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ENVIRONMENTAL RESPONSE STRATEGIES ON CLIMATE CHANGE FOR ENHANCING SUSTAINABLE SMALLHOLDER FARMERS' LIVELIHOODS IN SELECTED COMMUNITIES OF BUSHBUCKRIDGE NORTH, SOUTH AFRICA

Thabane VN[1] *, Agholor IA[2], Sithole MZ[3], Morepje MT[1], Msweli NS[1] and LI Mgwenya[1]

Variety Nkateko Thabane

*Corresponding author email: 201988429@ump.ac.za

ORCID ID: https://orcid.org/0000-0001-8259-4559 - Thabane VN
ORCID ID: https://orcid.org/0000-0001-8559-0246 - Agholor AI
ORCID ID: https://orcid.org/0000-0002-3873-1904 – Sithole MZ
ORCID ID: https://orcid.org/0000-0001-6478-8800 - Morepje MT
ORCID ID: https://orcid.org/0000-0002-2972-1034 - Msweli NS
ORCID ID: https://orcid.org/0000-0002-1743-5372 - Mgwenya LI

[1]School of Agricultural Sciences, University of Mpumalanga, Mbombela, 1200, South Africa

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ABSTRACT

Climate change has overwhelmingly affected agrarian reform food security and livelihoods in South Africa. Executing climate change response strategies is critical for meeting the demand for food and poverty alleviation. This study examined environmental response strategies for climate change to enhance sustainable livelihoods among smallholder farmers in Bushbuckridge, Ehlanzeni District, Mpumalanga, South Africa. The objective of the study was to investigate climate change response strategies and focus on effective adaptation strategies for smallholder farmers. The study used a structured questionnaire with surveyed samples of 300 respondents. Data were collected from June to August 2023 using a random sampling method to ensure representative results and a pre-test of questionnaires was undertaken with 30 smallholder farmers in the community. This is to eradicate inconsistencies and correct ambiguous statements that may have been inadvertently included in the questionnaire. Further, enumerators were carefully chosen and trained to effectively administer the survey, focusing on data collection methods, questionnaire comprehension, and ethics. Enumerators that were fluent in local languages (Xitsonga and Sepedi) ensured cultural sensitivity. Statistical Package for Social Sciences (SPSS) software version 28 was employed for data analysis. The binary logistic regression model was employed to analyze the relationships between socio-demographic variables and the dependent variables. The findings present significant positive correlations revealing that the level of education ($P<0.014$), farming experience ($P<0.053$), household size ($P< .007$), and land fertility ($P<0.047$), positively influenced the adoption of environmental response strategies for enhancing sustainable livelihoods of smallholder farmers in the study area. This study underscores the vital role of environmental response strategies for climate change while also exploring measures to improve farmers' livelihoods. The study recommends that investigating environmental response strategies for climate change informs evidence-based policy discourse and decisions, ultimately contributing to a climate-resilient future for South Africa. By understanding and implementing effective strategies, South Africa can protect its biodiversity, enhance food security, and promote sustainable development.

Key words: Climate change, response strategies, smallholder farmers, sustainable livelihoods, livelihoods, food security

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INTRODUCTION

Climate change is one of the biggest challenges ever faced by the agricultural sector across the world, especially smallholder farmers [1]. It poses a significant threat to smallholder farmers in rural South Africa due to their vulnerability to extreme weather patterns and rainfall [2]. The negative impacts of climate change, including heavy precipitation, drought, and floods, are expected to continue, with flood disasters affecting 147 million people globally by 2030 [3, 4].

South Africans may experience more floods, affecting 10,000-86,000 by 2030 [5]. The temperature rate in Africa has been increasing quicker than the world average standard, especially in South Africa and this is due to climate change [6]. The annual temperature of Africa has increased by an average rate of 0.13 °C (0.23 °F) per decade since 1910 [7]. As a result, the impact of climate change affected economic growth and development in sub-Saharan Africa between the years 2000 and 2018 [8].

Additionally, livelihoods are not only affected by climate change, however, non-climatic factors such as poverty, market access issues, financial constraints, and inadequate agricultural infrastructure significantly impact rural South Africa's livelihoods [9]. Food insecurity is the most prominent economic impact, and climate change has made it worse by lowering food supplies and raising their prices [1]. Poverty has increased, particularly in rural areas, as people seek employment in cities. This has led to decreased income and profit, increased unemployment, and worsened rising debt and loss of agricultural assets [10, 11].

