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ARTICLE

Smallholder Farmers' Perceptions of Climate Change Adaptation Strategies: The Case of the Greater Giyani Local Municipality, Limpopo Province

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ABSTRACT

Small-scale farmers' perceptions of climate change adaptation strategies are crucial for enhancing agricultural resilience and sustainability. Just like in most countries, the agricultural industry in South Africa has adopted several strategies aimed at mitigating challenges linked to climate change, which poses a significant threat to agricultural production, water resources, food security, and ecosystem health. Consequently, this study aimed to explore small-scale maize farmers' perceptions on the application of climate change adaptation strategies in Greater Giyani Local Municipality, Limpopo Province, South Africa. A sample of 130 small-scale maize farmers was selected using snowball and purposive sampling techniques. Descriptive statistics, including cross-tabulations and frequency distributions, were utilized to profile the socio-economic characteristics of the farmers, addressing the study's first objective. The binary logistic regression model was used to analyse the factors influencing small-scale maize farmers perceptions on the application of climate change adaptation strategies. The empirical results revealed several variables that significantly influenced small-scale maize farmers' perceptions on the application of climate change adaptation strategies. These included marital status, employment status, access to weather forecasts and participation in farmer cooperatives. The study recommended targeted support for smallholder farmers in the study area to improve their knowledge of climate change adaptation strategies, including flexible training programs and

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incentives. Enhancing access to weather forecasts, strengthening farmer cooperatives, and promoting experiential learning are also crucial.

Keywords: Climate Change; Perception; Adaptation Strategies; Small-Scale Maize Farmers

1. Introduction

Agriculture is a significant economic activity and remains crucial for both commercial and subsistence purposes, especially in developing countries [1]. Agriculture contributes notably to the Gross Domestic Product (GDP), provides food, creates employment, and boosts exports [2]. Agriculture is important in rural areas where small-scale farmers rely on it for their livelihood. Therefore, the advancement of agriculture holds the potential to eradicate poverty and sustainably feed approximately 10 billion people by 2050 [3]. However, climate change poses severe threats to agricultural productivity due to its effects on weather patterns, leading to unpredictable crop and livestock yields [4].

In Africa, agriculture employs two-thirds of the workforce and contributes significantly to GDP and export value [4]. However, the reliance on rain-fed agriculture makes the sector particularly vulnerable to climate variability, leading to increased occurrences of extreme weather events [5]. South Africa, with its semi-arid climate, is expressly susceptible, with over 70% of its agricultural activities being reliant on rain-fed methods [6]. Although maize is a staple crop and essential for food security in South Africa, it is heavily impacted by extreme weather events such as droughts and floods which significantly affected the yield [7, 8].

Various studies have explored technical adaptation measures such as crop diversification and improved irrigation practices to mitigate climate change impacts on small-scale maize farmers. For example, a study in Zimbabwe demonstrated that crop diversification significantly enhances productivity and resilience by improving household income, food security, and nutrition among smallholder farmers [9]. Similarly, research in Kenya found that diversifying crops can increase sales and improve agroecosystem resilience, helping farmers manage risks associated with climate variability [10]. In regions like Southern Africa, farmers have shifted from cash crops to more resilient food varieties as a response to climate change, indicating that crop diversification serves as a critical risk management strategy [11]. Improved irrigation practices are also essential; while irrigated systems typically face fewer vulnerabilities than rainfed systems, they still encounter challenges due to changing precipitation patterns [12]. Technological advancements in irrigation, such as drip systems, have been shown to enhance water efficiency and crop resilience [13]. However, there remains a gap in understanding farmers' perceptions and willingness to apply these strategies. Recognizing and addressing these perceptions is critical for developing targeted interventions that support farmers' adaptation efforts, ensuring the long-term sustainability of agriculture [14]. This study aimed to investigate small-scale maize farmers' perceptions on the application of climate change adaptation strategies in Greater Giyani Local Municipality, Limpopo Province. Through this investigation, the study sought to offer insights into the effectiveness of current adaptation strategies and the challenges hindering their implementation. By understanding these perspectives, tailored interventions can be crafted to support farmers' adaptation efforts, enhancing agricultural resilience amidst climate change challenges.

The objectives of this study were:

1. To profile the socio-economic characteristics of small-scale maize farmers in in Greater Giyani Local Municipality, Limpopo Province.
2. To analyse the factors influencing small-scale maize farmers' perceptions on the application of climate change adaptation strategies in the study area.

