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Socio-demographic Context of Resilience for Adaptation to Climate Change and Implication for Agricultural Extension in Buffelspruit, South Africa

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ABSTRACT

The study examined the socio-demographic characteristics of smallholder farmers' and resilience strategies for adaptation to climate change in Buffelspruit, South Africa. The objectives of the study were to determine local resilience strategies used by farmers and examine adoption behaviour in the use of local resilience strategies for mitigating climate change. The study was conducted in Buffelspruit community. A total number of 306 participants were selected randomly for this study. Structured and semi-structured questionnaires were used for data collection. The adoption behaviour of the farmers in the use of local resilience strategies was analysed using the logit model. Crop rotation, crop diversification and the adjustment of planting dates were the resilience strategies used by farmers. The result from the logit analysis reveals that gender (p = 0.047), level of education (p = 0.16), employment (p = 0.043), farm skills (p = 0.058), extension services (p = 0.011) and farm size (p = 0.022) influenced the adoption of climate resilient strategies in the study area. Extension education must move beyond technical training to enhance farmers' abilities for planning, problem solving, critical thinking and leadership skills to work with multiple stakeholders. Extension must be proactive with capacity development in climate change education.

Keywords: Climate change, Agriculture, Mitigation, Adoption, Resilience strategies.

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1. INTRODUCTION

The changes in the environment occasioned by weather-related events have far reaching implications to human activities. Over the years, the variations in weather conditions have impacted on crops and livestock production owing to minimal rainfall and erratic temperature (Ajala, 2017). A larger proportion of farmers in Sub-Saharan Africa (SSA) rely on natural rainfall for agricultural activities which is the livelihood of smallholder farmers (Senda, Kiker, Masikati, Chirima and Niekerk, 2020). Research has indicated that changes in climatic conditions which manifest in various dimensions such as floods, temperature fluctuations, livestock pest and diseases will affect many African countries because of inadequate weather mitigation strategies (Nyasimi, *et al.* 2014). With population increase and limited resources in Africa, the future of food security remains bleak. Annual growth in population is estimated at 2.4 %, and the likelihood of further increase is forecast to be 0.9 billion inhabitants by 2050 (FAO, 2018). About one fifth of Africa's population is at present malnourished and lack adequate shelter and other necessities of life. Therefore, the need to abate climatic events and intensify crop and livestock production becomes paramount. In South Africa, records have shown that the average annual rainfall is decreasing, days with high temperatures are increasing and there is a reduction in the average number of colder days (Word Bank Group, 2022). This has led to South Africa being considered amongst the highly at-risk nations to climate change in the African continent (Turpie and Visser, 2014). This situation is worrisome as the nation is going through economic depression, coupled with the problems that come with HIV/AIDS (Turpie and Visser, 2014). The less privileged smallholder farmers lack adequate opportunities to cushion the impact of climatic change, yet they depend primarily on agriculture for sustenance. According to Mpandeli, et.al, (2012), changes in climate alters the already depleted soil nutrients and agro environment of South Africa. In Mpumalanga, the impacts of environmental changes have become increasingly clear, particularly in the Nkomazi Local Municipality (Adeola, *et al.* 2016). The study, therefore, aimed to determine the building of resilience for climate change adaptation in crop production in Buffelspruit, South Africa.

Climate variations have posed challenges to water resources, availability of food, human well-being, ecological services, infrastructure, and natural environment in Buffelspruit. Farmers in the community have experienced the reality of climate change and water scarcity as most of them rely on rain-fed agricultural activities (Mpandeli, et.al, (2012). It is therefore key to formulate and implement effective climate resilience strategies to minimise the risks. Buffelspruit community is mainly involved in maize and vegetables production. Unfortunately, changes in the climatic conditions are posing challenges on their agricultural production. There are gaps in knowledge on building of resilience for climate change adaptation in crop production in Buffelspruit, South Africa. The farmers are generally aware of the changes in climatic conditions in the area but there is limited knowledge about climate change resilience strategies. However, greater understanding between public and private partnerships is needed, to complement government initiatives and efforts towards building resilience for climate change (Biagini and Miller, 2013).

