Katikati, 2017), poor facilities was ranked (80%) as the first challenge faced by emerging cattle farmers in Amathole and Chris Hani districts in the Eastern Cape province. Good infrastructure means easily motorable roads, the availability of effective market structures and holding facilities in good conditions.

5.4.3. Condition of the tools/equipment/facilities

In Figure 2, the different conditions of farms as at the time of visit was depicted. The majority of infrastructure in farms were in fairly good condition (broken, but can be fixed) (53.1% freq = 26) and only (20.4% freq =10) of poor infrastructure was witnessed. This means farmers in the study area don't experience infrastructural challenges. The extension officers that worked with us in the study mentioned that most of the good infrastructures that are found in good conditions were built by the government and the farmers are taking good care of them. Musemwa *et al*. (2007) recorded different results when they investigated the factors influencing smallholder farmer's choice of cattle marketing channels and the results revealed that the auction pens in Kamastone were in poor condition and infrastructure availability and state had a significant effect on the choice of marketing channel ($p< 0.05$).

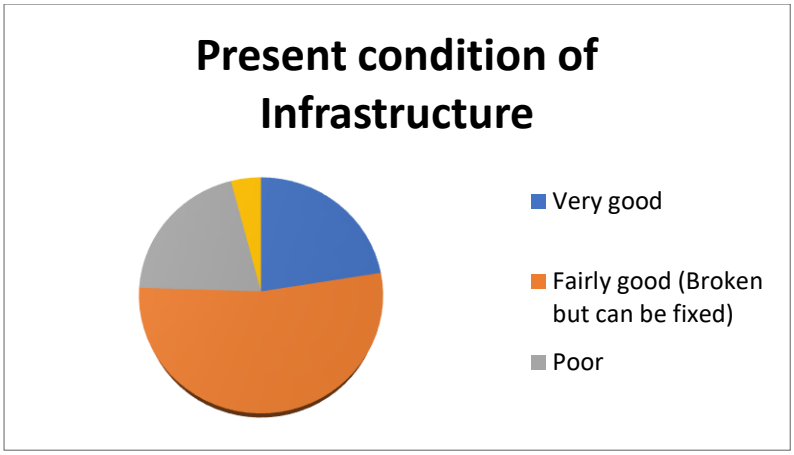


Figure 2: The condition of farm infrastructure as at the time of visit

5.4.4. Livestock Health

The majority (86.5%) of respondents revealed that they do not work with any veterinarian or animal health technician, while 15% (freq =7) agreed to have access to a vet or an animal health technician. Furthermore, 83% (freq= 44) of farmers claimed that they vaccinate their animals, even though they were not in position of any vaccination record (92.6%, freq =51) and vaccination plan. A prerequisite for communal farmers to succeed is that herd or flock health must be promoted, because animal diseases in the broadest sense will negate all efforts to improve livestock farming for the communities if left undiagnosed and unchecked (Masika & Mafu, 2004); (Mapiye *et al*., 2009).

5.4.5. Livestock breeding and selection

According to the findings of this study, 92.4% (freq =49) of respondents don't follow any breeding season practice. Only 7.7% (freq =4) observe the different management practices of breeding seasons. The respondents reasoned that they don't follow breeding seasons because the size of land is too small for their animals (51.1%, freq =24) and some said that they don't have enough knowledge to carry out the proper requirements in each season (31.9, freq= 15). The results also revealed that all respondents use natural breeding (100%, freq =53).

5.4.6. Animal Feed

Based on the current findings in figure 3, the respondents feed their livestock on pasture (40.4%, freq= 21), followed by a combination of pasture and commercial feed (15.4%, freq= 8). The present condition of the pastures lots was witnessed to have little grass and 39.6% (freq= 21) of the respondents indicated that their grass is in a poor deteriorating condition and quality. On the other hand, 22.6%, (freq= 12) of the other respondents reported that their pasture lands have a fair and a reasonable quantity of grass.

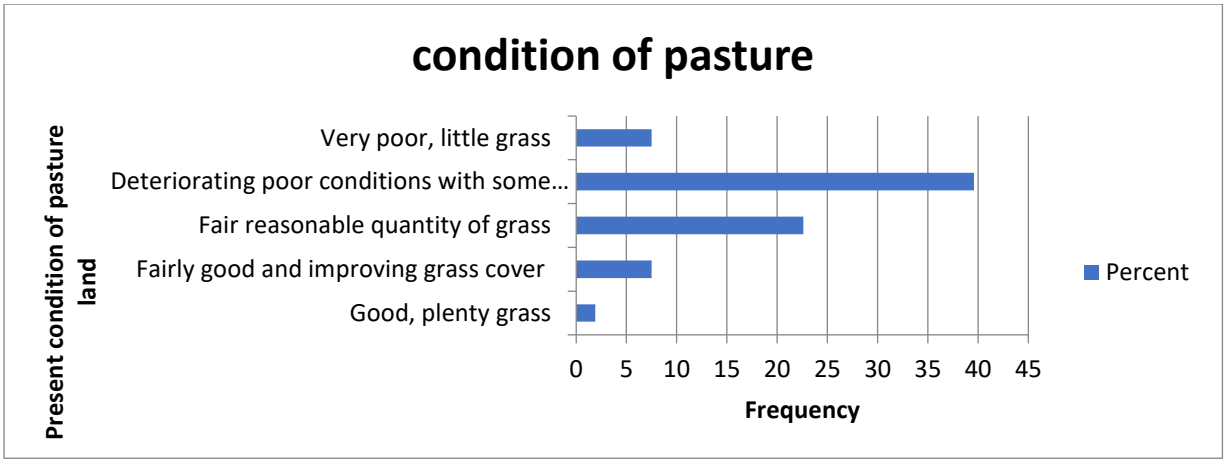


Figure 3: Pasture condition at the time of visit

5.4.7. Information dissemination

The use of modern technology creates opportunities for communal livestock farmers. Communal livestock farmers needs a range of information which includes current production techniques and market conditions, type of product demanded, quality, quantity, price and market opportunities (Bailey *et al*., 1999). In this study, results show that 96.2% (freq= 51) of the respondents did not receive any form of agricultural information through any technological device, while 3.8% (freq= 2) of the farmers claimed they do receive agricultural information on their technological device.

The various channels utilized by farmers in order to receive information include local extension officers (1.9% freq= 1), followed by a combination of radio, television and messages from Extension Officers (1.9%, freq= 1). Makaula & Yusuf (2021) discovered that in Umzimvubu local municipality, smallholder farmers mostly use mobile phones (23%), radio (25%), TV (20%) and internet (6%) for agricultural purposes.

Results of this survey revealed that 42.3% (freq =22) of the respondents have never attended any agricultural workshop, farmers day training workshop or farmer groups engagements. Likewise 34.6% (freq= 18) of farmers submitted that they have attended these events at least once. The importance of attending farmers training, farmers days engagements and farmers information groups is seen in the study conducted by Ampaire & Rothschild (2010) and the authors revealed that farmer training and support had an impact on animal health, livestock consumption, and livestock sales. Ampaire & Rothschild (2010) further observed that farmers who had received more training and support had less disease in pigs than those who had not been trained. Also, the farmers who had more training and support consumed more and sold more livestock.

From the evidence that was gathered in this study, it was noted that a substantial proportion of respondents (84.9%, freq= 45), were having difficulties in getting services and training. A lack of information and training for farmers is a major concern that can easily be addressed through an organized and efficiently implemented programme.

5.5. The need for efficient and effective information systems

According to figure 4, participants will prefer to get information through SMS (19%, freq=10), followed by more training opportunities (15.4%, freq= 8) and WhatsApp and Agricultural radio programmes (11.5%, freq= 6).

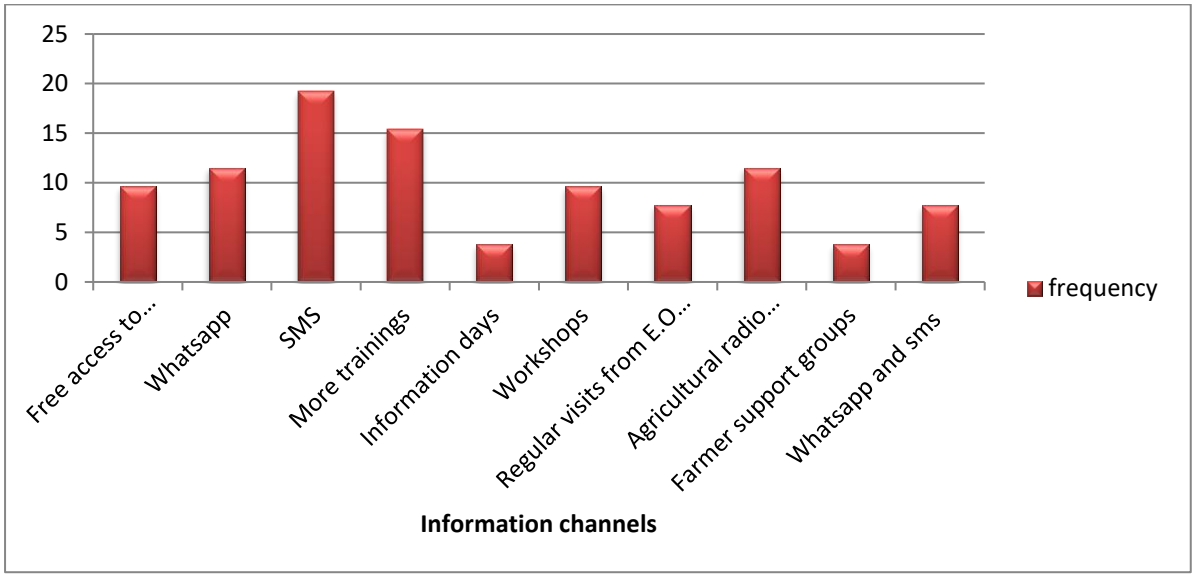


Figure 4: Responses to the need of various information channels

6. SUMMARY

It was observed that the communal livestock farmers in the study area were faced with several constraints that limited technology adoption. The constraints include low educational levels and lack of information and training amongst others. The study further revealed that most communal farmers have access to local Extension Officers and looking at sources of information that farmers chose to get information from, the sources are already available to the farmers, but most of them don't use them. Furthermore, the results revealed that majority of communal livestock farmers have access to mobile phones, which is a technological method that can be used to send and receive agricultural information from extension officers and veterinarian to communal livestock farmers. The use of mobile phones can be used to solve problems and give out advices. The high number of farmers who said they don't require the presence or the help of extension officers was surprising, this might be due to the fact that data collection was done under covid-19 lockdown regulations, and many farmers reasoned that extension officers will be putting their lives at risk by attending them.

7. CONCLUSION

In order to facilitate change in communal livestock farmers, individuals and in the community, agricultural information must be relevant and accessible to all farmers. The evidence from this study proved the hypotheses that many farmers are illiterate thus, the low rate of technological adoption. We conclude that low technological input contributes to low livestock productivity of farmers living in communal areas in the Lejweleputswa district. Training and the use of mobile phones which are already available to communal livestock farmers in this study have been demonstrated in literature to be beneficial. The veterinarians and animal health technicians are the carriers of information about prevalent animal diseases in the study area,

the symptoms and prevention methods that can be used by farmers. Therefore, they should be encouraged to constantly be in contact with communal livestock farmers for improved livestock production outcomes and profitability.

8. RECOMMENDATIONS

The following key recommendations were made:

1. A significant and sustained attempt should be undertaken by the government and non-government institutions to ensure that Extension Officers and farmers are frequently trained, both at local and provincial levels.
2. Extension officers need to visit farmers regularly and provide information on new technologies and new methods of farming.
3. There is a need to develop free online information platforms like Agricultural applications that has 24 hours online services using qualified agricultural consultants. This will not only benefit the farmers but it will also create job opportunities for youths.
4. Implementation of technologies should be specifically designed based on the needs of the farmers. E.g. mobile messages that cover market price alerts from local auctions and feedlots. The Apps that cover date of grazing management based on individual farmers' specific profile, dates of weaning and breeding etc. should be designed.

9. REFERENCES

AMPAIRE, A., & ROTHSCHILD, M. F., 2010. Effects of training and facilitation of farmers in Uganda on livestock development. *Livest. Res. Rural Dev*, *22*(7), 1.

ANIM, F., & VAN SCHALKWYK, H., 1996. Tenure arrangements and access to credit: The case of small-scale farmers in the Northern Province. *Agrekon*, *35*(4), 224-230.

ASHFAQ, M., KOUSAR, R., MAKHDUM, M.S.A. & NASIR, J. 2020. Empirical analysis of livestock productivity through improved breeding in Punjab, Pakistan. *J. Anim. Plant Sci*, *30*(6), pp.1642-1652.

ANTWI-AGYEI, P., & STRINGER, L. C., 2021. Improving the effectiveness of agricultural extension services in supporting farmers to adapt to climate change: Insights from northeastern Ghana. *Clim. Risk .Manag*, *32*, 100304.

BAILEY, D., BARRETT, C. B., LITTLE, P. D., & CHABARI, F., 1999. Livestock markets and risk management among East African pastoralists: A review and research agenda. *Available at SSRN 258370*.

DE JANVRY, A., & SADOULET, E., 2002. World poverty and the role of agricultural technology: direct and indirect effects. *J. Dev. stud*, *38*(4), 1-26.

FOURIE, P., MAHLAKO, S., & VAN DER WESTHUIZEN, C., 2018. Assessment of the management practices of emerging sheep production systems in the Eastern Free State: can the extensionist make a difference? *S. Afr. J. Agric. Ext.* *46*(2), 57-68.

GONI, S., SKENJANA, A., & NYANGIWE, N., 2018. The status of livestock production in communal farming areas of the Eastern Cape: A case of Majali Community in Peelton. *Appl. Anim. Husb.Rural Dev*, *11*(1), 34-40.

KATIKATI, A., 2017. *Assessment of production practices of emerging cattle farmers in the selected districts of the Eastern Cape Province, South Africa* Bloemfontein: Central University of Technology, Free State.

KIJIMA, Y., OTSUKA, K., & SSERUNKUUMA, D., 2011. Technology, Soil Fertility, and Poverty: The Case of NERICA Rice in Uganda. In *Emerging Development of Agriculture in East Africa* (pp. 153-167). Springer.

KOSGEY, I. S., 2004. *Breeding objectives and breeding strategies for small ruminants in the tropics*.ISBN 9789058089908 – 272.

KUNENE, N., & FOSSEY, A., 2006. A survey on livestock production in some traditional areas of Northern Kwazulu Natal in South Africa. *Livest. Res. Rural Dev*, *18*, 30-33.

MAKAULA, Z., & YUSUF, S., 2021. Information and communication technologies (ICT) towards agricultural development in rural areas: case of smallholder farmers in Umzimvubu local municipality of the Eastern Cape Province in South Africa. *S. Afr. J. Agric. Ext*, *49*(1), 81-90.

MÄKINEN, H., 2013. Farmers' managerial thinking and management process effectiveness as factors of financial success on Finnish dairy farms. *Agric. Food Sci*, *22*(4), 452-465.

MAMABOLO, M.J. AND WEBB, E.C. 2005. Goat production survey-fundamental aspects to model goat production systems in southern Africa. *A Case study*, pp.1-8.

MAPIYE, C., CHIMONYO, M., DZAMA, K., RAATS, J., & MAPEKULA, M., 2009. Opportunities for improving Nguni cattle production in the smallholder farming systems of South Africa. *Livest. Sci*, *124*(1-3), 196-204.

MASIKA, P., & MAFU, J., 2004. Aspects of goat farming in the communal farming systems of the central Eastern Cape, South Africa. *Small Ruminant Res*, *52*(1-2), 161-164.

MTHI, S., SKENJANA, A. & FAYEMI, P.O., 2017. Characteristics of small-scale sheep production systems in some communal areas of the Eastern Cape Province, South Africa. *Int. J. Livest. Prod*, *8*(12), pp.199-206.

MPHINYANE, M. S., & TERBLANCHÉ, S., 2006. Personal and socio-economical variables affecting the adoption of maize production intervention program by dryland farmers in the Vuwani district, Limpopo province. *S. Afr. J. Agric. Ext.*, *35*, 221-241.

MUNZHELELE, P., 2015. *Evaluation of the production systems and constraints of smallholder pig farming in three agro-ecological zones of Mpumalanga province, South Africa* (Doctoral dissertation)

MUSEMWA, L., CHAGWIZA, C., SIKUKA, W., FRASER, G., CHIMONYO, M., & MZILENI, N., 2007. Analysis of cattle marketing channels used by small scale farmers in the Eastern Cape Province, South Africa. *Livest. Res. Rural Dev*, *19*(9), 131.

NEEDHAM, T., LAMBRECHTS, H., & HOFFMAN, L., 2017. Castration of male livestock and the potential of immunocastration to improve animal we. *S. Afr. J. Anim, Sci*., *47*(6), 731-742.

RAMSAY, K., JAFTA, J., BOTHA, M., SHOLE, G., SCHOLTZ, M., & BESTER, J., 2006. South African country report on farm animal genetic resources. *Department of Agriculture*. Accessed 05 February2021.

IMPACT OF A MULTI-STAKEHOLDER APPROACH ON RURAL LIVELIHOOD AND SOCIO-ECONOMIC STATUS OF THE FARMING COMMUNITY AT ZANYOKWE IRRIGATION SCHEME, AMAHLATHI LOCAL MUNICIPALITY, EASTERN CAPE

Dumani, A.,[1] Mbangcolo, M.M[2]., Mpambani, B[2]., Mpengesi, X[1]. and Titimani, M.[1]

ABSTRACT

Access to finance and production inputs are some of the challenges that dominate the small-scale farming sector in South Africa. Public, Private Partnerships (PPP) are amongst some of the alternatives that could be utilized to assist small-scale farmers. Informal partnership was initiated between Department of Rural Development and Agrarian Reform (DRDAR), Rance Rural Development (RRD) and the farmers of Sidalukukhanya Agriculture Co-op (SAC) for pepper production at the Zanyokwe Irrigation Scheme. A study was conducted to evaluate the socio-economic impact of this partnership. A questionnaire was administered to the members of Sidalukukhanya Agric. Co-op for data collection. Results showed that this PPP significantly improved the livelihood and socio-economic status of SAC members farming at the Zanyokwe Irrigations Scheme. Through this partnership, a number of seasonal and permanent employment opportunities were created, while the farmers gained both the business and production skills. Therefore, this partnership has shown a potential in improving the livelihood and socio-economic status of Zanyokwe farmers.

