SOCIO-ECONOMIC CHARACTERISTICS INFLUENCING SMALL-SCALE FARMERS' LEVEL OF KNOWLEDGE ON CLIMATE-SMART AGRICULTURE IN MAHIKENG LOCAL MUNICIPALITY, NORTH WEST PROVINCE, SOUTH AFRICA

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ABSTRACT

The aim of the study was to identify knowledge gaps and the level of knowledge on climate-smart agriculture among small-scale farmers in Mahikeng Local Municipality. A simple random sampling technique was used to select 170 respondents from a population size of 1449. A descriptive and quantitative research design was used for this study. Data were collected using a structured questionnaire. Descriptive and inferential statistics were used to analyse data. Most respondents were males, married, had high school education and farming experience of more than 20 years. Livestock farming, was found to be the main agricultural activity amongst the respondents. Knowledge test statements revealed that, respondents had a low level of knowledge about climate-smart agriculture. Age, access to climate information, farm income per month and access to off-farm income had statistically significant relationships with respondents' level of knowledge on climate-smart agriculture. Based on the findings of this study, it is recommended that, there should be training and education activities which should be implemented to assist small-scale farmers in Mahikeng Local Municipality in increasing their knowledge on climate-smart agriculture.

Keywords: Climate-smart agriculture, Knowledge, Small-scale farmers, Socio-economic characteristics

1.   INTRODUCTION

1.1. Background and setting

The South African government has committed itself to prioritizing the development of small-scale farmers (Motiang & Webb, 2015:26; Department of Agriculture, Land Reform and Rural Development [DALRRD], 2018:1). Small-scale farmers in Sub-Saharan Africa, including South Africa, continue to depend on rain-fed agriculture, therefore this makes them vulnerable to unpredictable rainfall patterns (Adimassu & Kessler, 2016:2). Another major obstacle which continues to inhibit the development of small-scale farmers in Sub-Saharan Africa, is poor knowledge on strategies needed to respond to global warming and climate change (Gwambene, Saria, Jiwaji, Pauline, Msofe, Mussa, Tegeje, Messo, Mwanga & Shija, 2015:46). This is very concerning, because knowledge is an essential tool which is known to improve the agricultural

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productivity and profitability of farmers (Zhang, Wang & Duan, 2016:18), through assisting them in making informed decisions (Gwambene *et al.*, 2015:40).

On the background of the harsh reality of accelerated global warming and climate change, the Food and Agriculture Organization (FAO) of the United Nations (UN) presented a conceptual model of climate-smart agriculture during a climate change workshop held in Barcelona, Spain in 2009 (FAO, 2009:5). Climate-smart agriculture is an agricultural approach which combines concepts of adaptation, mitigation and sustainable agricultural profit-making into a one-housed model (Taylor, 2018:93). Owing to their high dependence on rain-water for farming purposes, small-scale farmers can greatly benefit from taking up climate-smart agriculture as a means of responding to the everyday reality of climate change. However, not much is known about the level of knowledge which small-scale farmers in Mahikeng Local Municipality have about climate-smart agriculture.

1.2. Statement of the problem

The Mahikeng Local Municipality is an area which is prone to drought conditions (Mahikeng Local Municipality, 2017). During the 2014/2015 and 2015/2016 summer growing seasons, the Mahikeng Local Municipality was one of the areas in the North West Province, which were devastated by climate change induced droughts and heat-waves. These conditions led to deaths of thousands of livestock and crop failure of grain crops, thus negatively affecting the profits of farmers, especially those farmers who depend on rain-fed agriculture (Archer, Landman, Tadross, Malherbe, Weepener, Maluleke & Marumbwa, 2017:26). The North West Department of Agriculture and Rural Development (NWDARD) indicates that, the frequency of drought conditions and heat-waves are expected to persist going into the future (NWDARD, 2017:11). Therefore, small-scale farmers in Mahikeng Local Municipality will remain vulnerable to droughts and heat-waves.

