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Rural Smallholder Maize Farmers' Adaptation and Coping Strategies to Climate Change in Thota-Moli, Maseru District, Lesotho

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ABSTRACT This paper examined factors that affect smallholder maize farmers' coping and adaptation strategies to climate change in Thota-Moli communal area in Maseru District in Lesotho. The study surveyed 70 respondents who were selected randomly from five villages using a structured questionnaire. The adaptation strategy index, descriptive statistics and the binary logistic regression model were utilised to analyse the data. The farmers ranked crop diversification and use of drought resistant varieties as the most useful adaptation strategies. The binary logit model results revealed that access to weather information, distance to input market, access to extension services, level of education and financing on-farm activities affect farmers' decision to cope with or adapt to effects of climate change. Hence, this study recommends that policy reforms should be guided by these socio-economic factors when developing strategies to expand the opportunities available for increased use of coping and adaptation strategies within rural farming communities.

INTRODUCTION

The agriculture sector in general and particularly smallholder agriculture is very sensitive to climatic conditions and the sector is under intense threat from climate change. In smallholder farming systems the situation is exacerbated by over reliance on non-irrigation techniques for cereal production. This increases rural population vulnerability to climate change due to reduced production of staple crops, like maize, leading to food and nutrition insecurity (Makuvaro et al. 2018). Besides, majority of smallholder farming households in Africa have inadequate farm equipment, farm in soils of low fertility, have limited income, often lack basic agronomic knowledge and have restricted access to climate information, and hence an increase in their vulnerability to negative impacts of variability to climate (Thamaga-Chitja and Morojele 2014; Ubisi et al. 2017). Ultimately, all these factors restrict the coping and adaptation ability of smallholder maize farmers. Moreover, in the context of Lesotho, high population densities make it very difficult for rural communities to sustain land-based livelihoods.

Farmers engage various adaptation strategies to climate change such as conservation agriculture, utilisation of improved seed crop varieties, soil conservation, planting of trees, irrigation and effecting changes to planting dates (Menike and Arachchi 2016). It is noteworthy that adaptation is influenced by exposure and sensitivity to climate impacts and is a function of climate vulnerability (Elum et al. 2017). Likewise, adaptation strategies that are employed by smallholder farmers are context specific, as there is no one size that fits all. They tend to change over time also depending on specific production systems as well as the location (Douxchamps et al. 2016). In that view, different smallholder farmers require different adoption strategies. Farmers' choice of specific adaptation methods is swayed by various socio-economic, institutional and environmental factors. Majority of communities in rural areas of developing countries, specifically those in Africa, are recognised as the most vulnerable to climate change impact due to reduced adaptive capacity and multiple stressors that they encounter (Parry et al. 2007; Gandure et al. 2013; Elum et al. 2017). Hence, it is important that farmers adapt to variability of climate change so as to minimise its negative impacts on their survival, given that the majority of rural poor communities in Africa rely on agriculture for their livelihoods.

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Agriculture contributes a relatively small proportion to Lesotho's national Gross Domestic Product (GDP), which is estimated at an average of six percent (World Bank 2017). Despite this low contribution to GDP, agriculture remains the main source of sustenance for almost eighty percent of the rural population in the country (World Bank 2018; World Bank Group 2019). In Lesotho, agriculture is mostly small-scale, characterised by extensive animal grazing and non-irrigation crop production system. The bulk of the population in Lesotho that relies on agriculture for survival resides either in the Lowlands or the Foothills where most of the arable land is found in the country (World Bank 2018).

According to Rantšo and Seboka (2019), Lesotho has been confronted with a massive food security dilemma for the past decade. Furthermore, approximately thirty percent of Lesotho's total population is vulnerable to food insecurity (WFP 2016). This is exacerbated by continuous changing climatic conditions such as drought and poor farming methods that have adversely affected smallholder maize farmers' production. Maize is the country's staple food. In Lesotho maize is one of the leading crops with an average harvest area of approximately 141,340 ha (Kuivanen et al. 2015).