1. INTRODUCTION

In South Africa, smallholder irrigation schemes were developed to improve rural livelihoods through sustainable food production for food security and poverty alleviation, yet these development objectives remain unfulfilled (Fanadzo *et al*., 2018). Irrigation schemes are among the vital tools that can be used to meet the world fast-rising food demands (Salah *et al*., 2007). FAO *et al*., (2017) indicated that global hunger increased in 2016 and the world undernourished population increased to an estimated 815 million people from 777 million in 2015. Hence, poverty reduction is highlighted in the South African sustainable developmental goals for vision 2030. However, the high cost of running the irrigation scheme which include the cost for infrastructure development, human capacity development, production inputs as well as mechanization result in low productivity of irrigation schemes. As a result, the objectives of irrigation schemes such as food production, poverty eradication and job creation for the betterment and development of rural livelihoods are often not met. Melvyn (2003), pointed the failure of irrigation schemes on government bodies who do not give enough financially support to the schemes. Fanadzo *et al*., (2018) further stated that the national agenda has a high interest on smallholder farmer development, however, there is insufficient financial

[1] Department of Rural Development and Agrarian Reform, Amahlathi Agricultural Office, PO Box 166, Stutterheim, 4930.

[2] Department of Rural Development and Agrarian Reform, Döhne Agricultural Development Institute, Stutterheim, Eastern Cape, South Africa

aziledumani@gmail.com

support by government to the sector. FAO (2016), also stated that the massive investments are required to unleash the potential of agriculture in irrigation schemes for sustainable development and poverty reduction, but low public budgetary allocations to the sector have lowered the production growth.

According to Raidimi *et al*., (2017), the involvement of the public sector alone is not sufficient to address multi-faceted problems confronted by the South African producers. This is mainly due to the limited government resources. As such, the partnerships that bring together public, private and civil society actors (PPPs) are highly encouraged as growth drivers for improving agricultural productivity and rural livelihood (Salah, 2007). Zagst (2012) defined the PPP's as a formalized partnership between public and private institutions to address sustainable agricultural development objectives, where the public benefits from the partnership are clearly defined, investment contributions as well as risks are shared, and the active roles exist for all partners. Hence, various stakeholder's involvement and the strengthening of existing PPP's is crucial for the future of agriculture development. Raidimi *et al*., (2017) emphatically, stated that the combined strength and synergies by multi-stakeholder system will naturally benefit farmers through application and transfer of new technologies to maximise their profit, which will address food security challenges and improve rural livelihoods. According to Mitchell (2008), partnerships between public and private sector are a good approach towards meeting various sustainable developmental goals within the country and should be explored to ensure food security. In his State of the Nation Address (2020), the president of the Republic of South Africa mentioned that "government cannot solve the South African economic challenges alone and our economy has not grown at any meaningful rate for over a decade" that necessitate inclusive approach for economic growth as well as to conquer the fight against the poverty scourge. Hence, Rance Rural Development (RRD), EC-DRDAR and Sidalukukhanya Agric Co-op farmers (SAC), farming at Zanyokwe irrigation scheme joined hands in an attempt to reduce poverty, create jobs and to ensure food security in the rural communities through pepper production. This study seeks to evaluate the impact of this partnership on rural livelihood and socio-economic status of the farming community at ZIS.

1.1. Objectives of the study

- To evaluate the impact of multi-stakeholder partnership on rural livelihood
- To assess the socio economic status on the farming community of Zanyokwe
- To demonstrate impact of partnership on agricultural productivity

2. METHODOLOGY

2.1. Study location

The survey was conducted at the Zanyokwe Irrigation Scheme (Figure 1) (S32°40'55.032", E27°9'9.681") in Keiskammahoek, Eastern Cape, South Africa. The scheme is owned by the members of the community, with each member owning portions of land ranging from 1 to 2 ha per household and the land is under traditional authority. The total size of the land is about 420 ha and the whole area is under irrigation. Farming is the major economic activity practised in the Keiskammahoek and the irrigation scheme plays a pivotal role to sustain crop production

within the area. Hence, farmers produce various crops for economic purposes as well as to sustain their livelihoods.

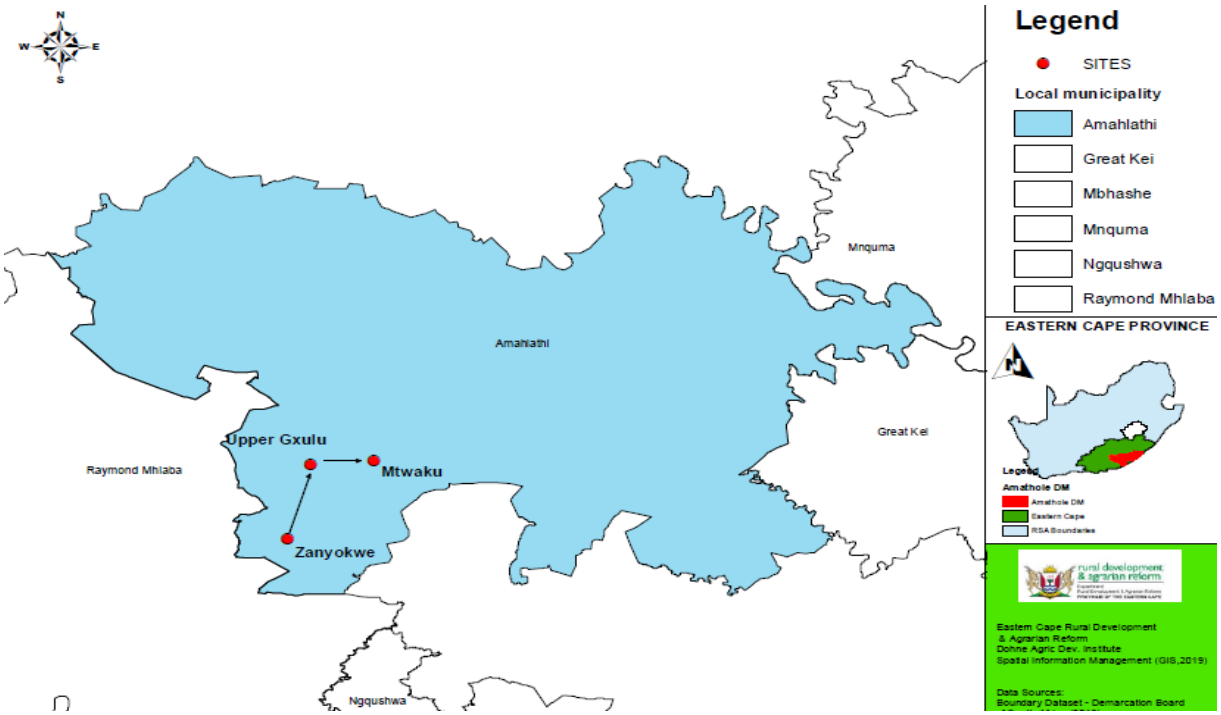


Figure 1: Map of Amahlathi Local Municipality showing Zanyokwe Irrigation Scheme in Keiskammahoek

2.2. Data collection

Although Zanyokwe Irrigation Scheme is big with multiple crop production activities within the scheme, this study focused on Sidalukukhanya Co-operative (Co-op) (SAC), which comprised of eighteen members and each member contributed a portion of land towards the formation of the for-Co-op. SAC is currently in partnership with DRDAR and RRD for the production of pepper and their beneficiation model is 50:50 of profit share. Hence, the study was conducted to evaluate the impact of this partnership on rural livelihood and socio-economic status on the members of this Co-op and their households. The information was collected through structured interviews in a form of questionnaire administered to a total of 12 participants that were randomly sampled.

2.3. Data analysis

Gathered data was entered, verified, coded and cleaned using the Microsoft Excel software package to ease the handling of both string and coded variables. The coded data was then exported into the Statistical Package for Social Sciences (SPSS 20.0) for descriptive analysis.

3. RESULTS AND DISCUSSION

3.1. Demographics of Sidalukukhanya co-op.

The survey revealed that the land on which the Co-op operates is 100 percent (%) owned by the farmers and they inherited it from the past generation. However, this is a communal land

under the traditional authority in terms of the land tenure. With regards to demographics of the Co-op, the women involvement and recognition by the Co-operatives (Co-op) members has been observed in the collected data, as shown in Figure 2. Results shows that the majority of the members are women and it is important that the executive committee is led by women. This implies that women are directly involved decision making of the project. This confirmed the notion by Koppen *et al*., (2017) that women are the pioneers of farming and are known for cultivation of land for ages. Dube (2012), also reported that about 59.9% of women are farming in the irrigation scheme and the majority of women hold high positions in the committee.

Results (Figure 3) revealed that the average age of the respondents and the majority of coop members are the middle aged (67%) and the elderly people are around 33%. This shows that there is some form of sustainability of the project when age is considered. However, there is a need for Co-op members to introduce their children in the farming industry for succession as well as long term sustainability of the project. However, Hofferth (2003) argued that elderly people have relatively rich experiences on social and physical environmental aspects that influence the farming. It has been observed that the majority of the respondents are married followed by single and widowed members whilst a few members are divorced.

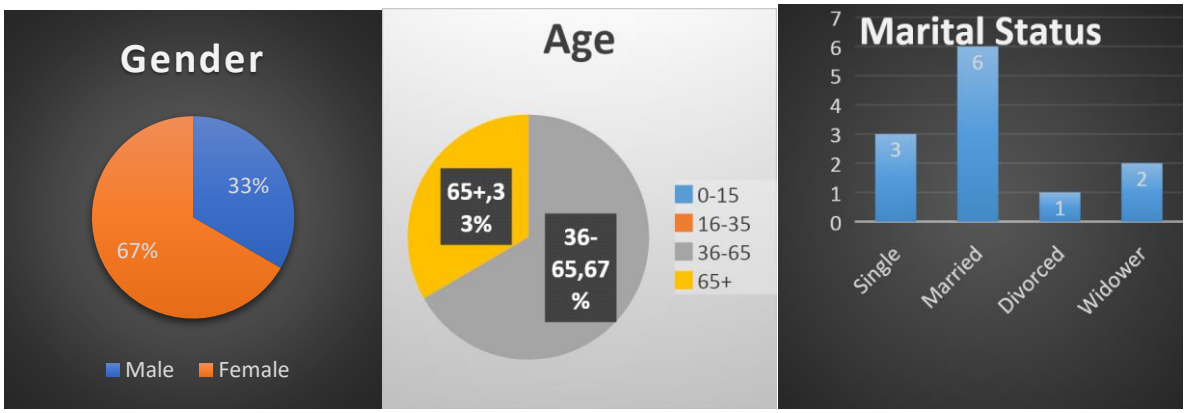


Figure 2: Demographics of the coop members.

The education level of the members that are participants in the PPP is presented in Figure 3 below. The results showed that all the members attended school, although 83% of the members ended their education at Grade 9, and about 8% had reached the secondary education (Grade 10-12). While none of the members held a post-matric qualification, they are average literate and are able to read and write and most importantly able to read the terms and conditions written in the partnership contract. According to Dube (2012), education is important in farming as it enables the farmer to easily process the information and use it to make informed decisions. Furthermore, education allows farmers to perform tasks more efficiently to enhance productivity and quality as well as to rapidly adapt in these changing environment and improve technologies. Paddy (2003) also stated that education status is crucial in farming as it influence the awareness of possible advantages of modernized agriculture through technological inputs, reading of agricultural literature such as inputs instructions and improve better decision-making.

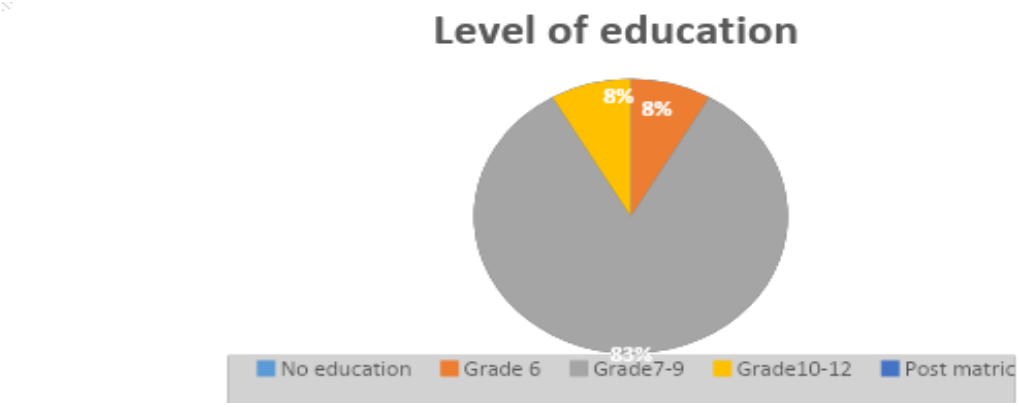


Figure 3: Education status of Sidalukukhanya Farmers Co-op.

3.2. The impact of partnership on socio-economic status and rural livelihood

3.2.1. Jobs created through partnership.

The results (Figure 4) indicated that the partnership had significantly played a pivotal role in creating both permanent and seasonal jobs. Through this partnership, employment opportunities for unskilled, semi-skilled as well as skilled labour in the rural communities of Amahlathi Local Municipality has been realized. As shown in Figure 4, approximately 13% of jobs are created in the field for the members of the Co-op while 6% is permanently employed in the processing factory. Similarly, 56% of seasonal employment intake occurred during planting and harvesting periods in the cropping fields at Zanyokwe Irrigation Scheme in Keiskammahoek. While, 25% of seasonal jobs was obtained through processing of produce at the agro-processing factory in Stutterheim. Dube (2012), reported that PPPs in agriculture had effectively encouraged the economic active populations which led to improved rural livelihoods in rural communities. However, Warnars *et al*., (2008) stated that agricultural based PPPs have economic multiplier effects that include employment opportunities for farm workers, produce transporters and retailers selling farm inputs to meet the production surge. Similarly, Mhalila (2007), reported that Agriculture PPPs had immense contribution to livelihood improvement, socio-economy and food security in the rural areas thus people no longer dependent on government food relief parcels from the government.

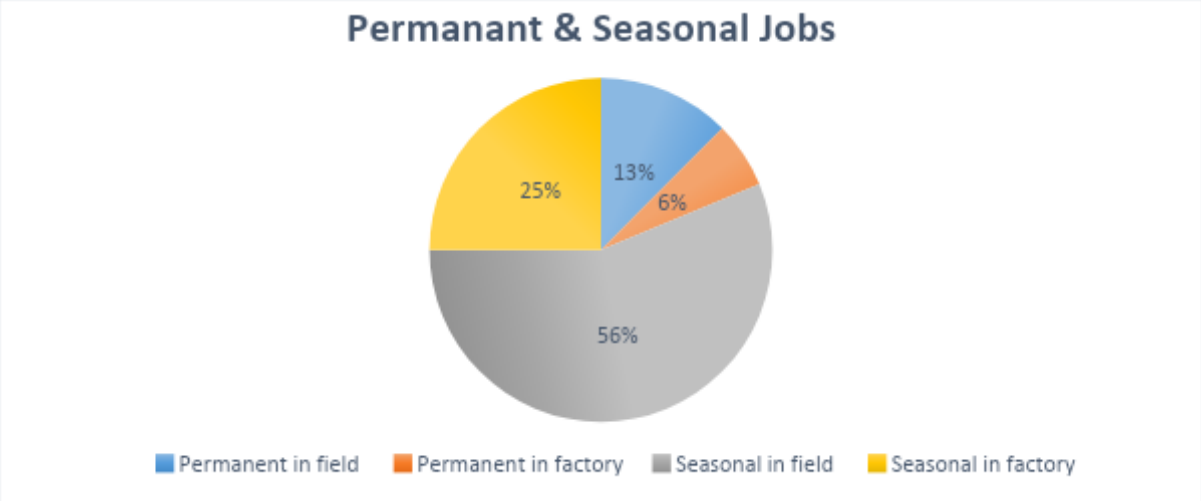


Figure 4: Permanent and seasonal employment status obtained through the PPP.

3.2.2. Skills attained through the partnership.

The results of this study (Figure 5) showed that farmers participating in the partnership had been capacitated with various skills such as management, record keeping, and financial as well as technical skills in order to improve their socio-economic status as well as their livelihood. As indicated the study focused on pepper, the majority of farmers were trained on Chilli pepper production to ensure good quality produce. Additionally, some farmers were trained on managerial and financial skills to improve the supervision in the Co-op. This in turn enabled them to supervise workers during the peak period of the season (planting and harvesting) Dube (2012) reported the significant impact on improvement of lives in communities participating in partnership at lower Gweru Irrigation Scheme.

Figure 5: Skills obtained by farmers through PPP.

3.2.3. Impact of partnership in the livelihoods of sidalukukhanya co-op farmers

The results (Figure 6) showed that the farmers of the Co-op benefited in various ways in the partnership for the betterment of their lives and these include financial stability from the produce profit share, jobs created in the value chain of Chilli pepper, which had a spill-over effect to the local community. The members of the Co-op indicated that they were able to buy

households assets and pay children school fees as well as other aspects such as extending their houses and buying of livestock. FAO (2016) reported that the income earned by smallholder farmers participating in PPPs enable them to live a better quality of life. Dube (2012) stated that farmers in irrigation schemes are capable of building better houses and furnish their homes. Warnars *et al*., (2009) also reported that amongst the benefits of PPPs in irrigation schemes is the substantial contribution to food security and economic progress of rural communities in the African countries, which in turn provide rural households with greater purchasing power for essential commodities, including improved access to health-care services and education.

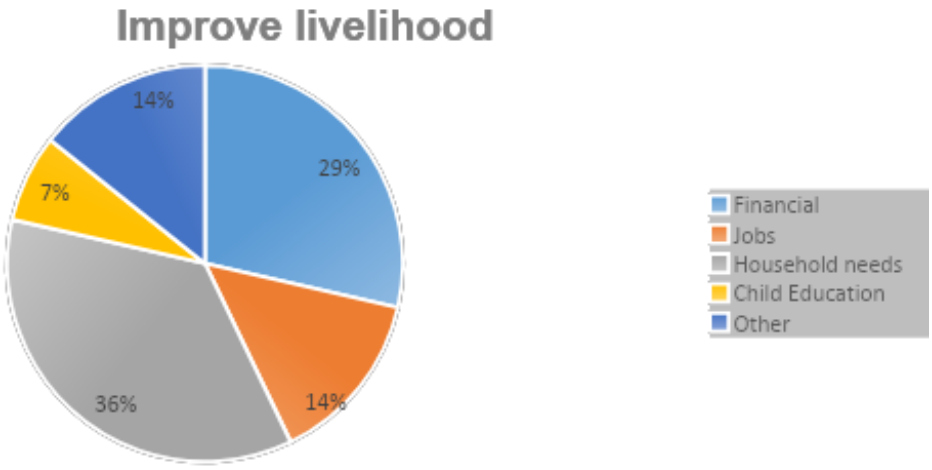


Figure 6: Impact of partnership on farmer's livelihoods.

