

Socio-Economic Analysis of Smallholder Farmers' Resilience to Climate Change in Jigawa State, Nigeria.

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Abstract

Smallholder farmers play a crucial role in the nation's agricultural food production and are generally the primary groups of people vulnerable to the impacts of climate change, continuing to suffer from the unpredictable weather patterns. The study analyzes the socio-economic characteristics of smallholder farmers' resilience to climate change in Jigawa state. A multistage sampling was used to collect data for the study. Primary data was collected using a structured questionnaire and data was analyzed using descriptive statistics and stochastic frontier production function. The results shows that most smallholder farmers are married and have some level of formal education most especially the adopters. These farmers believe climate change exist which tends to destroy farm and grazing lands. Loss of some crop varieties is the most perceived indicator of climate change. The stochastic frontier production function shows that farm size has a positive and significant value which suggests increasing cultivated land area significantly increases output. The use of improve seeds is positive and significant which shows that it increases production. Adoption also is significant which shows that farmers that adopt climate resilient practices are more productive. The result for inefficiency model shows that gender and membership are negative and statistically significant which implies that these variables increase efficiency. Natural shock is negative which explains that repeated exposure can improve technical efficiency with increase support. The constraints faced by adopters and non-adopters are inadequate farm tools and in adequate capital while non-adopters face additional constraints like inadequate extension services and lack of credit facilities. The study recommends the expansion of interventions by stakeholders to cover the whole state.

Keywords: Socio-economic, Smallholder, Climate change, Resilience

Introduction

Climate is real and its consequences are being felt globally, with poor rural households in developing countries bearing the brunt of the burden (Asfaw *et al.*, 2018; Gupta *et al.*, 2019; and Omerkhi *et al.*, 2020). Agricultural production remains the main source of livelihood for most rural communities in developing countries and Sub-Saharan Africa in particular. The agricultural sector in developing countries is predominantly small-scale and are generally food insecure, resource poor, highly heterogeneous and vulnerable to climate change (Serote *et al.*, 2021). Human socioeconomic activities particularly energy use led to climate change and affect the natural environment. The impact on some economic element is expected to include a reduction in yield, decreased marginal Gross Domestic Product (GDP) contribution from agriculture, change in geographical distribution of trades regimes, increased number of people at risk of hunger, food security, migration and civil unrest (Kemausuor *et al.*, 2011). Climate change is predicted to deepen poverty both directly and indirectly. The direct impacts include; loss of life, livelihoods, assets, infrastructure, from climate extreme events. On the other hand, the indirect effects are predicated on economic growth. Continuing climate change variation is predicted to alter the sectoral origins of growth, including the ability of the poor to engage in the non-farm sector, as well as increase inequality, and therefore to reduce the elasticity of growth (ERM, 2002).

Small holder farming forms a greater majority of the farming community worldwide (IFAD, 2011). According to federal office of statistics (1999), Smallholder farmers are those whose production capacity falls between 0.1 and 4.99 hectare holding. Smallholder farmers are cultivators, mostly in rural areas of developing countries practicing sedentary, intensive and diversified agricultural activities on relatively small farms, using family labour with little or sometimes no modern inputs and the farming is mostly rain-fed (Arias *et al.*, 2013). The main aim is for household consumption but little produce can be sold to support household on other pressing needs. There are an estimated 600 million smallholder farmers working on less than 5 acres (2 hectares) of land, according to Food and Agriculture Organization (FAO, 2021). Therefore, it implies that smallholder agriculture is a life blood of around over a billion people worldwide.

The ability to recover from or mitigate vulnerability to climate related shocks such as flood and drought is generally considered as climate resilience (Grashanet *et al.*, 2021). According to (UNDP 2014), to be disaster resilient a household (or community) should be able to maintain a sufficient level of income and production above the livelihood protection threshold during both normal periods and crisis periods to meet the minimum required expenditure and consumption. Various climate resilient agricultural practices have been promoted across Northern Nigeria which includes the use of drought tolerant crop varieties, early maturing seeds, water conservation techniques, minimum tillage, crop rotation, integrated soil fertility management and improved agronomic practices (Onyeneka and Nwajiuba, 2019).