Contemporary literatures (Ajala, 2017; Biagini, and Miller 2013) points to an increasing necessity for awareness and adoption of climate resilience strategies aimed at mitigating climate risk. In South Africa, such literatures arose from theoretical underpinnings with marginal limitations and inadequate field survey. Therefore, much remains to be surveyed and investigated, mainly with respect to climate resilience strategies and adoption by smallholder farmers. The study, therefore, aims to determine resilience strategies used by farmers for climate change and analyse adoption behaviour of farmers in the use of local resilience strategies for climate change in the study area.

2. METHODOLOGY

The research study was conducted in Nkomazi local municipality (group B Municipality), under Ehlanzeni District in the Mpumalanga province. This municipality is in the eastern part of Ehlanzeni District (Figure 4.1). It is located amongst the northern side of Eswatini and eastern part of Mozambique. It covers only 17% of its geographical zone and is the smallest out of the four municipalities within the district. The municipality has an estimated population of 393,030 (Statistics South Africa, 2011). It is characterised by a subtropical climate and average precipitation of 775mm with most rains experienced in January. The area is predominately rural and under the authority of traditional leaders. Buffelspruit is a community that sits under the Nkomazi Local Municipality with latitude 25.6605 ºS, 31.5170 ºE (Figure 4.1.1). It is situated about 22 kilometres south-east of Kaapmuiden (Statistics South Africa, 2011). The average population in this community is 8.202. The community is deeply rural with red textured soils which are conducive for most crops. Farmers in this community practise diversified farming, for instance they own cattle, pigs, chicken, goats, sheep, and some are into fishing. They also grow a variety of crops such as maize, citrus, sugarcane, legumes, tobacco, banana, cassava, and vegetables.