Rural smallholder maize farmers in Lesotho experience extreme climatic episodes like recurrent droughts, floods, frost, and hailstorms, which deprive them of their agricultural output because they rely on rain-fed agriculture. Such kind of climatic shocks and hazards cause long term stress in rural communities' survival, as they try to cope annually with severe frosts, erratic rainfall, depleted soil fertility and different types of land degeneration that affect both their livestock and crop productivity (Matarira et al. 2014). Furthermore, smallholder maize farmers in Lesotho experience a very short growing season because of short rainfall season and severe winter frost. Consequently, this causes high incidences of food insecurity in the country. Thus, over the years, Lesotho has depended on food imports mainly from South Africa and large scale relief assistance to meet its population's food deficit requirements.

These climates induced hazards such as droughts have caused massive negative social, economic and cultural ramifications amongst smallholder maize farming communities in Lesotho due to decreased productivity. Socially, there have been negative coping mechanisms, which have been entrenched due to dwindling resources like household food supplies (Kamara et al. 2020). School dropouts, child marriage, exchanging sex for food and child labour are some of the negative coping strategies that are on the increase in Lesotho's rural communities due to recurrent droughts (Ferreira and Schady 2009). Additionally, hazards emanating from climate change such as drought have reduced productivity leading to an increase in poverty. Economically, smallholder maize farmers in Lesotho continue to encounter dwindling access to dietary diversity and food due to their over reliance on non-irrigation agriculture. As such, their food reserves run out or diminish without timely periodic restoration (Kamara et al. 2020). Culturally, sustained drought conditions have decreased community absorptive and adaptive capacities, leading to increased vulnerability, reduced community cohesion and leading to negative coping strategies.

To date, a growing body of empirical research has been devoted towards gaining improved insights of farmers' response to climate change and unpack different policy efforts directed towards reducing individual exposure to adverse impacts of climate change and ultimately improve their livelihoods. Nonetheless, these practical and scholarly efforts are restrained by availability of adequate conceptually rigorous frameworks to evaluate occurrence of adaptation (Fischer 2019). Review of the climate change literature indicates that little scrutiny has been granted to the perceptions and options for adaptation of smallholder farmers, while much consideration has been devoted to climate change impacts, climate change system modelling, risk assessment and adaptation (Ayanlade et al. 2017). Moreover, the confusion that emanates in policy prescription by failing to clearly distinguish between coping and adaptation strategies has resulted in maladaptation. This is a situation in which adaptation efforts have resulted in unintended consequences of increasing vulnerability of others (Juhola et al. 2016; Barnett and O'Neill 2010). Similarly, there still exist major gaps in scientists' analysis, understanding and awareness of African rural farmers to climate change impacts towards their agricultural production (Ayanlade et al. 2017). Previous empirical studies have indicated that farmers' coping strategies with climate change are informed by their perceptions of changing climate (Abid et al. 2015; Li et al. 2013). Therefore, understanding smallholder maize farmers' perception on the effects of climate change in Lesotho is very crucial.

Despite efforts by scholars to better understand smallholder farmers' coping and adaption strategies, empirical research on coping and adaptation, specifically in Lesotho, is limited. Since 2015 only very few empirical research papers have been published on effects of climate change on smallholder farmers in Lesotho and to the authors' best knowledge none have been dedicated to smallholder maize farmers' coping and adaptation strategies to climate change. Furthermore, according to Thabane et al. (2014), in Lesotho, there are limited studies that focus on the impacts of climate change on smallholder farmers at local level, as most studies tend to dwell on smallholder farmers' vulnerability to climate change mainly at national level. It is against this background that this study is premised so as to contribute to empirical research and assist in filling in this research gap.

Objectives

The objective of this study is to investigate rural smallholder maize farmers' adaptation and coping strategies to climate change in Thato-Moli rural settlement, which is situated in Maseru District in Lesotho. Hence, this study attempts to expand scientific understanding on how smallholder maize farmers in Lesotho device coping and adaptation strategies to climate change. In-depth understanding of coping and adaptation mechanisms of farmers' choices assists in formulation of appropriate interventions in adaptation planning.