In addition, if the spirit of poverty eradication and sustainable livelihoods is to be maintained, the negative events resulting from climate change and economic impacts cannot be ignored, especially in South Africa. Research highlights that there are various identified response strategies that can be implemented to mitigate the effect of climate change such as climate-resilient farming techniques, investing in irrigation infrastructure, using early warning systems, supporting social protection programs, creating sustainable agricultural value chains, and assisting farmers' associations and cooperatives [12]. Another study discovered environmental impacts as one of the factors that also contribute to the poor livelihood of smallholder farmers. These include water degradation grazing land loss, decrease in natural resource availability affecting food output and revenue [5].

Dry conditions, such as in the western interior and northern west coast of South Africa may lead to drought, negatively impacting food security and nutrition. Moreover, land deterioration, desertification, and increased diseases threaten the health of people and animals, making farming and cattle raising difficult [13, 14]. Further looking at the national context, South Africa, plagued by high poverty and

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inequality rates, is acutely vulnerable to the devastating impacts of climate change. To meet their nutritional needs, 17.5% of households rely on subsistence farming [13]. However, climate change is increasingly forcing rural subsistence farmers to abandon their lands, rendering small-scale farming unsustainable [14].

This alarming trend threatens to exacerbate poverty and food insecurity [15]. Bushbuckridge farmers on the other hand face similar challenges and have adopted adaptation measures like planting dates, improved crop varieties, and crop diversification to adapt to climate change [16, 17, 18]. However, poor extension services, government support, and financial support are the most experienced barriers [19]. Smallholder farmers lack the necessary resources and capital, requiring government intervention [20]. Additional challenges faced by smallholder farmers include insufficient climate change data, limited access to agricultural extension services, lack of knowledge about climate change response strategies, financial constraints, poor infrastructure, high poverty, illiteracy, lack of information, natural disasters, poor institutions, and poor public and environmental health [21]. Climate change is expected to affect Africa earlier than other countries, making adaptation strategies highly needed. Predictions that by 2050, the costs of response strategies in Africa will reach USD 100 billion annually due to a global climate of 4°C warming by 2100. However, funds are needed for continental and national standards.

Governments should be encouraged to introduce innovations such as capacity-building, interconnected with agricultural extension systems and education through information and communication technologies, to help smallholder farmers implement the right climate change response strategies [22]. The identified gap is that climate change significantly impacts smallholder farmers' livelihoods, leading to socio-economic challenges like hunger, poverty, and unemployment. There is a lack of research on a local level on integrating activities, policies, and agricultural practices to improve rural livelihoods through adaptation strategies.

Despite these challenges, smallholder farmers in Bushbuckridge North have demonstrated resilience and adaptability. This study aimed to examine environmental response strategies of climate change employed by these farmers to enhance sustainable livelihoods, focusing on climate-smart agriculture practices, natural resource management, and community-based initiatives. By exploring context-specific strategies, this research sought to contribute to the development of effective climate resilience interventions tailored to the needs of smallholder farmers in Bushbuckridge North and similar rural contexts.

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MATERIALS AND METHODS

Study Area

The study was conducted at Bushbuckridge Local Municipality in Mpumalanga Province, South Africa, focusing on the neighborhoods of Cottondale, Thulamahashe, Dingleydale, and Acornhoek as shown in Figure 1. This area was selected because there are fewer studies on adaptation strategies conducted in Bushbuckridge. Also, smallholder farmers in Bushbuckidge are producing less than they should be due to a lack of knowledge about climate change adaptation strategies, which has resulted in low food production and led to food insecurity.

The study area is situated in the savanna biome, with a yearly temperature of 22°C and a range of rainfall from 800mm in the west to 580mm in the east. The municipality has a peri-urban character, with a high population density and a strain on natural resources. The municipality was split between Gazankulu and Lebowa during apartheid, leading to a strain on natural resources [16]. Bushbuckridge's population reached 541,248 in 2011, with an average annual growth rate of 0.79%, and high population densities ranging from 146 to over 300 people/km² as per the census 2011. Bushbuckridge municipality faces low-income levels, food insecurity, and a 50.1% unemployment rate. Poor infrastructure, including roads and piped water, is a significant issue [15].

