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INFLUENCE OF CLIMATE CHANGE KNOWLEDGE ON SELECTION OF INDIGENOUS ADAPTIVE STRATEGIES AMONG CASH CROP FARMERS

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Abstract. Climate change continues to threaten humanity's livelihoods, particularly those dependent on agriculture. Gradual changes in climate pose a significant threat to food security and sustainable agricultural productivity around the globe. This paper sought to investigate the influence of climate change knowledge on the selection of indigenous climate change adaptive strategies. The study was conducted in Vhembe district of Limpopo province, South Africa, in 2021. Structured questionnaires were administered to 300 emerging cash crop farmers during face-to-face interviews. Descriptive statistics were used to gain insight into the farmers' knowledge of climate change. A multinomial logistic model was used to determine the influence of climate change knowledge on the selection of indigenous adaptation strategies. The study discovered that most farmers were aware of climate change and subsequently preferred crop diversification and substitution of crops as their ideal adaptation strategies. This study recommends that adaptation to climate change should be a collaborative effort among the farming community.

Keywords: climate change, emerging farmers, adaptive strategies, knowledge

INTRODUCTION

Climate change has been known about for some time now, with global awareness of it varying with time. Studies have suggested that understanding of climate change in developing countries has been relatively low compared to other nations, with African countries rated as having the least knowledge (Jha and Gupta, 2016; Pelham, 2009). Although knowledge of climate change in Africa is still relatively low, its vulnerability to climate change is severe (IPCC, 2007). In Africa, farmers' knowledge about climate change has been gained through tragic experiences, including crop failures, reduced agricultural productivity, and disease outbreaks (Zoellick, 2009). The latter statement is supported by the findings of IFAD (2010), which noted that an increase in the awareness of climate change in grassroots communities has occurred through an inability to avoid its impacts. A study by Friis-Hansen et al. (2013) revealed that one of the most effective mechanisms to continuously improve adaptations to climate change among farmers is the promotion of awareness. Farmers' awareness of climate change and its impacts has continuously been noted as a decisive factor in the enhanced effort to combat the impacts of climate change within the agricultural community (Below et al., 2015).

It has been highlighted that farmers' awareness of climate change affects their efforts to adapt to and mitigate the impacts of climate change, ensuring food security and agricultural sustainability in the face of climate change (Comoé and Siegrist, 2015). Furthermore, it has been revealed that awareness of climate change shapes a country's capacity to adapt and mitigate the impacts of climate change that threatens the livelihoods of millions, particularly those dependent on agriculture (IPCC,

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2011). This finding is supported by a study conducted by Sarkar and Padaria (2016) which pointed out that the level of adaptation to climate change is associated with the level of awareness of climate change. A similar study on climate change adaptation among farmers has revealed that farmers with knowledge about climate change are in a better position to adopt climate change adaptive strategies than their counterparts (Asrat and Simane, 2018). Farmers' adaptation to climate change is sharpened by their awareness and experience of the impacts of climate change as it enables them to familiarize themselves with relevant adaptive strategies suitable for their operations (Shisanya and Mafongoya, 2016).

Farmers' knowledge and perceptions about climate change have been revealed to play a vital role in the adaptation process. This is because it allows them to identify their needs and plan future events aimed at adapting and mitigating the impacts of climate change (Tambo and Tahirou, 2013). Farmers' knowledge about climate change varies between groups of farmers, with some being aware of climate change through tragic experiences. In contrast, others are familiar with their observation of critical determinants (Mehar et al., 2016). It was also revealed in a study by Jha and Gupta (2016) that farmers who had experienced the impacts of climate change adapted to climate change more than their counterparts. In contrast, it has also been discovered that farmers who have noted some critical determinants of climate change are more eager to adapt to climate change than those who do not know about climate change (Mehar et al., 2016). Some farmers have initiated some adaptation and mitigation efforts in response to the observation of warmer winters and hotter summers (Shukla et al., 2019). A study conducted in South Africa has noted that farmers were obliged to adjust their farming practices to effectively respond to the climatic changes observed in recent years (Mpandeli et al., 2015).