Problem Statement

Nigeria is experiencing adverse climate conditions with negative impacts on the welfare of millions of people. The dominant role of agriculture makes it obvious that even minor climate deteriorations can cause devastating socioeconomic consequences (Paehler, 2007). Drought and flood extremes feature prominently northwards of the country, affecting crops farming and harvests as well as livestock production (the feed of which are mostly crop based). Climate change poses huge challenges to food security and the livelihood security of millions. Evidence has shown that climate change has already affected crop yields in many

countries (IPCC,2007; Deressa *et al*,2008). There are observed decline in crop yield and food crop production due to reduction in rainfall, relative humidity and increase in temperature in Nigeria (Agbola and Ojeleye,2007). Recently, the northern part of the country is faced with late onset of rainy season and there is increase in intensity of rain which causes serious flooding of farm lands destroying crops and threatening the lives of these farmers. This has prompted public debate on the apparent increased frequency of extreme, and in particular, on perceived increases in rainfall intensities (Dyson,1999).

Justification

Smallholder farming is compounded by many challenges including poverty, decreasing land due to other expanding land uses and also natural risks such as soil erosion, floods, droughts, crops and animal diseases. In addition, the nature of smallholder farming makes it most vulnerable to changes and variability in the climate (IFAD, 2011). Dealing with climate change will require strengthening the resilience of farmers and rural communities to help them adapt to the impact of climate change. Adaptation to climate risks and change therefore is increasingly important in developing countries. Building up resilience to reduce climate variability is the most significant climate challenge facing all countries, including Nigeria. Countries will need to factor climate risks and climate change adaptation into their developing plan and consider the range of interventions that will increase their resilience to climate change.

Aim

The aim of this study is to analyze the socio-economic effect of smallholder farmers resilience to climate change in Jigawa state, Nigeria

Objectives:

- i. Describe the socio-economic characteristics of adopters and non-adopters of climate resilient practices among smallholder farmers in the study area,
- ii. Assess the smallholder farmers' perception on climate change among the adopters and non-adopters,
- iii. Determine the effects of climate resilient practices on productivity and technical efficiency of the smallholder farmers,
- iv. Describe the constraints faced by farmers in adopting climate resilient practices in the study area.

Materials and Methods

The study was conducted in Jigawa State, the state has an average annual rainfall of about 700mm, which is higher in the southern part of the state (JARDA, 2006). However, the climate of Jigawa state is arid to semi-arid type, characterized by a long dry season and a short-wet season. The climatic variables are erratic and vary considerably over the year. Mean annual temperature is about 25°C but mean monthly values ranges between 21°C in the coolest month and 31°C in the hottest month. However, mean daily temperature could be as low as 20°C during the months of December and January when the cold dry harmattan wind blows from the Sahara Desert, while maximum daily temperatures reach up to about 42°C between the months of March to September. Cooler temperatures as low as 10°C are recorded during harmattan season between the months of October and February especially at night times. There is also a substantial day time/night time temperature variation during this period

(JARDA, 2006). Jigawa state is considered to be agrarian as more than 90 percent of the working adults are engaged in agriculture as a means of livelihood (JARDA, 2006).

Sample Size and Sampling Technique

Multistage sampling technique was used to select small holder farmers for the study. The first stage involves purposive selection of local government areas two each per agricultural zone. The local government areas includes; Zone 1 (Dutse and Buji), Zone 2 (Garki and Taura), Zone 3 (Auyo and Guri) and Zone 4 (Gwiwa and Sule tankarkar). The second stage involves the purposive selection of two communities from each local government area selected, making a total of 8 communities selected. The third stage involves the selection of two farmer groups from the 8 communities selected making a total of 16 farmer groups. The fourth stage involves the selection of 240 adopters and 238 non-adopters using Roa-soft sampling size calculator at 95% confidence level and 5% confidence interval. A total sample size of 478 for adopters and non-adopters was used for the study.