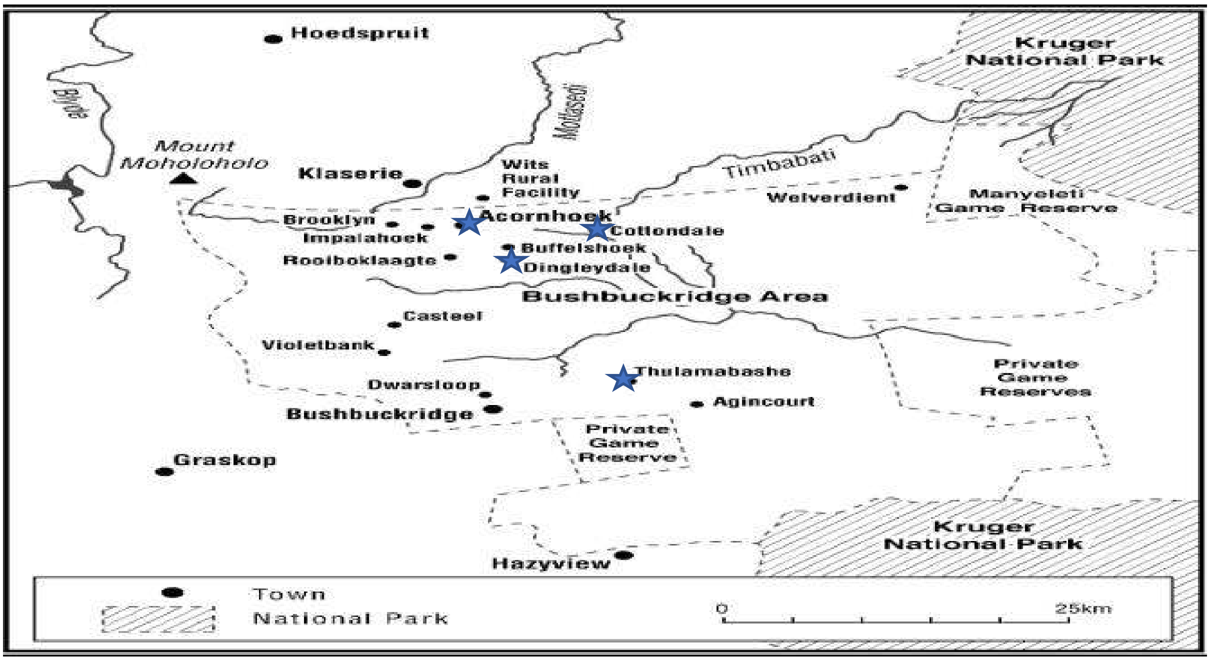

Figure 1: Map of Bushbuckridge Local Municipality areas (source: Niehaus [23])

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Sampling method and sample size

A simple random sampling method was utilised to select participants for the study. This ensured that every participant was treated with fairness and had an equal opportunity to partake in the study. The population of the municipality has 6000 smallholder farmers. The study sampled 375 smallholder farmers, calculated using Slovin's formula, whereby: $n = N / (1 + N(e)^2)$), considered the population size (N), anticipated sample size (n), and margin of error (5%), ensuring a representative and reliable sample.

$$n = \frac{N}{1+Ne^2}$$

$$n = \frac{6000}{1+6000(0.05)^2}$$

n=375 respondents

Sampling frame constraints, including temporal restrictions (time constraints) and gatekeeper reluctance (extension officers), resulted in a revised sample size of 300 smallholder farmers (80% of intended).

Questionnaire pretest

To guarantee clarity and precision, the questionnaire was pre-tested with 30 randomly selected smallholder farmers. After piloting, the questionnaire was refined to accurately capture key variables, boosting data reliability and validity.

Method of data collection

This study collected primary data through a survey using a structured questionnaire, developed from extensive literature research. Enumerators were carefully chosen and trained to effectively administer the survey, focusing on data collection methods, questionnaire comprehension, and ethics. Enumerators, fluent in local languages (Xitsonga and Sepedi), ensured cultural sensitivity. The final survey gathered data on farmers' demographics, climate change adaptation strategies, and perceptions. In addition, the questionnaire consisted of five sections: demographics (Section A), local adaptation strategies (Section B), climate change perceptions (Section C), government intervention strategies (Section D), and climate change impact on smallholder farmers' livelihoods (Section E). Variables were measured using nominal (gender, race), ordinal (education level), ratio (age, farm size), and Likert scales (climate change perceptions), as well as binary (yes/no) responses for adaptation strategies and government intervention awareness.

Data analysis

Data analysis was conducted using SPSS version 28.0. After cleaning and categorizing the data, binary logistic regression and descriptive statistics were

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applied to achieve the study's objectives. Specifically, binary logistic regression examined relationships between smallholder farmers' environmental response strategies and socio-economic characteristics, while descriptive statistics analyzed adoption rates and respondent characteristics. A comprehensive codebook ensured data transparency and repeatability.