Figure 1. Map of Ehlanzeni district

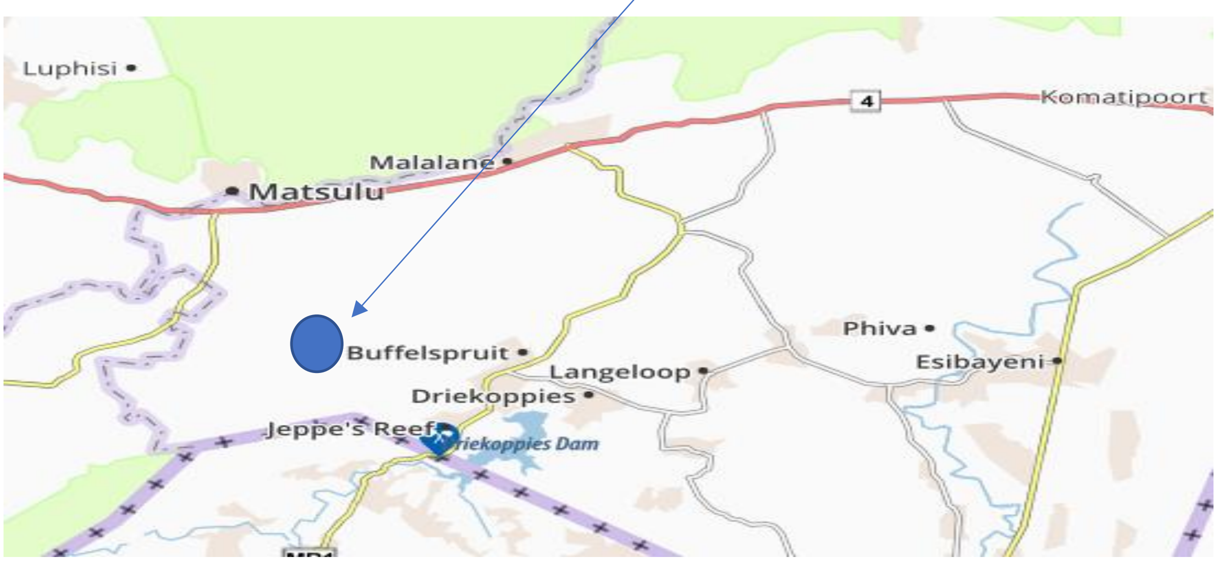

Figure 2. Map showing Buffelspruit community

2.1 The procedure

A mixed research techniques were adopted for the study. The field survey was carried out between March 2021 and December 2021. Prior to data collection, a recognisance survey was undertaken to identify the ecological zoning, and mapping of the area. Participatory rural appraisal tools such as the Venn diagram, transect walk was used for this process. Participation in the survey was voluntary and ethical clearance was obtained from the University of Mpumalanga Research Ethics Committee. Prior to data gathering, the questionnaire items were pretested with only thirty farmers. This approach assisted us to ascertain the time taken to administer each questionnaire and to allow for valuable modification and clarity. Primary data were collected from selected farmers using structured and semi-structured questionnaires, and field observation, while the focus group was used to authenticate and correct some indiscretions from respondents.

2.2 Sampling and sample size

The benchmark for addition of respondents to the survey was that a particular farmer had to be into farming for at least two farming seasons. Data collection was randomised, ensuring that no special consideration was given to anyone. The population of farmers available in the community was obtained from the information provided by the extension officer who work in the area. The determination of the sample size was realised using the Taherdoost (2017) formula. From this adopted formula, a confidence level of 95%, margin of error of 5%, and a definitive population size of 1500 in selected area was used to calculate the sample size. Based on the calculation, a sample size of 306 was realised and used for the study.

2.3 Instrument of data collection

The questionnaire employed to gather responses were group into two sections- the socio-demographic characteristics of the farmers and strategies used for climate change and adoption behaviour of farmers in the use of local resilience strategies.

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2.4 Multicollinearity Precaution

Multicollinearity usually occurs when independent variables in a regression appears correlated and can cause weakness in the statistical power of the model and result interpretation for any study (Belsley, et.al, 2005; Dormann, 2013). For this study, collinearity protection analysis test was performed using the variance inflation factor (VIF), which is a good measure for detecting multicollinearity in regression analysis because it allows the concurrent accommodation of different predictors (Graham, 2003). However, by employing the VIF, we regressed each predictor variable against other predictor variables. Any variable with VIF >5 was removed from the analysis.

2.5 Method of data analysis

The socio-demographic information of respondents was analysed using descriptive statistics which involved percentages and frequency distribution. The second aspect of the study was analysed by using the inferential statistics which involved the logit regression.

2.6 Analytical Techniques

Descriptive statistical techniques including frequency counts, percentages and mean distribution were used to investigate the respondents' socioeconomic and demographic characteristics, the level of mechanization (tractor use) in the farming system, and the contributions of tractor use among smallholder farmers in the study area. Logistic model (odds ratio likelihood) was used to determine factors influencing smallholder farmers' tractor use decisions.

2.7 Description of Variables Used in the study

Table 1. Summary of predictor variables hypothesised with their operational description, measurement and expected signs.

Variable and code	Operational description	Measurement unit	Expected sign
Gender (GNDR)	Male or Female	1= male	-

		2 = female	
Marital status (MARTST)	A state of conjugal,	1= Single, 2 = Married, 3 = Divorced, 4 = Widower, 5 = Widowed	+
Educational level (EDUCL)	Highest grade completed	Post-secondary = 1, secondary = 2, Primary = 3, Adult education = 4, No formal education = 5	+
Household size (HOUSHN)	Quantity of people living under the same roof	(≤3 =1), (4–6 =2), (7–9 =3), (≥10 =4)	−
Farm experience (PRODEXP)	Number of years engaged in farming	≤ 5years = 1, 6 -10years = 2, 11-15years = 3, ≥ 15years = 3	+
Farm size (FARMSZ)	Area cultivated in acres	≤1ha = 1, 2-5ha = 2, 6-9ha = 3, ≥10ha	-
Farming skills and (FRMSKLLS)	Dexterity in performance	Crop production = 1, Animal production = 2, Other = 3	+
Level of farming (FRMNGLV)	Whether subsistence or commercial	Subsistence = 1 Commercial = 2	-
Perception about climate change (CLIMTPERC)	Observed effects of climate change	Decreased crop production = 1, Decreased income = 2, No changes in crop production = 3, Market shortages = 4, Decrease in food security	+