4. SWEET CHILLI PEPPER CROP AS THE PPP "ECONOMIC BACKBONE

4.1. Growing practices

The economic backbone of the PPP is horticulture, predominantly sweet chilli pepper cropping. The crop is the member of S*olanaceae* plant family, scientifically known as *Capsicum annuum L*. and is commonly known as sweet chilli or bell pepper by locals. Sweet peppers originate from central and South America where numerous species were used for centuries (Manrique, 1993). The crop grows well under warm summer conditions and is sensitive to cold and frost (DAFF, 2013). The optimum temperature requirements for growth and development of sweet chilli peppers range from 20 - 27°C. In high temperatures above 32°C the crop drops flowers (Sajan *et al*., 2001).

Sweet peppers grow well when planted in deep, fertile and well-drained soils (DAFF, 2013). However, soil test is essential to determine soil nutrient content. Peppers grow best at soil pH between 6, 0 and 7, 0. The soil pH should be adjusted to near neutral (7, 0) for maximum yields (Anon, 2000). Water demands of pepper varies with stage of development, however, transplants must be watered to root level to ensure good establishment. Prior to planting, a thorough soil preparation is done with the aid of a tractor and the ridges are established to create rows. The black landscape fabric plastic is laid on ridges for weed suppression and moisture conservation. At planting, transplants are dipped in fungicide for fungal control. One transplant is placed per station, planted at 350 mm spacing between plants in double rows and a spacing of 800 mm allocated between rows for pathways to accommodate 80 000 plants/ha. To

maximise the crop yields, agronomic activities such as watering and hand weeding and insecticide applications are adhered to until the crop is ready for harvest. At harvesting the fruit is hand-picked and 25 tons/ha is regarded as the average yield. The harvested crop is then stored at cold room to maintain quality.

5. CHALLENGES ENCOUNTERED BY FARMERS:

- The Increased frequency of droughts is the major challenge highlighted by the farmers as a result, the area allocated to Chilli pepper has been reduced from 18 ha -12 ha in this current season, due to water shortages from the water source (Sandile Dam)
- Financial transparency between the private partner and the farmers.
- Farmers have no direct market access with end user of the produce.
- Adequate access roads within the scheme to accommodate the easy transportation of produce.

6. FUTURE PLANS

The private partner (RRD) plans to exit the primary production stage of the project and allow the farmers to produce the pepper on their own. However, RRD aims at being the potential market to the farmers by buying their produce for processing.

7. CONCLUSION AND RECOMMENDATIONS

The respondents mentioned many successes and good stories about the partnership. Moreover, respondents indicated that the training acquired from this partnership was vital and will enable them to continue producing even if the partner exits in the future. The partnership made a significant contribution to the livelihoods and socio-economic status through jobs creation for both the farmers and the local community around Zanyokwe Irrigation Scheme and other areas of Amahlathi LM. Hence, it is recommended that partnership of this nature expands to other irrigation schemes in the province to ensure food security and improvement of rural livelihoods throughout the Eastern Cape Province.

8. ACKNOWLEDGEMENTS

The authors would like to thank the farmers of Sidalukukhanya Agric Co-op and for their participation in the study. Extend our greatest gratitude to Rance Rural Development for allowing us to conduct the study and for their contribution towards the success of the study.

9. REFERENCES

ANONYMOUS., 2000. Chilli improved cultivation practices for horticultural crops (pp. 104-106). University of Agricultural Sciences, Bangalore.

DAFF., 2013. Production guidelines, Sweet Chilli Peppers (Capscum annuum) Printed and published by Department of Agriculture, Forestry and Fisheries online available www.daff.gov.za accessed 26February 2020

DUBE, K., 2012. Socio- economic impact assessment of Lower Gweru Irrigation scheme in Zimbabwe. A Master Thesis, University of South Africa. (Online) Available from: http://www.googlescholer/research/Thesis/MScES/dube.pdf

FANADZO, M. & NCUBE, B., 2018. Challenges and opportunities for revitalising smallholder irrigation schemes in South Africa. ISSN 1816-7950 (Online) = Water SA Vol. 44 No. 3 July 2018

FAO., 2016. Public–private partnerships for agribusiness development – A review of international experiences, by Rankin, M., Galvez Nogales, E, Santacoloma, P, Mhlanga, N and Rizzo, C. Rome, Italy

FAO., IFAD., UNICEF., WFP. & WHO., 2017. The state of food security and nutrition in the world 2017. Building resilience for peace and food security. FAO, Rome. URL: http://www.fao.org/3/a-i7695e.pdf (Accessed 18 January 2020).

HOFFERTH, S. L., 2003**.** Persistence and change in the food security of families with Children, 1997-199. Department of Family Studies, University of Maryland.

MELVYN, K., 2003. FAO/IPTRID Consultant, Knowledge Synthesis Report No3 – March 2003, Small Holder Irrigation Technology: Prospects for Sub Saharan Africa.

MHALILA, H., 2007. Morogoro Village Travel and Transport Project, FAO-ODI Study on the Appraisal of Models of Public-Private Partnerships for Rural Infrastructure Development, Rome: FAO.

MITCHELL, D., 2008. Partnerships between Government and Business in South Africa: A practical guide. German Ministry for Economic Corporation and Development. Germany.

PADDY, F., 2003. Gender differentials in land ownership and their impact on household food security: A case study Masaka District. A Master Thesis, Uganda Press, Baltimore and London. (Online) Available from: http://www.troz.uni-hohenheim.de/research/Thesis/MScES/paddy.pdf

RAIDIMI, E, N. & KABITI, H. M., 2017. Agricultural Extension, Research, and Development for increased food security: the need for Public-Private sector partnerships in South Africa. S. Afr. J. Agric. Ext., Vol. 45, No. 1, 2017: 49 – 63

SAJAN, M.K., GOWDA, K.K., KUMAR, S.N. & SREERAMU, B.S., 2001. Effect of bio-fertilizers on growth and yield of chilli (*Capsicum annuum L.), University of Agriculture science,* Bangalore-560065.Karnataka, India

SALAH, D., 2007. Emerging Public-Private Partnerships in Irrigation Development and Management. *Water Adviser for Agriculture and Rural Development, World Bank: sdarghouth@worldbank.org*. Paper no. 1 0 -05- 2 0 0 7

WARNERS, M., KAHAN, D. & LEHEL, S., 2009. Market-oriented agricultural infrastructure: appraisal of public-private partnerships. Agricultural management, marketing and finance occasional paper. Food and Agriculture Organization of the United Nations Rome, 2008

ZAGST, L., 2012. Socio-economic Survey CARE-MICCA Pilot Project in the United Republic of Tanzania, Final report, *Food and Agriculture Organization of the United Nations* (FAO) Climate, Energy and Tenure Division (NRC)

TOWARDS AN EFFICIENT POST COVID-19 ICT BASED EXTENSION SERVICE DELIVERY MODEL FOR THE SUGAR INDUSTRY OF ESWATINI

Dlamini, M.M[1]., Worth, S.H[2]. and Ajayi, O.A[3]

Corresponding author: Dlamini, M.M; Email: mzmdlamini@gmail.com

ABSTRACT

This study presents a designed ICT based extension service delivery system for the sugar industry of Eswatini. The model is an improvement of the current system and it presents a delivery system that is void of many limitations. This model emanates from findings of a survey which involved all smallholder sugarcane farmers (N=172) and their extension officers (N=17). The survey investigated how information and knowledge is currently managed within the sugar industry. Basically the model revolves around the use of mobile phones to relay information among the sugar industry stakeholders in a timely, more organised, productive and cost effective ways without contravention of the Covid 19 pandemic protocols. Sugarcane stakeholders, can now be able to exchange information using the model without having to meet physically; which is what most of the traditional approaches required. The exchange of information can be in a form of voiced, pre-recorded information in the form of texts, audio or audio visuals, This would go a long way in enhancing smallholder farmer's productivity as it has the potential of empowering more rural sugarcane farmers with crucial information for improved productivity. The model has the potential to sustain itself as the participation of the stakeholders is promoted.

Keywords: ICT, mobile phones, Covid 19, sugar industry.

1. INTRODUCTION

The global impact of the COVID-19 pandemic is expanding daily. Governments around the world are faced with a number of challenges related to reducing the overall impact of the pandemic while ensuring sufficient food supplies and the functioning of services to those most in need. Between the current disruptions and future threats to the food supply chain, the COVID-19 outbreak has generated extreme vulnerability in the agriculture sector. It is, therefore, crucial to mobilize all available instruments, institutions and stakeholders from both public and private sectors and civil society to ensure appropriate and timely response. Agricultural Extension and Advisory services (EAS) systems play an indispensable role at the frontline of the response to the pandemic in rural areas. However, to adapt to the emergency context within the government regulations, EAS providers need to rapidly change their way of operating

[1] Lecturer. Department of Agricultural Education and Extension, University of Eswatini, P. O. Box Luyengo, M205. Email: mzmdlamini@gmail.com. Cell: (+268)76045909

[2] Associate Professor. Department of Agricultural Extension and Rural Resource Management. University of KwaZulu-Natal. Email: worths@ukzn.ac.za

[3] Professor. Department of Agricultural Education and Extension, University of Eswatini, P. O. Box Luyengo, M205. Email: ajayi@uniswa.sz. Cell: (+268) 25170500

For decades, the kingdom of Eswatini has continued to grow sugarcane for processing and subsequent export to various countries. This has provided employment opportunities to a number of Eswatini citizens and also contributed immensely to the country's Gross Domestic Product (GDP). Through Eswatini Water and Agricultural Development Enterprise (ESWADE) the Eswatini government has been able to empower a number of smallholder farmers by building dams in the rural areas and facilitated the formation of farmer groups to embark on sugarcane production. This initiative has seen a number of smallholder farmers improving their livelihoods through the production of sugarcane especially in the lowveld of Eswatini. The outbreak of the Covid 19 pandemic has adversely affected the sugarcane production value chain at all levels especially in the area of information exchange as the nation had to lockdown to contain the spread of the virus.

Communication is central to agricultural extension and messages are the real information which is necessary in solving problems (Van den Ban, 2006). Man had always exchange information even with the growing of sugarcane. Farmers in a given area may have produced a given crop for many years but with time as climate change kicks in, weather patterns and soil conditions change and the invasion of pests and diseases deviate from the norm, new information becomes the only solution for the farmers to adjust to such changes and even benefit from these changes. Developing better ways of farming such as the introduction of new varieties which perform much better than the original ones are some of the available options brought about by updated or new information. Omotayo and Adedoyin (2005) observed that farmers in developing countries are slow in recognizing the importance of information as well as the use of ICT to acquire knowledge, instead they have over relied on the use of extension agents. According to Van den Ban (2006), extension agents may be the most effective sources for farmers but obviously not the most efficient as evidenced by huge costs, extent of coverage and time. Recently, the outbreak of the corona virus has made it even more difficult for farmers to meet physically and exchange information.

This paper aimed at evolving a model that will use ICT in Eswatini to strengthen sugarcane extension services such that the barriers presented by the long distances between extension officers and famers for a physical encounter can be effectively cut down such that sugarcane farmers in the farthest and remote rural areas can exchange information with any sugar industry stakeholder without physical contact, thereby minimising the spread of the Covid 19 pandemic and the extra cost of travelling. This will also address the challenge of top to bottom nature of earlier approaches where information was flowing in one direction. With the suggested model, sugarcane farmers can originate queries, and get immediate response via mobile phones while within their work stations.

2. LITERATURE REVIEW

Christoplos (2010, p. 3) defines extension as "systems that facilitates the access of farmers, the organisation and other market actors to knowledge, information and technologies; facilitate their interaction with partners in research, education, agribusiness, and other relevant institutions; and assist them to develop their own technical, organisational and management skills and practices". This definition presents extension as responsible for facilitating farmer's access to information, knowledge and technology as well as developing their own skills and

practices. These functions of extension can be efficiently executed by extension services personnel through the use of relevant ICTs well supported by the environment in which they operate.

The extension strategy of the Eswatini sugar industry aims at improving yields and ensures sustainability through providing technology transfer and advisory services to sugarcane growers on all aspects of sugarcane production. This include provision of advice about research findings to smallholder sugarcane growers and adoption of improved agricultural practises for increased productivity, profitability and sustainability (SSA, 2014/2015). These were attained through the short and medium strategies which include: the capacitation of extension officers to provide farm business management skills to the smallholder farmers; provision of a holistic extension service to growers and the continuous improvement in sucrose yield. The overall long term perspective of extension according to the report aims at moving extension from supply driven (Scheduled) to demand (On request) driven extension.

The Eswatini Sugar Association (ESA) expects that eighty percent of the smallholder sugarcane farmers should be able to make sound business management decisions within ten years of the strategy implementation. Salau, Saingbe, and Garba (2013) submitted that the time is now for the adoption of ICT by every stakeholder in agriculture so as to exchange relevant information in a more efficient way.

The introduction and subsequent use of ICTs by the sugarcane extension personnel and smallholder farmers could be an ideal vehicle that will enable this strategy to be implemented efficiently within the set time frame while maintaining the social distance which is crucial in reducing the spread of the corona virus. Debates have ensured on how ICT can assist in reducing poverty in developing nations (Heek, 1999). Samiullah and Rao (2003) noted that if ICTs are effectively implemented, they have the capacity to reduce poverty and enhance sustainable development however providing updated knowledge to smallholder farmers, especially those located in the remote poor areas can be challenging. ICTs have made such a challenging task manageable. For the smallholder sugarcane producer to improve production, new information that is accurate, reliable and presented timely is very crucial.

3. METHODOLOGY

This article emanates from a study that investigated the influence of extension services using Information Communication and Technology (ICTs) to improve the productivity of smallholder sugarcane farmers hence closing the productivity gap that exist between them and their large-scale counterparts. The study was a census and a structured questionnaire was used to interview all the smallholder sugarcane farmers (N=172), as well as all the sugarcane extension Officers (N=17) actively growing sugarcane in Eswatini during the year of data collection.

The study identified that the Eswatini sugar industry is equipped with characteristics that supports the use of ICTs by the sugar industry stakeholders to improve the productivity of smallholder sugarcane farmers (Dlamini and Worth, 2019). The study also discovered that these characteristics have not been fully harnessed for the benefit of smallholder farmers to optimise their productivity. The findings of the study revealed that both extension agents and

smallholder sugarcane farmers perceived themselves as ready for the implementation and subsequent use of ICTs to facilitate information dissemination among themselves.

Furthermore, the study revealed that both farmers and extension agents perceived what was regarded as barriers to the use of ICTs for information flow as not barriers to them (Dlamini and Worth, 2017). Finally the study revealed the type of information that sugarcane farmers require as well as accurate and reliable sources that have the capability of relaying such information on time. The most efficient ways through which this information could be relayed were also identified.

4. RESULTS AND DISCUSSIONS

4.1. The current sugarcane extension communication model

A number of institutions are responsible for the provision of advisory services and training to the sugarcane growers of Swaziland. These institutions include Eswatini Sugar Association (ESA), Eswatini Water and Agricultural Development Enterprise (ESWADE), Financiers, input suppliers and Government. Most of the communication with farmers around sugarcane production occurs through one or more of these institutions. Figure 1 depicts the current operational model in which sugarcane extension personnel is currently expected to relay information and knowledge between information generators and smallholder sugarcane farmers in Eswatini. Currently the process is completely manual. Extension officers are the ones who have the closest contact with the farmers. Most of the information they keep is on paper and maintained by each extension officer. This information is then translated to monthly reports that are submitted to the different extension mangers within the industry before they are included in the annual report. The process obviously suffers from severe paper based issues such as duplication, redundancy or in case of diary being lost; there is a need to recapture the information from scratch. Each extension service provider (Finance, suppliers, ESA, Government) compiles its annual report that is independent of the other.

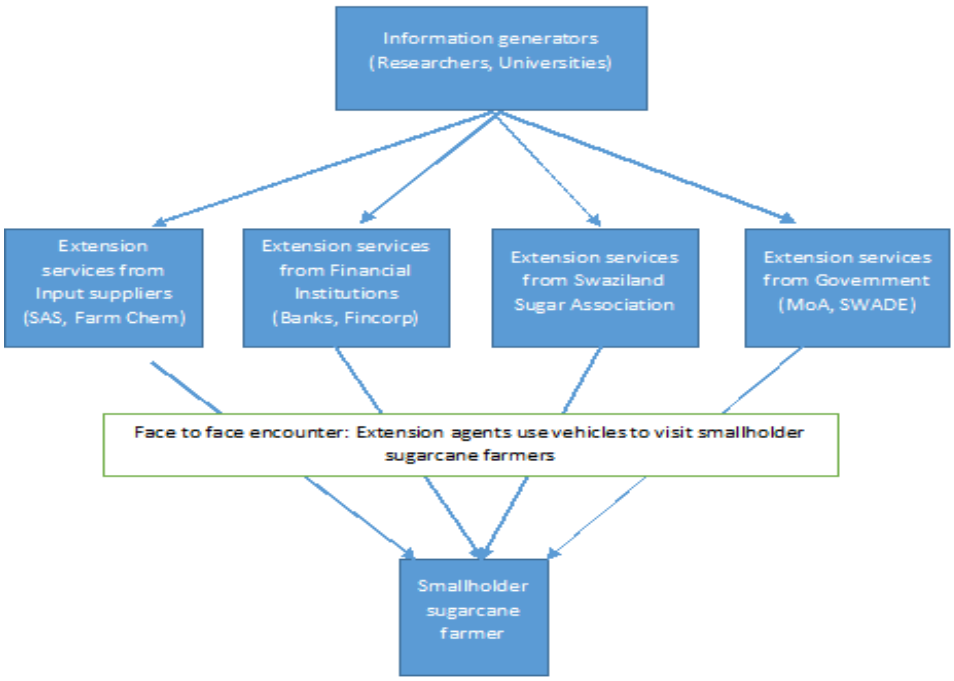


Figure 1: Current model for the sugar industry extension to deliver sugarcane production information to smallholder sugarcane farmers. (Dlamini and Worth, 2017)

Figure 1 shows that information and knowledge is disseminated through mainly the face to face method. Extension Agents are given vehicles and they travel from one sugarcane farmer to the next to disseminate or collect information related to sugarcane production following a pre-determined schedule. This approach was grossly disrupted by the outbreak of Covid 19 pandemic. A lot of man-hours were lost as extension agents could not move freely during the lockdown which was put in place to curb the spread and more over this approach has a great potential of spreading the Covid 19 pandemic. Currently there is no system that supports an extension service delivery which coordinates the three domains which are; Telecommunication, extension and Research for improved information dissemination thereby increasing the productivity of smallholder farmers and maintaining social distancing amongst participants as a way of reducing the spread of the corona virus.