Hypotheses of the study were:

1. Small-scale maize farmers in Greater Giyani Local Municipality, Limpopo Province have a negative perception towards the application of climate-smart approaches.
2. Factors such as age, gender, marital status and

other socio-economic characteristics do not influence the perception of small-scale maize farmers on the application of climate change adaptation strategies in the study area.

2. Materials and Methods

2.1. Research Data and Location

The study was conducted in Greater Giyani Local Municipality, part of the Mopani District in Limpopo Province, South Africa. The municipality, established under the South African Constitution of 1996, covers approximately 2967.27 km^2 and has a population of 256,300[15]. It consists of 31 wards and 91 villages, with main economic sectors including agriculture, tourism, retail, and transport. This research focused on small-scale maize farmers in Ward 27 to understand their specific challenges and adaptive strategies to climate change, which severely affects maize production due to heat waves and droughts.

Numerous studies have highlighted the challenges faced by small-scale maize farmers in the Greater Giyani Local Municipality[16–18]. The region is particularly vulnerable to climate change impacts, such as heat waves and droughts, which severely affect maize production. To gather data, face-to-face interviews were conducted using a structured questionnaire. The questionnaire was divided into three parts, each containing specific questions. The first part focused on gathering descriptive information about the socioeconomic characteristics of small-scale maize farmers. The second part investigated the utilization of adaptation strategies by farmers to mitigate the harmful effects of climate change. Lastly, the third part explored the factors that influenced farmers' perceptions of the application of climate change adaptation strategies. The main objective of the questionnaire was to gather comprehensive information about small-scale maize farmers' perceptions of climate change adaptation strategies and their application.

2.2. Sampling Frame

The list from which prospective respondents were chosen is known as a sampling frame[17]. The sampling frame for this study was made up of all the households in Greater Giyani Local Municipality. The decision to select a household as a sampling unit was important given that, according to the Food and Agriculture Organization (FAO)[19], most farming operations were performed at the household level, which had a direct effect on farming and adaptation practices at the farm level. The Greater Giyani Local Municipality had 1806 households[20].

The formula used to calculate the sample size for each village:

$$\text{Sample size} = \frac{Household\ population\ per\ village}{Total\ Household\ population} \times 130 \quad (1)$$

Table 1 present a list of small-scale maize farmers from the five villages was obtained from the traditional leaders.

2.3. Sampling Methods

Snowball Sampling and Purposive Sampling

In this study, snowball sampling was employed to identify the respondents. Snowball sampling, a non-probability sampling method, is used in social research to identify and enroll people who are difficult to reach using traditional sampling methods. It is a type of convenience sampling in which the researcher selects the initial volunteers, sometimes known as "seeds", based on their relevance to the study topic or their relationship to the target demographic. The traditional authorities of the Greater Giyani Local Municipality selected villages and provided a list of small-scale maize farmers to start this investigation. This list was used as a starting point to find possible participants. The researcher explicitly mentioned the research topic and purpose, the target population, and the participant characteristics of interest. The following step was to identify the initial seeds, which were small-scale farmers on the list who were related to or familiar with other possible respondents and could contribute useful information for the study.

The initial seeds were used to refer to other small-scale maize growers who fit the study's criteria. This referral process was repeated until enough participants were enrolled in the research. Using this strategy guaranteed that the sample included participants who would have been difficult to reach using typical sampling meth-

Table 1. Sample size of the selected villages in Greater Giyani Local Municipality.

Villages	Household Population	Sample Size	Percentage
Xitlakati	518	37	28.5
Khaxani	573	41	31.5
Mzilela	221	16	12.3
Matsotsosela	288	21	16.2
Mayephu	206	15	11.5
Total	1806	130	100

Source: Author's own calculations (2024).

ods, which increased the study's relevance and depth as it involves selecting samples because they have certain qualities or characteristics that permit in-depth exploration and comprehension of the primary themes and problems the researcher desires to examine [21]. In the context of studying farmers' perceptions of the application of climate change adaptation strategies, the researcher defined the population, which included any farmers impacted by climate change and who might have used or were aware of adaptation strategies.

2.4. Analytical Procedure

To achieve the first objective of identifying the socio-economic characteristics of small-scale maize farmers in ward 27 of the Greater Giyani Local Municipality, Limpopo Province, South Africa, descriptive statistics were conducted.

The study further utilized a Likert scale to evaluate the small-scale maize farmers perception on the application of climate change adaptation strategies in the study area. The Likert scale contained multiple statements relevant to the study, and respondents were requested to rate their degree of agreement with each statement. This rating ranged from strongly disagree to strongly agree. A 5-point Likert scale questionnaire was used, offering the options of "Strongly disagree," "Disagree," "Uncertain," "Agree," and "Strongly agree."