The model of the study

The model that was used in the study is the logistic regression model, which is a statistical procedure for predicting the correlation between dependent and independent variables, where the dependent variable is binary. The binary logistic regression helps to estimate the likelihood of events as a function of a set of independent variables that are hypothesised to impact an outcome. Whilst a set of predictor variables is known, the logistic regression model is used to categorize individuals into one or two groupings and identify which qualities best predict choice-making. Then again, concerning the distribution of the predictor variables X, there are no ideas made, as X variables may be continuous [24]. In most empirical studies, it is standard to identify the characteristics that impact the influence of smallholder farmers' decision-making by employing the logistic regression model [25]. Therefore, let R_i represent a dichotomous variable that would be equal to 1 if smallholder farmers are inclined to adopt climate change adaptation strategies and zero (0) otherwise [26].

Table 1 summarises the hypothesised predictor variables with their descriptions, measurement, and expected signs. Table 1 further illustrates and labels specific variables with a prediction on whether the variables will have a positive (+) or negative (-) influence on adoption.

$$Y = \beta o + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + \beta_{15} X_{15} + \mu$$

Where:

Y=Inclination to adopt climate change adaption strategies (Inclined to adopt=1, 0=Not inclined to adopt)

X_1-X_{15}=independent variables demarcated as: (demographics+)

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

X_2= Age (years) = (<36) =1, (36-40) =2, (41-45) =3,
(46-50) =4, (51-55) =5, (56-60) =6, (>60) =7

X_3 = Level of education (Not educated =1, Primary School Level = 2, High School Level = 3, Tertiary = 4)

X_4 =Marital status (Single=1, Married=2, Divorced=3, Separated=4, Widow=5, Widower=6)

X_5 = Farm experience (years) = (< 5years) = 1, (5 – 10years) = 2, (10- 15years) = 3, (15 – 20years) = 4, (> 20years) = 5

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X_6 = Size of farmland (numerical) = (< 5acres) = 1, (5 -10acres) = 2, (10– 15acres) = 3, (15 – 20acres) = 4, (> 20acres) = 5
X_7 = Household size (numerical) = (1-3) =1, (4-6) =2, (7-9) =3, (>10) =4
X_8 = Distance from farm to market (number in km) = (< 5km) = 1, (5 – 10km) = 2, (10- 15km) = 3, (15 – 20km) = 4 (> 20km) = 5
X_9 = Access to climate change information (Poor = 1, Fair = 2, Good = 3)
X_{10}= Access to Extension services (yes=1, No = 2)
X_{11} = Access to government support (yes = 1, No = 2)
X_{12}= Farmer's adaptation strategies (Change of plant date=1, Mixed cropping=2, Crop diversification=3, Intercropping=4, other=5)
X_{13}= Climate change farmer's perceptions (Replant forests=1, Crop rotation=2, Restore damaged ecosystems=3, Mulching=4, other =5)
X_{14}= Challenges of adopting adaptation strategies= (Inadequate climate change information=1, Limited government support=2, Insufficient funds=3, Lack of predictability of extreme events=4, other=5)
X_{15}=Extension farm visit= (Once a week=1, Fortnight=2, Monthly=3, annually=4, other =5)
β_0 = constant
B_1- β_9 = Regression coefficients
μ = error term

Ethical Approval

Before data collection, ethical clearance was granted by the research committee from the University of Mpumalanga (protocol reference number UMP/Thabane/201988429/MAGR/2023). The participants were provided with clear and understandable information about the study along with the objectives, before handing them the questionnaires. Informed consent was granted by the participants, and they were further notified that participation was voluntary, and they were free to stop at any time. Every participant was treated with fairness and assured that no harm would come to them while participating in the study.

RESULTS AND DISCUSSION

Socio-demographic traits of the smallholder farmers in the study area

Table 2 presents the respondents' socioeconomic features. In the study area, 40.7% of the respondents (40.7%) were over 56 years old. Female smallholder farmers (58.7%) showed more interest in rural practices compared to male farmers (41.3%). The educational attainment of smallholder farmers in Table 2 indicates that a majority (61.7%) had attended school up to the secondary level. Nearly 9% of respondents had families with more than ten members, while around 16.7% had households with fewer than ten members. The majority (65%) of smallholder farmers in the study area possessed farms of less than 5 acres, with 69.7% of

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them using the land primarily for farming as a means of livelihood. From the findings, 16% of respondents inherited their lands, while the majority (60.3%) possessed their lands outright.