4.2. Challenges of the existing extension system

The method of communication presented in Figure 1 is presented with some challenges for both smallholder sugarcane farmers and extension officers. It is less demand-driven in that officers cannot give guidance to farmers as and when it is needed. Extension workers also do not reside with farmers within the community which reduces the frequency of information exchange among these stakeholders. In addition, extension services provided by governments are not effective due to inadequate funding. Diamond (1992) noted that the quality of extension in Eswatini is plagued by many factors; the major problems center on lack of clearly defined technical messages to be disseminated to the majority of farmers. Oladele et al. (2009: 317-318) found that the key strengths of Eswatini's extension service were that it had improved its extension systems and method, extension plans were highly feasible, and the setting of extension administration units was effective. The same study found that the greatest weaknesses of Eswatini's extension service were over-centralization of the budget for extension work and insufficient manpower.

In addition, Keregero (2000: 79) found that Eswatini's extension service was not contributing to any significant improvement in the livelihoods of farmers. The key cause of this were "a lack of a clearly defined philosophy, often leading to the use of top-down, directive methods; the extension job being male dominated and gender stereotyping; and most of the frontline extension workers being youthful, moderately experienced in their job and relatively lowly qualified". Communication institutions mandated to disseminate information were not trusted by farmers and are further hampered by insufficient extension personnel "leading to inequitable and infrequent coverage" (Keregero, 2000:79).

Most of the smallholder sugarcane farmers are sparsely located in the remote rural areas. Extension agents have to travel long distances to reach them thereby attracting high travelling costs on fuel as well as increasing the risk of either spreading or catching the corona virus. Accessibility is a challenge due to poorly constructed roads which become worse during the rainy season. The frequency of visit to such areas by the extension agent is reduced by such factors thus depriving the farmer of crucial information. Farmers do not receive information on

time and these results to poor decisions being taken out of ignorance which ultimately leads to poor yields. These poor and remote smallholder farmers have minimum sources where they can obtain information as and when they needed it (Diamond, 1992).

Eweg (2005) also observed that some smallholder sugarcane farmers are circumstantial farmers. These are farmers who joined the sugarcane production business not because they had the passion for the business but because they found themselves within the development project area where sugarcane needed to be grown. Therefore, Eweg (2005) noted that this kind of farmer needs a lot of extension support and motivation to be convinced that the sugarcane production business is viable. It becomes therefore difficult for such farmers to perform efficiently under this type of extension model.

4.3. Emergence of a better sugarcane extension communication model

Sequel to the challenges associated with the existing model of communication, a new model is emerging from the modification in response to the challenges associated with the traditional model. The emerging model is a result of the study findings and it fits well to the country's telecom infrastructure. It aims at addressing the problems of converting extension information into digital form while at the same time allowing marginalised smallholder sugarcane farmers to have timely access to accurate information. It also fits well in the global strategies adopted by the World Health Organisation of social distancing as a way of reducing the spread of the coronavirus.

The model presented in Figure 2 is designed as sugarcane extension communication model that aims at facilitating better communication between sugarcane farmers, information generators and extension officers. This model identifies three elements injected into the existing model in order to promote efficient and effective information dissemination among the sugar industry stakeholders via ICTs. The model introduced a tele-centre to be administered by ESA in conjunction with Eswatini Mobile Telephone Network (MTN) to coordinate all information between the different extension service providers and smallholder sugarcane growers. This will reduce travelling costs and physical contact with farmers and all other stakeholders thus reducing the problem of time lag caused by lockdown implemented by the government to stem the spread of the deadly pandemic.

Also proposed is that every stakeholder especially smallholder farmers and extension officers should possess mobile phone applications for exchange of sugarcane production information among themselves and other stakeholders, which is the case with the entire Eswatini sugar industry as indicated by Dlamini and Worth (2019). This will ensure that technical messages are relayed timely and effectively between famers and extension officers. Finally, the model requires sufficient network coverage in all the areas where sugarcane is grown to enable the use of mobile phones for information dissemination. Again, Dlamini and Worth (2019) found that almost every sugarcane growing area in Swaziland is covered with the mobile network which may require enhanced signal strength at some places. This will enable every farmer to have unlimited access to information disseminated via ICT as presented in the model.

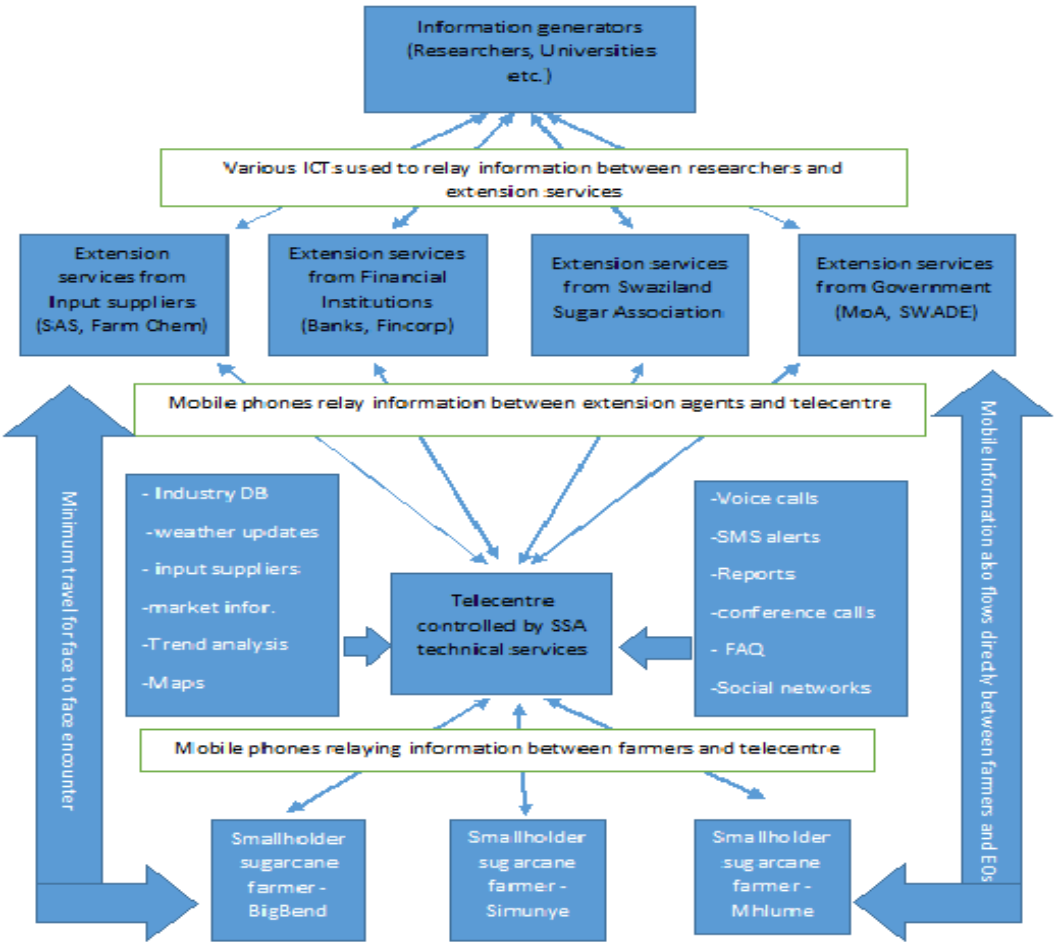


Figure 2: A refurbished model for the sugar industry extension to deliver sugarcane production information to smallholder sugarcane farmers

The interaction between rural farmers and extension officers via ICT within the tele-centre will be enhanced since there will always be people in the tele-centre who will facilitate the exchange of information thus giving both farmers and extension officers unlimited access to vital information.

The main component of the model consists of firstly the user base which are the sugarcane farmers, extension officers and institutional users. The second component is the user interface which consists of the mobile applications for farmers and extension officers as well as the web based interface for institutional users. This model suggest creating an extension system that allows accurate and reliable information to be circulated timely via mobile phones among the industry stakeholders enabling everyone to possess adequate and up to date information for making accurate decisions on time. This would improve sugarcane productivity of smallholder farmers.

4.4. Mobile phones

Despite their new entrance into remote agricultural communities, mobile phones are already assisting smallholder farmers in the rural remote areas to improve their agricultural activities.

Advances throughout the mobile phone ecosystem have presented numerous advantages to smallholder sugarcane farmers which include:

- Access – most rural and remote areas of developing countries are experiencing an increase in mobile wireless networks and the number of people using mobile phones is on the increase;
- Affordability – the availability of affordable gadgets has made it possible for even rural smallholder farmers to own second hand mobile phones and use it to exchange information; and
- Applications – the available applications and services found in mobile phones start from simple text messaging services to increasingly advanced software applications. This application allows even the less skilled person in terms of operating the gadgets to be able to benefit from them. Making/receiving a call and sending text messages are some of the applications that are simple to operate.

The most common way through which mobile phones can enhance sugarcane production is through facilitating farmer exposure to less costly information. Where sugarcane production areas are remote with inaccessible roads, substituting phone calls for travel reduces time and cost burden for every sugar industry stakeholder. Sugarcane farmers who utilise mobile phones do save on travelling costs (Overå, 2006) and this effect is more real to those farmers that are in remote areas (Muto & Yamano, 2009). It is not possible however, to completely avoid transport because extension officers do need to physically visit the farmers in field for real assessments and demonstrations.

Mobile phones are multifunctional devices ranging from regular phones to smart phones. Mobile phones do much more than simply placing a voice call. Table 1 summarises the various types of mobile technologies and their availability.

Table 1: Types and Availability of Mobile Technology

TECHNOLOGY	**DESCRIPTION**	**AVAILABILITY**
Voice	The most basic channel; avoids most literacy or linguistic barriers	Basic phones
Short Message Service (SMS)	Ubiquitous text-based message limited to 160 characters	Basic phones
Unstructured Supplementary Service Data (USSD)	A protocol used by Global service for mobile communications (GSM) phone to communicate with the mobile network.	Basic phone
Interactive Voice Response	Computer programs that respond to the voice input of callers	Basic phones
General Packet Radio Services (GPRS)	Low bandwidth data service	Mid-range phones
Software App (e.g. Java or iOS)	Preinstalled or downloaded software of varied sophistication	Smartphones

TECHNOLOGY	DESCRIPTION	AVAILABILITY
Mobile wireless Application Protocol (WAP)	A limited manner of browsing the internet	Mid-range phone
Multimedia Messaging Service (MMS)	SMS-based technology to transmit multimedia (Including images and video)	Mid-range phone
Camera	For capturing still or moving pictures	Mid-range phone
Bluetooth	Protocol for transmitting data over short distances	Mid-range phone
Mobile web	Full-fledged web access	Smart phones
Global Positioning System (GPS)	Technology allowing for location-based information	Smart phones

Source: https://www.crisscrossed.net/2009/11/01/the-many-potential-channels-for-mobile-services/

The capabilities of mobile phones are improving on a daily basis and information channels are converging. Smart phones and software applications provide advanced functionality such as conference calls, video conferencing, social media, GPS for mapping functionality, mobile money applications among others. Extension can now access many clients within a short space of time through mobile based learning platforms such as texts, pictures and short video clips which provide information to sugarcane farmers on how to improve their sugarcane production skills and knowledge.

4.5. The Information and communication Centre

This is the main engine of the model, and it consists of the technology centre, Infrastructure management, Knowledge management, helpline and the panel of experts.

The technology centre is where information is given to farmers/extension officers via mobile phones. The information may vary from general issues regarding sugarcane production to more specific issues such as weather updates, control of sugarcane pests and diseases, market environment among others. The study has revealed that sugarcane farmers are heavy users of regular phones manufactured by Nokia and Samsung.

Another advantage is that of collecting information from field for institutional users using mobile phones. This will ensure an efficient and accurate data collection process that will yield timely reports. This is also where there is infrastructure management which involves the management of information exchange links (Internet and Phone).

The main objective of knowledge management is to produce meaningful information from the operational data and get useful results from it through providing more personalised, client oriented and crucial information forwarded straight to the famer's handsets. The knowledge generated will be for researchers, research users and policy makers. Help line will operate like a call centre and it will address sugarcane production problems that cannot be solved via mobile applications. For issues that cannot be answered by the helpline staff, the call will be re-directed

to a conference call where an expert in the field will be asked to shed some light. Information from such discussions would be loaded in frequently Asked Questions (FAQ) database.

Panel of experts in sugarcane production would support the helpline staff. These will be knowledgeable extension officers already working in the field who will work as consultants for the helpline. Queries not addressed by the helpline will be forwarded to the appropriate research institutions. The extension agents are very important as they understand the language of researchers and the technical terminologies and could break it down to communicate well with the farmers in the language they could easily understand.
Specifically, the model aims at achieving the following

- Provision of accurate, reliable and timely usable information among the sugar industry stakeholders. The information will be about mainly the information needs of smallholder sugarcane farmers as identified by Dlamini and Worth (2019). Such information will be distributed through mobile applications.
- Disseminating information in local language. This is easier for Swaziland as one national language is used and understood by every citizen of the country.
- Delivering voice based content to the sugar industry stakeholders thus overcoming literacy barriers.
- Establishing a helpline backed by experts in the sugarcane growing field and providing advice within the shortest time possible.
- Improving agricultural extension by using specialized applications on mobile phones such as those applications that can aid in data collections for surveys conducted by research institutions.
- Creating a solid financial and technological base in terms of content.

4.6. The project impact

The model presents potential for a fair access to information by sugarcane growers especially smallholder farmers. This will improve the ability of farmers to make accurate and informed decisions thus improving their productivity. The process of collecting data using mobile phones will lower infrastructure costs, remove transportation costs, increase accuracy and also help in the monitoring of field staff. The project output will have an influence towards policy making and enhance the working standards of extension officers.

4.7. Opportunities offered by the model.

The model has the ability to assist the sugar industry stakeholders have access to up-to-date information and guidance from different reliable sources. These sources may include extension officers, other farmers, researchers and agricultural database websites among others. Requests are forwarded to the information communication centre where appropriate responses are generated by relevant researchers. This approach is different from the traditional one (Overå, 2006) where all queries are managed by one agricultural expert.

4.7.1. Unlimited exposure to information

Another important feature of the model is its ability to stimulate farmer driven extension where by farmers initiate request for guidance and assistance based on their unique needs. This model

also ensures that farmers get real time response to their requests; they do not have to wait for longer periods to submit their request which was the case with the traditional model when the extension officers were expected to visit them. The demands can be made almost immediately when there is need for it (Overå, 2006).

4.7.2. Cost effectiveness

The model is also potentially cost effective as the costs can be distributed to all the industry stakeholders so that it is shared equally. This will make even smallholder sugarcane farmers be able to contribute towards this project. The design is also self-sustainable as all the services it provides could be charged at a minimum fee. Donor agencies could also be encouraged to finance projects that are aimed at improving the productivity of smallholder rural farmers.

4.8. The challenges and ways to minimize the effects

This section of the paper highlights some of the possible challenges of the model and discusses how their effects could be minimized.

4.8.1. Illiteracy

Illiteracy has always been a challenge when it comes to technology adoption. This is especially very true when the technology has to do with information exchange. For instance, people who use their mobile phones for voice communication are more than those who use the mobile phones for text messaging functionality. New applications have been put in places that have the capacity to recognise voices. These applications are ideal for the illiterate population so that they can have access to information on "voice sites" (and not websites) in audio format.

4.8.2. Power supply requirement

All ICT tools need electricity to operate. However, as observed earlier in this study, Swaziland has embarked on a project of rural electrification which has seen the entire sugar belt receiving a complete coverage. This however could be supplemented by the use of solar panels during the day.

4.8.3. Funding

The funding needed to operate this model are in two parts; the establishment cost and the maintenance costs. These could be provided by a collaboration of the Eswatini Cane Growers Association, Eswatini Millers Association, sponsors and the government of Eswatini.

5. CONCLUSIONS AND RECOMMENDATIONS

Countries all over the world are engaged in national development and this objective is recommendable because people's lives are ultimately enhanced. For any country to achieve this objective, it must start this development at grass roots by first engaging agriculture and rural development. The first and important step towards this idea is the development of human resources by building their capacity to engage in productive agriculture by deploying innovations and technology. This could be done via the use of mass media channels. In Eswatini, where sugar production is an economic activity, it is important to maintain a good

balance in the dissemination of information among the sugar industry stakeholders so as to harness the full potential of rural populace towards attaining national development.

Farming in a sustainable manner is both knowledge intensive (Garforth & Lawrence, 1997) and information demanding compared to conventional methods, because skills effectively takes the space of external inputs (Garforth & Lawrence, 1997; Pretty, 1995). In essence, the roles of knowledge, information, technologies, skill and attitudes in sustainable agriculture cannot be overstated and sustainable farming would necessarily be best supported by extension through implementation of programmes aimed at building capacity among farmers.

In sum, the model could be adopted to achieve a strong and healthy agricultural extension delivery system in the sugar industry of Eswatini.

This model will no doubt assist the extension workers access more farmers in a cost-efficient manner with minimum contact as required in the post lockdown protocol advocated by the World Health Organisation to stem the spread of Covid 19. To achieve this, the following recommendations are made;

- This model should be subjected to continuous evaluation to keep improving the model.
- All the sugar industry stakeholders, especially the smallholder farmers should be trained on the use and benefits of the model.
- Pilot sites could be established in various locations of the country (e.g. in the three sugar mills of the country) to assess its effectiveness.
- The search for sponsorship should be undertaken where potential donors and government agencies should be requested to finance the project.

6. REFERENCES

CHRISTOPLOS, I. 2010. Mobilizing the potential of rural and agricultural extension.

DIAMOND, J. E. 1992. Agricultural extension in Swaziland: An evolution. Conference Proceedings of the Symposium for Research in Agricultural and Extension Education. Agricultural and Extension Education: Preparing for the 21st Century. Columbus, OH: The Ohio State University.

DLAMINI, M.M. & WORTH, S.H. 2019. Readiness of the Swaziland sugar industry towards the use of ICT specifically cell phones to access information: perceptions of smallholder sugarcane farmers and extension officers. *South African Journal of Agricultural Extension,* 47(3): 92-107

DLAMINI, M.M. & Worth, S. H. 2017. Barriers to Sugarcane Production Information Access via ICT: Perceptions of Extension Officers and Smallholder Sugarcane Growers in Swaziland. *Asian Journal of agricultural extension, Economics and Sociology*. 21(2):1- 13.

