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Factors Influencing the Choice of Climate Change Adaptation Strategies by Households: A Case of Mpolonjeni Area Development Programme (ADP) in Swaziland

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Abstract

The increased involvement of food relief agencies nearly on an annual basis is a clear indication that agricultural production continues to decline as a result of climate change. In order to mitigate the negative effect of climate change, households engage on adaptation strategies. The extent to which these impacts are felt depends mostly on the level of adaptation in response to climate change. The main objectives of the study were to identify the adaptation strategies employed by households and to analyse factors influencing the choice of adaptation strategies by households using personal interviews. The study used data from a random sample of 350 households. Descriptive statistics and multinomial logistic regression model were used to analyse the data. The results showed that adaptation strategies employed were; drought tolerant varieties, switching crops, irrigation, crop rotation, mulching, minimum tillage, early planting, late planting and intercropping. The results showed that the choice of adaptation strategies by households was significantly ($p < 0.05$) influenced by; age of household head, occupation of household head, being a member of a social group, land category, access to credit, access to extension services and training, high incidences of crop pest and disease, high input prices, high food prices, perceptions of households towards climate change. Moreover, the analysis showed that perceptions of households towards climate change significantly influence all adaptation strategies. However, sex and education level of the household head were insignificant in influencing household choice when adapting to climate change. It is recommended that there is need to educate households about the negative impact of climate change on cropping systems. The study also recommends that agriculture extension services should be strengthened, agriculture financial institutions should accommodate subsistence farmers on communal land and rural micro-finance institutions should be developed, in order to facilitate farmers to choose effective adaptation strategies.

Keywords: Climate change, Climate variability, Adaptation strategies, Multinomial logistic model

1. Introduction

1.1 Impact of Climate Change on Crop Production in Swaziland

Swaziland's sustainable development is threatened by climate change through adverse effects on the environment, health, food security, economic activities and physical infrastructure. Climate change is characterised by changes in precipitation patterns, rainfall variability and high temperatures which has increased the country's frequency of drought, floods, wildfires, windstorms and hailstorms (Manyatsi et al., 2010). For the past four decades, the country has been hit by severe droughts in 1983, 1992, 2001, 2007 and 2008, cyclone Domonia in 1984 and floods in 2000 (Brown, 2010; Gamedze, 2006; Manyatsi et al., 2010; Oseni & Masarirambi, 2011).

Climate change and variability has negatively affected livelihoods for most households in the Lowveld through low agricultural productivity in subsistence farming (Nxumalo, 2012). According to Manyatsi et al. (2010), rural households are adapting to climate change, however the issue of poverty and hunger has not been fully addressed by these attempts because 40% of the households rely on food aid. Adaptation to climate change requires that households first appreciate that climate has changed, identify useful adaptation options and choose among a wide range of adaptation strategies. This therefore, makes households within the same geographical location to use difference adaptation strategies in response to climate change and variability. However, the factors influencing their choice of the adaptation strategies are unknown hence the study. The main objective of the study therefore, was to identify the factors influencing the choice adaptation strategies by households.

2. Literature Review

2.1 Climate Change and Crop Production

Climate change is characterised by droughts and floods, which destroy plants and depletes the soil. The frequent droughts that have been observed over the past decades reduce soil moisture and water resources for plants, thus resulting in severe water stress. Reduced soil moisture decreases available water for irrigation and hinder plant growth in non-irrigated plants (Aydinalp & Cresser, 2008).

Drought and floods kill animals that are used by small-scale farmers for ploughing, thus leaving them with no choice, but to hire tractors. However, most rural households do not afford such services because of poor financial background. Drought reduces soil fertility by reducing the organic component of the soil as the amount of crop residues is reduced. This tends to increase the costs of farming as households need to apply fertiliser to avoid reduction of crop yields. Floods affect crop production through waterlogging and soil erosion, where such conditions interfere with soil fertility and therefore reduce crop yields.

According to Aydinalp and Cresser (2008) erratic rainfall has been recorded and observed in many geographical regions in the world. Rainfall frequency, distribution and intensity have changed, rainfall is poorly distributed throughout the growing season, such that there is no rain during the maturity stage of most crops. This results in total crop failure even if the crop has been performing well during the early stages of development. Rainfall intensity has changed in such a way that the total rainfall received does not balance the water demand for most crops. Similarly long dry periods have been observed during the planting season as a result of changed rainfall intensity which affect plant growth and eventually crop yield.