Table 1: Sampling of Crop Farmers (Adopters)

Agricultural Zones	Local Government Areas	Communities	Sample Size
Zone 1	Dutse	Dagwaje	16
		Gandunfawa	16
	Buji	Chakwama	16
		Jajikoli	16
Zone II	Garki	Daki daka	12
		Kaya	12
	Taura	Chakwaikwaiwa	10
		Yanyanga	16
Zone III	Kafin-hausa	Gidan mata	18
		Jalori	18
	Guri	Matara babba	10
		Margadu	16
Zone IV	Gwiwa	Buntusu	16
		Darina	16
	Auyo	Gamafoi	16
		Safa	16
Total			240

Source: Field Survey, 2025

Table 2: Sampling of Crop Farmers (Non-adopters)

Agricultural zones	Local Government Areas	Communities	Sample Size
Zone 1	Dutse	Kasarau	12
		Chamo	10
	Buji	Chakwama	10
Zone II	Garki	Gwadayi	15
		Fagen Gawo	12
		Gwarzo	15
	Taura	Kayar Gazara	15
		Sabon Garinyaya	10
Zone III	Kafin-hausa	Kwatalo	18
		Kutugun	18
	Guri	Kadira	18
		Adiyani	15
		Korayalyamma	18
Zone IV	Gwiwa	ZaumaSamawa	18
		Maifaru	18
	Sule-tankarkar	Sule Arewa	16
			238
Total			238

Source: Field Survey, 2025

Model Specification

Maximum likelihood estimates of stochastic frontier production function and efficiency ratio.

The Coelli maximum likelihood of stochastic frontier production function (assumed to be of cobb-Douglas) was used. The explicit form of the model is specified as follows;

$$\ln Y_i = \alpha_0 + \alpha_1 \ln X_1 + \alpha_2 \ln X_2 + \alpha_3 \ln X_3 + \alpha_4 \ln X_4 + \alpha_5 \ln X_5 + \alpha_6 \ln X_6 + \alpha_7 \ln X_7 + V_i - U_i \quad (1)$$

Where $\ln$ represents the natural logarithm:

Y_1 = Quantity of rice or maize produced(kg)

X_1 = Farm size (hectares)

X_2 = Fertilizer (N)

X_3 = Agrochemicals (liters)

X_4 = Labour used in (man days)

X_5 = Seeds

X_6 = Extension contact

X_7 = Adoption of climate resilient practices

S = unknown scalar parameters to be estimate

The inefficiency model (U_i) is specified as follows:

$$U_i = Z_0 + Z_1 X_{1i} + Z_2 X_{2i} + Z_3 X_{3i} + Z_4 X_{4i} + Z_5 X_{5i} + Z_6 X_{6i} + Z_7 X_{7i} + Z_8 X_{8i} + Z_9 X_{9i} + Z_{10} X_{10i} e_i \quad (2)$$

Where:

Z_1 = Age(years)

Z_2 = Education (years)

Z_3 = Gender (male =1 or female =0)

Z_4 = Farming experience(years)

Z_5 = Household size (number of persons)

Z_6 = Annual farm income (N)
 Z_7 = Extension contact (number of visits)
 Z_8 = Membership of cooperative (member=1, non-member=0)
 Z_9 = Adoption (adopter=1, non-adopter=0)
 Z_{10} = Natural shocks
 e_i = The error term.