MATERIALS AND METHODS

Study area

The study was conducted in Vhembe District, one of the five districts of Limpopo province, South Africa. Vhembe district has four local municipalities: Thulamela, Makhado, Musina, and Collins Chabane, and it covers about 25,597km^2 with a population estimate of about 1 393 949 people (STATSSA, 2016). Being part of Limpopo province, Vhembe district is one of the country's prime agricultural regions, well-known for its livestock production, fruits, vegetables, cereals, and tea (LTA, 2014).

Sampling technique and data collection

The study used a multistage, stratified random sampling technique. Firstly, farmers were classified by their local municipalities. A sample was then randomly selected from the three local strata. In each chosen municipality, several villages were selected randomly. Lastly, the study used a random selection of farmers in each village. The final sample comprised 300 emerging crop farmers. A structured questionnaire served as a data collection tool. Face-to-face interviews were held with respondents; structured questionnaires were administered to the respondents during interviews. A face-to-face interview minimizes errors and misunderstandings (Bless and Smith, 2000).

Empirical model

Table 1 below shows the explanatory variables for the empirical multinomial logit model of the influence of climate knowledge on the likelihood of the selection of adaptation strategies. Multinomial logistic regression is a simple extension of binary logistic regression that allows for more than two categories of the dependent variable (Starkweather and Moske, 2011). As is the case in this study, the multinomial logistic method was considered due to its ability to produce robust results on an ordinal and nominal scale of data. Furthermore, the model was also used elsewhere and produced robust results in studies to analyze the selection of adaptive strategies (Pundo and Fraser, 2006; Hassan and Nhemachena, 2008). Lastly, the multinomial logistic model was preferred as it permits the analysis of assessments across more than two categories, allowing selection probabilities to be determined for different categories (Wooldridge, 2002). Therefore, the empirical multinomial logistic model was specified as:

$$Y_i = f(X_1, X_2..., X_6)$$

where Y_i is the polychotomous dependent variable, and it is, therefore, the adaptation strategy chosen by the farmer. (Y_i) is defined as 0 for Resilient crop varieties, Calendar redefinition = 1, Crop diversification = 2, Substitution of crops = 3, and Fertilizer application = 4, while the explanatory variables are denoted by X_s, as shown in the table below. In the analysis, the base category is crop rotation pattern.

Table 1. Description of explanatory variables used in the regression model

Variable	Name description	Type of measure	Expected sign
X_1	Climate change awareness	0 = yes, 1 = doesn't know, 2 = not sure	+
X_2	Is climate change a threat?	dummy; 0 = yes, 1 = no	–/+
X_3	Can we tackle climate change?	dummy; 0 = yes, 1 = no	+
X_4	Access to weather information	dummy; 0 = yes, 1 = no	+
X_5	Source of weather information	0 = radio stations, 1 = newspapers, 2 = television, 3 = extension officers, 4 = others	–/+
X_6	Familiar with impacts of climate change?	dummy; 0 = yes, 1 = no	+
X_7	Temperature patterns	0 = temp. have increased, 1= temp. have decreased, 2 = temp. are still the same, 3= no observations	+
X_8	Rainfall pattern	0 = rain have increased, 1 = rain have decreased, 2 = rain are still the same, 3 = no observations	+
X_9	Drought occurrence	0 = occurs regularly, 1 = rarely occur, 2 = no observations	+
X_{10}	Flood occurrence	0 = occurs regularly, 1 = rarely occur, 2 = no observations	+

Source: author's computation, 2022.