2.2 Types of Adaptation Strategies to Climate Change

Adaptation strategies to climate change can be grouped into autonomous or private and planned or public sector adaptation strategies. Private adaptation strategies involve action taken by non-state agencies such as farmers, communities or organisations and or firms in response to climate change. According to Bruin (2011) adaptation strategies include switching crops, shifting crop calendar, engaging new management practices for a specific climate regime, changing irrigation system and selecting different cropping technologies. Public adaptation involves actions taken by local, regional and or national government to provide infrastructure and institutions to reduce the negative impact of climate change. Public adaptation strategies include development of new irrigation infrastructure, transport or storage infrastructure, land use arrangements and property rights, water shed management institutions (World Bank, 2010).

According to Sathaye and Christensen (1998), Bruin (2011) adaptation strategies can be either proactive or anticipatory depending whether it takes place before or after climate change. Reactive adaptation strategies addresses effects of climate change after they have been experienced, while proactive adaptation strategies are engaged in anticipation of climate change. In crop production**,** reactive adaptation strategies include control of soil erosion, construction of irrigation dams, improving soil fertility, development of new varieties, shifting planting and harvesting time. Anticipatory adaptation strategies on the other hand involve the development of tolerant cultivars, research development, policy measures on taxation and incentives. Gbetibouo (2009) suggested that smallholder farmers can adapt to climate change by changing planting dates and diversifying crops. This can be possible if government provides them with the necessary support. Smallholder farmers can also adapt to climate change by practicing soil and water conservation measures and planting trees (Yesuf et al, 2008).

2.3 Determinants of Adaptation Strategies to Climate Change

According to Yesuf et al. (2008) farmers' adaptation of climate change adaptation strategies is influenced by frequent and more accurate climate information from meteorological centres, formal and informal institutions, access to credit and extension information, amount of seasonal rainfall, geographical location, household size, age and literacy of household head. Nhemachena and Hassan (2007) found that markets, access to electricity and technology, land ownership and sex of the household head significantly influence household choice when adapting to climate change while Gbetibouo (2009) cited poverty, lack of secure property rights, lack of savings, farm size, lack of technical skills and off-farm employment as additional barriers to adoption of climate change adaptation strategies. Deressa et al. (2008)

urged that livestock ownership, local temperatures and amount of precipitation also determines the choice of households when adapting to climate change.

3. Methodology

3.1 Study Design

The study is a descriptive quantitative research to identify factors influencing the choice of adaptation strategies by households at Mpolonjeni Area Development Programme (ADP).

3.2 Study Area

Mpolonjeni ADP is located in the central east of Swaziland in the Lubombo administrative region and in the Lowveld ecological zone (Figure 1). It consists of Mpolonjeni and part of Lugongolweni constituencies. The ADP has five chiefdoms which are Mpolonjeni, kaLanga, kaNgcina, kaShoba and kaNdzangu and several communities with a population of 3157 households. The households are on communal land and rely mainly on rainfall for their crops. The study area has an altitude of 303m above sea level and has undulating plain to gently undulating plain. The soils range from red loam to red clay, which are fertile soils and are good for crop production except for root crops. The average minimum temperatures are 15.4^{0}C and maximum temperature of 28.3^{0}C (Vilakati, 1997).

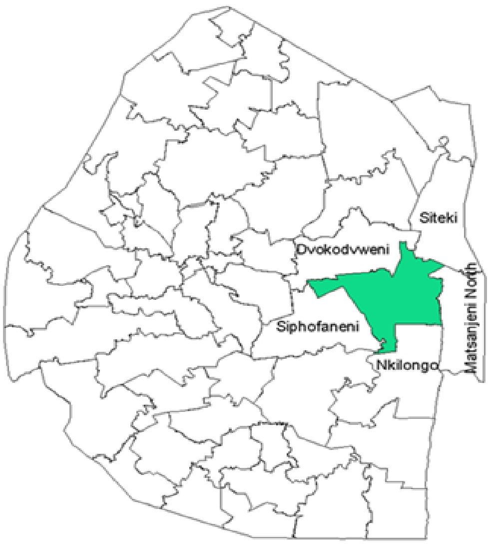

Figure 1. Map of Swaziland showing Mpolonjeni ADP

3.3 Sampling Procedures and Sample Size

The primary data used for the study were obtained from a cross sectional survey of households at Mpolonjeni ADP. A stratified random sampling was used to obtain a representative sample using the chiefdoms as strata and a sample of 350 households used for the study (Table 1). However, only 257 households of the sample were usable since they were the only ones producing crops.