To calculate the mean of the Likert scale responses, the following formula was used:

Mean = [(Number of respondents) × Sum of (score)] / (total number of participants)

Mean = (SD*1 + D*2 + U*3 + A*4 + SA*5) / total number of participants (2)

where SD = Strongly disagree, D = Disagree, U = Uncertain, A = Agree, and SA = Strongly agree. Therefore, if the mean score was less than 3.26, the farmers had a negative perception, and if the mean score was 3.26 or above, the farmers had a positive perception. This decision was made based on the assumption that a mean score below 3.26 indicated a predominantly negative sentiment or disagreement with the statements assessed in the Likert scale. It suggested that, on average, the farmers expressed a more negative viewpoint regarding the application of climate change adaptation strategies.

The study employed, the binary logistic regression model to achieve the second objective of this study, which was to determine factors influencing the small-scale maize farmers' perception on the application of climate change adaptation strategies in the study area. According to Ndhleve, Nakin and Longo-Mbenza [5], the binary logistic regression model is used to acquire the odds ratio in the presence of more than one explanatory variable. In this study, the dependent variable is a dichotomous variable with a value of 1 if the small-scale maize farmers have a positive perception of the application of climate change adaptation strategies and 0 otherwise. The choice of Binary Logistic Regression in this study is justified by its suitability for dichotomous outcomes, ability to handle non-linearity and heteroskedasticity, ease of interpretation through odds ratios, and robustness with mixed data types. These advantages make it a preferred method over OLS, LPM, or Probit models for analyzing factors influencing perceptions related to climate change adaptation strategies among small-scale maize farmers.

- Binary Logistic Regression Model

  The binary logistic regression model is expressed as follows [22]:

$$\ln\left(\frac{Pi}{1-Pi}\right) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \ldots + \beta_k x_k \quad (3)$$

$$Yi = In (pi / 1–pi) \quad (4)$$

Where:

Y = Dependent variable (Farmers Perception)

Pi/(1–Pi) is called the odds (likelihoods) ratio, if Pi is the probability of the farmer having a positive perception towards the application of climate change adaptation strategies, then 1–Pi represents the probability of not having a positive perception towards the application of climate change adaptation strategies.

Ln = The natural logarithm

β_0 = The regression constant (Intercept)

μ = The disturbance term

$\beta_1+\beta_2+B_3+...+\beta_{14}$ = The regression coefficients for the independent variables

$X_1+X_2+X_3+...+X_{14}$ = The independent variables

- Model Specification

$FMP = \beta_0 + \beta_1 AGE + \beta_2 GND + \beta_3 MRS + \beta_4 HSZ + \beta_5 EMS + \beta_6 LED + \beta_7 FMI + \beta_8 ATE + \beta_9 FSZ + \beta_{10} FATC + \beta_{11} AGT + \beta_{12} FME + \beta_{13} FMC + Ut$ (5)

Fourteen explanatory variables were logged in the model to determine factors influencing the small-scale maize farmers perception of the application of climate change adaptation strategies.

The following **Table 2** outlines the variables used to determine the factors influencing small-scale maize farmers' perceptions regarding the implementation of climate change adaptation strategies in the study area. The dependent variable, Farmers Perception (FMP), indicates whether farmers have a positive perception of these strategies, coded as 1 for positive and 0 for negative. The independent variables encompass a range of demographic, social, and economic factors that may influence farmers' perceptions. These include age, gender, marital status, household size, employment status, level of education, income, access to extension services, farm size, access to credit, agricultural training, farming experience, and participation in cooperatives. Each variable is categorized by its type dummy, categorical, or numerical and is associated with an expected sign that reflects its anticipated relationship with the dependent variable.

Table 2. Description of variables.