1.3. Aim, objectives and hypothesis

The aim of the study was to identify knowledge gaps and the level of knowledge on climate-smart agriculture among small-scale farmers in Mahikeng Local Municipality. The objectives of this study were to determine socio-economic characteristics of small-scale farmers in Mahikeng Local Municipality and to describe small-scale farmers' knowledge about climate-smart agriculture in Mahikeng Local Municipality. To analyse the relationship between socio-economic characteristics of small-scale farmers in Mahikeng Local Municipality and their level of knowledge about climate-smart agriculture, a null hypothesis was formulated. The null hypothesis for this study was: there is no statistically significant relationship between socio-economic characteristics of small-scale farmers in Mahikeng Local Municipality and their level of knowledge about climate-smart agriculture.

2. METHODOLOGY AND PROCEDURES

2.1. Study area

This study was conducted in the Mahikeng Local Municipality, Ngaka Modiri Molema District Municipality, North West Province, South Africa. The municipal offices are located in Mmabatho. Agriculture is a main economic activity in the Mahikeng Local Municipality. The

main agricultural commodities which are produced by farmers in the area are cattle, sheep, goats, maize and sunflower.

2.2. Research design

A descriptive and quantitative research design was used for this study. This research design was selected because it allows a researcher to accurately and systematically describe the characteristics of a given population of interest, using numerical data (Dulock, 1993:154).

2.3. Population of the study

The population of the study consisted of 1449 small-scale farmers involved in livestock, grain and mixed farming (livestock and grain crops), based in Mahikeng Local Municipality.

2.4. Sampling procedure and sample size

A simple random sampling technique was chosen in this study because it provided all the specified small-scale farmers in the study area with an equal probability to be selected during the sampling process. A population size (sampling frame) from a list of 1449 small-scale farmers was obtained from the Mahikeng local agricultural office of NWDARD for the specified area of study. From the population size (sampling frame) of 1449, a sample size of 170 with a margin of error of 9.3%, confidence level of 99% was obtained using the Raosoft software (Raosoft, 2004) for sample size calculation. Thus, a total of 170 small-scale farmers were randomly selected for this study.

2.5. Data collection

Data was collected in July, August, September and October of the year 2018, at livestock auctions, farmers' days organized by the NWDARD and farm visits. The first section of the questionnaire consisted of questions on the socio-economic characteristics of respondents. The second section of the questionnaire consisted of 15 knowledge test statements for respondents to choose whether they *agreed (2 points)* or *disagreed (1 point)* with the stated statement. The total knowledge level scores were then generated for each respondent, with 15 points being the lowest score possible and 30 points being the highest score possible for each respondent. The knowledge level scores were then grouped into two: with 15-18 points reflecting a low level of knowledge and given a dummy code of (0); and 19-30 points reflecting a high level of knowledge and given a dummy code of (1). The data collection method stated above was used by (Olorunfemi, Oladipo, Oladele, T.O. & Oladele, O.I., 2016:188).

2.6. Data analyses

Data were analysed using the statistical package for the social sciences (SPSS). Descriptive statistics were used to describe socio-economic characteristics of respondents and their knowledge on climate-smart agriculture. Tables were used to present the data. The binary logistic regression model was used to test the hypothesis. This model is used when a binary dependent variable is related to a set of continous and discrete independent variables. In this study, the dependent variable, being level of knowledge was categorized into two codes, with

the number 1 representing a high level of knowledge, and the number 0 representing a low level of knowledge.

2.7. Ethical considerations

This study obtained ethical clearance (NWU-00322-18-A9) on the 21st of May 2017 from the research ethics regulatory committee of the North-West University.

3. RESULTS AND DISCUSSIONS

3.1. Descriptive statistics of socio-economic characteristics of small-scale farmers in Mahikeng Local Municipality

The study has established that, the majority (73.5%) of small-scale farmers in Mahikeng Local Municipality are older than 40 years, while a mere 26.5% are younger than 41 years (Table 1). This indicates that, there is a low participation of youth in the small-scale agricultural sector in Mahikeng Local Municipality. Most small-scale farmers in Mahikeng Local Municipality are males (67.6%), while 32.4% are female farmers. The majority of respondents were married (55.9%). This means that, small-scale farmers in Mahikeng Local Municipality have close partners who support them as they juggle the everyday challenges of small-scale farming.