Findings: Data Presentation and Analysis

Table 3: Socioeconomic characteristics

Variable	Adopters		Non-adopters					
	Mean	Standard deviation	Min	Max	Mean	Standard deviation	Min	Max
Age	39	17.5	15	80	38	17.2	17	75
Years of experience	11	10.3	1	50	12	10.7	2	50
Number of household male	4	3.9	0	16	4	4.1	0	24
Number of household female	3	3.4	0	16	3	3.3	0	15
Number participating in production male	2	2.2	0	10	2	2.2	0	9
Number participating in production female	1	0.5	0	4	1	1	0	9

Source: Field survey, 2026

From the results presented in the table above it shows that the mean age of adopters and non-adopters was found to be 39 and 38 respectively which shows that the farmers are within their active age. The finding is consistent with the research conducted by Sennuga and Oyewole (2020) who reported a mean age of 35 years among smallholder farmers in Ogun state. These farmers have a minimum of 15 years for adopters and 17 years for non-adopters, these shows that the adopters are slightly younger when compared to the non-adopters and it's showing that program tried in including younger farmers and with a maximum of 80 years and 75 years for adopters and non-adopters, the older farmers are also not left behind.

The mean years of experience was found to be 11 and 12 years of experience and this shows that the farmers both adopters and non-adopters have some reasonable years of experience, which is similar with the findings of Abdulwahab *et al.*, 2023 who reported that maize farmers had an average farming experience of 10 years. Eventhough these farmers have a minimum of 1 and 2 years meaning there are beginners and with a maximum of 50 years shows that some of the farmers having a lot of experience. The result also shows that the mean number of household male is 4, this means that for every household for adopters and non-adopter they have an average number of four males and none in some household who have a minimum of zero since we have farmers that are single. For female in household, a mean of 3 was found and these means that in each household an average of 3 females are found. The result also shows that the number of household male participating in production are twice the number of female households.

Table 4: Sex, Marital status and educational level

Variable	Adopters Frequency	Percentage	Non-adopters Frequency	Percentage
Sex				
Male	144	54	106	50
Female	122	46	106	50
Marital status				
Single	54	20	32	15
Married	205	76	174	82
Divorced	2	1	0	0
Widowed	5	3	6	3
Educational level				
Quranic	89	34	67	32
Adult	17	6	2	1
Primary	48	18	58	27
Secondary	88	33	76	36
Tertiary	24	9	9	4
Extension Contact				
Yes	263	99	93	44
No	3	1	119	56