EWEG, M. 2005. The changing profile of smallholder 'sugarcane'farmers in South Africa. *Unpublished paper, South African Sugarcane Research Institute, Mount Edgecombe, South Africa*.

GARFORTH, C., & LAWRENCE, A. 1997. Supporting sustainable agriculture through extension in Asia. *Natural Resource Perspectives, 21*.

HEEK, R. 1999. Information and Communication Technologies, Poverty and Development. Development informatics Working Paper Series, Paper No5, June 1999, IDPM, Manchester.
KEREGERO, K. J. B. 2000. Reaching Swazi nation land farmers: challenges to the credibility of agricultural extension in Swaziland. *UNISWA Journal of Agriculture,* 9: 79-89.

MUTO, M., & YAMANO, T. 2009. The impact of mobile phone coverage expansion on market participation: Panel data evidence from Uganda. *World Development,* 37(12): 1887-1896.

OLADELE, O.I., J. LEPETU, S.K. SUBAIR and J. OBUH. 2009. SWOT analysis of extension systems in Southern African countries. *Journal of Agriculture and Environment for International Development 2009,* 103 (4): 309-32

OMOTAYO, A., & ADEDOYIN, S. 2005. Information Communication Technology (ICT) and Agricultural Extension: Emergency issues in transferring agricultural technology in developing countries. *Agricultural Extension in Nigeria. Ilorin: Agricultural Extension Society of Nigeria*.

OVERÅ, R. 2006. Networks, distance, and trust: Telecommunications development and changing trading practices in Ghana. *World Development,* 34(7): 1301-1315.

PRETTY, J. N. 1995. *Regenerating agriculture: policies and practice for sustainability and self-reliance*: Joseph Henry Press.

SALAU, E., SAINGBE, N., & GARBA, M. 2013. Agricultural Information Needs of Small Holder Farmers in Central Agricultural Zone of Nasarawa State. *Journal of Agricultural Extension.,* 17(2): 113-121.

SAMIULLAH, Y., & RAO, S. 2003. Role of ICTs in urban and rural poverty reduction. *DFID.*

SSA. (2014/2015). Annual Report. Mbabane. Swaziland.

VAN DEN BAN, A. W. 2006. *World trend in agricultural extension.* Paper presented at the Proceedings of the 2nd international conference of agriculture, education and environment held October 13-16, 2004 at the Rural Development Administration, Suwon, Korea.

THE ROLE OF BIOGAS SLURRY IN IMPROVING AVAILABILITY AND QUALITY OF GREEN FEED IN WINTER AND DROUGHT TIMES IN MACUBENI, EASTERN CAPE, SOUTH AFRICA

Matyholo-Mapeyi, N[1]. and Gambiza, J.[2]

ABSTRACT

The low quantity and poor quality of forage in rangelands during the dry season is one of the major factors limiting livestock production in the smallholder sector. Veld management practices have led to reduction in palatable grass species and this has lowered the quality of fodder available. The growing of fodder species and use of inorganic fertilizer is a commonly used strategy to increase fodder quantity and quality. The objective of this study was to assess the effects of biogas slurry on forage yield and quality of annual and perennial grass and legume forage species. Arrow leaf clover (*Trifolium vesiculosum)* and oats (*Avena sativa)* species were grown together per treatment as Annual legume and grass mix (ALG) where ALGs was slurry applied and ALGo was non slurry applied treatment. White clover (*Trifolium repense)* and fescue (*Arundicenae festuca)* were grown together as perennial legume and grass mix as PLG, where PLGs was slurry applied and PLGo non slurry applied a treatment. In 2012, slurry was applied to plots seven weeks after planting and then fortnightly thereafter until the third cut. The slurry was incorporated onto the soil surface during 2013 and 2014. Oats and fescue treatments were cut thrice annually. Cut 1, 2 and 3 done in May, July and September respectively. Legumes between grasses were not sampled due to missing data. Dry matter yields (DMY) were not significantly different among treatments. In 2012. DMY for cuts 2 and 3 differed significantly ($P<0.05$) across sites. Potassium (K) content showed significant differences ($P<0.05$) among treatments and across sites. Nitrogen content (N) in cut 1,2 and 3 showed significant differences amongst the treatments and across the sites whereas crude protein (CP) content at cut1 was not significantly different across the sites, but showed significant differences amongst the treatments in 2012 and in 2013. The digested slurry may have nitrogen losses due to the processing of heat to the stove.

Keywords: Biogas slurry, annual grass, perennial grass, dry matter yield, quality, quantity

1. INTRODUCTION

Livestock in communal areas depend on natural veld. It is important for the livestock owners to manage veld to maintain soil and its cover through applying sound veld management practices. Principles of veld management according to species in that particular veld are a guide onto how a certain veld could be managed and maintained (Edwards, 1981; Van Oudshoorn, 2014). Rangelands are important and their management must therefore reduce land degradation which is aggravated by soil erosion, overgrazing of veld, overstocking camps and lack of rules

[1] N Matyholo-Mapeyi: Researcher in the Department of Rural Development and Agrarian Reform, Dohne Agricultural Development Institute, Private X15, Stutterheim, 4930. Email: nobuntu.mapeyi@drdar.gov.za https://orcid.org/0000-0002-2027-5322

[2] Professor J. Gambiza: Associate Professor at Rhodes University, Department of Environmental Science, P O Box 94, Grahamstown, 6140. Email: james.gambiza@gmail.com

of the land tenure in communal lands. Projects on veld management and soil had made means to assist in recovery of certain previously mismanaged land where dongas have occurred with measures that could rehabilitate the land. In certain areas, land is recovering. Lack of knowledge of causes of land degradation led to shortage of feed resources for the livestock in communal land. In winter, there is a shortage of feed caused by lack of moisture, poor quality of the veld, since it becomes dry and unattractive to graze (De Villiers and Letty, 2000; Mapeyi and Gumede, 2009). Livestock owners relied on fences to have rested camps and now there are no fences existing to implement these rotational resting and grazing practices (Edwards, 1981; Tainton, 1999).

Commercial farmers invest in their livestock, but communal farmers opt for cost effective means of overwintering animals due to shortage of resources (Mapeyi et al, 2013a; Mapeyi et al, 2013b). Investment is slightly different because a livestock keeper have dignity owning livestock i.e. status amongst families (Ainslie, 2009). Various options to communal livestock owners are use of crop residues in arable lands, plant forage crops; buying bales and feed from co-operatives plant forage crops. Buying feed and bales is unaffordable, besides, the distance to and from the suppliers and transport costs limit this alternative means of supplementation. Therefore, it became important to introduce forage crops as one of the solutions to overwinter livestock. Less cropping activities had led to shortage of feed for livestock since maize stalks used to be grazed in winter in the arable lands. Shortage of feed and its quality in winter and drought times is a challenge to livestock production, Quality means the nutrient contents of the feed including CP; macro (N, P, K), micro elements namely: - magnesium (Mg), zinc (Zn), Iron (Fe), manganese (Mn) and fibre namely: - acid detergent fibre (ADF) and acid detergent lignin (ADL) contents.

Fertilisers are one of the inputs limiting crop production, therefore an alternative means would be use of organic fertilisers like kraal manure and bio-slurry. Fertilisers addifies the required nutrient contents by the soil to produce quality feed. When Bioslurry is used as a top dresser or as fertiliser it can be applied before or after planting and is an option to improve availability and quality of feed in winter for supplementing livestock. Planting forage crops could allow resting of the veld for winter, thus reducing trampling of the dry grass (Aucamp, 2008). The current practice by sheep owners in the study area is planting annual grass, oats, therefore the study will promote establishment of perennial grasses that may reduce input costs as mentioned above. Perennial grasses or legumes may require once land preparation and fertiliser application in seven years and only be maintained by a top dresser annually, that could either be slurry or any manure or any organic manure.

The objectives of the study were:-

- To study the effect of biogas slurry on quality of oats and fescue.
- To study the effect of biogas slurry on quantity of oats and fescue.
- To provide feed supplement for winter

2. MATERIALS AND METHODS

2.1. Study site

The study was conducted in 4 communities of Macubeni Administrative Area (AA) in Lady Frere in the Eastern Cape. Macubeni AA is situated 40 km south west of Indwe and 20 km north of Lady Frere and is under the Malahleni local municipality under Chris Hani district municipality. It lies between 27^0 01-16` E and 31^0 27-36' S. The average rainfall ranges between 501-600 mm per annum. The soil types of the selected sites are a mosaic of mudstones and sandstones with dolerite intrusions (Shackleton and Gambiza, 2008). The soils are stony and shallow.

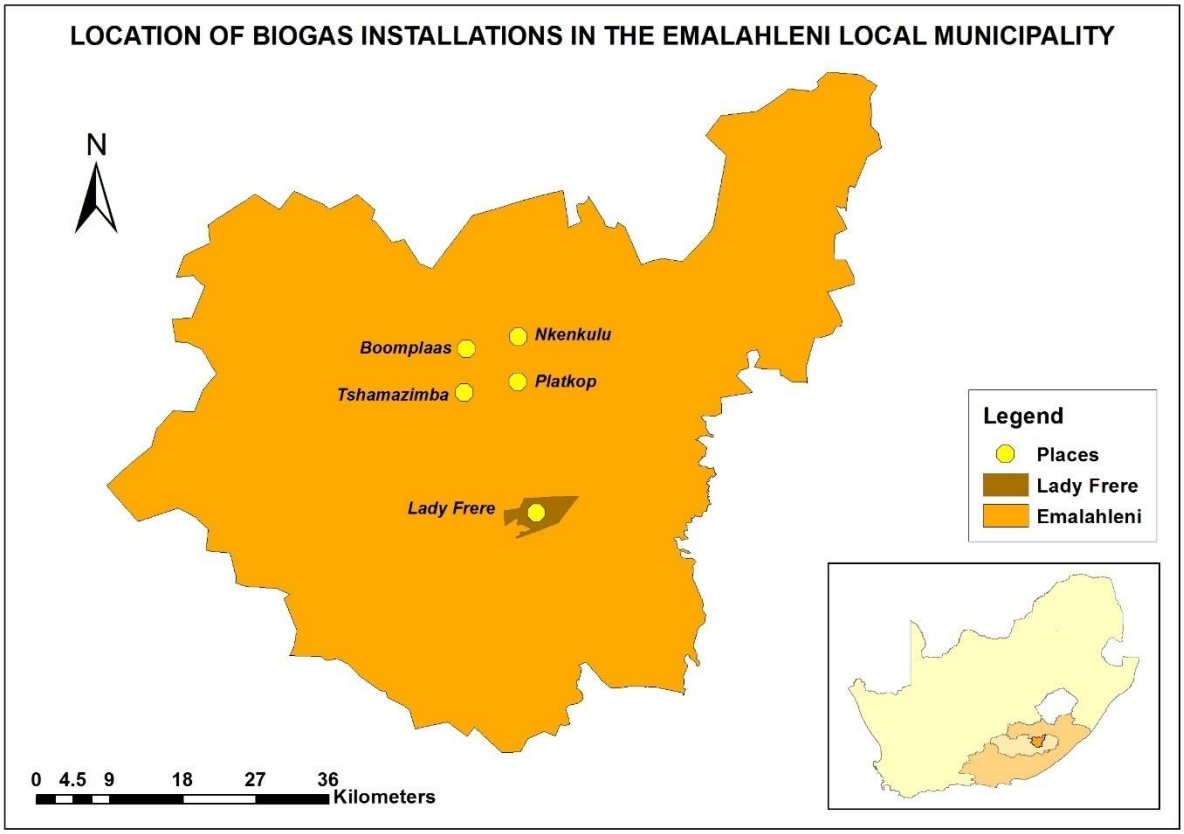


Figure 1. Map of Macubeni Administrative Area

It is characterised by a hilly and mountainous terrain, ranging between 1300 and 2100 meters above sea level. Dominating grass species are *Themeda triandra, Eragrostis capensis, Elionurus muticus, Harpochloa falx, Andropogon Appendiculus, Eragrostis curvula, Eragrostis choromelas, Microchloa caffra and Heteropogon contortus*. The sites are approximately 10km apart from each other. They are in four villages, namely: - Platkop, Nkenkulu, Boomplaas and Tshamazimba where there are bio digesters. The veld type in Macubeni is Grassland Biome as classified by (Mucina and Rutherford, 2006). The population in Macubeni Administrative area in Figure 1, is 7500 people in 14 villages and this is under the Grassland Biome (IKhwezi, 2003).

2.2. Experimental design

A factorial experimental design with three replications was used at each homestead. The two factors were the grass/legume mixture (two levels) and slurry (two levels). Each homestead was a block and each homestead had 12 plots of 25sqm with 1m border line. Plots were as follows: zero slurry treatments were ALG_0; PLG_0 and slurry applied plots/treatments were ALG_s& PLG_s. A denotes annual and P is for perennial mix. L stands for legume and G means grass. The annual legume and grass that was used were Arrow leaf clover (*Trifolium vesiculosum*) and oats (*Avena sativa*), whereas the perennial mix were the White clover (*Trifolium repens*) and Fescue (*Arundiceanae festuca)*. The species selected because they are cool season grasses and legumes survive in most soil type and lower rainfall areas (Bartholomew, 1995). Physical barriers between plots were installed around the slurry applied treatments to avoid contamination of non-slurry applied treatments. Enclosure cages were put in all 48 plots at the centre where the samples were collected i.e. in the square metre quadrant. The fence cages were chicken and rabbit proof.

2.3. Procedures

2.3.1. First year

2.3.1.1. Pre-planting until harvesting

Soil sampling was done in November 2011, prior to biogas digester setting up and planting. In all five sites, soils samples were collected by 150mm auger at 10cm depth. Samples were oven dried after the wet weight measurement and then oven dried and weighed. Samples were milled for analyses by the Atomic Absorption Spectrometry.

All five samples were submitted at the Dohne laboratory for current nutrient analysis and lime requirements for fertiliser recommendations to measure current fertility status of the soil. Dung and biogas slurry was analysed for nutrient quality that is Nitrogen (N), phosphorus (P), Potassium (K), Magnesium (Mg), Calcium (Ca) and Sodium (Na) and micro nutrients. The cattle slurry was ground and digested using a wet ashing technique followed by spectro photometric or calorimetric analysis of macro and micro nutrients mentioned above (Okaleb et al, 1993; AOAC 2000, AOAC 2002; Non-Affiliated Soil Analysis Working Committee, 1990). Tests for N content was analysed with Kjedahl flask (Scotford, 1998).

Figure 2. A Tractor tilling the soil

Figure 3. Farmers participating as a family

The first land preparation was done by a tractor and a disced in Figure 2. Levelling of seedbeds was done by hand where family members assisted in Figure 3. Planting was not done same week or same day in all sites, therefore there was a two week interval in all activities of the trial. The Oats cultivar used was Palli 40: 1.5kg seed for the 25sqm area i.e. each plot is 5m x 5m with border of 1m. Arrow leaf clover was an AR Zulu cultivar planted at 2g per plot, hand sprinkled over the plots. The Tall Fescue was Border seed cultivar 1.2kg per sqm and white clover cultivar used was Haifa at 2g. All seeds were broadcasted by hand.

Superphosphate was added at 750g per plot except at Kiti the soil recommendations were double the other sites and 1.5kg added. The site allocated was in an arable land whereas other sites were homestead gardens. Topdressing of the slurry applied plots i.e. ALGs and PLGs started by the seventh week post planting and every fortnight topdressing was done meaning that at week nine topdressing occurred.

Slurry application was done in the 8^{th} week in all slurry treatments/ plots, 20L of slurry and 20L of water in the non-slurry application plots. Irrigation was done fortnightly. Undiluted slurry was applied in the beginning but as it matures it was thicker and difficult to apply. Application was done by watering cans. Only two plots could be sampled at a time on the $8^{th,}$ 16^{th} and 24^{th} week. Grass height was measured by the ruler where 10 plants were measured across the plot and averaged. Sampling was done in a 1square metre (sqm) quadrat at the centre of the plot in three replicates of each treatment. After fodder samples were cut, topdressing with slurry was done. Plant samples were weighed for fresh herbage weight, dried overnight at 65^0C for 48hrs, weighed for dry mater content and milled for laboratory analysis of crude protein; macro, micro nutrients and fibre contents. There had been more focus on Dry matter yield, N, P, K in this study. After cut 3 all 48 plots in four sites were sampled for soil tests.

2.3.2. Second year

2.3.2.1. Pre-planting until harvesting

The adaptive management of the trial was done to cater for uncontrollable environmental factors (Chow and Chang, 2008). Plots which had between 80- 95% grass cover for perennial grass were reseeded by third week of March. The summer was dry in year 1 and 2.

Nonsignificant DMY led the application method. Oat plots with poor germination were replanted. The application method was changed by incorporation of slurry into the soil. A 20L bucket of slurry was applied since watering got clogged dung lumps the previous year. In a research done in Massey University Tuapaka Bull beef unit, herbage was hand plucked every 2 weeks before the animals could graze in each camp in a perennial grass and white clover mix (Machado et.al, 2005).

2.3.2.2. Pre-planting until harvesting in 3rd year

No superphosphate was applied to both slurry (i.e. ALGs, PLGs) and non-slurry (ALGo and PLGo) applied treatments. No legume seeds were planted and there were three sites where white clover never germinated. In 2013, arrow leaf clover seed was assumed to be in the soil. Irrigation was applied to slurry applied plots only and top dressed once this year. The slurry was not available due to non-working biogas tanks .Transportation so slurry from 2 aits for application occurred by 3rd year. Slurry applied treatments were irrigated until wet and no water was applied to the zero slurry applied treatments i.e. ALGo and PLGo plots.

Irrigation was done with a hosepipe. Burning of the slurry patches was observed when it was too dry.