METHODOLOGY

Study Area

Thota-Moli is a communal area in the Matsieng ward, which falls under the southern part of Maseru District in Lesotho. Thota-Moli area consists of the following communities and villages, namely, the Moshoeshoe I International Airport, are Mazenod, Mants'ebo, Thota Moli and Ha Masana communities, and is about 20 km away from the capital city of Lesotho, Maseru (Heath-Brown 2015). Maize is a very dominant crop produced by most households in the study area. According to the Bureau of Statistics (2016), Thota-Moli has a population of 55,571. Maseru District in which Thota-Moli is found has the highest density on arable land in the country estimated at 580.7 persons per square kilometer (Bureau of Statistics 2016). Therefore, generally smallholder maize farmers in Thota-Moli area also face the major challenge of high population densities, which makes it very difficult for these rural communities to sustain land-based livelihoods. This non-climate related challenge, acts as an additional stressor to the already existing climate related hazards and shocks that smallholder maize farmers in the area experience. Thota-Moli is located in the Lowlands agro-ecological zone of the country and this region is suitable for crop farming (Turner 2005; World Bank Group 2019). However, as is the case with the rest of the country, rainfall is sporadic and unreliable in Thota-Moli area. The southern part of Lowlands region in which Thota-Moli area is located receives an annual average rainfall of about 500mm (Lepheana 2002). Moreover, because the area is located in the southern part of the Lowlands region, it is moderately dry compared with the northern region (World Bank Group 2019).

Sampling Procedure and Sample Size Determination

A total of 70 respondents (smallholder maize farmers) obtained from five villages in Thota-Moli communal area were chosen using systematic random sampling from a list of households that was provided by the headman of each village. From each village 14 smallholder maize farmers were selected based on their easy accessibility as well as their representativeness. The selected 70 farmers were interviewed and it was hypothesised that the responses of farmers to climate change aspects would differ depending on their social and economic status. A survey tool in the form of a structured questionnaire was used to solicit information from respondents.

Data Analysis

The Statistical Package for the Social Sciences (IBM SPSS) Version 23 was used for data analysis. Firstly, the binary logistic regression model was employed to ascertain the factors that affect a farmer's individual decision to cope or adapt to the effects of climate change. This model was selected as the study makes use of one dichotomous dependent variable and multiple independent variables that influence the outcome variable, which requires the use of a standard method of analysis given that criterion. The purpose of the model is to approximate the likelihood that an observation with certain characteristics will fall into one of the specified categories. The "dependent variable"(Y_i) is dichotomous in nature, assuming the value 0, if a farmer chooses to cope or adapt, and 1, if he/she does not (P_i) will represent the probability that a farmer copes or adapts and (1-P_i) explains the probability that the farmer does not cope or adapt. Following a study by Goswami et al. (2011), that follows the Gujarati (2004) method, the functional form of the probability that a farmer copes or adapts is given as equation (1):

$$P_i = \frac{e^{\beta_i X_i}}{1 - e^{\beta_i X_i}}$$

The probability that a farmer does not cope is given as equation (2):

$$1 - P_i = \frac{e^{\beta_i X_i}}{1 - e^{\beta_i X_i}}$$

Where,

β_i is the vector of unspecified coefficients

X_i is the vector of predictor variables

From equations (1) and (2), equation (3) is derived:

$$\left(\frac{P_i}{1 - P_i}\right) = e^{\beta_i X_i}$$

Which signifies the odds ratio of coping or adapting.

Now taking both sides natural logarithms, equation (4) is derived:

$$L_i = ln\left(\frac{P_i}{1 - P_i}\right) = \beta_i X_i$$

Which signifies a logit model that indicates log of odds ratio of coping or adapting.

The advantages of using the binary logistic regression model over other models with similar functions such as the Probit Model is that it is not complex to compute, gives properly calibrated output and is easy to interpret.

Adaptation Strategy Index (ASI)

The adaptation strategy index (ASI) was utilised to analyse the adaptation approaches to climate change issues most frequently used by smallholder maize farmers in the study area. Adaptation strategies, which were used to mitigate against the effects of climate change and improve smallholder farmers' maize production, were captured in the survey questionnaire. Farmers rated the major components between adaptation strategies and maize production. Computation of the ASI followed a Likert scale, where frequently implemented adaptation strategies, those that were deemed to be of high importance, were assigned and marked as high priority on the adaptation strategies, medium scale for those implemented at medium level, low level for those approaches which were applied at a low level, and 0 for those mechanisms, which were not applied. The farmers had to rank usefulness in terms of a ranking system that took into account frequency of application and usefulness in relation to maize production. The study followed Asfaw et al. (2018) with modification of application of the adaptation strategy index. The formula for the adaptation strategy index was as follows:

$$ASI = AS_n \text{ x } 0 + AS_l \text{ x } 1 + AS_m \text{ x } + AS_h \text{ x } 3 \quad \ldots(5)$$

Where:

ASI = Adaptation Strategy Index

AS_n= Frequency of farmers rating adaptation strategy as having no importance

AS_L = Frequency of farmers rating adaptation strategy as having low importance

AS_M = Frequency of farmers rating adaptation strategy as having medium importance

AS_h = Frequency of farmers rating adaptation strategy as having high importance

RESULTS

Demographic and Socio-economic Characteristics of the Respondents

Socio-economic and demographic characteristics of smallholder farming households are vital when analysing coping and adaptation approaches to climate change, as they influence the social and economic behaviour of these households. As such, Table 1 presents some demographic and socio-economic attributes of respondents in the study area. Majority of the respondents were male (61%), while female farmers constituted thirty-nine percent of the sampled smallholder maize farmers. These findings are consistent with similar studies in the region, which showed that males dominate as household heads in smallholder farming communities (Mabuku et al. 2019; Muroyiwa et al. 2021).

However, despite this set up gender inequalities cause smallholder women farmers to be more vulnerable to vagaries of climate change because of the African social system (Batool et al. 2018). As such, gender is a very vital factor in determining coping and adaptation decisions of smallholder farming communities to climate change.

Age is a vital aspect in coping and adapting to climate change, as it reveals farming experience.

Table 1: Demographic and socio-economic characteristics of respondents

Variable	*Frequency*	*Percentage (%)*
Gender		
Male	43	61.4
Female	27	38.6
Age		
0 - 20	0	0
21 - 40	26	34.3
41 - 60	28	40
61 and older	16	25.7
Cope and/or Adapt		
Yes	49	70
No	21	30
Household Size		
1 - 3	33	47.1
4 - 6	28	40
7 - 9	9	12.9
10 and above		
Farm Size		
0.1 – 4 acres	48	68.5
5 – 9 acres	18	25.8
10 acres and above	4	5.7
Level of Education		
Not having formal education	21	30
Attained primary school	9	12.9
Attained secondary school	7	10
Attained high school	10	14.3
Attained tertiary level	23	32.8
Monthly Income		
Less than M1000.00	14	20
M1000.00 – M3000.00	26	37.1
M3001.00 – M5000.00	17	24.3
More than M5000.00	13	18.6
Occupation		
Part-time farmer	37	52.9
Full-time farmer	33	47.1
Marital Status		
Single	16	22.9
Married	43	61.4
Widow/Widower	10	14.3
Divorced/Separated	1	1.4
Access to Extension		
Yes	16	22.9
No	54	77.1

Source: Field survey 2020

Older farmers are deemed to be more experienced compared to younger farmers. Therefore, age is an essential aspect in agricultural productivity of smallholder farmers. The age group with the youngest farmers was between 21-40 years and they constituted thirty-four percent of the sampled respondents. The majority of the farmers (40%) were in the age category of 41-60 years. Finally, the oldest age group were those farmers who were above 61 years and they accounted for twenty-six percent of the respondents. These results are consistent with previous findings of Makuvaro et al. (2018) and Muroyiwa et al. (2021) on the impact of farmers' age on wealth status and ability to cope with natural calamities.

The survey sample results from Table 1 indicate that the household size with 1 to 3 members is the most dominant household size in study area accounting for forty-seven percent, followed by 4 to 6 that constituted forty percent of the sample. There were a very small proportion of households comprising of 7 to 9 members, which was about thirteen percent of the sample. In smallholder farming communities, large household sizes determine availability of labour for agricultural operations compared to smaller household sizes. This study result highlights that smallholder maize farmers in the study area had enough household members to engage in farm operations.

The average smallholder maize farmer from this study had a farm size between 0.1 and 4 acres, which is almost the same with the national average landholding size specifically in Maseru District. This shows high population densities, which makes it very difficult for these rural communities to sustain land-based livelihoods. Such kind of a scenario has negative consequences towards the farmers' adoption of coping and adaptation mechanisms to climate change (Deressa et al. 2009).

Additionally, education levels were relatively low, as nearly thirty percent of the respondents had not attained any formal education, thirteen percent had attained primary level of education, cumulatively twenty-four percent had attained some secondary education, with very few household heads having attained tertiary education (33%). Education has effects on the adoption of coping and adaptation approaches to climate variability and change. This is due to the fact that higher educational levels, are more likely to improve understanding of climate change effects and the approaches that need to be implemented in mitigating such impacts (Alemayehu and Bewket 2017). In the same vein, the majority of respondents at seventy-seven percent indicated that they had no access to extension, and this has detrimental effects on their coping and adaptation approaches to climate change. Inadequate access to agricultural extension was also highlighted previously as one of the major factors, which hinder smallholder farmers' adaptation practices to climate variability and change (Masud et al. 2017).