Source: Field survey, 2026

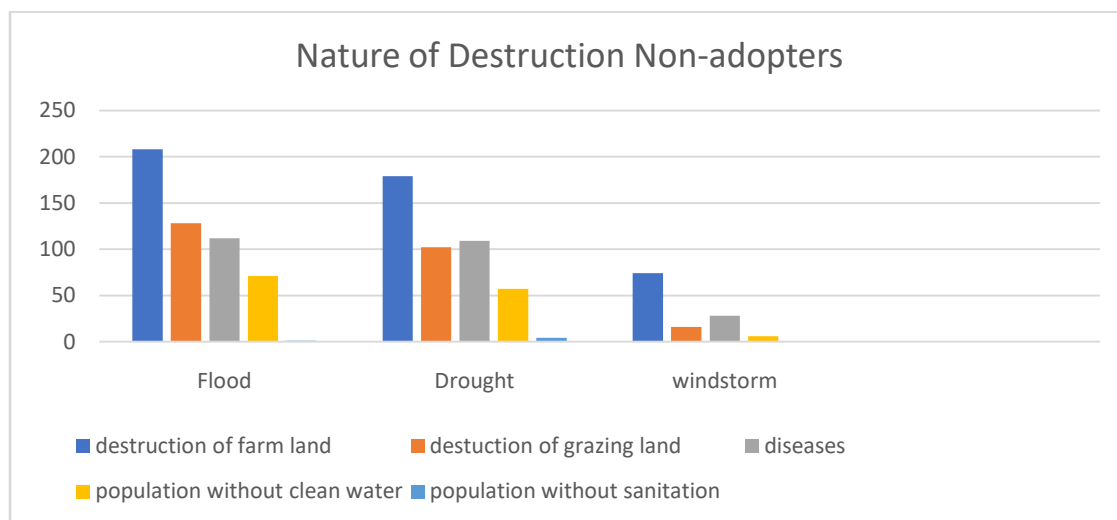
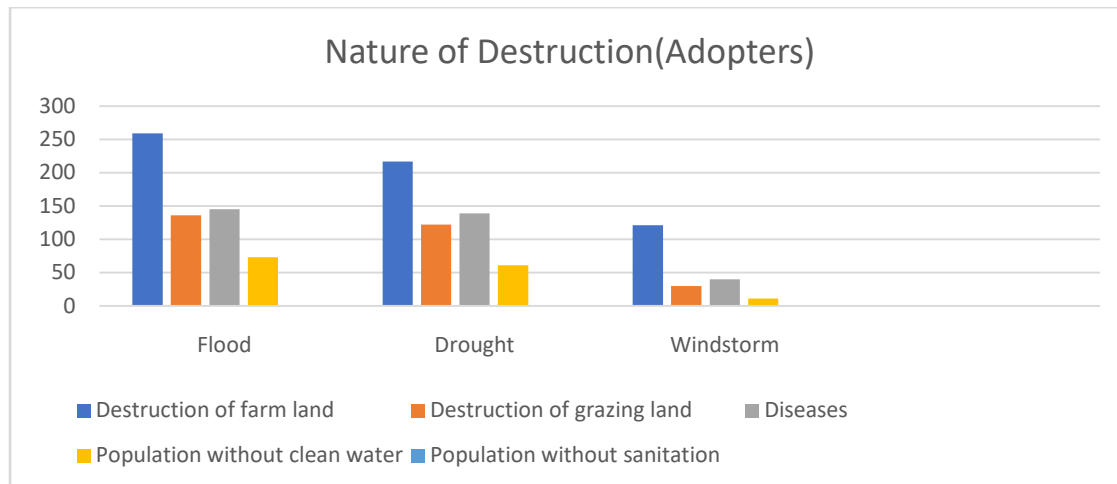
From the result presented above it shows that male adopters are more when compared to the female farmers and are similar with the findings of Ali *et al.*, 2023 who found out that rice farming is a male dominated enterprise in Jigawa state, while for non-adopters there are equal number of males and females and it shows that female farmers are actively engaged in farming which is consistent with the findings of Mohammed *et al.*, 2022 who showed the existence of significant number of women engaged in cereal production. Most of these farmers are married while some are single, divorced and widowed but for the non-adopters none of them are divorced. These show that most of these farmers have some form of responsibilities to take care of their families, Ahungwa *et al.* (2020) reported that farmers were predominantly married. From the result above it shows that farmers both adopters and non-adopters have some level of education and these could be advantageous in dissemination of technological practices easier. Adopters are more in contact with extension officers more who train them on different climate resilient practices.

Table 5: Perception of Climate Change

Variables	Adopters Frequency	Percentage	Non-adopters Frequency	Percentage
Do you believe climate change exists				
Yes	249	94	195	92
No	17	6	17	8
Reason				
Loss of some crop varieties				
Yes	215	81	172	81
No	51	19	40	19
Increased droughty conditions				
Yes	155	58	124	59
No	111	42	88	41
Irregular rainfall pattern				
Yes	163	61	133	63
No	103	39	79	37
Decline agricultural yield				
Yes	170	64	134	63
No	96	36	78	37
Decrease livestock feed				
Yes	162	61	121	57
No	104	39	91	43
Reduce water availability				
Yes	145	55	114	54
No	121	45	98	46

Source: Field survey, 2026

The result presented above shows that both adopters and non-adopters believe climate change exists but with different reasons which is also similar with the findings of Muhammad *et al.* (2024) who confirmed clear evidence of climate variability affecting rice production. They all believed that it exists because of loss of some crop varieties, some crop varieties are no more due to change in climatic conditions. Another reason is as a result of decrease in agricultural yield which could as a result of frequent occurrence of flood and drought, and its similar with the findings of Salisu (2022) which shows that climate variability and increase dry spells negatively affect agricultural production in northern Nigeria. Irregular rainfall pattern means differences in its expected pattern in timing, amount and duration which makes it difficult for farmers to know when it's the right time for planting, Oru and Adesoye, (2024) reported that climate change significantly reduces agricultural productivity through erratic rainfall, rising temperatures and extreme weather events leading to lower crop yields. Reduce water availability was the least among the reasons climate change exists.