Extension service (EXTNRESP)	Positive reaction of extension to farmers' needs	Yes = 1 No = 2	+
Government support (GVNMTSPRT)	Support provided by government	Very poor = 1, Poor = 2, Good = 3, Very good = 4, Excellent = 5	+
Services provided by extension services (TYPSSERVS)	Services provided by extension personnel	Training = 1, Skill development = 2, Information sharing = 3, Water conservation = 4, None = 5	+

2.8 The adopted model

The logistic regression model is considered ideal when there is a combination of categorical variables. It is used to obtain probabilities when more than one explanatory variable is present to predict best decision (Sperandei, 2014). There are no key assumptions on logistic regression on the relationship between independent and dependant predictor variables (X); though, X variables may be continuous. In agricultural production this approach is well recognized in experiential research that seek to establish factors affecting decision making. With reference to Agholor (2020), let R_i represent a dichotomous variable that would be equal to 1 if farmers decide to adopt resilience strategies and 2 if they did not. The likelihood of the choice to adopt, $Pr\ (R_i=1)$, or not $Pr\ (R_i=0)$ is derived as follows:

The technique that was used to determine the adoption behaviour is indicated below:

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots\ldots\ldots\ldots + \beta_{11} X_{11} + \mu$

Where:

Y = willingness or choice to use or apply local resilience strategies (Farmers use local strategies = 1, 2 = otherwise)

X_1 - X_9 = independent variables demarcated as:

X_1 = Gender (Male = 1, Female = 2)

X_2= Marital status (Single = 1, Married = 2, Divorced = 3, Widower = 4, Widowed = 5)

X_3 = Highest educational level (Post – secondary education =1, secondary = 2, Primary = 3, Adult education = 4, No formal education = 5)

X_4 = Household size (≤ 3 = 1, 4 to 6 = 2, 7 to 9 = 3, ≥ 10 = 4)

X_5 = Employment status (Formally employed = 1, Farming = 2, Unemployed = 3, self-employed = 4, Pensioner = 5)

X_6 = Farmer's years of experience (≤ 5 years = 1, 6 to 10 years = 2, 11 to 15 years = 3, ≥ 15 years = 4)

X_7 = Farm size (≤ 1 hectare = 1, 2 to 5 hectares = 2, 6 to 9 hectares = 3, ≥ 10 hectares)

X_8= Farming skills and knowledge (Crop production = 1, Animal production = 2, Other = 3, None = 4

X_9 = Level of farming (Subsistence = 1, Commercial = 2)

X_{10} = Perception about climate change (Decreased crop production = 1, Decreased income = 2, No changes in crop production = 3, Market shortages = 4, No crop production = 5, Decrease in food security = 6)

X_{11} = Extension response to farmers' calls (Yes = 1, No = 0)

X_{12} = Rating government 's support (Very poor = 1, Poor =2, Good = 3, Very good = 4, Excellent = 5)

Types of services provided by extension services (Training = 1, Skill development = 2, Information sharing = 3, Water conservation = 4, None = 5)