		Variable	Description	Unit of Measurement	Expected Sign
			Dependent Variables		
Yik	FMP	Farmers perception	1 if the small-scale maize farmers have a positive perception of the application of climate change adaptation strategies, and 0 otherwise	Dummy	
			Independent Variables		
X_1	AGE	AGE	Actual number of years	Number	
X_2	GND	Gender	1 if the farmer is male, 0 if the respondent is female	Dummy	+
X_3	MRS	Marital status	0 if the farmer is single, 1 if married, 2 if widowed and 3 if divorced	Categorical	+/–
X_4	HSZ	Household size	The actual number of household members	Number	+
X_5	EMS	Employment status	0 if the farmer is employed, 1 if unemployed, 2 if part-time employed, 3 if temporarily employed	Categorical	+
X_6	LED	Level of education	0 if the farmer has no formal education, 1 for primary education, 2 for secondary, 3 for tertiary	Categorical	+
X_7	FMI	Farmer's income	Income per annum	Rands	+
X_8	ATE	Access to extension	1 if farmer has access to extension service; 0 otherwise	Dummy	+
X_9	FSZ	Farm size	The size of land owned by the farmers	Hectares	+
X_10	ATC	Access to credit	1 if the farmer has access to credit, 0 otherwise	Dummy	+
X_11	AGT	Agricultural training	1 if the farmer has access to training, 0 otherwise	Dummy	+
X_12	FME	Farming experience	Number of years in farming	Years	+
X_13	FMC	Farmer's cooperatives	1 if the farmer is in a farmers' cooperative association, 0 otherwise	Dummy	+/–

Source: Author's own compilation (2024).

To assess multicollinearity, the variance inflation factor (VIF) for each variable was determined as presented in **Table 3**. A VIF number greater than 10 denotes a multicollinearity concern. However, the results revealed that all variables had VIFs less than 10, with an average VIF of 1.86 and an inverse VIF of 0.59. This shows that multicollinearity was not an issue among the variables. The analysis was carried out with IBM SPSS Version 26.0 software.

Table 3. Diagnostic test (multicollinearity).

Explanatory Variable	**Collinearity Statistics**	
	VIF	1/VIF
Age	3.62	0.28
Gender	1.19	0.84
Marital status	1.44	0.69
Household size	1.30	0.77
Employment status	2.16	0.46
Level of education	2.80	0.36
Farmer's income	1.54	0.65
Access to extension services	2.25	0.44
Farm size in hectares	1.45	0.70
Access to credit	1.98	0.50
Agricultural training	2.35	0.43
Farming experience	1.80	0.56
Climate change awareness	1.60	0.62
Access to weather forecast	1.36	0.74
Farmers Cooperatives	1.60	0.63
Mean VIF	1.85	0.59

Source: Survey data (2024).

3. Results and Discussion

3.1. The Socio-Economic Characteristics of Small-Scale Maize Farmers

The results in **Table 4** revealed that the age of small-scale maize farmers in the Greater Giyani Local Municipality ranges from 23 to 85 years, with a mean age of 57 years. This suggests that the average farmer in the area is elderly, with a significant standard deviation of 17 years indicating a diverse age range among the farmers. Younger farmers (minimum age of 23 years) may be more open to adopting new technologies, while older farmers (maximum age of 85 years) bring extensive experience but may be less inclined towards change. Even though previous studies, such as Akanbi, Davis and Ndarana [14] and Haque, Kumar and Bhullar [23], suggest that farming experience rather than age significantly impacts the adoption of climate adaptation strategies.

Regarding household size, the results showed an average of 5 people per household, with a minimum of 1 and a maximum of 10 household members. The moderate standard deviation of 1.8 people indicates variability in household sizes. Smaller households may struggle with labour-intensive farming activities, while larger households, despite facing potential financial burdens, can provide more labour for farming tasks [24]. Larger households may also face challenges in investing in necessary inputs and technologies due to higher dependency ratios, as highlighted by Kulla [25] and Mamkwe [26]. The farm size distribution indicates that small-scale maize farms in the area range from 1 to 21 hectares, with an average size of 4.22 hectares. The significant standard deviation of 3.2 hectares reflects the ranges within which most of the small-scale land sizes in the area are concentrated.

Table 5 provides an overview of the socio-economic characteristics of small-scale maize farmers in the Greater Giyani Local Municipality. The data in **Table 5** highlights a majority female participation in farming (60.8%), with male farmers constituting 39.2%. Marital status indicates that most farmers are married (64.6%), while smaller percentages are single (16.2%), widowed (16.9%), and divorced (2.3%).

Regarding education, 39.2% of farmers have no formal education, while 29.2% and 25.4% have secondary and tertiary education, respectively. A small percentage (6.2%) has completed primary education. Employment status shows that 75.4% of farmers are unemployed, with the remaining 24.6% employed. The majority of farmers earn less than R2500 per month, with 50% of them having an income between R1500 and R2500, while 16.2% earn more than R5000.