Smallholder Farmers' Coping Strategies

Smallholder maize farmers in the study area employ various approaches against short-term impacts (coping) as well as long-term effects (adaptation) of climate change. The different coping and adaptation strategies were drawn based on previous experience, reviewing of relevant literature concerning coping and adaptation approaches to climate change as well as available data. Based on this, about twenty-one (21) various coping approaches were identified. According to Alemayehu and Bewket (2017), the choice of a coping mechanism is guided by local context suitability, profitability, cost and acceptance. Table 2 shows the different coping mechanisms that are utilised by smallholder maize farmers in Thato-Moli area during times of crisis and shocks.

The majority (70%) of the respondents chose to plant short season crops to cope with the effects of climate change. This could be because short season crops are ready for harvest faster and help in reducing household food consumption pressure. This finding is in line with those of Tripathi and Mishra (2017), who found out that growing short duration crops is one of the coping strategies widely employed by smallholder farmers.

About fifty-one percent of the people interviewed stated the use of pesticides as a coping mechanism to climate change and variability (Table 2). Since most of the smallholder maize farmers in Thato-Moli area complained that the prevalence of pests that attack their produce has increased, pesticides significantly assist in controlling them.

Some forty-seven percent of the surveyed households practice intercropping as a coping strategy. This could be due to the fact that intercropping offers numerous benefits to farmers such as variety of cultivated crops, balancing household food demand, and complementing division of plant resources such as nitrogen in a case where-

Table 2: Farmers' coping strategies

Coping strategy	*Farmers that use the strategy*		*Farmers that do not use the strategy*	
	Frequency	*Percentage (%)*	*Frequency*	*Percentage (%)*
Planting short season crops	49	70	21	30
Using pesticides	36	51.4	34	48.6
Intercropping	33	47.1	37	52.9
Livelihood diversification	32	45.7	38	54.3
Mulching	31	44.3	39	55.7
Better storage methods	29	41.4	41	58.6
Reducing use of chemical fertiliser	28	40	42	60
Rainwater harvesting	23	32.9	47	67.1
Selling livestock	22	31.4	48	68.6
Stockpiling grain	21	30	49	70
Using subsidies	18	25.7	52	74.3
Reducing quality of household food consumed	16	22.9	54	77.1
Better transport of produce	14	20	56	80
Reducing quantity of household food consumed	14	20	56	80
Reducing frequency of household meals	14	20	56	80
Getting food aid	11	15.7	59	84.3
Renting out land	8	11.4	62	88.6
Reducing tillage	7	10	63	90
Borrowing money/agricultural assets	6	8.6	64	91.4
Selling land	5	7.1	65	92.9
Migrating seasonally	1	1.4	69	98.6

by a nitrogen fixing plant is grown. Furthermore, intercropping reduces vulnerability of crops to pests and diseases and helps in hindering the growth of weeds. Previous empirical studies have also reported similar findings (Williams et al. 2018; Tripathi and Mishra 2017; Shikuku et al. 2017). Another forty-six percent of the farmers chose to use livelihood diversification as a coping mechanism. The reason being that livelihood diversification allows farmers to invest in off-farm activities that are profitable, which will allow them to invest in the use of coping and adaptation strategies. The least used coping strategy was seasonal migration by the farmer, which was used by only 1.4 percent of the farmers. This could be due to the fact that most of the farmers do not have the opportunity of acquiring seasonal jobs elsewhere and, therefore, have no reason to migrate. Similar results were also postulated by Bawakyillenuo et al. (2016) and Alemayehu and Bewket (2017), who also found that very few farmers used seasonal migration as a coping strategy.

Smallholder Farmers' Adaptation Strategies

A list of adaptation strategies was presented to respondents so that they could indicate the ones they had used. Table 3 illustrates smallholder farmers' adoption of adaptation mechanisms in Thota-Moli area. The findings show that 61.4 percent of the farmers adapted to the effects of climate change by using fertilisers. Since most of the farmers stipulated that their soils had become less fertile, fertilisers help improve the quality of the land, which in turn, increases the crop yield.