The nature of destruction caused by flood is believed to destroy farm lands by flooding the whole farm land becoming waterlogged. It also destroys grazing land and causes diseases such as cholera as a result of these, it causes in-accessibility of clean drinking water for the population for both adopters and non-adopters and also causing people to live without sanitation.

Drought as an extreme event affects farmers adopters and non-adopters and the nature of destruction includes destroying farm land, grazing lands causing disease and leads to population living without clean water, drought is not believed to have cause people to leave without sanitation.

From the graph it shows that farmers adopters and non-adopters believed wind storm occurs and cause destruction of farm land, there is a minimal destruction of grazing land and also a cause of diseases. Wind storm from the graph shows that it is not a cause for population to leave without clean drinking water and sanitation for both adopters and non-adopters.

Table 6: Stochastic Frontier Production

Output	Coefficient	Std error	Z	P> /Z/
Constant	4.542	1.210	3.75	0.000***
Farm size	10.668	0.351	30.41	0.000***
Fertilizer	0.0067	0.008	0.86	0.389
Agrochemicals	-0.004	0.001	-2.91	0.004**
Labour	-0.000	0.000	-0.74	0.457
Seed	0.017	0.007	2.39	0.017*
Extension	0.276	0.440	0.63	0.531
Adoption of CRP	0.562	0.288	1.95	0.051*
Lambda/	0.009	1.055		
Log likelihood	-289.992			
Wald chi 2 (7)	1045.61			
Prob >chi 2	0.0000			

Source: Field survey, 2026

The highly significant Wald chi square statistics $X^2 = 1,045$ indicates that the explanatory variables jointly provide a statistically significant explanation of variations in output. The stochastic frontier production estimates revealed that farm size, seed and adoption of climate resilient practices had positive effects on agricultural output. Farm size had a positive and highly significant effect on output (10.668; $p < 0.001$, indicating the importance of land availability in enhancing production which similar with the findings of Olubunmi-Ajayi *et al.*, (2024) who reported that farm size significantly increases maize output. Use of improved seeds also had a positive and significant effect ($\beta = 0.017$; 0.017). It shows that use of improve seeds increase production. Agrochemical use had a negative and statistically significant coefficient ($\beta = -0.004$; $p = 0.004$) which may suggest inefficient or excessive application of agrochemicals among farmers which could reduce yield. Adoption of climate resilient practices had a positive coefficient ($\beta = 0.562$) and was statistically significant at 10% level ($p = 0.051$), suggesting that adoption of climate resilient practices is associated with higher agricultural output.

Table 7: Inefficiency Result

Output	Coefficient	Std error	Z	P> /Z/
Constant	2.722	1.125	2.42	0.016
Age	-0.013	0.011	-1.19	0.235
Education	-0.938	0.699	-1.34	0.180
Gender	-0.768	0.274	-2.80	0.005**
Experience	0.010	0.021	0.51	0.612
Household size	0.042	0.026	1.58	0.115
Income	0.000	4.04e-7	37.46	0.000**
Extension	0.575	0.309	1.46	0.143
Membership	-0.626	0.309	-2.02	0.043**
Adoption	0.686	0.119	5.76	0.000***
Natural shocks	-0.174	0.055	-3.14	0.002**
Lambda	0.007	0.979		
Log likelihood	-248.463			
Wald chi 2 (10)	1997.65			
Prob >chi 2	0.0000			