RESULTS AND DISCUSSION

Socioeconomic characteristics of farmers

The results from Table 2 show that the study sample had more female farmers involved in cash crop farming, accounting for 57.7%. In terms of marital status, the dominant group was married farmers. The results further revealed that the dominant age group of farmers in the study sample was 60 years and above, while those within

Table 2. Distribution of respondents according to their socioeconomic characteristics

Variables	Frequency	Percentage
1	2	3
Age		
21–39 years	90	30
40–59 years	92	30.7
60 and above years	118	39.3
Agric. qualification		
in possession	73	24.3
doesn't have	227	75.7
Formal education		
no formal education	133	44.3
primary education	39	13
secondary education	59	19.7
tertiary education	69	23
Farming experience		
less than a year	37	12.3
1–5 years	77	25.7
6–10 years	49	16.3
more than 10 years	137	45.7
Occupation		
farming	122	40.7
unemployed	53	17.7
employed	41	13.7
pensioner	58	19.3
self-employed	26	8.6

Source: field data, 2021.

the age groups of 21–39 and 40–59 were similar as they accounted for 30% and 30.9% respectively. Most of the farmers – about 75.7% – in the study sample were found not to have any agricultural qualifications, while the minority had agricultural qualifications, including some with a certificate in plant production. When it comes to formal education, the dominant group was farmers without any formal qualifications. The results also revealed that farmers with tertiary and secondary school qualifications accounted for 23% and 19.7%, respectively. In terms of farming experience, the study sample was dominated by farmers with more than ten years in farming. The amount of farming experience could also be influenced by the age group factor, as most were 60 years and above. The following group in the rankings were farmers with farming experience of up to five years. Regarding farmers' occupation, most indicated farming as their primary means of earning a living, while those who were farming and still employed elsewhere accounted for only 13.7%.

Awareness of climate change among farmers

Figure 1 shows information about the awareness of climate change among emerging cash crop farmers during the data collection period.

Most farmers (74.3%) in the study area indicated that they were familiar with climate change. The middle group of farmers were not sure about their knowledge of climate change, which accounted for 15.7%. Farmers who indicated that they were not sure about climate change accounted for 10%; these are farmers who didn't show a clear, distinct difference of either being aware or entirely unaware of climate change. The study's results add to the recent common trend of most farmers in various parts of the globe being aware of climate change. Abid et al. (2015) also discovered that farmers are aware of climate change worldwide. Subsequently, they adopt adaptive strategies to adjust their farming practices to respond to such observed climatic changes. Das and Ghosh (2020) also noted similar results that most farmers were aware of climate change issues.

Familiarity with the impacts of climate change on agriculture among farmers

For a distinct conclusion about farmers' awareness of climate change, the study discovered that farmers who indicated that they are familiar with the impacts of climate change accounted for 78.6% of the group, as shown in Fig. 2.

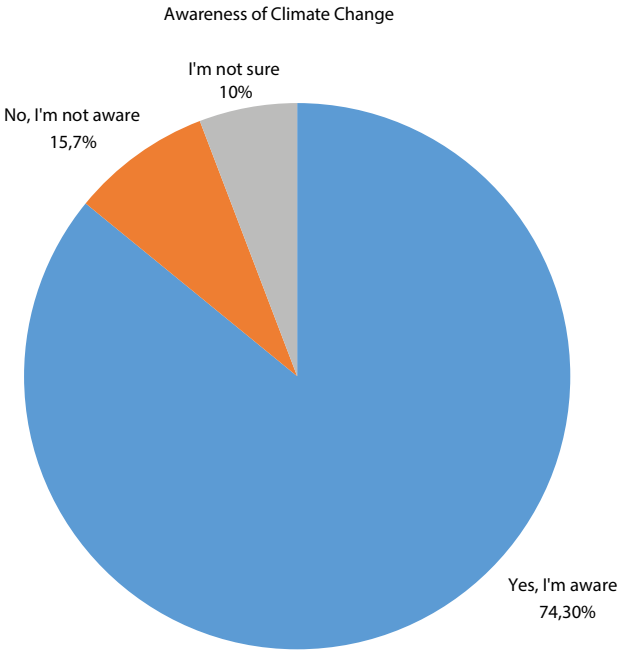

Fig. 1. Distribution of climate change knowledge among farmers
Source: field data, 2021.