3. RESULTS

Dry matter yields

Table 1: Showing DMY of oats and fescue treatment (kg/ha)

YEAR	CUT NO.	ALGo	ALGs	PLGo	PLGs
2012	1	4077^{b}	2668^{a}	2531^{a}	3827^{b}
	2	782.5^{c}	402.2^{a}	599.9^{b}	565.0^{b}
	3	2660^{bc}	1908^{a}	2167^{ab}	2758^{c}
2013	1	4285^{b}	4110^{b}	3220^{a}	2642^{a}
	2	4419^{a}	4504^{a}	4582^{a}	4060^{a}
	3	5229^{b}	4425^{a}	5016^{a}	4895^{a}
2014	1	2495^{ab}	2486^{ab}	2678^{b}	1941^{a}
	2	5090^{b}	3931^{a}	4375^{ab}	4521^{ab}
	3	2110^{a}	2175^{a}	2195^{ab}	2552^{b}

Table 2: Showing DMY of oats and fescue per site (kg/ha)

YEAR	CUT NO.	Kiti	Makoma	Nyiki	Sothuko
2012	1	2913	3777	3207	3207
	2	585	790	233	742
	3	1694	4115	1652	2031
2013	1	4048	3168	4289	2752
	2	3669	6189	3373	4334
	3	4756	4410	5386	5013
2014	1	3158	2168	2153	2120
	2	5644	3727	4163	4380

	3	2279	1972	2213	2569

ALG= annual legume and grass mix i.e. arrow leaf clover and oats, PLG= perennial legume and grass mix i.e. white clover and fescue, s=slurry applied, o=Zero slurry, ct=cut, yr=year

In 2012 dry matter yields (DMY) were not significantly different among treatments ($P<0.05$) and across sites in Table 1 and 2. In 2013 DMY showed highly significant differences ($P<0.05$) amongst treatments and across the sites. In 2014, DMY showed significant differences at cut 1 and 3 across the sites, but non-significant in cut 2 amongst treatments. All cuts per treatment in perennial mixture showed non-significant results except ct1yr1, ct3yr1, ct3yr2, ct2yr3, ct3yr3 where PLGs is significantly higher than PLGo.

3. NUTRIENT QUALITY IN OATS AND FESCUE

The data for micro-nutrients and fibre were excluded in this paper and this is stated due to the fact quality entails macro and micronutrient content in a feed and fibre content. Soil nutrient contents were not presented to measure impact of slurry.

Table 3: Showing K content of oats and fescue per treatment

YEAR	CUT NO.	ALGo	ALGs	PLGo	PLGs
2012	1	3.82^{a}	5.03^{ab}	6.92^{b}	5.89^{b}
	2	1.553^{a}	1.771^{ab}	1.866^{bc}	1.96^{c}
	3	1.432^{a}	1.708^{ab}	1.898^{bc}	2.282^{c}
2013	1	2.06^{b}	1.488^{a}	1.286^{a}	1.364^{a}
	2	1.241^{ab}	1.594^{b}	1.164^{a}	1.043^{a}
	3	2.498^{a}	2.689^{ab}	2.865^{ab}	3.079^{b}
2014	1	2.502^{a}	2.685^{ab}	2.865ab	3.079^{b}
	2	1.492^{b}	1.829^{c}	1.085^{a}	1.336^{ab}
	3	1.462^{a}	1.458^{a}	1.351^{a}	1.406^{a}

Table 4: Showing K content of oats and fescue per site (%)

YEAR	CUT NO.	Kiti	Makoma	Nyiki	Sothuko
2012	1	4.56	5.5	6.52	5.09
	2	1.263	2.29	1.098	2.5
	3	1.431	2.29	1.099	2.5
2013	1	1.536	1.615	1.202	1.844
	2	3.669	2.189	2.373	2.334
	3	3.469	2.967	1.964	2.73
2014	1	1.964	2.73	3.469	2.967
	2	1.105	1.836	1.537	1.264

	3	1.115	1.626	1.399	1.537

Table 5: Showing CP content of oats and fescue per treatment (%)

YEAR	CUT NO.	ALGo	ALGs	PLGo	PLGs
2012	1	11^{a}	13.51^{ab}	15.55^{bc}	16.97^{c}
	2	7.12^{a}	7.86^{a}	10.77^{b}	10.32^{b}
	3	7.04^{a}	7.92^{a}	10.68^{b}	10.41^{b}
2013	1	15.4^{b}	14.92^{b}	9.85^{a}	9.52^{a}
	2	10.01^{ab}	12.26^{b}	7.26^{a}	7.79^{a}
	3	9.56^{ab}	7.71^{a}	10.95^{ab}	11.43^{b}
2014	1	9.55^{ab}	7.72^{a}	10.95^{ab}	11.43^{b}
	2	6.94^{b}	8.77^{c}	5.07^{a}	6.35^{ab}
	3	8.07^{a}	8.06^{a}	9.34^{a}	7.16^{a}

Table 6: Showing CP content of oats and fescue per site (%)

YEAR	CUT NO.	Kiti	Makoma	Nyiki	Sothuko
2012	1	13.24	15.03	12.99	15.77
	2	7.45	13.07	7.44	8.1
	3	7.45	13.07	7.44	8.1
2013	1	13.24	15.03	12.99	15.77
	2	7.45	13.07	7.44	8.1
	3	11.27	9.63	7.41	11.33
2014	1	7.41	11.33	11.27	9.63
	2	5.26	7.42	7.13	7.32
	3	4.8	9.82	7.56	10.46

Table 7: Showing N content of oats and fescue per treatment

YEAR	CUT NO.	ALGo	ALGs	PLGo	PLGs
2012	1	1.76^{a}	2.161^{ab}	2.487^{bc}	2.714^{c}
	2	1.138^{a}	1.257^{a}	1.723^{b}	1.651^{b}
	3	1.126^{a}	1.268^{a}	1.709^{b}	1.666^{b}
2013	1	1.88^{ab}	2.39^{b}	1.58^{a}	1.52^{a}
	2	1.601^{ab}	1.961^{b}	1.161^{a}	1.246^{a}
	3	1.529^{ab}	1.234^{a}	1.752^{ab}	1.828^{b}
2014	1	1.529^{ab}	1.234^{a}	1.752^{ab}	1.828^{b}
	2	1.11^{b}	1.403^{c}	0.811^{a}	1.016^{ab}
	3	1.292^{a}	1.289^{a}	1.494^{bc}	1.145^{a}

Table 8: Showing N content of oats and fescue per site (%)

YEAR	CUT NO.	Kiti	Makoma	Nyiki	Sothuko
2012	1	2.118	2.404	2.078	2.523
	2	1.192	2.091	1.19	1.295

	3	1.192	2.091	1.19	1.295
2013	1	1.67	1.91	1.26	2.53
	2	0.24	0.28	0.209	0.202
	3	1.803	1.542	1.185	1.813
2014	1	1.185	1.813	1.803	1.542
	2	0.841	1.188	1.14	1.172
	3	0.768	1.57	1.209	1.674

Table 9: Showing P content of oats and fescue per treatment (%)

YEAR	CUT NO.	ALGo	ALGs	PLGo	PLGs
2012	1	0.261^{ab}	0.3^{b}	0.246^{a}	0.312^{a}
	2	0.25^{a}	0.25^{a}	0.25^{ab}	1.35^{b}
	3	0.249^{a}	0.254^{a}	0.245^{a}	0.255^{a}
2013	1	0.269^{ab}	0.301^{b}	0.208^{a}	0.217^{a}
	2	0.1783^{bc}	0.2224^{c}	0.1239^{a}	0.1496^{ab}
	3	0.26^{a}	0.23^{a}	0.213^{a}	0.229^{a}
2014	1	0.261^{a}	0.229^{a}	0.213^{a}	0.229^{a}
	2	0.089^{a}	0.126^{a}	0.092^{bc}	0.125^{c}
	3	0.186^{ab}	0.253^{b}	0.193^{a}	0.166^{a}

Table 10: Showing P content of oats and fescue per site (%)

YEAR	CUT NO.	Kiti	Makoma	Nyiki	Sothuko
2012	1	0.283	0.266	0.280	0.290
	2	1.34	0.28	0.230	0.260
	3	0.241	0.276	0.226	0.261
2013	1	0.208	0.343	0.191	0.254
	2	0.24	0.28	0.209	0.202
	3	0.24	0.28	0.209	0.202
2014	1	0.209	0.202	0.24	0.28
	2	0.069	0.104	0.112	0.148
	3	0.089	0.217	0.247	0.244

In Tables 3 to 10, K content showed significant differences ($P<0.05$) among treatments and across sites (Table 4). Nitrogen content (N) in cut 1,2 and 3 showed significant differences amongst the treatments and across the sites(Table 7 and 8) whereas crude protein (CP) content at cut1 was not significantly different across the sites, but showed significant differences amongst the treatments in 2012. In the same year CP at cut 2 and 3 showed highly significant differences for oats. In 2013, there were highly significant differences in K content at cut1, 2 and 3 across the sites; CP contents were significantly different at cut1 across the sites and amongst the treatments, but cut 2 and 3 showed non-significant differences ($P>0.05$). P content showed non-significant differences in 2012 and 2013 at all cuts and highly significant differences in 2014 in all cuts. This year, so superphosphate was applied to the treatments. Residual effect of the previous application and slurry P might have resulted to this impact. In

2014, K content showed significant differences across the sites and amongst treatments. By the third cut, the grass was short, flowering and dry in Figure 4.

Figure 4: Oats stand in 2012 October dry weather before the third cut

4. DISCUSSION AND CONCLUSION

The dry matter yields of oats with slurry (ALGs) and fescue with slurry (PLGs) were lower in Tables 1, 2 and 3. Availability of fodder in this study had not been achieved in terms of yield increase, but quality had been achieved. Quality in CP and N content was higher in slurry applied plots for both annual and perennial grass. Awareness of planting fodder in the small area to supplement selected animals was achieved, because livestock owner thought about a big area to supplement whereas a small area may to forester orphans and first lambing females.

Green fodder availability was achieved, because few weak animals could be grazed to nurse the young ones. Greenness means better quality as seen in the sampling of plants higher CP and N contents at cut 1 from Table 5, 6, 7 and 8. Significant differences in K and crude protein meant that there was an improvement by the slurry N to plants both top dressed and incorporated slurry in all the planting seasons i.e. from 2012 to 2014. The crude protein content showed significant differences amongst the treatments in Figure Organic manures had increased yields under dryland conditions for summer crops like maize and spinach (Mnkeni and Mkile, 2006; Silwana, 2008; Mhlontlo, 2008). The study had not achieved N supply to plants through the legumes mixed with the fescue and oats, because oats pure stand and grass pure stands had less biomass yields compared to vetch and oats mixture. Bioslurry increased/improved cereal crop production by 10-30% compared to ordinary manure (Warnars and Oppenworth, 2014). This has been proved in root crops, vegetables and fruit trees. A research done to compare combinations of soil fertilisation with organic and inorganic fertilisers, whereby rock phosphate was mixed with slurry (RPS), slurry only (S), slurry and superphosphate (SPS), slurry and potash (PS) and it was found that the cabbage yield increase was 15.19% in RPS; 20.6%S; 29.7%SPS; 24.9% PS (Warnars and Oppenworth, 2014).

In research conducted in Turkey for crude protein yields of oats mixture of vetch at 75:25 showed that oats pure stand had 7.8% CP and mixture were and 16.3%CP (Niu et al, 2010; Carpici and Tunalli, 2012). Dry matter yields of oats and vetch mixture at 75:25were had lower DMY 15487kg/ha compared to oats pure stand at 17176kg/ha. This therefore means, that there was competition between oats and vetch for nutrients, moisture and light.

Legume's data was not collected due to ungerminated plots. The impact of the legumes is unknown in terms of n supply to either soil or plants the next season. In research done in Uganda to rehabilitate degraded veld, manure and cow dung was used where legumes and grasses were planted and there was improved water infiltration, and increased species richness in the veld being rehabilitated (Mugerwa et.al, 2009). There was also an improved vegetative cover and high dry matter production.

Available green feed in winter was achieved from both annual and perennial forage crops. The vegetative cover in the gardens like a mat was maintained throughout winter. Fescue replanting was minimal, which therefore means that costs of land preparation and establishment inputs were minimised by the second and third year. Quality was indicated by greenness of grass during the dry period and this attracted neighbours to observe the trial performance. Use of the biogas slurry to both top dress and incorporate onto the soil. Use of organic fertilisers enhances the soil organism which promote good soil health and sustainability of soil use (Abubaker, 2012).

Commercial herds and industrialisation released gas emissions that are said to destroy the ozone layer. Recycling of industrial by-products from factories, farms, abattoirs in slurry pits for producing the fertiliser products had reduced the danger of these gases, hence the bioslurry was used in this study. The gaps identified in the study was studying the changes per season of microbial activity influencing the nutrient content of the slurry throughout the year (Herencia and Maqueda, 2016). Further research will be to measure the influence of the best level of application of the slurry to meet the required amount of N by both soil and the plant.

5. REFERENCES

ABUBAKER, J. 2012. Effects of fertilisation with biogas on crop yield, soil microbiology and greenhouse gas emissions: recycling of plant nutrients from bio-energy production. Swedish University of Agricultural Sciences. Uppsala.

AINSLIE, A. 2013. The socio-cultural context and meanings associated with livestock keeping in rural South Africa. *African J. of Range and Forage Science*, 30(2):5-38.

AUSTIN, G. AND BLIGNAUT, JM. 2007. South African national rural domestic feasibility assessment. Cape Town: AGAMA Energy

AOAC: Official Methods of plant analyses. 2002. In Howitz W. Vol. 1 The Scientific Association, AOAC International Publishers.

AOAC: Official Methods of analyses. 2000. In Howitz W. 17th edn, The Scientific Association, AOAC International Publishers.

AUCAMP, AJ. 2008. Linking cultivated pastures with rangelands. Grassroots: Newsletter of the Grassland Society of Southern Africa Vol 8. No 4.

BARTHOLOMEW, PE. 1995. Pasture Production Guidelines in KwaZulu-Natal. http://agriculture.kzntl.gov.za/portal/AgricPublications/Production guidelines/Pastures in KZN.

BIRHANE, E, AYNEKULU, E, MEKURIA, W. AND ENDALE D. 2011. Management, use and ecology of medicinal plants in degraded dry lands of Tigray, Northern Ethiopia. J. of Medicinal plants Research vol. 5 no3 pp309-318.

BITTMAN, S, VLIET, LJ P, KOWALENKO, CG, MC GINN, S, HUNT, D. E. AND BOUNAIX, F. 2004. Surface banding liquid manure over aeration slots. American Journal of Agronomy. Vol.97 No.5 p1304-3313.

CARPICI, EB. AND TUNALLI, MM. 2012. Effects of mixture rates on forage yield and quality of mixtures of common vetch combined with oat, barley and wheat under a winter intercropping system of southern Marmara Region. J. of Food, Agric. and Environ. Vol. 10(2) p649-652.

CHOW, SHEIN-CHUNG. AND CHANG, M. 2008. Adaptive design methods in clinical trials-a review. Orphanet Journal of Rare Diseases. Vol.3 p11.

EDWARDS, P.J. 1981. Grazing management. In N.M. Tainton (ed.) Chapter 15. Veld and pasture management in South Africa. University of Natal Press, Pietermaritzburg.

EDWARDS, P.J. 1981. Principles of grassland management: Terms describing aspects of vegetation and its management. In N.M. Tainton (ed.) Chapter 14. Veld and pasture management in South Africa. University of Natal Press, Pietermaritzburg

GOVENDER, N, TROLLOPE, WSW. AND VAN WILGE, BW. 2006. The effect of fire season, fire frequency, rainfall and management on fire intensity in savannah vegetation in South Africa. Journal of Applied ecology Vol. 43 Issue 4 p748-758.

GURUNG, B. 1997. Training Manual: Proper Utilisation of Bio-slurry.Chamber of Commerce, Narayanghat. Chitwan.

GUSH, MB, GELDENHUYS, PJ, DYE, CJ. AND BULCOCK, HH. 2011. Volumes and effluencies of water-use within selected indigenous and introduced tree species in South Africa: Current results and potential application. In proceedings of the 5th National Forests and Woodlands Symposium, Richards Bay, 11-14th April.

HERENCIA, JF. AND C. MAQUEDA. 2016. Effect of time and dose of organic fertilizers on soil fertility, nutrient content and yield of vegetables. Journal of Agric. Sci. Vol.154. P1343-1361.

HOWITZ W 2002. Official methods of analysis of the AOAC. 17th edn, AOAC International Publishers. USA.

IKHWEZI. 2003. Land Use Plan for the Macubeni Catchment, Malahleni District, Eastern Cape. GTZ Transform: Pretoria; 188

ISLAM, MS. 2006. Use of Bio slurry as Organic Fertilizers in Bangladesh Agriculture. Proceedings of the International Workshop on the use of Bioslurry Domestic Biogas Programme 27-28 September 2006, Bangkok, Thailand.

ISLAM, M.R., RAHMAN, S. M. E., ISLAM, K. M. S. AND CHOWDHURY, R. 2008. Effect of the application of dried slurry on yield and chemical composition of maize fodder (Zea mays). Bang.J.Anim.Sci Vol. 37 p52-57.

KRAAIJ, T AND WARD, D. 2006. Effect of rain, nitrogen, fire and grazing on tree recruitment and early tree survival in bush encroached savannah, South Africa. Plant ecology. Vol.186 Issue 2, p235-246.

LUKEHURST, C, FROST, P. AND AL SEADI, T. 2010. Nutrient management in digestate and fertilizer management plans. In Chapter 3. Utilisation of digesta.
Machado, CF, Morris, ST, Hodgson, J. & Fathalla, M. 2005. Seasonal changes of herbage quality within a New Zealand beef cattle finishing pasture, New Zealand J. of Agricultural Research, Vol. 48 p265-270.

MAPEYI, N. AND GUMEDE, SA. 2012. Promoting fodder production to assist with nutritional supplementation of livestock in winter and drought periods in the Nkwezela community in KwaZulu-Natal. Grassroots Vol.12 No.4 p41.

MAPEYI, N, ZONDI, LT, M.M. AND GAMBIZA, J. 2013a. Challenges of sustainable winter forage planting by communal farmers in Macubeni, Lady Frere in Eastern Cape. Proceedings of the 46th South African Society for

MAPEYI, N, QAMBATA, MM. AND GAMBIZA, J. 2013b. The effect of Bioslurry application on the Crude protein content and yields in Macubeni, Lady Frere in Eastern Cape. Proceedings of the 48th Grassland Society for Southern Africa (GSSA) from 15th - 19th July in Modimolle, Limpopo Province, South Africa.

MHLONTLO, S. 2008. Effect of sheep kraal manure and intercropping with maize on growth, nutrient uptake and yield of a vegetable *Amaranthus* accession in Central Region of the Eastern Cape, South Africa. MSc thesis.

MNKENI, PNS. & MKILE, Z. 2006. Characterisation of kraal manure andoptimization of its use as fertilizer in the Eastern Cape Province. In: VanAverbeke et al. (eds.). Smallholder Farming and Management of Soil Fertility in the Eastern Cape, South Africa: Chapter 8. UNISA Press (Accepted).