Most (65.3%) small-scale farmers in Mahikeng Local Municipality have a high school education. This means that, they are able to read and write, based on the high school education they have received. There is a high level of farming experience (above 20 years) which exists among a majority (48.9%) of small-scale farmers in Mahikeng Local Municipality. Only some (39.4%) of respondents' recall having contact with public agricultural extension officers. This is in spite of the fact that, the local public agricultural extension office is responsible for supporting all farmers within its area with relevant information and tools to ensure that, the farmers make profits and produce food for communities. Access to off-farm income is a financial resource which most (69.4%) of the small-scale farmers in Mahikeng Local Municipality do not have. This means that, these farmers depend on farming to settle their living expenses, as well as those of their family members.

It is very alarming to note that, the majority (93.5%) of small-scale farmers in Mahikeng Local Municipality do not have access to climate information. This means that, global warming and climate change are serious threats to the farming careers of these farmers. Almost all (98.2%) of the respondents indicated that, they do not have access to credit. This indicates that, small-scale farmers in Mahikeng Local Municipality are operating as farmers who have very limited alternative sources of funds to run their day to day farming operations.

Consistent with the definition of small-scale farmers by the DALRRD (2018:12), the majority (65.3%) of small-scale farmers in Mahikeng Local Municipality obtain monthly farm income of not more than R10 000. This means that these farmers do not make more than R120 000 from farming per annum. In addition, most (75.9%) small-scale farmers in Mahikeng Local Municipality are not part of farmer groups. This situation raises a serious concern for farming profitability of respondents, a majority (60.6%) of whom already do not have a contact with the public agricultural extension office. A majority (68.8%) of small-scale farmers in Mahikeng Local Municipality have at least four members in their households, this means that these

farmers have a responsibility of providing food and money not only for themselves, but for other people too.

Table 1: Descriptive statistics of socio-economic variables (n = 170)

Socio-economic variable	Categories and codes		Frequency (%)	Mean
Age	Less than 30 years old	(0)	9 (5.3%)	49 years old
	31 – 40 years old	(1)	36 (21.2%)	
	41 – 50 years old	(2)	48 (28.2%)	
	51 – 60 years old	(3)	50 (29.4%)	
	Above 60 years old	(4)	27 (15.9%)	
Gender	Female	(0)	55 (32.4%)	
	Male	(1)	115 (67.6%)	
Marital status	Single	(0)	64 (37.6%)	
	Married	(1)	95 (55.9%)	
	Divorced	(2)	1 (0.6%)	
	Widowed	(3)	10 (5.9%)	
Level of education	No formal schooling	(0)	4 (2.4%)	
	Primary school	(1)	15 (8.8%)	
	High school	(2)	111 (65.3%)	
	College	(3)	37 (21.8%)	
	University	(4)	3 (1.7%)	
Farming experience	Less than 10 years	(0)	31 (18.2%)	21 years
	10 – 20 years	(1)	56 (32.9%)	
	Above 20 years	(2)	83 (48.9%)	
Contact with public agricultural extension officers	No	(0)	103 (60.6%)	
	Yes	(1)	67 (39.4%)	
Access to off-farm income	No	(0)	118 (69.4%)	
	Yes	(1)	52 (30.6%)	
Access to climate information	No	(0)	159 (93.5%)	
	Yes	(1)	11 (6.5%)	
Access to credit	No	(0)	167 (98.2%)	
	Yes	(1)	3 (1.8%)	
Membership to farmer group	No	(0)	129 (75.9%)	
	Yes	(1)	41 (24.1%)	
Farm income per month	Not more than R10 000	(0)	111 (65.3%)	R8 908
	R10 001 – R20 000	(1)	43 (25.3%)	
	R20 001 – R30 000	(2)	14 (8.2%)	
	R30 001 – R40 000	(3)	1 (0.6%)	
	More than R40 000	(4)	1 (0.6%)	
Size of household	1 – 3 people	(0)	53 (31.2%)	5 people
	4 – 6 people	(1)	83 (48.8%)	
	Above 6 people	(2)	34 (20%)	
Type of farming	Grain crops only	(0)	41 (24.1%)	
	Livestock only	(1)	101 (59.4%)	
	Grain crops and livestock	(2)	28 (16.5%)	

Most (59.4%) small-scale farmers in Mahikeng Local Municipality are livestock farmers. This may be, because crop farming is very tedious and requires a lot of inputs for successful yields. Additionally, this may be because the farmers are able to utilize communal grazing land water resources for livestock production more easily than for grain crop production.