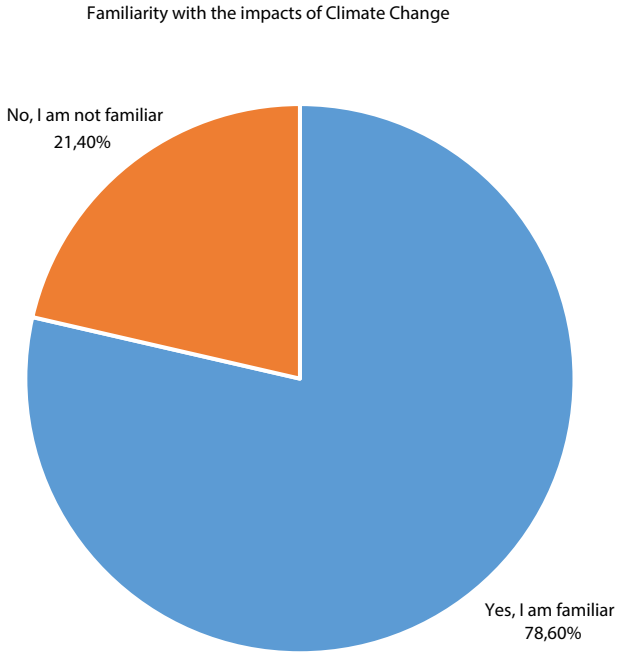

Fig. 2. Farmers' awareness of the impacts of climate change
Source: field data, 2021.

In comparison, those unfamiliar with such impacts accounted for 21.4%. The margin between the two groups is high, particularly for farmers within the same geographical area. The most common identified impacts of climate change among the farmers were a decline in agricultural productivity, less desirable produce, marketing difficulties, loss of farm income, and increased production costs. Studies like this have also noted that farmers are aware of the impacts of climate change, including a decrease in agricultural productivity, poor quality of products, and increased food insecurity (Mulinde et al., 2019; Shukla et al., 2019).

Selection of climate change adaptive strategies among farmers

The study also assessed farmers' selection of adaptive strategies to adapt to climate change and mitigate its impacts on their farms. With the respondents of the study situated in remote areas where the adoption of agricultural technologies is relatively low due to lack of resources, the study focused on traditional climate change adaptation strategies, namely, resilient crop varieties, calendar redefinition, crop diversification, fertilizer application, the substitution of crops, and changing crop rotation patterns. Figure 3 shows the percentages of each identified adaptive strategy that would stand a chance of being selected from the pool.

The study results revealed that crop diversification is the most selected strategy, accounting for 33.5% of those chosen. Crop diversification is a well-known strategy among farmers, particularly for its cost-friendly nature and ability to generate income from multiple enterprises within the same farm unit. Substitution of crops came second, which is influenced by the cost implications associated with its adoption. 27.6% of the farmers chose substitution of crops. The selection of calendar redefinition was also among the first three strategies that received preference, at 12.6%. Calendar redefinition is one of the most cost-friendly adaptive strategies as elderly farmers mainly depend on observing climate variability to determine how best to adjust their planting dates. The least selected adaptive strategy among the farmers was resilient crop varieties, at 4.9%. Crops resistant to harsh conditions, such as prolonged drought, are costly, making it difficult for farmers with fewer resources to use for adaptation. The least selected adaptive strategies were changing crop rotation patterns and fertilizer application. Some farmers deem the costs of fertilizers to be high, while when it comes to changing crop rotation patterns, its selection is associated with an increased workload.

Influence of climate change knowledge on selection of adaptive strategies

Table 3 below shows the result of farmers' decision to select indigenous adaptive strategies influenced by their knowledge of climate change.