Table 1. Population and sample size of households from the chiefdoms of Mpolonjeni ADP

Community	Population size	Sample size
Mpolonjeni	614	68
Langa	1645	183
Ngcina	157	17
Shoba	441	49
Ndzangu	300	33
Total	3 157	350

3.4 Data Collection and Analysis

Data were collected through personal interview, using a questionnaire. Data were analysed using Microsoft excel 2010 statistical package and STATA version 10 statistical package. Multinomial logistic regression model was used to analyse the factors influencing the choice of climate change adaptation strategies by households while descriptive statistics was used to analyse adaptation strategies used by households.

3.5 Analytical Framework

Multinomial logistic regression model (MNL) was used to analyse the factors influencing households' choice of climate change adaptation strategies. According to Magombo et al. (2011), MNL model for choice of adaptation strategies specifies the relationship between the probability of choosing an adaptation option and the set of explanatory variables. The adaptation strategies were grouped into six groups since households used more than one strategy and one group was 'no adapting to climate change'. Therefore, the groups were; drought tolerant varieties and shifting planting dates; no adaptation; drought tolerant varieties, shifting planting dates and conservational agriculture; shifting planting dates and conservational agriculture; all strategies; irrigation and any other strategies.

The MNL model was as follows;

$$Y_i = \text{In}\ (P_{j/}P_1) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 \quad + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9$$
$$+\beta_{10} X_{10} \quad + \beta_{11} X_{11} + \beta_{12} X_{12} + e_i$$

Where Y_i = adaptation strategy (no adaptation; drought tolerant varieties, shifting planting dates and conservational agriculture; conservational agriculture and shifting planting dates; all strategies; irrigation and any other strategies)

X_i, where $_i$ = 1, 2,…………13, are explanatory variables. The dependent variables are listed in Table 2 below.

Table 2. Independent variables used in the multinomial logistic regression model

Independent variable	**Coding**	**Category**	**Expected sign**
Sex of household head	1 = male, 0 = female	Dummy	+ / -
Age of household head	Years	Continuous	+ / -
Education level of household head	Years	Continuous	+
Occupation of household head	1= farming, 0 = none farming	Dummy	+ / -
Member of social group	1= social group, 0 = no social group	Dummy	+
Land category	1= own land, 0 = rented land	Dummy	+
Access to credit	1 = access to credit, 0 = no credit	Dummy	+
Access to extension services and training	1 = access to extension services, 0 = no extension services	Dummy	+
High incidences of crop pest and disease	1= high incidents of pest and diseases, 0 = no pests and diseases	Dummy	+ /-

High input prices	1= high input prices, 0 = low input prices	Dummy	-
High food prices	1= high food prices, 0 = low food prices	Dummy	-
Perceptions of households towards climate change	1= perceived climate change, 0 = did not perceive climate change	Dummy	+

4. Results and discussion

4.1 Descriptive Statistics for Respondents

Table 3 presents the demographic characteristics of respondents in the study. The percentage of male headed households was 68.5 % while female headed households were 31.5%. According to Nhemachena and Hassan (2007), female headed households are more likely to take up adaptation options since most of rural farming is done by women, while men are employed in towns, cities and mines. Women therefore, have more farming experience and information on crop management practices than men. However, women are more vulnerable to poverty and have less access to education than men in most rural households. This can have a negative impact when adapting to climate change as wealth and education are important determinates on adaptation strategies where wealth and education have a positive implication to adoption of climate change adaptation strategies (Gbetibouo, 2009).

The household heads that were above 50 years were 61.9 % and there were no child headed households. However, the majority of the household heads belonged to the non-active age group, but had experience in farming. Old age has a negative relationship to adopting climate change adaptation strategies as agriculture is labour intensive hence it requires health individuals. The majority (67.3 %) household heads were married and this implies that most household heads had land property rights. The results showed that farming is the major source of income despite the fact that it is subsistence rainfed farming. Maddison (2006) argued that high education level diminishes the probability that no adaptation is taken. From the analysis, more than half of the households' heads were illiterate (55.6 %) and this makes it is difficult for households' heads to understand new farming systems and technologies.