Source: Field survey, 2026

The results above shows that gender, income, membership, adoption of climate resilient practices and natural shocks significantly influenced production inefficiency. Gender had a negative and significant coefficient ($\beta = -0.768$, $p = 0.005$), indicating that female farmers are less likely to be technically efficient when compared with their male counterpart and its consistent with the findings of Osondu *et al.*, 2025 who found out that female farmers operated farther from the production frontier than male farmers. Income had a positive and highly significant effect on inefficiency, while membership had a negative and significant effect suggesting that membership was associated with improved production efficiency which is similar to the findings of Akinyemi *et al.*, 2025 who reported that age, formal education, cooperative and membership significantly reduced technical inefficiency among cocoa farmers. Adoption of climate resilient practices had a positive and highly significant coefficient indicating higher estimated inefficiency among adopters. Natural shocks had a negative and significant effect on inefficiency ($\beta = -0.174$, $p = 0.002$) which shows that weather anomalies can reduce inefficiency especially under certain adaptive conditions and is similar with the findings of Tol (2021).

Table 8: Constraints faced by Farmers

Constraints	Adopters	Ranking	Non-adopters	Ranking
Inadequate farm tools	Frequency/Percentage		Frequency/Percentage	
Yes	222(84)	1 st	182(86)	1 st
No	44(16)		30(14)	
Inadequate capital				
Yes	210(79)	2 nd	165(78)	2 nd
No	56(21)		47(21)	
Lack of credit facilities				
Yes	108(46)	8 th	166(78)	2 nd
No	158(54)		46(20)	
Cultural belief				
Yes	124(43)	10 th	114(42)	8 th
No	142(57)		98(58)	
Inadequate extension services				
Yes	154(54)	6 th	150(71)	3 rd
No	122(46)		62(29)	
Un-favorable climatic conditions				
Yes	148(56)	5 th	120(56)	6 th
No	118(44)		92(44)	
Lack of improved seeds				
Yes	135(51)	7 th	137(65)	4 th
No	131(49)		75(35)	
Pest and diseases				
Yes	169(64)	3 rd	137(65)	4 th
No	97(36)		75(35)	
Lack of ready market				
Yes	115(43)	9 th	93(44)	7 th
No	151(57)		116(56)	
High cost of transportation				
Yes	143(58)	4 th	118(56)	6 th
No	123(42)		94(44)	
Low selling price				
Yes	113(40)	10 th	123(58)	5 th
No	153(60)		89(42)	

Source: Field survey, 2026

The results presented in the table shows constraints encountered by small-scale farmers, adopters and non-adopters of climate resilient practices. Most farmers face problems like inadequate farm tools, pest and diseases and un-favorable climatic condition the most.

There are general problems that affects both adopters and non-adopters, which includes unfavorable climatic conditions, pest and diseases and high cost of transportation. While some problems affecting non-adopters the most happens to be the least problems in case of adopters and these includes lack of credit facilities, inadequate extension services, lack of ready markets and low selling price.

The overall results can be summarized that adopters mostly face problems of pest and diseases, unfavorable climate conditions while non-adopters mostly complain of inadequate capital and lack of credit facilities while inadequate farm tools, inadequate capital, high cost of transportation is a general problem, just like pest and diseases and unfavorable conditions.

Based on the quantitative and qualitative analysis of data collected, it can be concluded that there are frequent occurrence of flood, drought and wind storms in these areas which are noticed and felt by these farmers and is seriously affecting their livelihood. Increase farm size, adoption of climate resilient practices and use of improved seeds significantly improves farmers productivity which shows that adopters are productive when compared with their counterpart. The variables that increase technical efficiency of these farmers includes gender, membership and natural shocks which explains repeated exposure to climate change can improve technical efficiency with increased support. The constraints faced by adopters and non-adopters are inadequate farm tools and inadequate capital while non-adopters face additional constraints like inadequate extension services and lack of credit facilities.

Recommendations

The government or other stakeholders should expand interventions to cover the whole state to ensure equitable access to climate-resilient practices and training. Secondly, extension services should therefore provide continuous training on proper input utilization even after program cycles conclude, with particular emphasis on agrochemical application, to ensure that adoption translates into optimal productivity gains.

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