Adoption of diversification of crops cultivated was done by fifty-eight percent of the farmers. This may be because diversification of crop insures against climatic variability and gives farmers the opportunity to cultivate a wide variety of crops. Similar findings were also inferred in previous studies (Akhtar et al. 2018; Tripathi and Mishra 2017). Findings from this study went on to reveal that fifty-six percent of the interviewed farmers practice crop rotation as an adaptation approach. Probably this is because crop rotation improves soil structure, reduces the occurrence of weeds and reduces the prevalence of pests. Additionally, 52.9 percent of the farmers changed their planting dates. This could be because farmers were aware of climate change and the variable weather changes, which have caused them to choose to modify their original planting dates. The information provided by the respondents on changing of planting dates concur with the study by Ike and Ezeafulukwe (2015).

Use of maize varieties that are tolerant to erratic rainfall as an adaptation mechanism was stated by fifty-one percent of the interviewed farmers. This could be because most of the farmers have

Table 3: Farmers' adaptation strategies

Adaptation strategy	*Farmers that use the strategy*		*Farmers that do not use the strategy*	
	Frequency	*Percentage (%)*	*Frequency*	*Percentage (%)*
Using fertilisers	43	61.4	27	38.6
Diversifying the crops cultivated	41	58.6	29	41.4
Crop rotation	39	55.7	31	44.3
Changing planting dates	37	52.9	33	47.1
Use of maize varieties that are tolerant to erratic rainfall	36	51.4	34	48.6
Use of maize varieties that are drought resistant	31	44.3	39	55.7
Diversifying farm activities	31	44.3	39	55.7
Use of maize varieties that are resistant to pests and diseases	28	40	42	60
Expansion of farming activities	27	38.6	43	61.4
Planting early	27	38.6	43	61.4
Expanding water reservoirs	19	27.1	51	72.9
Digging wells and ponds	9	12.9	61	87.1
Improved irrigation	8	11.4	62	88.6
Cover cropping	7	10	63	90
Relocation of crops	0	0	70	100

perceived that rainfall patterns have become irregular and can no longer be relied upon for the success of their crops.

None of the farmers chose to relocate their crops as an adaptation strategy. This could be as a result of farmers being financially constrained and not being able to afford to move their crops to areas where climate change has made little effects on crop production. This finding concurs with that of Akhtar et al. (2018), who found that a very limited number of farmers chose to relocate their crops so as to adapt to the repercussions of climate change.

Relationship between Adaptation Strategies and Maize Production

The study used the adaptation strategy index so as to determine the association between adaptation approaches and maize production following, Asfaw et al. (2018) and Muroyiwa et al. (2021) who also used the index. The assumption was that if respondents ranked the adaptation strategy highly, it meant that they find it useful in mitigating and adapting to the impacts of climate change. Table 4 presents the surveyed farmers' ranking of different adaptation strategies and their impact on maize production.

Diversifying crops cultivated was ranked first with an Adaptation Strategy Index of 183. Smallholder farmers follow a subsistence agricultural practice (Mendoza et al. 2017) and their aim is to make available as much as possible variety for household consumption and to sell a fraction of these crops for income in order to meet their other needs at household level, reducing the pressure of relying on only maize. The use of maize varieties that are tolerant to erratic rainfall, use of maize varieties that are drought resistant and use of maize varieties that are drought resistant were ranked second, third and fourth, respectively. Heavy rainfall, dry spells and occurrence of pests and diseases are very prevalent lately and obtaining advanced maize seeds significantly assists in lowering losses caused by crop failure (Schroeder et al. 2013). Out of 20 adaptation strategies, the least ranked was relocating crops with an Adaptation Strategy Index of 21. The farmers explained that it would cost them more to grow and maintain their maize produce elsewhere without being able to oversee and have ease of access to their fields as constantly as they would prefer.