MUCINA, L, AND RUTHERFORD, MC. 2006 (Eds). The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19. South African National Biodiversity Institute, Pretoria.

MUGERWA, S, MPAIRWE, D, SABILITI, EN, MUTETIKKA, G, KIWUWA, G, ZZIWA, E. AND PEDEN, D. 2009. Cattle manure and reseeding effects on pasture productivity. CGIAR Challenge program on Water and Food.

NIU, Y, NAN, Z, BELLOTTI, W, WHISH, J. AND BELL, L. 2010. Dry matter yield and nutritive value of differentrotationson Longdong http://www.regional.org.za.au/au/asa/2010/passtures-forage-crops/7355-niuyn_edi

OBA G. AND KAITIRA, LM. 2006. Herder knowledge of landscape assessments in arid rangelands in northern Tanzania. J. of Arid Environment.

OKALEBO, JR, GATHUA, KW. AND WOOMER, PL. 1993. Laboratory methods of soil and plant analysis: a working manual. TSBF-KARI. Marvel EPZ Ltd., Nairobi.

SHACKLETON, CM. AND GAMBIZA, J. 2008. Social and Ecological trade-offs in combating land degradation: the case of invasion by a woody shrub (*Euryops floribundus*) at Macubeni, South Africa. *Land Degradation & Development*, vol. 19, no. 4, p.454-464.

SCHILS, R.L.M AND KOK, I, 2003. Effects of cattle slurry manure management on grass yield. Netherlands Journal of Agricultural Science Vol 51. No1-2. 41-65.

SILWANA, TT. 2005. Response of component crops in maize (*Zea mays L.*) /bean (*Phaseolus vulgaris L.*) intercrop to manural treatments and weeding in the Eastern Cape region of South Africa. PhD thesis.

TACKENBERG, O. 2007. A new method for non-destructive measurement of biomass, growth rates, vertical biomass distribution and dry matter content based on digital image analysis. Annals of Botany. Vol. 99 no.4p777-783.

TAINTON, TM, AUCAMP, AJ. AND DANKWERTS, JE. 1999. Principles of managing veld. In N.M. Tainton (ed.) Chapter 7 Veld management in South Africa. University of Natal Press, Pietermaritzburg.

THE NON-AFFILIATED SOIL ANALYSIS WORKING COMMITTEE, 1990. Handbook of standard soil testing methods for advisory purposes. Soil Science Society of South Africa, Sunnyside, Pretoria.

VAN AVERBERKE, W. & DE LANGE, A. O., 1995. Agro-ecological conditions and land use. In: C. De Wet and W. Van Averbeke (eds). Regional overview of land reform-related issues in the Eastern Cape Province. Working paper 24 EC 2, LAPC, Johannesburg, South Africa.

VAN OUDSTHOORN, F. 2014. Guide to Grasses of Sourthern Africa. 4th edn, Briza Publications, Pretoria, South Africa.

WARNARS, L. AND OPPENOORTH, H. 2014. Bioslurry: A Supreme fertilizer- A study on Bioslurry results and uses. https://www.hivos.org/news/bioslurry-worlds-brown-gold-new-hivos-study

ZONDI, LT. AND GAMBIZA, J. 2012. Fodder production in Macubeni, Lady Frere in Eastern Cape. Proceedings of the 47th Grassland Society for Southern Africa (GSSA) from 16th to 20th July in Langebaan, Western Cape Province, South Africa.

THE RELEVANCE OF FACILITATION AND IMPLICATIONS ON AGRICULTURAL PERFORMANCE OF SMALL-SCALE FARMERS IN EASTERN CAPE PROVINCE.

Mazwane, S., Loki, O. and Ndlazilwana, L.C

Corresponding author**:** Mazwane, S; Email: sukoluhlemazwane@ump.ac.za

ABSTRACT

The current form of the agricultural extension service system has been struggling to achieve desired levels of rural development, change and/ or economic growth. Among the several agricultural extension challenges hindering rural agricultural growth is the way extension services are facilitated. Consequently, and for the longest period of time, the relevance of agricultural extension services facilitation to needs or farmer's problems has been a major concern. Against this backdrop, the present study set out to investigate the agricultural extension services facilitation relevance and its implications on agricultural performance of small-scale farmers. A sample of 201 small-scale famers from 5 districts in the Eastern Cape were selected using non-probability (availability) sampling method and data was collected using a semi-structured questionnaires. Farmer interviews and discussions were also conducted to complement data collected using the questionnaire. The Ordinary Least Square (OLS) regression technique was employed to analyse the effect that facilitation method has on the performance of small-scale farmers. Results from the OLS regression show that level of education, farming methodologies, advice from extension officials, cash crops, and land size had an effect on the performance of small-scale farmers. The study concluded that extension services facilitation is facing numerous challenges in the areas of service efficiency, impact of the services delivered and of lack accountability from extension officers. This could have an adverse impact on the socio-economic issues facing rural areas such as accelerating rural and economic growth, food and nutrition insecurity, inequality and unemployment.

Keywords*:* Facilitation, agricultural performance, small-scale farmers

1. INTRODUCTION

According to the National Development Plan for South Africa and its Vision for 2030, South African's rural communities should have greater opportunities to participate fully in the economic, social and political life of the country. Agricultural extension is at the heart of this development since they are the primary contact of public sector support for learning and training of rural farmers. According to Loki (2016), assisting farmers to be more productive has long been a common practice as well as a priority of the agricultural ministry in South Africa. Agricultural extension services are essential for farmers, as they serve to link them with authorities (the Department of Agriculture, and other stakeholders), resources, and information, and provide them with the capacity development needed to improve their productivity (Davies 2008).

Over the years, agricultural growth of small-scale farmers has been on the decline raising concerns on the relevance and applicability of the information or advice facilitated by extension officials (Ngemntu 2010; Makara, 2010; Hlatshwayo & Worth, 2016). According to the National Policy of Extension Services, "Extension and advisory services face major challenges in the areas of relevance, efficiency, accountability and sustainability extension service system has been cannot facilitate rural development, change and/ or accelerate economic growth" (DAFF, 2016:2).

The recent political unrest, inevitable economic slump and the continued decline of agricultural contribution to the total GDP (which stands at 0.4%) have led to many doubting the ability of the sector to sustain those who depend on it (Hlomendlini, 2016). Economic estimates indicate a population growth of 2.39% (current population of 1,094,365,629) in the next 10 years (2030) in the Sub-Saharan Africa region (Sub-Saharan African population, 2019). This means the need to produce more food becomes a priority for many government ministries (AFRA, 2014; DAFF, 2015; FAO, 2015; AGRA, 2016). Therefore, strengthening of smallholder agricultural capacities and development of more responsive, relevant extension and advisory services is necessary to counter the socio-economic challenges (such as poverty; unemployment food insecurity) facing rural communities (Hlatshwayo & Worth, 2016).

According to Van Niekerk *et al* (2009), investment in agricultural research, training of officials to facilitate extension services to farmers can help improve farm income and contribute to reducing socio-economic challenges. Success in agriculture depends on the quality of extension support services provided, if this holds true, facilitating relevant, need specific and area based information because increasingly important. It is against this background that this study was undertaken to relevance of extension services facilitation and its implications on agricultural performance of small-scale farmers in the Eastern Cape Province

2. METHODOLOGY

2.1. Study area and data collection

The study was undertaken in five Districts in the Eastern Cape Province and these include; Amathole, Joe Gqabi, Chris Hani, O.R. Tambo and Alfred Nzo. The study employed a quantitative research approach and collected data on a simple of 201 small-scale farmers. Data was collected using a structured questionnaire through interviews and discussion using availability/accidental sampling technique.

2.2. Data Analyses

The study used descriptive statistics to establish the relationship between socio-economic characteristics of farmers and agricultural performance.

2.2.1. Ordinary least squares (OLS)

Ordinary least squares (OLS) regression is a generalised linear modelling technique that may be used to model a single response variable that has been recorded on at least an interval scale. The technique may be applied to single or multiple explanatory variables and categorical explanatory variables that have been appropriately coded (Fox, 2002). In this case, it was used

to assess agricultural performance of small-scale farmers and looking at their agricultural income.

Model specification

The OLS regression analysis used agricultural income as the dependant variable for agricultural performance. Farmers' demographic information (captured as Age groups, level of education), farming characteristics (farming goals, land size, total number of livestock cash crops) and extension services variables (captured as insufficient extension visits, farming methodologies advice not useful to farming needs) as helped with identifying the independent (X) suitable for the OLS. The variables found to be affecting extension services were used as X variables in the equation.

The model is specified implicitly as; $Y_i = a + b\boldsymbol{X}_i + \mathcal{E}_i$

a = constant

b_s = regression coefficients

$\mathcal{E}_i$ = error term

Y = dependent variable

X_i = Vector of independent variable

In this setting, Y is agricultural income, which is taken as a core measure of farmers' performance.

2.2.2. Explanatory variables used in the econometrics model

Table 1 shows the expected outcomes (behaviour) of the independent variables that were included in the linear regression model.

Table 1: Relationships between dependent and explanatory variables OLS

Dependent variable	**Measure**	
Agricultural income	Continuous (Rands) Money made from selling agricultural products and by-products	
Explanatory variable	**Measure**	**Expected outcome**
Age groups	Categorical – 20 years and less = 0;	+
	21- 35 years = 1;	+
	36-50 years = 2;	+
	51-65 years =3;	+
	66 years and older = 4	-
Level of education	Categorical - No education = 0;	-
	Primary = 1;	+/-
	Secondary = 2;	+
	Tertiary = 3	+
Land size	Continuous (Hectares)	+

Farming goals	Dummy - Yes achieved = 1; Not Achieved = 0	+
Farming systems	Categorical - Crop farming = 0,	+
	Livestock farming = 1,	+
	Mixed farming = 2	+/-
Cash crops	Dummy - Cash crop = 1; No cash crops = 0	-
Total number of livestock	Continuous - Number of livestock	+
farming methodologies	Dummy- No change in practices = 0, Change in practices = 1	+
Insufficient extension visits	Dummy - Visits sufficient =1; Visits not sufficient = 0	+
Advice not useful to farming needs	Dummy - Advice useful = 1; Advice not useful = 0	-

Source: Field survey, 2019

3. RESULTS AND DISCUSSIONS

In this section, descriptive statistics of the sample respondents and the estimation results of the OLS regression are presented.

3.1. Sample Characteristics

Demographic characteristics of the farmers in the study areas are provided in Table 2, including: age, farm experience, gender, marital status and the level of education.

Table 2: Demographic characteristics

Variable	Description	Frequency (n=201)	Percentage (%)
Age	Years		
21-35		15	8
36-50		68	34
51-65		64	32
>65		54	28
Farm experience	Years		
>10		98	49
11-25		79	39
26-35		19	10
>36		5	2
Gender	Male	147	73
	Female	54	27
Marital status	Single	79	39
	Married	122	61

Education	No education	21	10
	Primary	40	20
	Secondary	89	45
	Tertiary	51	25

Source: Field survey, 2019

Age is thought to be related to how progressive a farmer is in terms of seeking knowledge, adopting new technologies and practices (Albers, 2013). In Table 1, age was divided into four groups and the distribution shows 34% (36-50 years) and 32% (51-65 years) had the majority of farmers. Similar to age, farming experience was divided and the distributions suggests shows 49% (majority) had farm experience > 10 years. Table 1 shows, 73% of farmers were males, with 61% indicating that they are married and being married in agriculture.

In agriculture, being married has its advantages, for example, decision making, and farming operations will not stop if another partner is sick (Mniki, 2009; StatsSA, 2016).

Education as reported showed that secondary (45%) and tertiary (25%) had the highest proportion of farmers compared to primary and no formal education. This indicates that farmers in the study area were able to read, write and do their own research. Highly educated farmers tend to be more flexible and willing to pay for new ideas and farming advances that will improve their farming practices compared to less educated farmers (Bester, 2008).

3.2. Agricultural income

Farmers in this study were found to be involved in selling cash crops, livestock and/or animal products. Table 3 below looks at the distribution of farmers' average agricultural income for each enterprise farmers were involved in.

Table 3: Agricultural income

Variables	Mean (R)	Std. deviation
Cash crops	302745.56	1003493.04
Livestock	132949.86	322018.92
Livestock by products	601175.17	764857.15

Source: Field survey, 2019

The average annual income made from selling crops was R302745 which was greater than that of livestock farmers R132949. Livestock by products had the highest proportion of income (R601175.17). The findings are slightly different to those made by DAFF (2016) that animals (livestock) and animal products generate the largest sales in South Africa followed by horticultural crops and products and field crops.

3.3.3. Farming activities

Farmers in all the districts seemed to participate in farming (crop and vegetables) for diverse aims. Table 4 displays various crops cultivated and livestock raised by farmers in the growing season of 2018/19.

Table 4: Farming activities

Variable	Frequency n= 201	Percentage %
Crop production	22	11
Livestock production	46	23
Mixed farming	133	66

Source: Field survey, 2019

Table 4.4 showed that 66% (majority) indicated that they practice mixed farming with livestock production the most practiced. This is line with the findings made by Goni *et al*. (2018), that about 70% of South Africa's total area is suitable only for livestock production.

3.3.4. Access to extension services

Table 5 presents results on extension services that farmers had access to in the study areas. In recent years agricultural extension has come to encompass a wide range of activities in both the public and private sectors, however, the exchange of information continues to be the primary focus of all extension activities.

Table 5: Access to extension services

Variable	Description	Frequency n=201	Percentage (%)
Are you aware of extension services in your area	Yes No	199 2	99 1
Do you access to extension services	Yes No	192 9	95 5
Frequency of extension visits	Weekly Monthly Quarterly Annually Never visit	11 51 93 36 10	6 25 46 18 5
Satisfied with frequency of extension visits	Yes No	99 102	49 51
Quality of extension services	Very good Good Neutral Poor Very poor	23 86 58 24 6	12 44 29 12 3

Source: Field survey, 2019

Table 5 shows that the majority of farmers (99%) were aware of extension officials in their area and indicated to have accessed extension services. Farmers (46%) indicated that visits from official were on quarterly basis, and they were not satisfied with the frequency of visits (51%). The farmers also indicated that the quality of extension service received was good

(44%).These result suggests that respondents in the study area had no difficulty in accessing government extension services and this might positively impact on the production levels.

3.3.5. Farmers' opinion on extension services

Table 6 looks at farmers' opinion on the overall extension services, these were investigated using the Likert rating scale. As demonstrated in Table 6, farmers were presented with five questions relating to the function of extension officers. The questions were informed by the literature reviewed on challenges affecting extension services in South Africa. A tradition 1-5 Likert rating scale was chosen for this section where strongly agree =5, Agree=4 undecided=3 disagree=2, strongly disagree=1.

Table 6: Farmers' opinion on extension services

Insufficient visit	Frequency	Percentage
Strongly Agree	28	14
Agree	78	39
Undecided	13	6
Disagree	60	30
Strongly Disagree	22	11
Advice not relevant		
Strongly Agree	18	9
Agree	104	53
Undecided	20	10
Disagree	47	23
Strongly Disagree	9	5
Frequency of feedback poor		
Strongly Agree	52	26
Agree	55	27
Undecided	31	15
Disagree	50	25
Strongly Disagree	13	7
Technical expertise good		
Strongly Agree	18	9
Agree	35	17
Undecided	21	11
Disagree	100	50
Strongly Disagree	27	13

Source: Field survey, 2019

From the questions in Table 6 farmers indicated their dissatisfaction with; extension visits (39%), advice extension officers give pertain their farming (53%), feedback on information and samples collected (27%) and technical expertise (50%). The findings are in line with several articles that found similar challenges with extension services in South Africa (Düvel, 2000; Umhlaba Rural Services, 2006; De Villiers, 2008 & Maoba, 2016).

3.3.6. Services facilitated by agricultural extension officers to farmers

Table 7, reports on the types of extension services delivered to smallholder farmers in the study areas.

Table 7: Services delivered by agricultural extension agents to farmers

Extension services delivered to you by extension officers	Description	Frequency n=201	Percent %
Marketing of products	Yes	49	24
	No	152	76
Risk Management services	Yes	58	29
	No	143	71
Farm management services	Yes	153	76
	No	48	24
Weed and / diseases control	Yes	141	70
	No	60	30
Fertilizer/ and vaccine	Yes	68	34
	No	132	66
Record keeping	Yes	60	30
	No	141	70

Source: Field survey, 2019

Farmers were asked to indicate the extension services delivered to them by extension officers. The responses in Table 7 indicate that the majority of farmers only received farm management (76%) and weed and/disease control services (70%).

4. EMPIRICAL RESULTS AND DISCUSSION

The following section presents results of the Ordinary Least Squares (OLS) regression chosen to assess agricultural performance of small-scale farmers. Agricultural income was used as a dependent variable and eleven explanatory variables were fitted into the regression model.

Table 8**:** Factors influencing agricultural performance of small-scale farmers

Agricultural income	Coefficient	Std. Err.	P>t
Age groups	220982.4	76125.64	0.004***
Level of education	103839.7	48083.58	0.032**
Land size	1029.139	302.5535	0.002***
Farming goals	184722.2	67973.54	0.007**
Faming systems	55105.43	62997.84	0.383
Cash crops	327845.2	98826.08	0.001***
Total number of livestock	-107.5313	73.1039	0.143
Change in yield returns	-200089.9	149202.1	0.181
farming methodologies	-259952.9	122647.2	0.025**
Insufficient extension visits	-164553.5	140153	0.242
Advice not relevant to farmers' needs	152162	118173.3	0.199

_Cons	-436015.3	217061.4	0.036
Notes: *** p<0.001, ** p<0.05, *p<0.1 Number of obs = 201 Prob > F = *** R-squared = 0.6825			

Source: Field survey, 2019

From the eleven variables fitted in the OLS regression, six variables had a significant influence on the agricultural performance of farmers in Eastern Cape. Age (divided into groups), level of education, land size, farming goals, growing of cash crops and farming methodologies had a significant influence on the agricultural performance of farmers. The R-squared value is 68%, suggesting a reasonably powerful model.

4.2.1. Age groups

According to Table 7, age categorised into age groups was significant at 1% level relative to agricultural income of farmers($p<0.001$). The coefficient was positive, suggesting that age has significantly positive effect on agricultural performance. Age was significant maybe because farmers of all age groups were often flexible and willing to try on new technologies and farming methodologies that can improve their yield returns and later agricultural income.

4.2.2. Level of Education

It is widely believed that the higher the level of formal education the more likely the farmer will be willing to engage in programmes and approaches that have higher payoff to productivity Agholor, 2010). As shown in Table 3 education was found to be significant by 5% level related to agricultural income ($p<0.05$).