β_0 = constant

B_1- β_9 = standardized partial regression coefficients

μ = error term

3. RESULTS AND DISCUSIONS

3.1 The socio-economic characteristics of respondents

Table 2 shows that majority (59.8%) of the interviewed respondents were female, while 40.2% were male. Evidence from the focussed group discussions indicated that women were more in agriculture. This finding is corroborated by the study of Njobe (2015) who found that African women make-up 52% of the total population in the agricultural sector. Nonetheless, this study does not display gender assessment and representation, but sufficient to reveal that there were more female respondents during the survey as compared to the male. In similar study on gender gap in agriculture, Agholor (2019) found that improving gender equity in agriculture will translate into improving productive abilities amongst farmers while creating a competitive environment for agriculture to increase growth-path in Sub-Saharan Africa. The age of respondents shows that only 14.4% of the youths are active in agricultural activities. Farmers, whose age ranged between 41 to 50 years was 32.4% while 19.3% were above 50 years of age. The result supports the findings by Uttej, Rao, Sreenivasulu and Lata (2019); Cheteni (2016), who found that a limited percentage of youth are active in agricultural activities. The propensity for developing rural communities depend upon the potential of the youth to engage in agricultural programmes. Furthermore, the survey found that 37.3% of the respondents were single while 43.8% were married and 6.5% were divorced. Respondents who are widower and widowed were 9.2% and 3.3 % respectively. Furthermore, the survey indicated that respondents with post-secondary education and secondary education were 2.9% and 19.9% respectively. while 32.7% had primary education. According to data 7.8% of the respondents had adult education training while 36.6% had no formal education. Education and training have a significant role in agriculture especially in the adoption of innovation. Mentorship and internship programmes of informal education can offer valuable support to farmers in rural communities (Johnson, et.al, 2020).

The household size shows that 16.3% of the respondents had less than three members while 44.4% of the household had 4 to 6 members. The finding further revealed that 30.1% of the participants had household size of 7 to 9 and 9.2% had 10 persons within the household. However, there is possibility for increase agricultural production in larger household size if a farmer uses family labour in agricultural activities (Siphesihle and Lelethu, 2020). Most households in South Africa, relies on agriculture for employment, food supplies and income generation (Chotonge (2013). Farm experience was investigated and result show that 4.2% had 5 years farm experience and majority (67.3%), had more than 15 years of farm experience while 10.1%, 18.3% had 6-10 years, 11 to 15 years of farm experience respectively. The research results show that 4.2% of respondents interviewed had 5 years' experience in farming, 10.1% had 6 to 10 years of experience and 18.3% had 11 to 15 years of experience. The majority (67.3%) had more than 15 years of experience in agricultural activities. Farmers who cultivate less than one acre of land were 79.7% while 5.2% had farms that ranged from 2 to 5 acres. However, 2.9% of farmers had 6 to 9 acres of land while 12.1% cultivates had more than 10 acres of land.

Table 2. Socio-demographic information of respondents

Variables	Frequency	%
Gender:		
Male	123	40.2
Female	183	59.8
Total	306	100.0
Age:		
<30	44	14.4
31 - 40	104	34.0
41 - 50	99	32.4
>51	59	19.3
Total	306	100.0
Marital status		
Single	114	37.3
Married	134	43.8
Divorced	20	6.5
Widower	28	9.2
Widowed	10	3.3
Total	306	100.0
Level of education		
No formal education	112	36.6
Adult education	24	7.8
Primary education	100	32.7
Secondary education	61	19.9

Post-secondary education	9	2.9
Total	306	100.0
Household size		
≤ 3	50	16.3
4 to 6	136	44.4
7 to 9	92	30.1
≥10	28	9.2
Total	306	100.0
Years of farming experience		
<5 years	13	4.2
6-10 years	31	10.1
11-15	56	18.3
>15 years	206	67.3
Total	306	100.0
Farm size		
< 1acres	244	79.7
2-5 acres	16	5.2
6-9	9	2.9
>10 acres	37	12.1
Total	306	100.0

3.2 Types of crops grown by farmers in the study area

Crop production is the major agricultural activity practiced by rural farmers in the study area. These subsistence farmers grow different crops as indicated in Table …... The result from the survey indicates that 11.8% of the farmers are involved in vegetable production, 26.1% grew tobacco, 13.4% grew sugar cane, 4.6% grew legumes, 2.6% grew fruits and 41.5% grew maize. Maize is the stable food of the people, and it is mainly grown in Buffelspruit community.