3.2. Small-scale farmers' knowledge about climate-smart agriculture

Table 2 indicates that 81.2% of the respondents disagreed with statements stating that, (i) climate-smart agriculture builds the resilience of farmers to climate change-related negative effects on their agricultural production by primarily focusing on the real needs of farmers and (ii) climate-smart agriculture assists farmers in reducing greenhouse gas emissions through mitigation measures, which are a secondary co-benefit to adaptation.

A majority (80.6%) of the respondents disagreed with statements stating that, (i) climate-smart agriculture pro-actively assists and supports farmers by identifying barriers to adoption of climate-smart agricultural practices by providing solutions in terms of policies, strategies, actions and incentives, and (ii) climate-smart agriculture uses integrated options such as education and training in building multiple areas of famers' adaptive capacity and resilience to climate change (Table 2).

While 80% of the respondents did not agree that, (i) climate-smart agriculture assists farmers in sustainably managing their soil productivity through the control of soil erosion, management of soil nutrients, management of soil cover, management of soil microorganisms, management of soil organic matter and management of soil-water balance, (ii) climate-smart agriculture enables farmers to be progressive, while optimising climatic conditions in order to maximise agricultural outputs in a sustainable manner and they also do not agree that, (iii) climate-smart agriculture builds the adaptive capacity of farmers by assisting them in coping with risk, uncertainty and anxiety which they may have due to the negative effects of climate change (Table 2).

Table 3 indicates that, a majority (75.9%) of small-scale farmers in Mahikeng Local Municipality have a low level of knowledge about climate-smart agriculture. This means that, there is a huge knowledge gap which needs to be filled to ensure that, small-scale farmers in Mahikeng Local Municipality are able to possess knowledge about climate-smart agriculture as a tool which will assist them in making decisions to combat the negative effects of global warming and climate change, thus reducing the vulnerability of their profits and livelihoods.
However, 24.7% of the respondents agreed that, climate-smart agriculture enhances the achievement of national food security and developmental goals. A further 23.5% of the respondents agreed that, climate-smart agriculture promotes the conservation of natural resources and the services they provide to agriculture (Table 2). This indicates that, there is small but very important proportion of small-scale farmers within Mahikeng Local Municipality who acknowledge that, climate-smart agriculture is important to achieving sustainable food security and the achievement of sustainable utilization and conservation of scarce natural resources. Table 3 indicates that, there are 24.1% of small-scale farmers in Mahikeng Local Municipality who have a high level of knowledge about climate-smart agriculture.

This means that, this group of farmers have been able to acquire information on climate-smart agriculture or related concepts such sustainable or conservation agriculture, which has made them knowledgeable about this particular topic of extremely high importance. This is positive because, these farmers may be able to assist their colleagues who have a lower level of knowledge on climate-smart agriculture.

Table 2: Knowledge test statements

Statement	Agree Frequency (%)	Disagree Frequency (%)	Mean
Climate-smart agriculture focuses on vulnerable groups such as rainfall dependent smallholder farmers, so that their livelihoods are not negatively affected and reduced by severe climate change events.	35 (20.6%)	135 (79.4%)	1.21
Climate-smart agriculture uses integrated options such as education and training in building multiple areas of famers' adaptive capacity and resilience to climate change, it does so by linking government and related stakeholders with the aim of supporting farmers.	33 (19.4%)	137 (80.6%)	1.19
Climate-smart agriculture builds the resilience of farmers to climate change-related negative effects on their agricultural production by primarily focusing on the real needs of farmers.	32 (18.8%)	138 (81.2%)	1.19
Climate-smart agriculture assists farmers in sustainably managing their soil productivity through the control of soil erosion, management of soil nutrients, management of soil cover, management of soil microorganisms, management of soil organic matter and management of soil-water balance.	34 (20%)	136 (80%)	1.20
Climate-smart agriculture assists farmers in reducing greenhouse gas emissions through mitigation measures, which are a secondary co-benefit to adaptation.	32 (18.8%)	138 (81.2%)	1.19
Climate-smart agriculture enables farmers to be progressive, while optimising climatic conditions in order to maximise agricultural outputs in a sustainable manner.	34 (20%)	136 (80%)	1.20
Climate-smart agriculture promotes the conservation of natural resources and the services they provide to agriculture.	40 (23.5%)	130 (76.5%)	1.24
Climate-smart agriculture enhances the achievement of national food security and developmental goals.	42 (24.7%)	128 (75.3%)	1.25
Climate-smart agriculture pro-actively assists and supports farmers by identifying barriers to	33 (19.4%)	137 (80.6)	1.19

