Impact of Climate change adaptation strategies on Net farm income of Smallholder maize farmers in South Africa

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Introduction

- Constantly rising temperatures have negatively affected agricultural activities in Southern African Development Communities (SADC), while perpetual rainfall has resulted in the flooding of both land surfaces and water bodies (Omotoso et al., 2023; Acharyya, 2020).
- Regrettably, South Africa is among the most environmentally challenged countries in the SADC region (Akanbi et al., 2021).
- Because a large proportion of the country is semi-arid and experiences a low average rainfall (464mm) relative to the world average of 990mm, the predicted variations in precipitation are expected to have adverse effects on South Africa's food production (Akano et al., 2023)
- Therefore, it is imperative to analyze the complementary relationships among the adopted CCAS, namely, those factors influencing the intensity at which they are adopted, as well as the productivity levels of the smallholder maize farmers of North West, South Africa

Materials and Method

Primary data was used for this study gathered via a field survey of smallholder maize farmers in South Africa's North-West province during the 2022 agricultural season. A multistage sampling technique was adopted in selecting 316 smallholder farmers across the four municipalities (Bojanala District, Ngaka Modiri Molema District, Dr Kenneth Kaunda District, and Dr Ruth Segomotsi Mompati District Municipality) in the province (Figure 1)

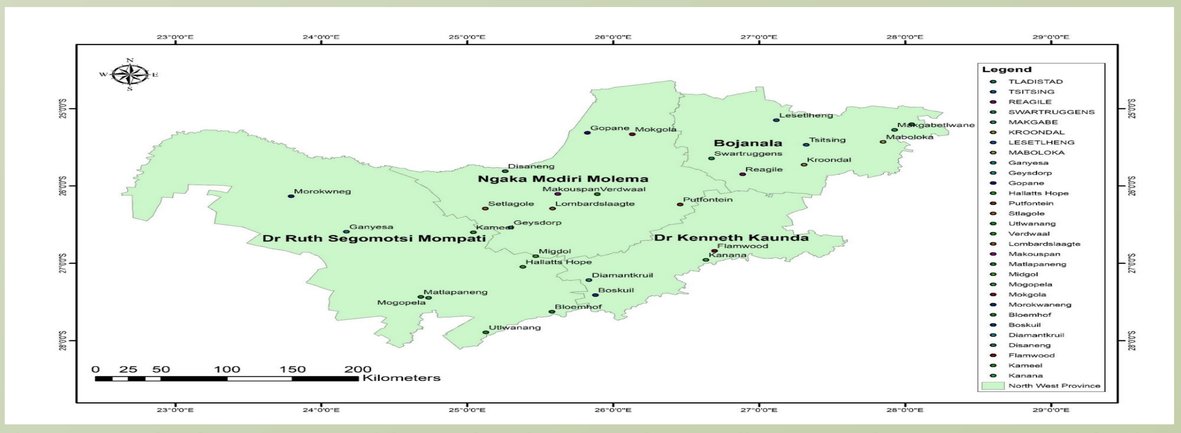

Fig. 1. Geographical representation of the 30 selected maize production villages in North West province, South Africa

Results

Table 1: Summarized statistics of variables used in the models (n = 316)

Variables	Descriptions	Mean	Std. Dev.
Dependent variables			
CCAS adoption	(1) if the household head (HH) adopted any CCAS, (0) if otherwise	0.77	0.58
Adoption intensity of CCAS	Number of CCAS adopted by the HH	6.02	3.17
Independent variables			
Gender	If HH is male=(1), if female=(0)	0.62	0.51
Age	Actual household head's age in years	44.69	15.82
Educational level	(1) formal education, (0) = non-formal	0.76	0.42
Farming experience	Years of maize farming experience	6.71	3.17
Marital status	If HH is married=(1), otherwise=(0)	0.73	0.48
Main occupation	(1) if HH's main occupation is farming, (0) if otherwise	0.84	0.35
Household size	Number of people in household	4.15	2.17
Farm size	Total land cultivated (in hectares)	3.26	1.18
Net farm income	Revenue from maize sales	5593.72	1495.34
Extension services	(1) if HH has access, (0) if otherwise	0.72	0.47
Membership of organization	(1) if HH is a member of any organization; (0) if otherwise	0.61	0.42
Credit source	(1) if HH has access, (0) if otherwise	0.68	0.56
Climate information	(1) if HH has access, (0) if otherwise	0.79	0.50

Determinants of adoption intensity of CCAS – Negative Binomial Regression

Table 2. NBRM of maize farmers' adoption intensity of CCAS in the study area

Variables	Coefficient	Robust Std. Err.	Marginal effect
Gender	-0.057***	0.021	-0.032
Age of household head	0.073***	0.018	0.093
Educational status	-1.061	0.891	-0.048
Household size	0.057	0.061	0.063
Main occupation	0.047**	0.021	0.057
Farm size	0.187**	0.093	0.053
Farming experience	0.573***	0.213	0.034
Off-farm income	0.155*	0.081	0.073
Membership of organization	-0.079	0.084	-0.108
Credit	0.137**	0.051	0.031
Extension service	0.373	0.527	0.028
Climate information	0.148***	0.036	0.025
Constant	1.531***	0.591	
Pseudo R^2	0.657		
Chi-square	129.21		
Number of observations	316		
McFadden	0.034		
AIC	1402.06		
BIC	1370.31		
Prob > chi^2	0.000		