The coefficient was positive indicating a positive effect level of education has on agricultural income of farmers. Educated farmers are often receptive to new ideas or innovations that improve production compared to their illiterate counterparts. This is line with the findings made by Ulimwengu and Sanyal (2011), that education has a positive role in improving farm production because a farmer with a higher level of education (post-matric qualification for example) can get, process, and use information to better their farm and get income.

4.2.3. Land size

The land issue in South African has been at the forefront of many debates since the inception of the post-apartheid government in 1994 (Williams *et al.*, 2008). Lager farm size (land) and/or their ownership have been non-existence among small-scale farmers. Land size was significant at 1% relative to agricultural income. The coefficient was positive indicating land has a significantly positive effect on agricultural income of farmers. Similar assertions were made by Dunn and Williams (2000) in their study that large farm size has a positive relationship with net income variability.

4.2.4. Farming goals

The primary goal for farming is to maximise farm/yields returns while ensuring the sustainability of farm resources (Sikwela, 2013). Farming goals are either short, medium or long-term and these influence how a farmer uses the available resources in his farm and/or community to achieve them. Farming goals were significant at a 1% level to agricultural income ($p<0.001$). The coefficient was positive, suggesting a directly positive effect farming goals have on agricultural income.

4.2.5. Cash crops

Cash crops are defined as crops produced for their commercial value rather than for use by a farmer (Dlova, 2001). Cash crops were statistical significance level of 1% related to agricultural income ($p<0.001$). The coefficient was positive indicating a positively direct effect cash crops have on agricultural income. Cash crop producing farmers make money out of their farming activities compared to non-cash farming.

4.2.6. Farming methodologies

Farming methodologies (ways) was significant by 5% related to farmers' agricultural income ($p<0.05$). The coefficient was negative suggesting, farming methodologies have no positively direct effect on famers' income.

5. CONCLUSION

The study investigated the relevance of facilitation and implications on agricultural performance of small-scale farmers in Eastern Cape Province. The findings indicate that the dominant age groups were 36-50 years and 51-65 years with a farming experience that is > 10 years. Moreover the average annual income made from selling livestock by products was greater than that of crops and livestock. Majority of farmers indicated to have accessed extension services on quarterly basis, however, were not satisfied with the frequency of visits.

The study also revealed that farmers were dissatisfaction with the frequency of extension visits, advice extension officers give pertain their farming, feedback on information and samples collected, and technical expertise of officials. The findings are in line with several articles who found similar challenges with extension services in South Africa. Moreover, the study showed that farm management and weed and/disease control were the only services delivered to (majority of) farmers. From the OLS, results showed that age, high levels of education, access to land, and practicing crop farming had a significantly positive effect on agricultural income (performance) of small-scale farmers in Eastern Cape Province. The study concluded that the facilitation of extension services in South Africa has not improved despite the structural and policy changes, and the National Development Plan vision for rural communities put in place. The sector remains challenged in areas of relevancy frequency of extension visits, and technical expertise. These challenges influence the performance of smallholder farmers who are purely depended on extension for services and input provision.

6. REFERENCES

BESTER, B.J. 2008. *Summary: Agricultural Marketing and the importance of Agricultural Marketing*. Unpublished Supplementary Lecture Notes for AGE121.

CONRADIE, B.I. 2016. The Implications of a Weak Public Extension Service for the Productivity Performance of Karoo Agriculture. *South African Journal of Agricultural* Extension, 44(2): 99-109, DOI: Http://Dx.Doi.Org/10.17159/2413-3221/2016/V44n2a396

DAVIS, K., 2008. Extension in sub-Saharan Africa: Overview and assessment of past and current models and future prospects. JIAEE., 15(3):15-28.

DAVIS, K.E. & TERBLANCHÉ, S.E. 2016. Challenges facing the agricultural extension landscape in South Africa, quo vadis? *South African Journal of Agricultural Extension*, 44(2): 231-247, DOI: http://dx.doi.org/10.17159/2413-3221/2016/v44n2a428

Dunn, J.W. & Williams, J.R. 2000. *Farm characteristics that influence Net farm income variability and loss*. Paper presented at the Western Agricultural Economics Association Annual Meetings, Vancouver, British Columbia, June 29-July1, 2000

DEPARTMENT OF AGRICULTURE, 2005. National education and training strategy for agriculture and rural development in South Africa.

DEPARTMENT OF AGRICULTURE, FORESTRY AND FISHERIES. 2016. *National policy on extension and advisory services 2016.* Available from: www.daff.gov.za [Accessed: 2019/03/29].

DLOVA, M.R. 2001. *Agricultural production in the Hertzog agricultural cooperative of the Seymour district in the Eastern Cape, South Africa*. Unpublished Master's Thesis University of Fort Hare, Alice.

DÜVEL, G. 2000. Towards an appropriate extension approach for agricultural and rural development in South Africa. *South African Journal of Agricultural Extension*, 29: 10-23.
Eastern Cape Department of Agriculture. 2008. *Food Security*. Eastern Cape, Bisho.

HLOMENDLINI, H. 2016. *South African Commercial Farmers: The Food Producers of Sub-Saharan Africa*. AGRI SA.
HLATSHWAYO, P.P.K. & WORTH, S.H. 2016. Stakeholders' Perceptions about Visibility and Accountability of the State Agricultural Extension in Nquthu Area, KwaZulu-Natal Province, South Africa. *South African Journal of Agricultural Extension*, 44(2), 174-185, DOI: Http://Dx.Doi.Org/10.17159/2413-3221/2016/V44n2a416 [Accessed: 18/10/2019]

LOKI, O. 2016. *The Accessibility of Extension Services and the Agricultural performance of Smallholder Farmers in two communities in Nkonkobe Local Municipality, Eastern Cape: A*

Case Study of Phathikhala and Ngcabasa Locations. Master's Thesis University of Fort Hare, Alice.

MAKARA, N.M. 2010. *An investigation of the role and impact of the extension services in the massive food programme introduced at Zanyokwe irrigation scheme of the Amahlathi local municipality in the Eastern Cape*. Master's Thesis, University of Fort Hare Alice.

MAOBA, S. 2016. *Farmers' perception of agricultural extension service delivery in Germiston region*, Gauteng Province, South Africa.

MNIKI, S. 2009. *Socio-economic impact of drought induced disasters on farm owners of Nkonkobe Local Municipality*. Master's Thesis, University of the Free State, Bloemfontein, South Africa.

NGEMNTU, S.T. 2010. *An investigation of the production and marketing challenges faced by small-scale farmers in Amahlathi municipality: A case study of Zanyokwe irrigation scheme and Silwindlala woman's project*. Master's Thesis, University of Fort Hare Alice, South Africa.

SUB SAHARAN AFRICA POPULATION. 2019. Retrieved 2020-01-23, from http://worldpopulationreview.com/continents/sub-saharan-africa/

ULIMWENGU, J. & SANYAL, P. 2011. *Joint estimation of farmers' stated willingness to pay for agricultural services*. International Food Policy Research Institute, Discussion paper 01070.

UMHLABA RURAL SERVICES. 2006. *A national review of the comprehensive agricultural support programme*. Department of Agriculture, South Africa. Available from: http://www.participation.org.za/docs/caspreviewmarch2007.pdf. [Accessed: 20/06/2016].

STATISTICS SOUTH AFRICA 2011. *Strategic plan 2010/11 – 2014/15* / Statistics South Africa. Available from: www.statssa.gov.za. [Accessed: 12/11/2019].

VAN NIEKERK, J.A., STROEBEL, A., VAN ROOYEN, C.J., WHITFIELD, K.P. & SWANEPOEL, F.J.C. 2009. Towards designing a new agricultural extension service for the Eastern Cape Province: A perception analysis. *South African Journal of Agricultural Extension*, 38: 65-76.

WILLIAMS, B., MAYSON, D., DE SATGÉ, R., EPSTEIN, S. & SEMWAYO, T. 2008. *Extension and small holder agriculture key issues from a review of the literature*.

WORTH, S. 2012. *Agricultural extension in South Africa: status quo report*. Department of Agriculture, Forestry and Fisheries, South Africa.

ROLES OF AGRICULTURAL EXTENSION PRACTITIONERS IN PROMOTING CLIMATE SMART AGRICULTURE IN MBOMBELA MUNICIPALITY OF MPUMALANGA, SOUTH AFRICA.

Khwidzhili, H

(This Article Was Not Available at the Time the Proceedings was Produced).

ASSESSMENT OF EXTENSION PRACTITIONERS' PERCEPTIONS OF COVID-19 LOCKDOWN RESTRICTIONS AND ATTENDANCE OF (CLIMATESMART AGRICULTURE - CSA) WORKPLACE TRAINING. PRESENTER: T.G. NGOTHO

Ngotho, T.G., Maboa, L.G., Masekwana, N.S., Anderson, J.J. and Walker, S.

(This Article Was Not Available at the Time the Proceedings was Produced).

CONFERENCE PROGRAMME

PROGRAMME

2021

54th ANNUAL CONFERENCE OF THE SOUTH AFRICAN SOCIETY FOR AGRICULTURAL EXTENSION

"FACILITATION FOR DEVELOPMENT IN AGRICULTURAL EXTENSION IN THE NEW ERA (COVID-19 PANDEMIC)"

ASHANTI ESTATE
SONSTRAAL ROAD
PAARL
WESTERN CAPE

11 – 14 OCTOBER

MONDAY, 11 OCTOBER 2021

13:00 – 19:00	**EARLY REGISTRATION**	
15:30 – 16:00	TEA BREAK	
16:00 – 17:30	Side event – Article writing	Prof Beatrice Conradie
16:00 – 18:00	Board Meeting	

SUPPER: OWN ARRANGEMENTS

TUESDAY, 12 OCTOBER 2021

OPENING SESSION
Chairperson: Johan Van Niekerk

08:00 – 09:30	**LATE REGISTRATION**
09:30 – 09:40	Scriptures and Prayer – Mr Gavilin Darries
09:40 – 09:50	Welcome: Ms Mantombi Mbongo – President SASAE
09:50 – 10:00	Welcome to Western Cape Province – HOD: Dr Mogale Sebopetsa
10:00 – 10:20	Official Opening of the 54th SASAE Conference – MEC: Dr Ivan Meyer
10:20 – 10:**55**	Keynote speaker: Dr Mercy Akeredolu (Virtual)
10:55 – 11:35	**TEA BREAK**
11:35 – 12:15	Keynote speaker: Ms Joyene Isaacs
12:15 – 13:30	**LUNCH BREAK**

SECOND SESSION
Chairperson: Dr Jan Swanepoel

	TOP 5 ACADEMIC PAPERS
13:30 – 13:55	**W.T. Shiba & M. Aliber** - The Effect of Recapitalisation and Development Programme on Agricultural Production of Land Reform Beneficiaries in the Eastern Cape Province of South Africa.
13:55 – 14:20	**T.E. Mokhesengoane, H.C. Van der Westhuizen & J.A. Van Niekerk** - Stocking Rate of Extensive Land Reform Livestock Farmers During 2018/2019 Drought: Bloemfontein Grassland Biome Case Study.
14:20 – 14:45	**B.I. Conradie** - Using Action Research to Develop a Drought Adaptation Strategy.
14:45 – 15:10	**M. Mkhungela** - Livelihood Analysis of Gasela Community in Amahlathi Local Municipality of the Eastern Cape Province.
15:10 – 15:35	**R. Carelsen, B. Ncube & M. Fanadzo** - An Assessment of the Effectiveness of Extension Services in the Overberg and West Coast Districts, Western Cape Province.
15:35 - 16:15	Panel Discussion: Q & A (Facilitator: Dr J.W. Swanepoel)
16:15 – 16:45	**TEA BREAK**
17:00 – 18:30	**ANNUAL GENERAL MEETING**

SUPPER: OWN ARRANGEMENTS

WEDNESDAY, 13 OCTOBER 2021

THIRD SESSION
Chairperson: Dr Hlami Ngwenya

08:00 – 12:00	Case Study Presenters to meet Dr Swanepoel
08:30 – 10:00	Poster Session: Five minutes presentation for each poster and viewing
10:00 – 10:45	**TEA BREAK**
10:45 – 11:05	Afrigenius Presentation – Mr Flubert Taga
11:05 – 12:05	Prof Stephanie Midgley – Climate Change and Extension
12:05 – 13:30	**LUNCH BREAK**
13:30 – 13:50	Mark Anthony Williams – Producer
13:50 – 14:10	Kaashif Toefy – Producer
14:10 – 14:30	Jacky Goliath – Producer
14:30 – 15:15	**TEA BREAK**
15:15 – 16:15	Q & A (Facilitator: Dr Hlami Ngwenya)
15:15 – 17:00	Case Study Presentations – Knock out round

SUPPER: OWN ARRANGEMENTS

THURSDAY, 14 OCTOBER 2021

FOURTH SESSION

	Chairperson: Mr Mthi ***Food Security***	***Chairperson: Mr Garane*** ***Covid-19 and Extension***	***Chairperson: Prof Nyangiwe*** ***Livestock***
08:30 – 8:55	**M.E. Bornman & D.C. Lubuku** From Backyard to Boardroom – The Role Played by Agricultural Extension. **Presenter: M.E. Bornman**	**A. Ngqulana, M. Christian, L. Mdoda & P. Jiba** Effectiveness of Advanced Technology Transfer During Covid-19 on Smallholder Farmers in South Africa: A Review. **Presenter: A. Ngqulana**	**S. Ntweni & C. van der Westhuizen** An Assessment of the Extension and Government Support Services in Communal Livestock Production in the Mhlontlo Local Municipality of the Eastern Cape Province, South Africa. **Presenter: S. Ntweni**
08:55 – 09:20	**M.N. Shushu** The Effect of the Food Insecurities in Farming and Non-Farming Households: Lesson Learnt from Households in the Francis Baard District Municipality, Northern Cape Province of South Africa. **Presenter: M.N. Shushu**	**M. Christian, P. Jiba, O. Loki, H. Khobai & U. Luvhengo** Analysing the Delivery of Public Agricultural Extension Services to Rural Household's during COVID-19: A Case Study of Idutywa, Eastern Cape, South Africa. **Presenter: M. Christian**	**L. Qokweni, M. Chimonyo & M.C. Marufu** Differences in Burden of Gastrointestinal Nematode Infestations in Indigenous Does Foraging in Grassland and Forestland Vegetation Types **Presenter: L. Qokweni**

09:20 – 09:45	**G. Darries** Impact Assessment of Community and Household Food Gardens and the Influence on Livelihoods and Food Security: A Case Study in the Overberg District Suurbraak Village in the Western Cape, South Africa. **Presenter: G. Darries**	**O. Loki, M. Aliber & M. Christian** Factors Influencing Farmer's Access to Extension Services and its Implication on Agricultural Production Post the Covid-19 Pandemic in the Eastern Cape. **Presenter: O. Loki**	**L.M. Molieleng, P.J. Fourie & I.C. Nwafor** Facilitating Change in Individuals, Groups and Organisations: The Role of Technology Adoption by Communal Livestock Farmers. **Presenter: L.M. Molieleng**
09:45 – 10:10	**A. Dumani, M.M. Mbangcolo & X. Mpengesi** Impact of a Multi-Stakeholder Approach on Rural Livelihood and Socio-Economic Status of the Farming Community at Zanyokwe Irrigation Scheme, Amahlathi Local Municipality, Eastern Cape. **Presenter: A. Dumani**	**M.M. Dlamini, S. Worth & O. A. Ajayi** Towards an Efficient Post Covid-19 ICT Based Extension Service Delivery Model for the Sugar Industry of Eswatini. **Presenter: M.M. Dlamini**	**N. Matyholo-Mapeyi** The Role of Biogas Slurry on Improving Yield and Quality of Grass Planted in Macubeni, Eastern Cape, South Africa. **Presenter: Matyholo-Mapeyi**
10:10 – 10:50	**TEA BREAK**		

	Chairperson: Ms Nzalie Mlahlwa Smallholder Farmers	Chairperson: Ms Marlize Bornman
10:50 – 11:15	**S. Mazwane, O Loki & L.C. Ndlazilwana** The Relevance of Agricultural Extension Facilitation and Agricultural Performance of Small-Scale Farmers in Eastern Cape Province. **Presenter: S. Mazwane**	**B.M. Hlalele** A Comparative Analysis of Key Climate Change Variables in the Pre and Post Covid-19: An Agricultural Development External Project Risk. **Presenter: B.M. Hlalele**
11:15 – 11:40	**H. Khwidzhili** Roles of Agricultural Extension Practitioners in Promoting Climate Smart Agriculture in Mbombela Municipality of Mpumalanga, South Africa. **Presenter: H. Khwidzhili**	**T.G. Ngotho, L.G. Maboa, N.S. Masekwana, J.J. Anderson & S. Walker** Assessment of Extension Practitioners Perceptions of Covid-19 Lockdown Restrictions and Attendance of (Climate-Smart Agriculture - CSA) Workplace Training. **Presenter: T.G. Ngotho**
11:40 – 12:30	**COMPULSORY**: SASAE – The Way Forward Workshop (Facilitator: Dr Hlami Ngwenya)	
12:30 – 13:45	**LUNCH BREAK**	

SIXTH SESSION

	Success stories **Chairperson: Dr Mmantoa Kgaphola**
13:45 – 14:00	**M.W. Kheswa, B. Mpambani & K.B. Jokazi** The Impact of the Demonstration Trials on School Nutrition Gardening Program (SNGP) in Selected Schools Under Amahlathi Local Municipality, Eastern Cape.
14:00 – 14:15	**C. Geldenhuys, G. Van der Walt & M. Mbongo** Facilitating Change in Individuals, Groups and Organisations on Smithfield Commonage through the Introduction of a Weaner Calf Competition and Livestock Auctions.
14:15 – 14:30	**S.D. Mafuyeka on behalf of Bohlabela Team**
14:30 – 14:45	**S. Mlimo** Livestock Improvement Initiative – DARD Intensifies Provincial Livestock Improvement Programme.
14:45 – 15:00	**D.P. Troskie** Western Cape Department of Agriculture: Moving Beyond the Covid-19 Pandemic
15:00 – 15:15	**J.W. Swanepoel**
15:15 – 15:45	**TEA BREAK**
15:45 – 16:30	Case study Competition Presentations – Dr J.W. Swanepoel and Mr M. Anthony
19:00	**GALA DINNER**

FRIDAY, 15 OCTOBER 2021

BREAKFAST AT YOUR OWN ACCOMMODATION/DEPARTURE