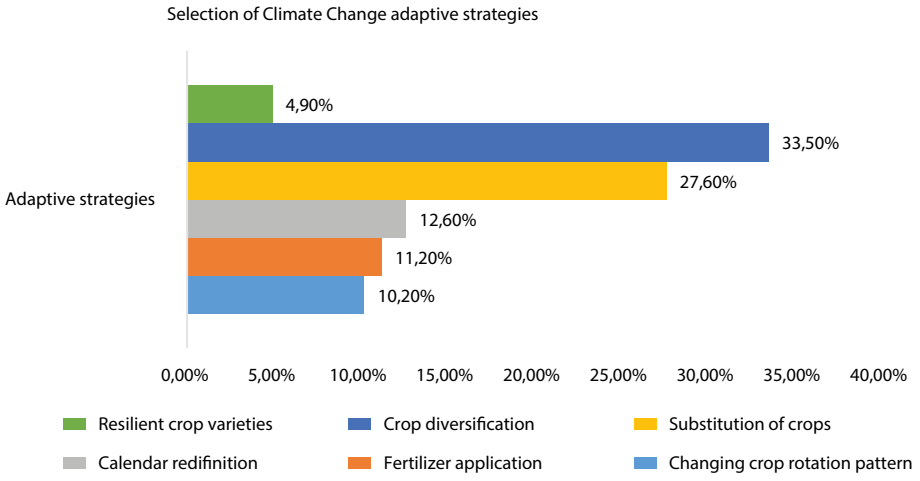

Fig. 3. Farmers' selection of climate change adaptive strategies
Source: field data, 2021.

Table 3. Parameter estimates of the multinomial logit climate change adaptation model

Explanatory variable	Resilient crop varieties		Calendar redefinition		Crop diversification		Substitution of crops		Fertilizer application	
	coeff.	P-level	coeff.	P-level	coeff.	P-level	coeff.	P-level	coeff.	P-level
X_1	.556	.009***	1.019	.007	.383	.033**	–.688	.275	–.093	.893
X_2	.311	.635	.903	.092*	.178	.010**	–.215	.795	.230	.798
X_3	1.601	.005***	.756	.628	–1.380	.003***	–1.263	.050**	–1.422	.421
X_4	1.060	.233	–1.312	1.399	–.171	.254	–.442	.586	.711	.421
X_5	–.029	.114	–.236	1.211	–.451	.002***	–.160	.428	–.211	.390
X_6	1.322	.219	.898	.319	.286	.232	.979	.037**	.070	.938
X_7	–1.472	.016**	.434	.039**	.703	.009***	–.599	.111	–.280	.504
X_8	–1.062	.334	.690	.067*	.214	.948	.554	.313	–.505	.043**
X_9	.308	.011	.400	.547	–.006	.258	.080	.820	.435	.282
X_{10}	.955	.194	.564	.269	.635	.387	.757	.150	.005	.994
Constant	–.569	.783	.111	.938	1.149	.328	.152	.902	.892	.508
Diagnostics										
base category	changing crop rotation patterns									
number of observations	300									
LR chi-square	271.362									
–2 Log likelihood	408.021									
Pseudo-R2	.197									

coeff. – coefficients.
***, **, *Significant at 1%, 5%, and 10% probability level, respectively.
Source: field data, 2021.

Resilient crop varieties

The study results show that the selection of resilient crop varieties is significantly influenced by farmers' awareness of climate change (X_1), their view that we can tackle climate change (X_3), and farmers' observation of temperature patterns over time (X_7). Farmers' awareness of climate change and their positive belief that it can be tackled using different strategies significantly influences the use of resilient crop varieties at a 1% significance level, at P-values of 0.09 and 0.05 respectively. Farmers in remote areas prefer crop varieties as some are more resilient to climatic conditions than others, mostly drought tolerant varieties. Most farmers within the study sample believed that the annual temperature has been on the rise over the last couple of years. Their adoption of resilient crop varieties supports this notion. The study's findings align with that of Acevedo et al. (2020), who found that the resilient crop varieties strategy helps farmers to adapt to drought and heat. Farmers who have noted a gradual increase in the temperature patterns have opted to use resilient crop varieties as their climate change adaptation strategy at 5% significance level. A study by Ali and Erenstein (2017) concluded that most younger farmers are likely to adopt resilient crop varieties due to their innovative nature, which agrees with the findings of this elderly-dominated farmers study.