Most observed weather patterns

The study investigated the most observed weather patterns for the past 5 years by smallholder farmers in the study area. The study found that more than 98% of the smallholder farmers were aware of climate change, and only 0.3% of the respondents indicated that they had never heard of climate change. Approximately 99% of smallholder farmers reported noticing changes in environmental conditions in their area over the past five years.

The findings of the study indicate that 44% of the smallholder farmers agreed that flooding has been the main climate issue in the past 5 years, while 7.3% argued that their area had been affected by too much drought. Since water is a vital nutrient for crops, farmers were negatively affected physically, emotionally, mentally, and financially due to the drought. This finding disagrees with the study by Graw *et al*. [27], who reported a high percentage indicating that drought is the dominant factor affecting crop production in the Eastern Cape.

Most used adaptation strategies

The adaptation strategies employed by smallholder farmers, as shown in Fig. 2, reveal that crop diversification was the most preferred method. This method was utilized by 36% of respondents, due to its benefits in increasing soil productivity, ensuring stable production, pest control, and cost savings. This approach is particularly favoured in Ethiopia, where farmers leverage their local knowledge and environmental conditions to adopt effective response strategies [28]. In contrast, farmers in the Olifants region prefer utilizing improved seed varieties. However, some farmers rely on a single strategy due to limited adaptation knowledge and implementation capacity [29]. This study is supported by existing literature, which highlights the importance of crop diversification and improved seed varieties in enhancing resilience to climate change [30].

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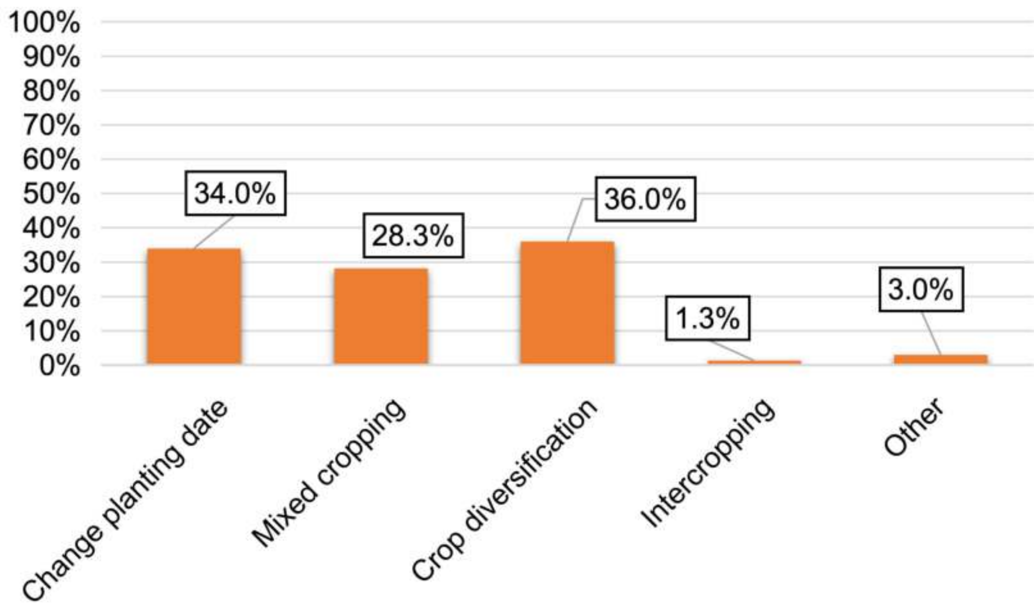

Figure 2: Most used adaptation strategies by respondents

Challenges faced by smallholder farmers

Farmers in the study area faced significant obstacles in adapting to climate change as shown in Fig 3. The primary barrier, cited by 51% of smallholder farmers, was inadequate government support, indicating a lack of guidance from extension officers on effective adaptation strategies. Additionally, 37.7% of respondents cited insufficient funding as a major hindrance, while 10.3% pointed to the unpredictability of extreme weather events and 1% mentioned inadequate access to climate change information as a key challenge. These findings highlight the need for enhanced government support, financial resources, and climate information to facilitate farmers' adaptation to climate change.