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Table 3 Types of crops grown by farmers in the study area

Variables	Frequency	Percent
Vegetable crops	36	11.8
Tobacco	80	26.1
Sugar cane	41	13.4
Legumes	14	4.6
Fruits	8	2.6
Maize	127	41.5
Total	306	100.0

Source: Survey data (2021)

3.3 Source of climate change information in the study area

The result as indicated in Table 4 reveal that 17.6% of the participants are aware of climate change occurrences in the area. Most of the respondents (52.9%) relied on mainstream media as source of information about climate change-related events. Although agricultural extension play a role in disseminating information, only 11.1% of farmers rely on their services. Farmers who depend on their own observations about climate change were 18.3%. It is important to understand that the mainstream media play a remarkable role in climate change awareness. Similarly, Kakade (2013) stated that the media play a significant role in information dissemination.

Table 3.1 distribution of climate change information in the study area

Variables	Frequency	Percent
Informal education	54	17.6
Media (Television, newspaper, and radio)	162	52.9
Extension services	34	11.1
Own observation	56	18.3
Total	306	100.0

Source: Survey data (2021)

3.4 Local resilience strategies for climate change in the study area

Local strategies adopted by subsistence farmers were surveyed and the results (Table 5.11) indicate that 9.8% of the respondents regarded crop rotation as a resilience option. The respondents who considered crop diversification and the adjustment of planting dates as resilience strategies were 6.9% and 32.4% respectively. Consistent with related studies, Tibesigwa, Visser, Hunter, Collinson, and Twine, (2015); and Nhemachena, (2007) found that crops diversification, cultivation of different crop varieties, adjustment of planting and harvesting dates are more profitable alternative for climate resilience approach. Result further reveal that 9.2% considered moving from crop to livestock farming as an option and 17.6% deemed mixed farming as an alternative. The increase in the use of fertilizers and pesticides was an option which was considered by 6.9% while 5.9% perceived soil and water conservation while 11.8% opted for increased in irrigation practice as resilience strategy.

Table 3.2 Local resilience strategies adaptation options in the study area

Variables	Frequency	%
Crop rotation	30	9.8
Crop diversification	21	6.9
Adjustment of planting dates	99	32.4
Changing from crop to livestock farming	28	9.2
Mixed farming	53	17.3
Increased use of fertilizer and pesticides	21	6.9
Soil and water conservation	18	5.9
Increased irrigation	36	11.8
Total	306	100.0

Source: Survey data (2021)

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3.5 The determinants of adaptation to climate resilience strategies

The logit model (Table 6) used in the survey indicate Chi-Square of 301.003, Pearson 324.700, Deviance 299.617, Pseudo R-Square: Cox and Snell 0.226, Nagelkerke 0.317 0.773 and McFadden 0.206 which implies that the model has acceptable illustrative power and a good fit for the study.

The results from the logit analysis reveal that eight of the variables (gender, educational level, employment status, farm skills, extension services, and farm size) influence the adoption of climate resilient strategies in the study area.

Gender with a *P-value* = 0.047 and β = 0.655 is significant and positively influence the adoption of climate resilient strategy. This finding suggests that holding all variables constant, the adoption of local resilience strategies increases by 0.655 times as the number of females increases. This result disagrees with the study by Orser and Riding (2018), on the influence of gender in the adoption of technology among SMEs, found that women are less likely to adopt innovation than men due to stereotype and attitudes associated with gender differences. The level of education recorded a *P-value* = 0.016, and the coefficient of β = 1.096 which indicate that level of education is significant and positively related to adoption of climate resilience strategy. The findings suggest that for every increase in the level of education, there is 1.096 times increase in the rate of adoption of climate change resilient strategies. This result is supported by Oduro-ofori, *et al*. (2015) who discovered that an increase in farmers' level of education increases production output. Employment of respondents was significant with a *P-value* = 0.04 and positively (β = 1.859) related to adoption of climate change resilience strategy. The finding suggests that for every unit increase in the number of employed farmers, there is 1.859 times increase in the adoption of climate resilience strategy. This result is expected because extra income earned by households from off-farm activities may assist in the purchase of farm resources to cushion the effect of climate change and consequently adopt resilience strategies. This finding is corroborated by Akinnagbe and Ajayi (2010) who found that off-farm income creates the prospects for lasting climate change adaptation strategies.