Access to extension services is limited, with 63.1% of farmers lacking access. A significant proportion (71.5%) also lacks access to credit, while only 28.5% can obtain it. Slightly more than half of the farmers (53%) have received agricultural training. Farming experience varies, with 63.8% having more than five years of experience, while a small number (6.2%) have less than two years. Access to weather forecasts is almost evenly split, with 51.5% having access and 48.5% without.

Table 4. Frequency table for continuous variables of small-scale maize farmers.

Variables	Range	Minimum	Maximum	Mean	Std. Deviation
Age	62	23	85	57	17
Household size	9	1	10	5	1.8
Farm size	21	1	21	4.22	3.2

Source: Own survey (2024).

3.2. Results on Small-Scale Maize Farmers Perception on the Application of Climate Change Adaptation Strategies in the Study Area

The Likert scale results presented in **Table 6** provide the context on the farmers perceptions towards the application of climate change adaptation strategies. The study is based on responses to five statements, ranging from Strongly Disagree (SD) to Strongly Agree (SA). The mean scores and standard deviations for each statement indicate whether farmers' perceptions are typically positive or negative.

Most small-scale maize farmers (a combined 79.2%) agreed and strongly agreed that climate change adaptation strategies are necessary for the long-term sustainability of their farms as indicated in **Table 6**. The high mean score of 3.98 suggested a strong positive perception, implying that most farmers saw the relevance of these strategies in maintaining their agricultural activity. Despite this awareness, farmers faced substantial challenges such as a lack of cash, limited access to financing, and insufficient government help such as extension services, all of which hampered their capacity to properly execute these critical strategies.

A large percentage of farmers (74.6%) indicated their willingness to adopt and implement climate change adaptation strategies on their farms. The mean score of 3.76 represented a positive perception, indicating that most farmers were willing to incorporate these ideas into their farming practices. Nonetheless, their willingness was frequently tempered by fundamental constraints such as financial limits and a lack of comprehensive government backing, which limited their ability to carry out what they intended.

The findings show a lack of confidence among small-scale maize farmers in their knowledge of climate change adaptation strategies, with a combined 79.3% strongly disagreeing and disagreeing with this statement. The low mean score of 1.93 suggested a negative perception, implying that many small-scale maize farmers were not well-informed about various strategies that may be used on their farm. This knowledge gap constituted a substantial hurdle, which was frequently worsened by insufficient training programmes and limited access to extension services, impeding effective adaptation.

A significant majority of farmers (56.9%) stated that climate change adaptation strategies were effective in mitigating the effects of climate change on their farms. The average score of 3.48 suggested a positive perception, indicating confidence in the effectiveness of these strategies. However, the execution of these effective solutions was sometimes delayed by considerable obstacles such as a lack of financial resources, limited access to financing, and insufficient government support, including extension services and agricultural training.

The replies expressed varying opinions on the practicality and feasibility of implementing climate change adaptation techniques. Although a combined 51.5% of farmers agreed and strongly agreed, an impressive 36.1% disagreed or strongly disagreed. The mean score of 3.13 was slightly below the threshold for a positive perception, reflecting general doubt regarding the practicality of these strategies on their farms. Therefore, in summary the results indicate that 55.1% of small-scale maize farmers in the Greater Giyani Local Municipality hold a positive perception towards the application of climate change adaptation strategies, while 33.2% have a negative perception.

Table 7 highlights the various adaptation strategies employed by small-scale maize farmers in the Greater Giyani Local Municipality to combat climate change. The most frequently used strategy was crop diversification, with 32.4% of farmers employing this

Table 5. Socio-economic characteristics of small-scale maize farmers.

Variables	Outcome	Frequency	Percentage
Gender	Female	79	60.8
	Male	51	39.2
Marital status	Single	21	16.2
	Married	84	64.6
	Divorced	3	2.3
	Widowed	22	16.9
Employment status	Employed	32	24.6
	Unemployed	98	75.4
Level of education	No formal education	51	39.2
	Primary level	8	6.2
	Secondary level	38	29.2
	Tertiary level	33	25.4
Farmer's income	At most R1500	21	16.2
	Between R1500 and R2500 both inclusive	65	50
	Between R2500 and R3500 inclusive	12	9.9
	Between R3500 and R5000 inclusive	11	8.5
	Above R5000	21	16.2
Access to extension services	Yes	48	36.9
	No	82	63.1
Access to credit	Yes	37	28.5
	No	93	71.5
Agricultural training	Yes	69	53
	No	61	47
Farming Experience	Less than 2 years	8	6.2
	Between 2 and 3 years	18	13.8
	Between 4 and 5 years	21	16.2
	Above 5 years	83	63.8
Access to weather forecast information	Yes	67	51.5
	No	63	48.5

Source: Own survey (2024).

method to reduce the risk of total crop failure and enhance food security. According to Ndlheve, Nakin and Longo-Mbenza [5], farmers who produce a range of crops reduce the danger of total crop failure due to poor climatic circumstances, hence improving food security and distributing risk, this strategy also promotes sustainable farming practices by preserving soil health. Changing planting times is another critical strategy adopted by 19.4% of farmers, enabling them to align agricultural activities with shifting weather patterns for improved crop yields. The changing planting time enabled better integration of crop growth with favourable meteorological conditions, resulting in enhanced production, Heino [27].