Table 4: Farmers' adaptation strategies index

Adaptation strategy	*Level of importance*				*ASI*	*Rank*
	High	*Med*	*Low*	*None*		
Diversifying the crops cultivated	48	17	5	0	183	1
Use of maize varieties that are resistant to pests and diseases	44	18	6	2	174	2
Use of maize varieties that are tolerant to erratic rainfall	47	12	8	3	173	3
Use of maize varieties that are drought resistant	43	17	5	5	168	4
Investing in off-farm activities	38	21	6	5	162	5
Improved irrigation	33	24	8	5	155	6
Diversifying farm activities	33	19	14	4	151	7
Expansion of farming activities	33	19	14	4	151	8
Using fertilisers	27	21	14	8	137	9
Crop rotation	33	12	13	12	136	10
Farming near water sources	33	9	11	17	128	11
Expanding water reservoirs	27	15	14	14	125	12
Changing planting dates	25	12	11	22	110	13
Trenching against flood water	17	16	20	17	103	14
Digging wells and ponds	12	24	11	23	95	15
Planting early	21	4	16	29	87	16
Scaling back on-farm operations	15	10	22	23	87	17
Cover cropping	5	18	14	33	65	18
Relocation of crops	1	2	10	57	21	19

Factors Affecting Farmers' Decision to Cope with or Adapt to Effects of Climate Change

The binary logistic regression shown in Table 5 was utilised to analyse factors that affect farmers' decision to cope or adapt to the effects of climate change. The model is significant at one percent and the *Nagelkerke* R^2 of 0.553 indicates that more of the variation was explained by the model with an overall prediction percentage of fifty-five percent as shown in Table 5.

DISCUSSION

Level of Education

The findings indicate that education level positively and significantly influences the farmers' choices to cope or adapt to climate change effects at ten percent significance level with an odds ratio of 6.093. This means that respondents with higher educational levels are 6.093 times more presumably to cope and/or adapt in comparison with those that have not received any formal education. The findings correspond with *a priori* expectations and could be because farmers that are more educated might be better aware and informed on the effects of climate change and how to mitigate them with the use of coping and adaptation approaches. Young farmers especially are more likely to be more literate and educated compared to older farmers. Hence, they are keener to adopt adaptation mechanisms that mitigate against climate change and take risks, than the older generation. Perhaps there is a tendency by older farmers to stick to their outdated farming methods rather than switching to modern techniques. Similar findings were also confirmed by Muroyiwa et al. (2021) and Alemayehu and Bewket (2017) who found that the level of education significantly influences the farmers' choice to adapt to climate change. Conversely, the findings of this study differ with those of Tessema et al. (2013) and Legesse et al. (2012) who state that the age of farmers in eastern Ethiopia had no bearing on adopting climate change adaptation approaches.

Access to Weather Information

The findings show that the access to weather information variable negatively and significantly influences the farmers' choice to cope or adapt to climate change effects at one percent significance level with an odds ratio of 0.005. This means that farmers that had weather information access were 0.005 times less likely to cope and/or adapt in comparison with those that had no access to weather information. These findings contradict the study's *a priori* expectations and could be because farm-

Table 5: Factors affecting farmers' decision to cope with or adapt to effects of climate change

Variables	*Coefficients*	*Odds ratios*	*Standard error*	*Significance*
Age	0.022	1.023	0.035	0.519
Household size	-0.259	0.771	0.249	0.297
Gender	-0.897	0.408	0.837	0.284
Level of education	1.807	6.093	1.050	0.085*
Marital status	-0.657	0.518	0.940	0.485
Farm size	0.147	1.159	0.136	0.278
Monthly income	-0.560	0.571	1.134	0.621
Occupation	-0.691	0.501	1.027	0.501
Household labour	0.105	1.111	0.825	0.899
Access to weather information	-5.299	0.005	2.042	0.009***
Extension services	-4.135	0.016	1.633	0.011**
Land acquisition	0.992	2.695	1.542	0.520
Access to credit	-0.695	0.499	1.082	0.521
Distance to input market	3.108	22.384	1.265	0.014**
Member of farmer group(s)	-0.005	0.995	2.623	0.998
Methods used to finance on-farm activities	3.558	35.096	1.319	0.007***
Type of farming system	-1.026	0.358	1.238	0.407
Constant	3.074	21.623	3.363	0.361

Note: ***,** and * denote statistical significance at 1%, 5% and 10% probability levels, respectively Log likelihood = 50.906, Number of obs = 70, LR $Chi^2 (17) = 34.615$, Prob > $Chi^2 = 0.007$, Pseudo $R^2 = 0.553$

ers are possibly accustomed to highly variable weather patterns, and forecasts do not make actionable knowledge available to them. These findings are contrary to those of Wood et al. (2014), who highlighted that weather information access had a positive and significant influence on farmers' choices of farming practices.