Furthermore, farm size shows a significant and positive relationship to the adoption of climate change resilience strategy with a *P- value* = 0.022 and β = 2.010. The implication is that for every increase in household farm size, there is 2.010 times increase in the rate of adoption of local climate change resilient strategies provided all the other variables are held constant. The finding is consistent with the studies by Mwangi and Kariuki (2015); Dessart, Barreiro-Hurle and van Bavel, 2019), found that there is a positive interconnection amongst risk-averse households who cultivate large acres of land and predisposed to invest and adopt climate resilience strategies. Farming skills and knowledge has a P-value = 0.058, and a coefficient β = 1.297 which shows that farm skills and knowledge is significant and positively related to adoption of climate resilience strategy. This result suggests that an increase in farming skills and knowledge increases the rate of adoption of local climate resilient strategies by 1.297 times. This result is in line with the finding of Myeni and Moeletsi (2020) found that improved farming skills and knowledge build farmers' capacity to contribute to sustainable agriculture and effective adoption of climate risk management (Myeni and Moeletsi, 2020).

According to data, attitude of respondents with *P-value* = 0.102 was not significant but positively (β = 0.887) related to the adoption of climate resilience strategy. Farmers' positive attitude about climate change can potentially increase their willingness to make changes that may translate to effective adoption (Damodar and Nibal, 2020). This result is supported by the studies of Davis, Robert, Jennifer, Jessica, and Jeremy, 2013; Agholor and Ogujiuba 2021, who found that attitudinal variables remain a precursor to the adoption of farming practice. Nevertheless, for any behaviour to occur amongst farmers, antecedents like personality traits, motivational factors, subjective norms, self-efficacy, and entrepreneurial potential plays a significant role. Extension services is a significant variable with a *P-value* = 0.011 and positively related to adoption of climate change resilience strategy. The finding reveals that for every increase in extension services to farmers, the adoption of local climate resilient strategies increases by 1.719 times. Extension advisory services play a major role in implementing innovation, information sharing and skill development. The role of extension services in mitigation of climate change amongst others include effective communication through the utilization of various approaches including demonstrations, posters, leaflets et-cetera (Ozor and Nnaji, 2011).

Table 3.3 logit regression showing factors influencing adoption of local climate resilience strategies

Independent variable	B	Std. Error	Wald	df	Sig.	Exp(B)	95% confidence Interval for Exp(B)	
							Lower Bound	Upper Bound
Intercept	-.920	1.815	.257	1	.612			
Gender	.655	.329	3.956	1	.047**	1.925	1.010	3.670
Marital status	-.359	1.090	.108	1	.742	.698	.083	5.911
Highest educational level	1.096	.456	5.785	1	.016**	2.991	1.225	7.304
Household size	-.286	.671	.182	1	.670	.751	.201	2.801
Employment status	1.859	.921	4.077	1	.043**	6.419	1.056	39.012
Years of experience	-1.150	.890	1.670	1	.196	.317	.055	1.811
Farm size	2.010	.881	5.212	1	.022**	7.466	1.329	41.938
Farming skills and knowledge	1.297	.685	3.587	1	.058*	3.658	.956	14.003
Attitude about climate change	.887	.543	2.671	1	.102	2.427	.838	7.030
Extension service	.158	.461	.117	1	.732	1.171	.474	2.889
-2 Log Likelihood	301.003							
Goodness-of-Fit: Pearson Deviance	299.617							
Pseudo R-Square: Cox and Snell Nagelkerke McFadden	.226 .317 .206							

Level of significance *0.05, 0.01**, 0.001***

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3.6 Resilience for adaptation to climate change and implication for agricultural Extension

The variations in climate ultimately have devastating impact on agriculture, ecosystem, human settlement, migration, water resources, diseases, and human health in South Africa. Climate change have truncated agricultural production process both in terms of quantity and quality of outputs as well as increase cost of production. The overwhelming effects of adverse climate events culminate to affecting food security and livelihoods. Climate risk management requires trade-offs between risk reduction and cost, where it becomes more expensive and increasingly technically challenging to prepare for events that are very unlikely to occur. Climate resilience strategy entails that the associated risks of climate event be considered and managed to achieve a suitable level of control given that the ability to survive and recover from shocks are in place (OECD, 2014a).