Efficient water management practices, such as rainwater harvesting and water storage facilities, are used by 12.6% of farmers to ensure adequate water supply during droughts as indicated in **Table 7**. According to Woetzel, Pinner and Samandari [28], mulching and the creation of small dams or ponds significantly increased water availability. Improved irrigation practices, including drip and sprinkler systems, are employed by 14.6% of farmers to maximize water use efficiency and crop yield. Encouraging the use of new irrigation systems and providing appropriate training enabled farmers to make the best use of available water resources. This method reduced water waste while ensuring that crops received enough water to thrive optimally, FAO [29] and World Bank [3].

Table 6. Likert scale results.

Statements	Rating					Mean Score	σ	Decision
	SD 1	D 2	U 3	A 4	SA 5			
1. I believe that climate change adaptation strategies are necessary for the long-term sustainability of my farm	3 (2.3)	14 (10.8)	10 (7.7)	58 (44.6)	45 (34.6)	3.98	1.03	Positive perception
2. I am willing to adopt and implement climate change adaptation strategies on my farm	2 (1.5)	19 (14.6)	12 (9.2)	72 (55.4)	25 (19.2)	3.76	0.98	Positive perception
3. I feel knowledgeable about the different climate change adaptation strategies that can be applied on my farm	60 (46.2)	43 (33.1)	10 (7.7)	10 (7.7)	7 (5.4)	1.93	1.16	Negative perception
4. I perceive climate change adaptation strategies to be effective in mitigating the impact of climate change on my farm	2 (1.5)	26 (20)	28 (21.5)	56 (43.1)	18 (13.8)	3.48	1.01	Positive perception
5. I believe that climate change adaptation strategies are practical and feasible to implement on my farm	16 (12.3)	31 (23.8)	16 (12.3)	54 (41.5)	10 (10)	3.13	1.24	Negative perception

Source: Survey data (2024).
Note: N=130, SD = Strongly disagree, D = Disagree, U = Uncertain, A = Agree, and SA = Strongly agree. Decision: weighted average = 16.28/5 = 3.26, therefore the decision will be Positive perception if the mean score is ≥3.26, then negative perception if the mean score is < 3.26.

Table 7. Adaptation strategies adopted by small-scale maize farmers in the study area.

Adaptation Strategies Adopted by Farmers in Study Area	Number of Times Mentioned by Farmers	Percentage (%)
Crop diversification	100	32.4
Change planting time	60	19.4
Water management	39	12.6
Improved irrigation practices	46	14.6
Use climate resilient crop varieties	33	10.7
Adjust farming practice	10	3.2
Other adaptation strategies	22	7.1

Source: Own survey (2024).

Additionally, 10.7% of farmers use climate-resilient crop varieties designed to withstand extreme weather conditions, for example, TELA® Bt maize, which is genetically modified maize hybrids. The majority of small-scale maize farmers indicated that they are not aware of such maize seeds that can withstand harsh weather conditions. This lack of awareness has impeded the widespread adoption of these climate-resilient crops. Adjusting farming practices, such as altering plant spacing and pest control strategies, is adopted by 3.2% of farmers to address climate-related challenges. Other strategies, utilized by 7.1% of farmers, include mulching, composting, and organic manure application to maintain soil fertility and moisture. Despite these efforts, farmers face significant challenges in implementing these strategies effectively due to a lack of funding, limited access to financing, minimal government support, and inadequate infrastructure.

4. Results on Factors Influencing the Small-Scale Maize Farmers Perception on the Application of Climate Change Adaptation Strategies in the Study Area

The Omnibus Tests of model coefficients were used to assess the fitness of the binary logistic regression model. As presented in **Table 8** the Chi-square statistic was used to conduct the assessment, and the result was a value of 66.418 with a p-value less than 0.005. These findings show a highly significant association between the dependent variable and the collection of independent variables in the final model, as opposed to the null model, which lacks any predictors. The high Chi-square value, together with the extremely low p-value, highlights the model's usefulness in explaining the variability in the dependent variable, validating the predictors' robustness and statistical significance.