adoption of climate-smart agricultural practices by providing solutions in terms of policies, strategies, actions and incentives.			
Climate-smart agriculture builds the adaptive capacity of farmers by assisting them in coping with risk, uncertainty and anxiety which they may have due to the negative effects of climate change.	34 (20%)	136 (80%)	1.20
In building farmers' resilience to climate change, climate-smart agriculture tailors solutions to farmers based on their specific local contexts, capacities, social, economic and environmental situations.	36 (21.2%)	134 (78.8%)	1.21
Climate-smart agriculture builds the adaptive capacity of farmers by reducing the vulnerability of their agricultural production systems to climate change and shocks.	36 (21.2%)	134 (78.8%)	1.21
Climate-smart agriculture promotes farmer resilience to climate change through effective communication of science-based climate-smart agricultural solutions through the extension system.	35 (20.6%)	135 (79.4%)	1.21
Climate-smart agriculture strengthens farmer livelihoods by improving their access to relevant support services such as information, financial products and markets.	35 (20.6%)	135 (79.4%)	1.21
Climate-smart agriculture enables food insecure communities to build-up food security in a sustainable manner by assisting them in building resilience, supporting adaptation, reducing greenhouse gas emissions, enhancing farm productivity and livelihoods.	36 (21.2%)	134 (78.8%)	1.21
Total number of statements			15
Grand mean			1.21
Chronbach's alpha			0.996

Table 3: Level of knowledge about climate-smart agriculture

Level of knowledge	Points	Frequency (%)
Low	15 – 18	129 (75.9%)
High	19 – 30	41 (24.1%)

3.3. Test for multicollinearity

There are statistical disturbances which should be inspected before running a binary logistic regression model. This should be done to ensure that statistical inferences made from the model are reliable and accurate. One such disturbance, which commonly occurs in binary logistic models and other models, is multicollinearity (Chen, 2012:1894; Midi, Sarkar & Rana, 2010:255).

Multicollinearity occurs when there is the presence of significant linear intercorrelations and inter-associations among the data, which form variables (Midi *et al.*, 2010:255). If there is the presence of multicollinearity within the input data, then output statistical inferences will not be accurate and reliable (Statistics Solutions, 2018).

Tolerance and Variance Inflation Factor (VIF) values were used in this study to detect multicollinearity (Midi *et al.*, 2010:258). According to these researchers, the value of Tolerance should not be less than 0.1 and VIF should not exceed 10. VIF and Tolerance tests for independent variables (age, gender, marital status, level of education, farming experience, contact with public agricultural extension officers, access to off-farm income, access to climate information, access to credit, farm income per month, membership to farmer group, size of household and type of farming) were ran in a model. The collinearity statistics of variables which showed statistical significance in the logistic model are presented in Table 4.

Table 4: Collinearity statistics

Independent variable	Tolerance	Variance inflation factor
Age	0.320	3.122
Access to off-farm income	0.659	1.518
Access to climate information	0.860	1.163
Farm income per month	0.665	1.505

3.4. Binary logistic regression model results

A total of 170 observations were used in the binary logistic regression model. The computed likelihood ratio chi square statistics showed statistical significance ($p < 0.01$). This implies that, the estimated parameters were not jointly equal to zero. A likelihood ratio chi square of 56.214 and a pseudo R square of 0.424 showed that the model is valid and has adequate explanatory power (Table 5).

Age had a statistically significant ($p < 0.1$) and negative relationship with respondents' knowledge about climate-smart agriculture. This indicates that, a unit increase in age (one year older), decreases the probability of a respondent having a high level of knowledge about climate-smart agriculture, by 3.130 units with 90% confidence level (Table 5). This implies that, younger and more youthful respondents, have a high level of knowledge about climate-smart agriculture. Younger and more youthful small-scale farmers have a high level of knowledge on climate-smart agriculture because they are energetic, agile and are able to search for information on the internet, therefore they become more exposed to innovations in agriculture. On the contrary, a regression analysis ran by Akrofi-Atitianti, Speranza, Bockel and Asare (2018:14), indicated that older small-scale farmers are more likely to practice climate-smart agriculture, meaning that older farmers know more about climate-smart agriculture.