Extension activities encompasses the broad areas of human development which transcends to giving assistance, sharing information, and developing trust. Extension officers must assist farmers to received hands-on training in various areas of farm planning and management. Timely weather indicators, climate-risk and resilience management should be supported by extension to help farmers adopt viable climate resilience measures. Subject-matter specialist and extension advisors must have a sound knowledge of climate change dynamics to help farmers build appropriate resilience strategies (Mncina and Agholor 2021).

Extension needs to have access to quality information, reliable data, and capacity to enhance and modify planning related to climate resilience strategies. This can be attained through the development of online access on transparent information on past and future climate related events. Extension access to information should be complemented with the development of technical and institutional capacity to manage climate resilience strategies with the intention of assisting the farmers. Climate change resilience approach requires the involvement of a range of stakeholders in climate risk assessments. These include different levels of government, academics, non-governmental organisations, local and indigenous communities, and the private sector. The inclusion of government, NGOs, private sectors, local and indigenous communities are important given that vulnerability to climate change differs by factors such as social class and gender (OECD, 2018).

Extension must consider the diversity of the community and allow equal participation in marshalling and discussing climate resilience strategies. A well-prepared participatory approach by extension can improve decision-making and build support for implementing climate-resilient strategies (Burton, Dube, Campbell-lendrum, Davis, Klein, Linnerooth-bayer, Sanghi, and Toth 2012). Extension's advisors should be involved in developing appropriate management systems that will assist farmers to adopt climate resilience approach in farming. For instance, disseminating information about local cultivars of drought-resistant crop varieties, sharing with farmers their knowledge of cropping and management systems that are adaptive to changing climate conditions such as mixed cropping, sequential cropping, and zero-till agricultural practices (Mustapha, S.B; Undiandeye, U. C. and Gwary, M.M. 2012). The ability of farmers to deal with different forms of weather-related events will become ever more crucial, and extension advisors must pay attention to educating farmers about available alternatives to enhance responses to resilience strategies.

4. CONCLUSIONS

Crop production is the major agricultural activity and farmers grow different crops in the study area. The local resilience strategies adopted by subsistence farmers were crop rotation, crop diversification and the adjustment of planting dates. The results from the logit analysis reveal that gender, educational level, employment status, farm skills, extension services, and farm size influence the adoption of climate resilient strategies in the study area. The ability of farmers to deal with different forms of weather-related events is crucial, and extension advisors' efforts must pay attention to educating farmers about available alternatives to enhance resilience strategies. The extension implication for adaptation to climate resilience approach addresses the need for access to quality information, reliable data, and capacity to modify planning related to climate resilience strategies. Online access, transparent information on past and future climate actions are paramount for extension to recognise. Extension access to information should be complemented with the development of technical and institutional capacity to manage climate-related risks with the intention of assisting the farmers. Climate change risks requires the involvement of a range of stakeholders in climate risk assessments and resilience planning.

5. RECOMMENDATIONS

The study recommends that government and other stakeholders should actively assist rural farmers with resources to improve their resilience strategies in ameliorating the impact of climate change. The local government, traditional leaders, and farmers need to work together in identifying other local climate change resilience strategies. This will enhance agricultural production, income, and food security in the study area. Extension education must move beyond technical training to enhancing farmers' abilities for planning, problem solving, critical thinking, building consensus and leadership skills to work with farmers. Extension must be proactive with capacity development in climate change.

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