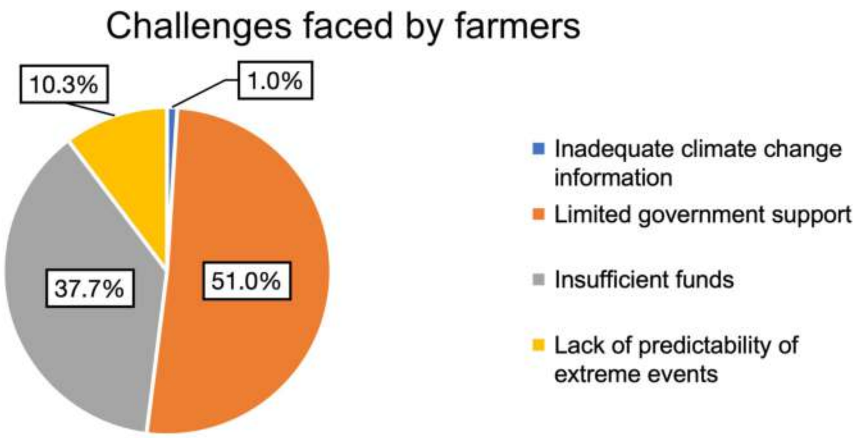

Figure 3: Challenges faced by farmers and extension services

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These findings align with those of Olabanji *et al.* [29], who reported poor access to extension services, climate change information, and soil fertility as limiting factors for farmers in Olifants. Notably, 65.3% of respondents received government support as indicated in Table 4, but 46% of them noted that this support was sporadic. The Eastern Cape respondents (68%) reported not receiving any extension services. This study complements previous research by underscoring the importance of consistent extension visits in facilitating climate change adaptation and improving farmers' productivity, food security, and poverty alleviation [31].

Empirical results of the study

In the model summary (Table 5), the Nagelkerke *R* Square, and Coz and Snell *R* Square (a measure of goodness of fit in logistic regression analysis), were .228 and .171, respectively. However, the Nagelkerke *R* Square ranges from 0 to 1, with values closer to 1 indicating that the model is a better fit for the data used study. The level of education, farm experience, fertility of the land, and size of the household were the four factors that were considered to influence farmers' inclination towards the adoption of climate change adaptation strategies with the overall objective of safeguarding their livelihoods from climate change.

The only predictor variable with a negative (-) sign was the household size, indicating that an increase in the size of the household may be associated with a decrease in the perception of the impact of climate change on smallholder farmers' means of livelihood. The positive (+) signs of the other three predictors indicate that an increase in these predictors can be linked to a rise in farmers' perceptions of the impact of climate change on their ability to earn a living. The independent variables were chosen and examined for their applicability to adoption behaviour.

The relationship between the smallholder farmers' independent variables and the farmers' inclination towards climate change adaptation is presented in Table 6. Notably, the level of education of respondents had a positive influence on their willingness to adapt to climate change, with a statistically significant *p-value* of 0.014 and a coefficient of β = 1.554. This indicates that increased education enhances critical thinking, empowering farmers to connect climate-related changes to their livelihoods and raises the likelihood of adaptation to climate change impacts on their livelihoods. Consistent with studies by Ntshangase *et al.* [32], Bako *et al.* [33], and Morepje *et al.* [34], education enables informed decision-making about climate change impacts.

Moreover, farmers value education as a vital tool for understanding effective response strategies to minimize climate change impacts and improve livelihoods. Additionally, household size was a significant predictor variable (*p-value* = 0.007),

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implying that larger households may have varying urgency concerning climate change adaptation and its impact on their livelihoods. The findings further show that household size had a significant yet negative influence on smallholder farmers' inclination towards climate adaptation strategies, with a coefficient of β = -1.307. This result implies that for every unit increase in household size, there is a proportional decrease of 1.307 in the adoption of climate change adaptation strategies to safeguard their smallholder farms (livelihoods). This finding disagrees with the study of Atube *et al*. [35] on the determinants of smallholder farmers' adaptation strategies on the effects of climate change as household size had a significant and positive impact on farmers' inclination towards the adoption of climate change adaptation strategies. A study by Morepje *et al.* [36], shows that large households are more likely to adopt climate change adaptation strategies compared to small household sizes due to the availability of labor.