Access to off-farm income enables small-scale farmers to have extra financial resources which they can utilize to purchase learning material for a price, with the aim of increasing their knowledge of contemporary practices in agriculture.

Access to off-farm income had a statistically significant (p < 0.05) and positive relationship with respondents' knowledge about climate-smart agriculture. This indicates that, a unit increase in access to off-farm income, increases the probability of a respondent having a high level of knowledge about climate-smart agriculture, by 5.888 units with 95% confidence level (Table 5). This implies that, respondents with access to off-farm income, have a high level of knowledge about climate-smart agriculture.

Access to climate information had a statistically significant ($p < 0.01$) and positive relationship with respondents' knowledge about climate-smart agriculture. This indicates that, a unit increase in access to climate information, increases the probability of a respondent having a high level of knowledge about climate-smart agriculture, by 7.762 units with 99% confidence level (Table 5). This implies that, respondents without access to climate information, have a low level knowledge about climate-smart agriculture. Small-scale farmers without access to climate information are unable to deeply appreciate the changes which are happening to the global climate system, therefore they are less motivated to search for information on climate-smart Agriculture. Farm income per month had a statistically significant ($p < 0.05$) and negative relationship with respondents' knowledge about climate-smart agriculture.

This indicates that, a unit increase in farm income per month, decreases the probability of a respondent having a high knowledge about climate-smart agriculture, by 4.966 units with 95% confidence level (Table 5). This implies that, respondents who obtain high levels of farm income per month, have a low level of knowledge about climate-smart agriculture. Small-scale farmers who earn a high income per month undermine the importance of climate-smart agriculture practices because they do not yet feel the financial strain which is brought by the negative impacts of climate change on agriculture. Therefore, they are less motivated to search for information on mechanisms which are aimed at combating the negative effects of climate change on agriculture. However, Masud, Azam, Mohiuddin, Banna, Akhtar, Alam and Begum (2017:704), indicate that farmers with a higher level of income are more likely to find ways of adapting to climate change, such as gathering information on climate-smart agriculture with the aim of increasing their knowledge on the topic.

The null hypothesis of this study is rejected because, there are statistically significant relationships (p < 0.05) between socio-economic characteristics of small-scale farmers in Mahikeng Local Municipality and their level of knowledge about climate-smart agriculture. Therefore, socio-economic characteristics of small-scale farmers need to be seriously considered and taken into account when implementing strategies of increasing the uptake of knowledge of climate-smart agriculture by small-scale farmers in Mahikeng Local Municipality. In agreement, Anuga, Gordon, Boon and Surugu (2019:133) indicated that, socio-economic characteristics of small-scale farmers influence their relationship with climate-smart agriculture.

Table 5: Results of the binary logistic regression model

Independent variable	Coefficient	Standard error	Marginal effect	*p* – value
Age	-0.619	0.350	3.130	0.077*
Access to off-farm income	1.374	0.566	5.888	0.015**
Access to climate information	3.155	1.132	7.762	0.005***
Farm income per month	-1.465	0.658	4.966	0.026**
Log likelihood function	129.288			
Likelihood ratio chi square	56.214			
Pseudo R square	0.424			

Note: *** Denotes statistically significant at 1%
** Denotes statistically significant at 5%
* Denotes statistically significant at 10%

4.   SUMMARY

Most small-scale farmers in Mahikeng Local Municipality are male livestock farmers, older than 40 years old, with no access to off-farm income, climate information and credit. The findings of this study indicate that, small-scale farmers in Mahikeng Local Municipality have a low level of knowledge about climate-smart agriculture. There was a statistically significant and negative relationship between the age of respondents and their level of knowledge about climate-smart agriculture. There was also a statistically significant and negative relationship between the farm income per month of respondents and their level of knowledge about climate-smart agriculture.

Access to off-farm income had a statistically significant and positive relationship with respondents' level of knowledge about climate-smart agriculture. While, access to climate information also had a statistically significant and positive relationship with respondents' level of knowledge about climate-smart agriculture. The null hypothesis of the study was rejected because, there were statistically significant relationships between socio-economic characteristics of respondents and their level of knowledge about climate-smart agriculture.