Calendar redefinition

Farmers who adopted calendar redefinition as their adaptation strategy were those who perceived climate change as a threat (X_2) and who had observed changes in both temperature (X_7) and rainfall patterns (X_8). Farmers

who perceived climate change as a threat saw a need to change their planting dates to combat the impact of climate change on their enterprises. A study that assessed farmers' adaptation to climate change by Ali and Erenstein (2017) discovered that farmers were likely to adopt calendar redefinition and substitution of crops after noting changes in weather patterns. Furthermore, the study revealed that farmers who perceive climate change as a threat to farming have experienced reduced productivity and livestock loss due to extreme temperatures and reduced rainfall. The study also showed that farmers who have observed an increase in annual temperatures have opted to use calendar redefinition as their strategy. The same applies to farmers who have observed declining yearly rainfall patterns. Ultimately, farmers change their planting dates to adjust to the current climatic conditions and to suit their produce.

Crop diversification

The study's results show that various factors influence the adoption of crop diversification, such as awareness of climate change, climate change threat to farming, farmers' belief that they can tackle climate change, and observation of temperature changes over time. Understanding climate change has positively and significantly influenced farmers to adopt crop diversification. These farmers believed climate change was a threat and thought it could be tackled, particularly by adopting crop diversification. The findings are also consistent with the results of a study by Piedra-Bonilla et al. (2020), who noted that farmers use crop diversification as an effective means to cope with climatic shocks. The study results reveal that changing the source of weather-related information from radio stations to another platform negatively impacts the selection of crop diversification as an ideal strategy. Furthermore, the study results show that farmers who have observed an annual increase in temperature opt to adopt crop diversification as their adaptation strategy.

Substitution of crops

Substitution of crops is commonly practiced to retain nutrients in the ground as it significantly influences the quality of the produce planted. The study's findings reveal that farmers who opted for crop substitution believed they could not tackle climate change at a 5% level of significance. Furthermore, the study also indicates that farmers familiar with climate change's impacts also opted for substituting crops as their adaptation strategy. Contrary to the literature, the study's findings suggest that when farmers do not perceive that they can tackle climate change, it reduces the chance of them selecting substitution of crops as a strategy by 1.2 units, as shown in Table 3. Regarding farmers' familiarity with the impacts of climate change, the study reveals that such understanding positively and significantly influences farmers to select substitution of crops as their ideal adaptation strategy. A survey by Cui (2020) has indicated that climate-driven crop substitution has played an imperative role in the production expansion of some crops.

Fertilizer application

The study results revealed the application of fertilizers to be statistically significant at a 5% significance level, at a P-value of 0.43. Furthermore, the study noted that farmers who had opted to use fertilizers to enhance their productivity in the face of climate change were those who had observed a shift in rainfall patterns over time (X_8). It is essential to ensure that there is water, or that the soil has moisture before applying fertilizers to the crops. This theory could explain why the observation of rainfall patterns significantly influences the application of fertilizer. Since it is best to wait after rain before applying fertilizer, observation of rainfall patterns becomes critical when applying it. Diallo et al. (2020) also noted that farmers who had observed the critical determinants of climate change applied fertilizer as their adaptive strategy to mitigate the impact of climate change.

CONCLUSION

Agricultural production depends on the climate, making climate change a critical component of its performance. Observing climatic changes over time is essential for proper planning and informed decisions among agricultural stakeholders. This study investigated the awareness of climate change among emerging cash crop farmers. The study revealed that most farmers in the study sample were aware of climate change. The study's results uncovered that, due to the cost-friendly nature of specific adaptive strategies and the workload required to implement them, most farmers in the sample study preferred crop diversification and substitution of crops as their coping strategies, respectively. Using resilient crop

varieties and applying fertilizers were the least preferred due to their cost implications.