Table 3. Demographic characteristics for respondents at Mpolonjeni ADP

Item	Frequency	Percentage
Sex		
Male	176	68.5
Female	81	31.5
Total	257	100
Age group		
19 - 30 years	7	2.7
31 - 40 years	34	13.2
41 - 50 years	57	22.2
Above 50 years	159	61.9
Total	257	100
Marital status		
Married	173	67.3
Single	16	6.2
Divorced	4	1.6
Widowed	57	22.2
Separated	7	2.7
Total	257	100
Education level of household		
Illiterate	143	55.6
Completed primary school	44	17.1
Junior secondary level	35	13.6
Senior secondary level	24	9.3

Professional college certificate	8	3.1
University education	1	0.4
Adult education	2	0.8
Total	257	100
Occupation		
Farming	99	38.5
Salaried employment	78	30.4
Non agribusiness	24	9.3
Casual farm work	20	7.8
Casual off farm work	1	0.4
Household chores	35	13.4
Total	257	100

4.2 Land Used for the Different Adaptation Strategies

Table 4 shows that 1361 ha were used for maize, indicating that most households are not planting drought tolerant crops and maize still dominates despite the disappointing low yields. From the total cultivated land, 90.4% was used for maize, 6.1% for cotton, 2.2% for beans, 0.7% for sorghum, 0.3% for groundnuts and 0.2% for cowpeas. Households were using tradition seeds (1061 ha) instead of recommended drought tolerant varieties. Minimum tillage and crop rotation had low land coverage.

Table 4. Amount of land used for different adaptation strategies

Item	Area (ha)
Crop	
Maize	1 361.0
Sorghum	12.0
Cotton	92.5
Dry beans	33.5
Groundnuts	4.5
Cowpeas	3.0
Total	1 506.5
Type of seed	
Drought resistant varieties	300.0
Traditional seeds	1 061.0
Total	1 361.0
Type of watering system	
Irrigation	92.0
Rainfed	1 269.0
Total	1 361.0
Minimum tillage	
Minimum tillage	207.0
Convectional agriculture	1 154.0
Total	1 361.0
Crop rotation	
Groundnuts	4.5
Maize	1 361.0
Total	1 365.5

4.3 Factors Influencing the Choice of Climate Change Adaptation Strategies by Households

The results of the multinomial logistic regression model for the different adaptation strategies categories are presented in Table 5. The results show that perceptions of households towards climate change (percp), high food prices (food), access to credit (cred) and land category (land cat) significantly ($p < 0.01$) influence the choice of not adapting to climate change compared to adapting using drought tolerant varieties and shifting planting time. The results suggest that when households perceive a change in climate, the probability for not adapting becomes reduced compared to that of adapting by using drought resistant varieties and shifting planting time. High food prices reduce the probability for not adapting to climate change compared to adapting by using drought tolerant varieties and shifting planting time. This is because households will adapt to increase crop production so that they will be able to produce their own food to avoid high food prices in the markets.

Owning land increases the probability that the household will not adapt to climate change by 313% (4.130 - 1) compared to adapting by using drought tolerant varieties and shifting planting time. This shows that renting land increases the likelihood of adapting because rural households do not have enough money to buy hybrid seeds, so they would rather not adapt by using drought tolerant varieties. Age of household head (age) significantly ($p< 0.05$) influence the choice of not adapting to climate change compared to adapting using drought tolerant varieties and shifting planting time. This implies that for every additional year in age of the household head, the probability of not adapting to climate change is increased 283% (3.83 - 1) compared to adapting by using drought tolerant varieties and shifting planting time. This implies that as the household head gets older, he or she is reluctant to use new technology, but rather opt for not adapting to climate change.

Occupation of the household head (occp) and perceptions of households towards climate change (percp) significantly ($p <0.01$) influence the choice of adapting to climate change using conservation agriculture, drought tolerant varieties and shifting planting time compared to using drought tolerant varieties and shifting planting times. This implies that when the household head is a farmer the probability of adapting to climate change using conservational agriculture, drought tolerant varieties and shifting planting time is 43.3 % (1.43 - 1) higher than adapting using drought tolerant varieties and shifting planting time. This is because when fully engaged in farming, households will have enough time to explore more adaptation options and focus all their resources to farming since it is their livelihood than those with other sources of income.