5.   CONCLUSIONS

There is a low level of participation of youth in the small-scale farming sector in Mahikeng Local Municipality. There are more male small-scale farmers in Mahikeng Local Municipality than female ones. Livestock farming is the most popular farming activity among small-scale farmers in Mahikeng Local Municipality. Serious lack of access to off-farm income, climate information and credit, are serious points of concern because lack of these resources makes the small-scale farmers in Mahikeng Local Municipality much vulnerable to threats posed by global warming and climate change.

Small-scale farmers in Mahikeng Local Municipality lack knowledge on climate-smart agriculture. Younger respondents have more knowledge about climate-smart agriculture than their older colleagues. It is interesting to note that, respondents who receive a high level of income per month, have a low level of knowledge about climate-smart agriculture. Respondents with access to off-farm income had high level of knowledge about climate-smart agriculture. Respondents with access to climate information also had a high level of knowledge about climate-smart agriculture.

6.   RECOMMENDATIONS

There should be urgent initiatives which should be designed and implemented by the NWDARD in conjunction with the Mahikeng Local Municipality, which should be aimed at increasing youth participation in the small-scale farming industry in Mahikeng. This will encourage youth entrepreneurship and contribute towards reducing the high level of youth unemployment in South Africa. Although there are some female small-scale farmers in the study area, the Mahikeng Local Municipality as the local government and the NWDARD, should roll-out campaigns in all communities of Mahikeng to inspire female farmers to be at the forefront of climate-smart agriculture initiatives in the area.

Due to the high level of participation in livestock farming, there should be more funds put in place by the NWDARD for developing small-scale livestock farmers in Mahikeng into large-scale livestock farmers, while following the climate-smart agriculture approach.

Importantly, funds to be invested in the small-scale livestock sector in Mahikeng should concurrently include targeted initiatives to encourage and financially support women in the sector. The majority of small-scale farmers in Mahikeng Local Municipality are older than 40 years old, have more than 20 years of experience as farmers, therefore the local agricultural extension office in Mahikeng and its associated stakeholders, both in the private and public sector should be very patient and respectful when teaching these group of aged and experienced farmers about climate-smart agriculture.

The Agricultural Research Council (ARC) of South Africa through their soil, climate and water unit, should urgently assist the small-scale farmers of the Mahikeng Local Municipality with climate information on a consistent basis. This public agricultural research institution should bear in mind that most small-scale rural farmers in areas such as Mahikeng, are staying in remote areas with poor internet connections and are also not technologically advanced as yet, and have limited post-school education. Therefore, the manner in which the farmers are assisted should be more personal, through face to face communication through focus group meetings or personal phone calls. This will ensure that these farmers have a better appreciation of the importance of climate information to a farming enterprise, even the farming enterprise is small-scale. Credit finance should be made available to small-scale farmers in Mahikeng Local Municipality by reputable business organizations who work with the NWDARD. This access to the credit finance will enable the farmers to continue farming even when they do not have enough farm income from previous seasons, which may have been affected by droughts and heat-waves associated with global warming and climate change.

Due to their low level of knowledge on climate-smart agriculture, small-scale farmers in Mahikeng Local Municipality should be offered training and education as soon as possible, to

improve their level of knowledge on climate-smart agriculture. This service should be provided by the NWDARD, ARC and the North-West University (NWU) Faculty of Natural and Agricultural Sciences (FNAS) because these institutions have the information, knowledge and capacity to be able to assist these respective farmers through their staff and students.

Activities aimed at increasing the level of knowledge on climate-smart agriculture among small-scale farmers in Mahikeng Local Municipality, should be targeted more at older farmers because they are the ones who are more associated with a low level of knowledge on climate-smart agriculture. Furthermore, young people who have studied agriculture and are actively involved in the industry, should be the ones who bring knowledge to their older counterparts, in an efficient and effective manner through the use of technological devices which have access to the internet. Additionally, activities aimed at increasing the level of knowledge about climate-smart agriculture among small-scale farmers in Mahikeng Local Municipality should focus on all farmers, despite their farm income per month because respondents who indicated that they earn a higher farm income, were shown to have a low level of knowledge about climate-smart agriculture. Further studies should look into other factors which may facilitate a positive relationship between small-scale farmers and climate-smart agriculture.

7.   ACKNOWLEDGEMENTS

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