In contrast, farmers preferred not to adopt crop rotation due to the workload associated with it. The discovery of this study that most farmers are familiar with climate change points out the existing gap in some farmers' knowledge of climate change. These findings further indicate the importance of the constant dissemination of information on climate change in various areas. The study also recommends that farmers and other key role-players within the agricultural community be educated on issues relating to climate change as it is deemed the most effective tool to prepare farmers for climate change adaptation. The fact that some farmers prefer to implement some adaptive strategies due to their costs points out the need to adapt to climate change being a collaborative effort, with different kinds of support for grassroots communities being essential. Stakeholders should utilize various mechanisms to support farmers in adapting to climate change. The study also recommends that climate finance mechanisms be localized to respond to the specific dynamics of each group of farmers to avoid a one-fits-all model.

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REFERENCES

Abid, M., Scheffran, J., Schneider, U.A., Ashfaq, M., (2015). Farmers' perceptions of and adaptation strategies to climate change and their determinants: the case of Punjab province, Pakistan. Earth Syst. Dyn., 6(1), 225–243. https://doi.org/10.5194/esd-6-225-2015

Acevedo, M., Pixley, K., Zinyengere, N., Meng, S., Tufan, H., Cichy, K., Bizikova, L., Isaacs, K., Ghezzi-Kopel, K., Porciello, J. (2020). A scoping review of adoption of climate-resilient crops by small-scale producers in low-and middle-income countries. Nat. Plant., 6(10), 1231–1241. https://doi.org/10.1038/s41477-020-00783-z

Ali, A., Erenstein, O. (2017). Assessing farmer use of climate change adaptation practices and impacts on food security and poverty in Pakistan. Clim. Risk Manag., 16, 183–194. https://doi.org/10.1016/j.crm.2016.12.001

Asrat, P., Simane, B. (2018). Farmers' perception of climate change and adaptation strategies in the Dabus watershed, North-West Ethiopia. Ecol. Proces., 7(1), 7. https://doi.org/10.1186/s13717-018-0118-8

Below, T.B., Schmid, J.C., Sieber, S. (2015). Farmers' knowledge and perception of climatic risks and options for climate change adaptation: a case study from two Tanzanian villages. Reg. Env. Change, 15(7), 1169–1180. https://doi.org/10.1007/s10113-014-0620-1

Bless, C., Smith, H.C. (2000). Fundamentals of Social Research Methods: An African Experience (3rd ed.). Juta, Cape Town.

Comoé, H., Siegrist, M. (2015). Relevant drivers of farmers' decision behaviour regarding their adaptation to climate change: a case study of two regions in Côte d'Ivoire. Mitig. Adapt. Strat. Glob. Change, 20(2), 179–199. https://doi.org/10.1007/s11027-013-9486-7

Cui, X. (2020). Climate change and adaptation in agriculture: Evidence from US cropping patterns. J. Env. Econ. Manag., 101, 102306. https://doi.org/10.1016/j.jeem.2020.102306

Das, U., Ghosh, S. (2020). Factors driving farmers' knowledge on climate change in a climatically vulnerable state of India. Nat. Hazard., 102(3), 1419–1434. https://doi.org/10.1007/s11069-020-03973-2

Diallo, A., Donkor, E., Owusu, V. (2020). Climate change adaptation strategies, productivity and sustainable food security in southern Mali. Clim. Change, 159(3), 309–327. https://doi.org/10.1007/s10584-020-02684-8

Friis-Hansen, E., Bashaasha, B., Aben, C. (2013). Decentralization and implementation of climate change policy in Uganda. DIIS Working Paper No. 27.

Hassan, R., Nhemachena, C. (2008). Determinants of African farmers' strategies for adapting to climate change: Multinomial choice analysis. Afr. J. Agric. Res. Econ., 2(1).

IFAD (2010). Livestock and climate change. IFAD publishers, Rome.