Table 8. Omnibus tests of model coefficients results.

Omnibus Tests of Model Coefficients			
	Chi-square	df	Sig.
Step	66.418	15	<0.001
Block	66.418	15	<0.001
Model	66.418	15	<0.001

Source: SPSS and survey data (2024).

The Model Summary uses pseudo-R-square statistics to assess the performance of the binary logistic regression model in explaining variation in the dependent variable. In this analysis, the Cox & Snell R-square is 0.40, whereas the Nagelkerke R-square is 0.548. Although "Pseudo" implies that these R-square values are not precise measurements of explained variance, they are a good approximation. Specifically, Nagelkerke's R-square of 0.548 indicates that the independent variables in the model account for approximately 54.8% of the criterion variable's variance as indicated in **Table 9**. This result suggests that the binary logistic regression model has strong explanatory power, demonstrating that the independent variables together explain a significant percentage of the variability in the dependent variable and validating the model's efficiency in capturing significant correlations between the independent factors and the dependent variable.

Table 10 summarizes the binary regression results that investigate the factors influencing small-scale maize farmers' perceptions regarding the application of climate change adaptation strategies.

4.1. Significant Variables

4.1.1. Marital Status of Small-Scale Maize Farmers

The marital status of small-scale maize farmers is marginally significant at the 10% level (p = 0.06), with a negative coefficient (B = −0.863). This indicates that being married, divorced, or widowed decreases the likelihood of perceiving the importance of the application of climate change adaptation strategies when compared to single farmers. The odds ratio (Exp(B) = 0.422) showed that these groups are 57.8% less likely to have a positive perception than single farmers. The study by Haque, Kumar and Bhullar [23] found that marital status significantly influences farmers' perceptions and adaptation to climate change, highlighting the constraints faced by married individuals compared to their single counterparts. Similar findings by Saguye [30] suggest that marital status had a marginally significant negative impact on farmers' perceptions of climate change adaptation strategies implying that marriage may lessen farmers' perceptions of the need to adapt to climate change.

4.1.2. Employment Status of Small-Scale Maize Farmers

The employment status of small-scale maize farmers is statistically significant at the 5% level (p = 0.017), with a negative coefficient (B = −2.364). This indicates that being unemployed significantly reduces the likelihood of perceiving the essence of the application of climate change adaptation strategies. The odds ratio (Exp(B) = 0.094) revealed that small-scale maize farmers in these employment categories are 90.6% less likely to have a positive perception compared to employed farmers. This is most likely because unemployment causes financial uncertainty, restricting farmers' ability to invest in and implement climate change adaptation strategies. This is consistent with the South African National Climate Change adaptation strategy's findings, which emphasise the need for stable employment conditions to foster positive perceptions and engagement with adaptation strategies. It highlights how financial constraints can impede effective adaptation efforts [31].

4.1.3. Access to Weather Forecast

Access and use of weather forecast information is an important adaptation strategy for maize farmers. Farmers that use weather forecasting information can make more informed decisions regarding planting, harvesting, and other farm management activities [2]. According to Hewitt and Moufouma-Okia [32], climate information, including observations and monitoring of the

Table 9. Model summary results.

Model Summary			
Step	−2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	103.700a	0.40	0.548

Source: SPSS and survey data (2024).

Table 10. Binary regression results on factors influencing the small-scale maize farmers perception on the application of climate change adaptation strategies.

Explanatory Variables	B	S.E.	Wald	Sig.	Exp(B)
Constant	−2.244	2.158	1.082	0.298	0.106
Age	−0.005	0.029	0.037	0.847	0.995
Gender	−0.111	0.536	0.043	0.836	0.895
Marital status	−0.863	0.458	3.551	0.06*	0.422
Household size	−0.088	0.168	0.271	0.603	0.916
Employment status	−2.364	0.987	5.736	0.017**	0.094
Level of education	−0.211	0.298	0.501	0.479	0.81
Farmer's income	0.262	0.299	0.767	0.381	1.3
Access to extension services	0.286	0.712	0.161	0.688	1.331
Farm size in hectares	−0.04	0.088	0.204	0.651	0.961
Agricultural training	0.585	0.79	0.548	0.459	1.795
Farming experience	0.378	0.253	2.226	0.136	1.459
Climate change awareness	0.751	0.785	0.915	0.339	2.12
Access to weather forecast information	3.092	1.099	7.911	0.005***	22.021
Farmers cooperatives	1.452	0.669	4.711	0.03**	0.234