Perceiving that climate has changed reduces the probability of adapting using conservational agriculture, drought tolerant varieties and shifting planting time over adapting using drought tolerant varieties and shifting planting time. Access to credit and high incidence of crop pests and diseases (pstdz), significantly ($p <0.05$) influence the choice of adapting to climate change using conservation agriculture, drought tolerant varieties and shifting planting time as adaptation strategies compared to using drought tolerant varieties and shifting planting time. The results suggest that access to credit reduces the probability of farmers adapting using conservational agriculture, drought tolerant varieties and shifting planting time by 76.6% (0.231- 1) compared to adapting using drought tolerant varieties and shifting planting time. Households would use credit to purchase hybrid seeds than focussing on conservational agriculture. High incidence of crop pests and diseases reduces the chances of adapting using conservation agriculture, drought tolerant varieties and shifting planting time by 34.3% (0.657 - 1) compared to adapting using drought tolerant varieties and shifting planting time. However, conservational agricultural methods such as crop rotation reduces crop pests and diseases such that when households have observed increased crop pests and diseases, they are expected to include conservation agriculture as they adapt to climate change. These results are contrary to *apriori* expectations where the variables were expected to increase the probability of adapting using conservation agriculture and shifting planting time.

Being a member of a social group (soc) and access to extension services (ext) significantly ($p <0.1$) influence the choice of household adapting to climate change using conservation agriculture, drought tolerant varieties and shifting planting time as adaptation strategies compared to using drought tolerant varieties and shifting planting time. This implies that being a member of a social group increases the probability of adapting using conservation agriculture, drought tolerant varieties and shifting planting time by 18.5% (1.185 - 1) over and above that of adapting using drought tolerant varieties and shifting planting time. This is because social groups such as farmers' cooperatives provide information on farming, credits and resources that can be used when adapting to climate change. Access to extension services reduces the probability of using conservation agriculture, drought tolerant varieties and shifting planting time by 64.7% (0.353 - 1) compared to adapting using drought tolerant varieties and shifting planting time and this is contrary to *aprori* expectations. Access to extension services (ext) and perceptions of households towards climate change (percp) significantly (p< 0.01) influence the choice of adapting to climate change using conservation agriculture and shifting planting time as adaptation strategies compared to using drought tolerant varieties and shifting planting time. Access to extension services reduces the probability of adapting using conservation agriculture and shifting planting time by 76.5 % (0.235 - 1) compared to adapting using drought tolerant varieties and shifting planting time. Perceiving that climate has changed reduces the probability of adapting using conservational agriculture and shifting planting time over and above that of adapting using drought tolerant varieties and shifting planting time.

High incidence of crop pests and diseases (pstdz), high input prices (inp) and being a member of a social group (soc) significantly (p< 0.1) influence the choice of adapting using conservation agriculture and shifting planting time as adaptation strategies compared to using drought tolerant varieties and shifting planting time. The results suggest that high incidences of pests/diseases reduces the probability of adapting using conservation agriculture and shifting planting time by 27.7% (0.723 - 1) compared to adapting using drought tolerant varieties and shifting planting time. However, high incidence of crop pests and diseases was expected to increase the likelihood of adapting using conservational agriculture and shifting planting date over using drought tolerant varieties and shifting planting dates. The reason the results are contrary might be that households are not aware of the importance of conservation agriculture as biological control of crop pests and diseases. High input prices increase the probability of adapting using conservation agriculture and shifting planting time by 46.2% (1.462- 1) compared to that of adapting using drought tolerant varieties and shifting planting time. This implies that households lack resources to buy inputs such as drought tolerant varieties. Being a member of a social group increases the likelihood of adapting to climate change using conservational agriculture and shifting planting time by 16.2% (1.162 - 1) compared to using drought tolerant varieties and shifting planting time.