IPCC (2011). Managing the risks of extreme events and disasters to advance climate change adaptation: A special report on working group I and working group II of the intergovernmental panel on climate change.

IPCC (2007). Impacts, adaptations and vulnerability. Fourth Assessment Report. Cambridge University Press, Cambridge, UK.

Jha, C.K., Gupta, V. (2016). Climate change adaptation in Indian agriculture assessing farmers' perception and adaptive choices. In: W. Leal Filho, H. Musa, G. Cavan, P. O'Hare, J. Seixas (Eds.), Climate change adaptation, resilience and hazards. Climate change management. Springer, Cham. https://doi.org/10.1007/978-3-319-39880-8_17

LTA (Limpopo Travel Agency) (2014). Retrieved June 4th 2022 from: http://www.golimpopo.com

Mehar, M., Mittal, S., Prasad, N. (2016). Farmers coping strategies for climate shock: Is it differentiated by gender? J. Rural Stud., 44, 123–131. https://doi.org/10.1016/j.jrurstud.2016.01.001

Mpandeli, S., Nesamvuni, E., Maponya, P. (2015). Adapting to the impacts of drought by smallholder farmers in Sekhukhune district in Limpopo province, South Africa. J. Agric. Sci., 7(2), 115. https://doi.org/10.5539/jas.v7n2p115

Mulinde, C., Majaliwa, J.G.M., Twinomuhangi, R., Mfitumukiza, D., Komutunga, E., Ampaire, E., Asiimwe, J., Van Asten, P., Jassogne, L. (2019). Perceived climate risks and adaptation drivers in diverse coffee landscapes of Uganda. NJAS-Wageningen. J. Life Sci., 88, 31–44. https://doi.org/10.1016/j.njas.2018.12.002

Pelham, B. (2009). Awareness, opinions about global warming vary worldwide. From publication of Gallup word, 1–2.

Piedra-Bonilla, E.B., da Cunha, D.A., Braga, M.J. (2020). Climate variability and crop diversification in Brazil: An ordered probit analysis. J. Clean. Prod., 256, 120252. https://doi.org/10.1016/j.jclepro.2020.120252

Pundo, M.O., Fraser, G.C. (2006). Multinomial logit analysis of household cooking fuel choice in rural Kenya: The case of Kisumu district. Agrekon, 45(1), 24–37.

Sarkar, S., Padaria, R.N. (2016). Farmers' awareness and risk perception about climate change in coastal ecosystem of West Bengal. Indian Res. J. Exten. Edu., 10(2), 32–38.

Shisanya, S., Mafongoya, P. (2016). Adaptation to climate change and the impacts on household food security among rural farmers in uMzinyathi District of Kwazulu-Natal, South Africa. Food Sec., 8, 597–608. https://doi.org/10.1007/s12571-016-0569-7

Shukla, R., Agarwal, A., Sachdeva, K., Kurths, J., Joshi, P.K. (2019). Climate change perception: an analysis of climate change and risk perceptions among farmer types of Indian Western Himalayas. Clim. Change, 152(1), 103–119. https://doi.org/10.1007/s10584-018-2314-z

Starkweather, J., Moske, A.K. (2011). Multinomial logistic regression Lecture notes.

STATSSA (Statistics South Africa). (2016). First quarter publication. Retrieved Jun 4th 2022 from: https://www.statssa.gov.za

Tambo, J.A., Tahirou, A. (2013). Smallholder farmers' perceptions of and adaptations to climate change in the Nigerian savanna. Env. Change, 13, 375–388. https://doi.org/10.1007/s10113-012-0351-0

Wooldridge, J.M. (2002). Econometric analysis of cross section and panel data. MIT press: Cambridge, MA.

Wooldridge, J.M. (2010). Econometric analysis of cross section and panel data. MIT press.

Zoellick, R.B. (2009). A Climate Smart Future. The Nation Newspapers. Vintage Press Limited, Lagos, Nigeria.