Farm experience had a significant positive impact in swaying smallholder farmers' inclination towards the adoption of climate change adaption strategies, with a *p-value* of 0.053 and a coefficient of β = 1.023. This indicates that a unit increase in farm experience raises the log odds of adopting climate change adaption strategies lessening the impacts of climate change on farmers' livelihoods by 0.053. Consequently, smallholder farmers with more years of experience were more likely to adopt climate change adaptation strategies. This is consistent with the study of Fadina *et al.* [37] who reported that farm experience positively affects livelihood improvement. Moreover, farm experience influenced the adoption of climate-smart agriculture (CSA) in a study by Msweli *et al.* [38], suggesting that experienced household heads acquire greater competence in climatic conditions, increasing the likelihood of practicing various response strategies to climate change.

In addition, the predictor variable of land fertility was found to be statistically significant for farmers, with a *p-value* of 0.047. The results (Table 6) further indicated that land fertility positively influenced the farmers' inclination to adopt climate change adaption strategies with a *p-value* of 0.047 and a coefficient of β = 0.262. This means that for every unit increase in land fertility, there is an increase in the adoption of climate change adaptation strategies. Therefore, smallholder farmers who had no soil fertility problems had a better chance of higher yields to sustain livelihoods. Land fertility is anticipated to have a negative connection with the adoption of climate change adaptation strategies. This is a result that smallholder farmers with productive lands may not normally achieve higher returns [39].

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CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

The study's findings demonstrated that Bushbuckridge farming was most appealing to older female smallholder farmers. Additionally, most farmers lacked knowledge of climate change due to their low education levels. However, most of them were aware of the effects of climate change on crop production and livelihoods, despite their low education levels. Over-flooding, which impacted the yields of almost all smallholder farmers and led to food insecurity, was because of climate change.

Despite the fact that farmers knew about environmental change influences, smallholder farmers actually had no reliable information about any potential answers to environmental change influences. Despite having some knowledge of climate change response strategies, smallholder farmers faced challenges in implementing them due to inadequate government support. To mitigate the impacts of climate change, they attempted to diversify their crops, but this approach proved ineffective without sufficient backing.

Smallholder farmers emphasize the need for regular government assistance, including frequent farm visits and addressing key factors such as education, household size, farm experience, and land fertility. This support would enable them to effectively adapt to climate change, ensure food security, reduce poverty, and boost production. The study recommends translating climate change information from scientific to simple language for smallholder farmers. Additionally, the level of education significantly influences adaptation strategy adoption on climate change as it impacts smallholder farmers' inclination towards climate change adaptation.

Therefore, it is recommended that farmers receive education in the form of training and workshops through extension officers to boost smallholder farmers' knowledge and skills on climate change adaptation. Climate change is complex and requires a holistic understanding among smallholder farmers. Governments should strengthen connections with extension agents and implement agricultural insurance policies to compensate farmers for losses. Climate-smart practices like crop intensification and fertilizer application should be promoted. Smallholder farmers should adopt adaptation strategies with extension officers' help and receive training on other agricultural practices.

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Conflict of interest

The authors declare no conflict of interest.

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Table 1: Summary of independent variables hypothesized with their operational description, measurement, and expected signs

Variables and code	Operational description	Measurement unit	Expected sign
Gender	Gender of participants Female or male	Female = 1 Male = 2	+/-
Age	Number of years of Respondents	(<30 years) = 1 (30-40 years) = 2 (40-50 years) = 3 (>60 years) = 4	-
Level of education	Highest grade accomplished	No school = 1, primary = 2, secondary = 3, tertiary level = 4	+
Marital status	Respondent's relationship status	Single = 1, Married = 2, Divorced = 3, Separated = 4, Widow = 5, Widower = 6	+
Farm experience	Respondent's number of years farming	(< 5years) = 1, (5 – 10years) = 2, (10-15years) = 3, (15 – 20years) = 4, (> 20years) = 5	+
Farm size	Respondent's size of the farm	(< 5acres) = 1, (5 -10acres) = 2, (10–15acres) = 3, (15 – 20acres) = 4, (> 20acres) = 5	+
Household size	Respondent's household size	(1-3) = 1, (4-6) = 2, (7-9) = 3, (>10) = 4	+
Distance from the farm to the market	Respondent's location concerning the nearest town	(< 5km) = 1, (5 – 10km) = 2, (10-15km) = 3, (15 – 20km) = 4 (> 20km) = 5	-
Access to climate change information	Respondent's access to climate change information	Poor = 1, Fair = 2, Good = 3	+
Access to extension services	Respondent's access to agricultural extension services	1 = yes, 2 = no	+
Access to government support	Respondent's access to government support	1 = yes, 2 = no	+
Farmer's Adaptation Strategies	Respondent's adaptation strategies	Change of plant date = 1, Mixed cropping = 2, Crop diversification = 3, Intercropping = 4, other = 5	+
Climate change farmers' perception	Respondents perceived climatic conditions.	Replant forests = 1, Crop rotation = 2, Restore damaged ecosystems = 3, Mulching = 4, other = 5	-/+