Note: ***, **, * are significant levels at 1%, 5%, and 10%, respectively.
Source: SPSS and survey data (2024).

climate system, is critical for developing reliable short-term weather forecasts on daily, monthly, and seasonal timescales. The findings of the study showed that access to weather forecasts is highly significant at the 1% level (p = 0.005), with a positive coefficient (B = 3.092). This indicates that having access to weather forecasts greatly increases the likelihood of perceiving the importance of the application of climate change adaptation strategies. The odds ratio (Exp(B) = 22.021) suggests that farmers with access to weather forecasts are 22 times more likely to have a positive perception compared to those without access.

4.1.4. Access to Farmers Cooperatives

The results indicated that access to farmer cooperatives is statistically significant at the 5% level (p = 0.03), with a positive coefficient (B = 1.452). This suggests that being a member of a farmer cooperative increases the likelihood of perceiving the application of climate change adaptation strategies. The odds ratio (Exp(B) = 4.27) revealed that cooperative members are 4.27 times more likely to have a positive perception compared to non-members. Access to farmers' cooperatives is critical for small-scale maize farmers because they provide a forum for sharing resources, support, and information on climate change adaptation strategies. Cooperatives' shared resources and collective efforts can create an understanding of urgency and raise perception about individual adaptation actions. These findings are consistent with previous research [33], which suggests that cooperative membership improves access to information and resources for adaptation, emphasising cooperatives' role in fostering climate adaptation among farmers [34].

4.2. Insignificant Variables

The binary logistic regression model results demonstrate that various explanatory variables were found to have no significant influence on small-scale maize farmers' perceptions of the application of climate change adaptation strategies. These insignificant variables include age, gender, household size, education level, farmer income, access to extension services, farm size in hectares, agricultural training, farming experience, and climate change awareness. Although these variables were not statistically significant, that does not make them irrelevant. Rather, this study provides little evidence to substantiate their impact on farmers' perception of the application of climate change adaptation strategies in the Greater Giyani Local Municipality.

5. Conclusions and Recommendations

The study hypothesized that maize farmers have a negative perception towards the application of the climate-smart approach, and socio-economic factors do not influence the perception of small-scale maize farmers on the application of climate change adaptation strategies in the Greater Giyani Local Municipality, Limpopo Province. The study rejected this hypothesis and concluded that socio-economic factors influence the perception of small-scale maize farmers on the application of climate change strategies in the study area. Furthermore, the study revealed that the majority of the farmers in the study area had a positive perception of the application of climate change strategies Therefore, to increase the effectiveness of weather forecast information, expenditures should be made to improve the accessibility of locally relevant weather information. Furthermore, training programs should be created to teach farmers how to evaluate and apply weather forecasts to make informed farming decisions, such as planting and harvesting times.

Author Contributions

The authors' contributions for this research article are as follows: Conceptualization: M.N.D., L.L.J., M.J.P.; Methodology: M.J.P. and M.N.D.; Software: M.N.D. and M.J.P.; Validation: L.L.J., M.J.P., and M.N.D.; Formal Analysis: M.N.D.; Investigation: M.N.D.; Resources: L.L.J.; Data Curation: M.N.D.; Writing Original Draft Preparation: M.N.D.; Writing Review and Editing: L.L.J. and M.J.P.; Visualization: M.N.D.; Supervision: L.L.J. and M.J.P.; Project Administration: L.L.J.; All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted received ethical approval from the Turfloop Research Ethics Committee (TREC) at the University of Limpopo (protocol code TREC/1636/2023, approved on 31 October 2023).

Informed Consent Statement

Informed consent was obtained from all participants involved in the study, and written consent has been secured before data collection. The study adhered to the principles outlined in the Declaration of Helsinki and received ethical approval from the Turfloop Research Ethics Committee (TREC) at the University of Limpopo, under protocol code TREC/1636/2023, which was approved on 31 October 2023.

Data Availability Statement

The data collected for this study were primary, obtained through face-to-face interviews with small-scale maize farmers in ward 27 of the Greater Giyani Municipality, Limpopo, South Africa. The data was subsequently cleaned and analyzed using SPSS. While we encourage data sharing to promote transparency and further research, it is important to note that, due to the agreement made with participants regarding confidentiality, we cannot share identifiable data with third parties. Therefore, no new datasets are publicly available from this study.

Conflicts of Interest

The authors declare no conflict of interest.

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