High input prices (inp), high incidences of crop pest and diseases (pstdz) and perceptions of households towards climate change (percp) significantly (p<0.01) influence the choice of adapting to climate change using all adaptation strategies compared to adapting using drought tolerant varieties and shifting planting time. This implies that high input prices increase the likelihood of using all adaptation strategies by 65.6 % (1.656 - 1) over and above that of adapting using drought tolerant varieties and shifting planting time. High incidence of pests and diseases reduces the probability of adapting using all adaptation strategies by 43.4% (0.566 - 1) compared to adapting using drought tolerant varieties and shifting planting time. Perceiving that climate has change reduces the probability of adapting using all adaptation strategies over and above that of adapting using drought tolerant varieties and shifting planting time. These results are contrary to *apriori* expectations. Occupation of household head (occp) significantly (p< 0.05) influence the choice of adapting to climate change using all adaptation strategies compare to adapting using drought tolerant varieties and shifting planting time. This implies that the probability of adapting to climate change using all adaptation strategies is 20.9% (1.209 - 1) higher and above that of adapting using drought tolerant varieties and shifting planting time. The reason is that households whose livelihood is on farming will have more time to engage and explore many adaptation strategies than those who are part time farmers. Adapting using all strategies would also increase the chances for crops to survive even during unfavourable and harsh climatic conditions. Being a member of a social group (soc) significantly ($p< 0.1$) influence the choice of adapting to climate change using all adaptation strategies compare to adapting using drought tolerant varieties and shifting planting time. This implies that the probability that the household will adapt using all adaptation strategies is increased by 13.9% (1.138 - 1) above that of adapting using drought tolerant varieties and shifting planting time. This is because social groups provide information such as farming management systems, credits for inputs and adaptation resources that can be important when adapting to climate change.

High input prices (inp), access to extension (ext) and high incidences of crop pests/diseases (pstdz), and perceptions of households towards climate change (percp) significantly ($p< 0.01$) influence the choice of adapting using irrigation and any other strategies compared to adapting using drought tolerant varieties and shifting planting time. This implies that high input prices increase the probability of adapting using irrigation and any other strategies by 90.0 % (1.90 - 1) compared to using drought tolerant varieties and shifting planting time. Access to extension services reduces the probability of adapting using irrigation and any other strategies by 88.1% (0.119 - 1) compared to that of using drought tolerant varieties and shifting planting time. High incidence of pests/diseases reduces the probability of adapting using irrigation and any other strategies by 50.8% (0.492 - 1) over and above that of using drought tolerant varieties and shifting planting time. Perceiving that climate has change reduces the probability of adapting using all adaptation strategies over and above that of adapting using drought tolerant varieties and shifting planting time. Occupation of the household head (occp) significantly ($p< 0.05$) influence the choice of adapting using irrigation and any other strategies compared to adapting using drought tolerant varieties and shifting planting time. This implies that being a full time farmer increases the probability of adapting using irrigation and any other strategies by 25.7 % (1.2586 - 1) compared to using drought tolerant varieties and shifting planting time. Age of the household head significantly ($p<0.1$) influence the choice of adapting using irrigation and any other strategies compared to adapting using drought tolerant varieties and shifting planting time. This implies that for every additional year in age of the household head, the probability of adapting using irrigation and any other strategies increases by 73.3 % (1.73 - 1) compared to using drought tolerant varieties and shifting planting time.

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Table 5 Multinomial logistic regression estimates for the choice of adaptation strategies