Extension Services Access

The study results indicate that extension services access variable negatively and significantly influences the farmers' decision to cope and/or adapt to climate change effects at five percent significance level with an odds ratio of 0.016. This means that farmers with extension services access are 0.016 times less likely to cope and/or adapt in comparison with those that do not have access to extension services. These findings contradict *a priori* expectations and could be due to the fact that the role of extension in minimising climate change effects by giving timely information to farmers has not been explored. One plausible reason for this is that generally smallholder maize farmers in Thota-Moli area lack access to extension as shown in Table 1. Therefore, by default the importance of extension services towards influencing farmers decision to adopt adaptation strategies is discarded, as they tend to use their own means and ways to adapt to climate change. These findings are contrary to those of Nhemachena and Hassan (2007) and Yigezu et al. (2018) who found that availability of extension services positively and significantly influence farmers' choices.

Distance to Input Market

The findings show that the distance to input market variable had a positive and significant influence on the farmers' choice to cope and/or adapt to climate change effects at five percent significance level with an odds ratio of 22.384. This means that farmers with better access to input markets are 22.384 times more presumably to cope and/or adapt in comparison with farmers who do not have good access to input markets. The findings agree with *a priori* expectations and could be because farmers with good access to markets are more likely to be aware and updated on information about the effects of climate change and how to mitigate them. The findings concur with those of Adimassu and Kessler (2016) and are contrary to those of Menike and Arachchi (2016) who established that market access had an insignificant influence on farmers' adaptation choices to climate change.

Financing On-farm Activities

Methods of financing on-farm activities had a positive and significant influence on the farmers' choice to cope and/or adapt to climate change effects at one percent significance level with an odds ratio of 35.096. This means that farmers who use external funds such as cash remittances to finance on-farm activities are 35.096 times more likely to cope and/or adapt in comparison with farmers who use only their own funds to finance on-farm activities. These findings are in line with *a priori* expectations and might be because farmers whose income includes external funds are able to invest in on-farm practices more, as they might have their household financial burdens eased. These results are in tandem with those of Banerjee et al. (2016) who explained that households that receive remittances are more likely to increase their adaptive capacity.

CONCLUSION

This research analysed the factors affecting the farmers' decision to cope with and/or adapt to effects of climate change in Thota-Moli communal settlement in Maseru District, Lesotho. Moreover, the study examined the intensity of adopting adaptation approaches and their resultant effects on maize production of farmers in Thota-Moli area. The over reliance of farmers on rain-fed farming techniques increases their vulnerability to harsh and extreme climatic conditions. Climate change has negatively impacted the sustenance of smallholder farmers. Therefore, to circumvent these challenges, smallholder farmers in Thota-Moli communal area utilised a wide range of coping and adaptation approaches against these short and long term effects. The most common coping strategy among the respondents was the cultivation of short season crops and the widely used adaptation strategy was the application of organic fertiliser in crop production.

The study used the adaptation strategy index in order to ascertain the association among adopting adaptation approaches as well as maize production. Adaptation strategies were ranked by respondents according to their importance in adapting to climate change and in their success to alleviate reduction in production of maize. The interviewed farmers ranked crop diversification as the most important adaptation strategy. This could be because smallholder farmers mainly produce for subsistence. As such, they want to make available as much as possible variety for household consumption and to sell a fraction of these crops for income in order to meet their other needs at household level reducing the pressure of relying on only maize.

The results of the study provided empirical evidence that level of education, weather information access, distance to input market, extension services access and financing on-farm activities affect farmers' decision to cope with and/or adapt to effects of climate change. The study concludes that policies on adaptation should be guided by these socio-economic factors to build on existing coping and adaptation mechanisms in the study area.

RECOMMENDATIONS

These study findings recommend numerous policy measures such as expanding the availability of subsidised input markets and assembling irrigation systems in the rural areas. Timely dissemination of climate change information can be facilitated through improving contact between farmers and extension workers. Moreover, farmer trainings are also required to enlighten farmers about the effects of climate change as well as how to use weather forecasts to improve their choices of coping and adaptation strategies. Similarly, encouraging formation of farmer based organisations or cooperatives can go a long way in assisting farmers towards sourcing of inputs within a close range at cheaper prices as they benefit from economies of scale. Implementation of such strategies requires that farmers have better access to finances. This can be achieved by the government easing loan access and offering farmers grants that are specifically acquired for mitigating the effects of climate change.

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