Note: *, **, and *** denote 10%, 5%, and 1% significance level, respectively

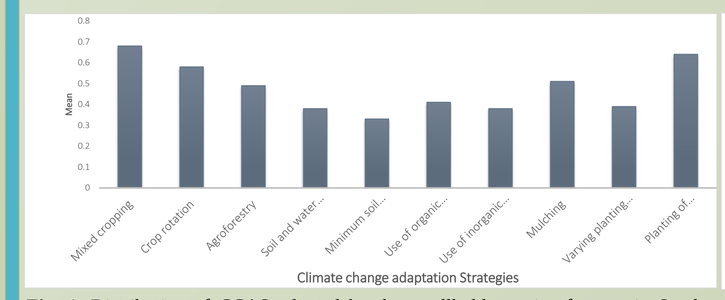

Fig. 1. Distribution of CCAS adopted by the smallholder maize farmers in South Africa

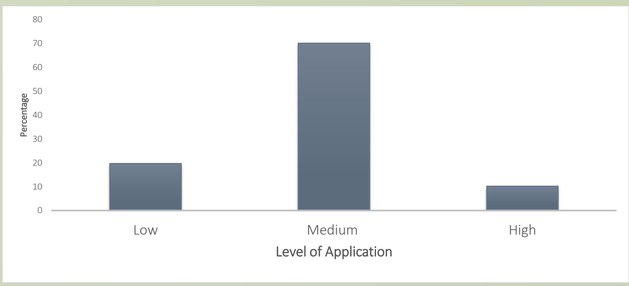

Fig. 2: Level of application of CCAS by the smallholder maize farmers in South Africa

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Table 3. Maximum likelihood estimates of Endogenous Switching Regression Model for the adoption of CCAS and the impacts of their adoption on the net incomes of smallholder maize farmers

	Adaptation		Net farm income			
			Adopters		Non-adopters	
Variables	Coef.	St.Er.	Coef.	St.Er.	Coef.	St.Er.
Gender	-0.216	0.164	-0.505	0.416	-0.604	0.713
Age of household head	0.668	0.756	0.389	0.615	0.364	0.669
Educational status	0.819**	0.402	0.890***	0.167	-0.188	0.371
Household size	-0.227*	0.101	-0.731	0.878	0.136	0.442
Marital status	-0.078	0.109	0.147**	0.065	-0.012	0.069
Main occupation	0.835	0.981	-0.150	0.261	0.170	0.233
Farm size	-0.831	0.798	0.057***	0.011	0.101***	0.023
Years of farming experience	0.538	0.904	0.062	0.120	-0.362**	0.197
Off-farm income	-0.041	0.170	-0.057	0.088	0.126*	0.071
Membership of organization	-0.409	0.391	0.312	0.289	0.377	0.483
Credit	0.667	0.545	-0.011	0.045	-0.126	0.241
Extension service	-0.515	0.976	0.041	0.059	0.070	0.092
Climate information	0.471***	0.202	-0.962	1.091	0.147	0.822
Constant	0.124***	0.017	0.578***	0.190	0.132***	0.038
rho_1	0.851***	0.105				
Log-Likelihood	27.67***					
Number of observations	316		243		73	

Note: *, **, and *** denote 10%, 5%, and 1% significance level, respectively

Discussions

- As the impacts of climate change increase over time, noticeable gaps and shortcomings were that smallholder maize farming households are being affected, resulting in low productivity, and reduced incomes.
- As a result, it is crucial to under the complementarity among the adopted adaptation strategies to climate change and their impact on the net farm income of smallholder maize farmers in South Africa is crucial.
- The result revealed that CCAS adopters are better off than non-adopters in terms of productivity and net farm income.
- On the other hand, the socioeconomic variables of the selected households and certain farm variables (farm size and farming experience) enhanced the complementarity between the adopted CCAS.
- Additionally, the age of the household head, farm size, access to credit and climate information were found to influence the adoption intensity of CCAS.

Conclusions and recommendations

- The study outcomes indicated that to achieve FAO's (2022) sustainable agricultural goals in South Africa, farmers must develop in terms of their resilience to climate change by adopting CCAS to augment their food productivity.
- In light of the study's outcome, the study recommends the government policies and investment plans should be geared to promote and enhance extension services, on-farm demonstration training, and the dissemination of CCAS knowledge, particularly directed at the country's smallholder maize farmers.
- The government and policymakers should establish alternative livelihood options (off-farm incomes) to assist smallholder farmers, particularly those with large households, to allow them to cope with the consequences of climate change and to increase productivity

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