	no adaptation			**drought tolerant varieties, conservation agriculture and shifting planting time**			**conservation agriculture and shifting planting time**			**all strategies**			**irrigation and any other strategies**		
	Coef. (β)	**Exp.(β)**	**p-value**	**Coef. (β)**	**Exp.(β)**	**p-value**	**Coef. (β)**	**Exp.(β)**	**p-value**	**Coef. (β)**	**Exp.(β)**	**p-value**	**Coef. (β)**	**Exp.(β)**	**p-value**
β_0	-14.60(5.23)	0.000000456	0.005	11.76 (3.70)	128027.42	0.001	13.31 (2.75)	602202	0.000	11.50 (2.51)	99167.7	0.000	12.59 (3.36)	294612.4	0.000
Sex	0.53 (0.63)	1.700	0.398	0.11 (0.55)	1.116	0.837	0.04 (0.51)	1.040	0.931	-0.43 (0.40)	0.651	0.280	-0.77 (0.70)	0.4630	0.268
Age	1.34** (0.62)	3.829	0.031	0.72 (0.46)	2.054	0.118	0.24 (0.29)	1.271	0.406	0.32 (0.22)	1.377	0.146	0.55* (0.32)	1.73325	0.080
Edu.	0.71 (0.27)	1.074	0.795	-0.05 (0.24)	0.951	0.828	-0.13 (0.21)	0.879	0.527	0.15 (0.13)	1.162	0.248	0.17 (0.16)	1.1853	0.303
Occp.	0.42 (0.13)	1.043	0.741	0.36*** (0.10)	1.433	0.000	0.13 (0.10)	1.139	0.179	0.19** (0.81)	1.209	0.020	0.23** (0.11)	1.2586	0.039
Soc.	0.13 (0.17)	1.141	0.428	0.17* (0.10)	1.185	0.089	0.15* (0.86)	1.162	0.075	0.13* (0.70)	1.138	0.056	0.16 (0.12)	1.1735	0.195
Land cat.	1.42*** (0.42)	4.125	0.001	.037 (0.54)	1..443	0.494	0.38 (0.46)	1.462	0.413	0.11 (0.46)	1.116	0.817	0.33 (0.64)	1.3909	0.599
Cred.	13.84*** (0.81)	1031395.77	0.000	-1.45** (0.70)	0.234	00.037	(0.23 (0.90)	1.259	0.799	1.06 (0.46)	2.886	0.166	0.73 (0.99)	2.0750	0.463
Ext.	0.17 (0.87)	1.185	10.847	-1.04* (0.62)	0.353	0.092	-1.45*** (0.56)	0.235	0.010	-0.77 (0.74)	0.463	0.106	-2.12*** (0.62)	0.119	0.001
Pstdz.	0.38 (0.32)	0.687	0.240	-0.420** (0.19)	0.657	0.029	-0.3244* (0.18)	0.723	0.081	-0.57*** (0.19)	0.566	0.003	-0.71*** (0.22)	0.492	0.001
Inp.	0.30 (0.39)	1.350	0.442	-0.03 (0.36)	0.970	0.931	0.38* (0.21)	1.462	0.060	0.50*** (0.17)	1.656	0.003	0.64*** (0.24)	1.900	0.008
food	-11.8*** (0.97)	0.0000	0.000	-0.24 (0.89)	0.787	0.787	0.49 (0.42)	1.050	0.908	-0.50 (0.31)	0.854	0.612	0.11 (0.45)	1.122	0.799
Percp.	-13.8*** (1.58)	0.0000	0.000	-14.37*** (1.13)	0.0000	0.00000574	-15.81*** (0.83)	0.00000	0.00 136	-15.56*** (0.87)	0.00000	0.00 0174	-16.50*** (0.87)	0.00000	0.000 68

*** = values statistically significant at 0.01 probability level, ** = values statistically significant at 0.05 probability level, * = values statistically significant at 0.10 probability level
Base category: drought resistant and shifting planting time
Number of observations: 257

5 Conclusions and Recommendations

5.1 Conclusions

Households were aware of climate change but not all of them responded by adapting to the changed climate in order to reduce the negative impact and increases resilience on cropping systems. Those adapting to climate change were using drought tolerant varieties, early and late planting, minimum tillage, crop rotation, intercropping, mulching and irrigation as adaptation strategies. Socioeconomic factors of the households influenced households' choice when adapting to climate change, where some hinders, while others promote adoption of adaptation strategies. Explanatory variables that were significant in influencing choice of households when adapting to climate change were; age of household head, occupation of household head, being a member of social group, land category, access to credit, access to extension services, training, high incidences of crop pest and disease, high input prices, high food prices, perception of households towards climate change. Sex and education level of household head were not significant in influencing household choices when adapting using any of the identified adaptation strategies meanwhile perception towards climate change was significant in all the adaptation strategies.

These results point out the importance of farmers' unions, organisations and cooperatives as a resource centre for information and finances to farmers as being a member of any of these organisation had a significant role. Access to extension services and training provided guidance and monitors households when adapting to climate change and hence its significance in the analysis. Adapting using conservational agriculture was discouraged by weak extension service support, hence this was not a popular choice.

5.2 Recommendations

In terms of policy implications, the identified adaptation strategies should be promoted and supported by government, nongovernmental organisation and civil society organisations if households in the study area and other rural communities in Swaziland are to be resilient and improve adaptive capacity to climate change impacts. Factors influencing households' decisions to adopt climate change strategies point the need for government support households and ensure sustainability of agricultural activities and enhance food security. Agriculture extension services should be strengthened by increasing the interaction between households and extension officers by providing enough transport to ensure they conduct adequate field visits to farmers.

Agriculture Financial Institutions need to be strengthened and accommodate farmers on communal land. There is also a need for policies aimed at enhancing household level adaptation through the support of Department of Meteorological service by reporting and alerting households about weather changes in an understandable way so that they can be able to plan for the future when farming.

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