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Challenges of Adopting Adaptation Strategies	Respondent's challenges in adapting to adaptation strategies	Inadequate climate change information = 1, Limited government support = 2, Insufficient funds = 3, Lack of predictability of extreme events = 4, other = 5	-
Extension farm visit	Respondent extension farm visit	Once a week=1, Fortnight=2, Monthly=3, annually=4, other =5	+

Source: (Own Data, 2023)

Table 2: The distribution of farmers' socio-demographic traits

Characteristics	Categories	Percentage (%)
Age (Years)	<30	13.3
	31-35	7.7
	36-40	10.3
	41-45	7.3
	46-50	10.3
	51-55	10.3
	>56	40.7
Gender	Female	58.7
	Male	41.3
Level of education	No School	6.7
	ABET	3.0
	Primary level	20.3
	Secondary level	61.7
	Tertiary level	8.3
Marital status	Single	49.0
	Married	46.0
	Divorced	1.3
	Widow	3.0
	Widower	.7
Household size(acres)	1-3	16.7
	4-6	54.0
	7-9	20.3
	>10	9.0
Farm size(acres)	<5	65.0
	6-10	19.3
	11-15	11.7
	16-20	2.7
	>20	1.3
Source of income (ZAR)	Sassa grant	5.7
	Pension	21.7
	Farming	69.7
	Part-time job	2.7
	Other	.3
Land ownership	Own	60.3
	Renting	19.7

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	Communal Inheritance Other	3.7 16.0 .3
Farm experience (years)	<5 6-10 11-15 16-20 >20	30.7 20.7 15.3 10.3 23.0
Land fertility	Very infertile Infertile Neither fertile or infertile Very fertile Fertile	.7 15.3 12.0 25.7 46.3

Source: (Own data, 2023)

Table 3: Climate change awareness and most observed weather patterns

Climate change awareness among farmers			
	Response	**Frequency**	**Percentage**
Have you heard about climate change?	Yes	299	99.7
	No	1	0.3
Most observed weather patterns			
	Response	**Frequency**	**Percentage**
Drought	Observed	22	7.3
	Not observed	278	92.7
Floods	Observed	132	44.0
	Not observed	168	56.0
Extreme wet seasons	Observed	7	2.3
	Not observed	293	97.7
Other weather patterns	Observed	44	14.7
	Not observed	256	85.3

Source: (Own Data, 2023)

Table 4: Access to government support and frequency of support received

Access to government support			
	Response	**Frequency**	**Percentage**
Do you receive government support?	Yes	196	65.3
	No	104	34.7
The frequency at which government support is received			
		Frequency	**Percentage**
Once a week		5	1.7
Fortnight		18	6.0
Monthly		138	46.0
Annually		49	16.3
Other		90	30.0

Source: (Own Data, 2023)

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Table 5: Model summary

Step	-2 Log likelihood	Cox and Snell R Square	Nagelkerke R Square
1	357.103°	.171	.228
2	358.457°	.167	.223

Source:(Own Data, 2023)

Table 6: Factors influencing farmers' inclination toward climate change adaptation

Predictor variables	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
Gender	-.409	.318	1.655	1	.198	.665	.357	1.239
Age	.204	.623	.107	1	.743	1.227	.361	4.163
Level of education	1.554	.630	6.080	1	.014**	4.730	1.375	16.265
Household size	-1.307	.481	7.373	1	.007**	.271	.105	.695
Source of income	-1.326	1.070	1.538	1	.215	.265	.033	2.160
Land ownership	-1.055	.784	1.811	1	.178	.348	.075	1.619
Farm experience	1.023	.530	3.733	1	.053*	2.782	.985	7.853
Farm size	-1.341	.897	2.231	1	.135	.262	.045	1.520
Crop type	-.076	.069	1.239	1	.266	.927	.810	1.060
Land's fertility	.262	.132	3.936	1	.047*	1.300	1.003	1.684
Source of water	-1.110	.906	1.500	1	.221	.330	.056	1.947
Constant	21.473	40193.085	.000	1	1.000	2115488200.163		
-2 Log likelihood	357.103							
Cox and Snell R Square	.171							
Nagelkerke R Square	.228							

Source: (Own Data, 2023)

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