



EFFECTS OF LAND-BASED STRATEGIES FOR CLIMATE CHANGE MITIGATION, ADAPTATION ON MAIZE FARMER'S PRODUCTION: A STUDY OF WORLD BANK INTERVENTION IN NORTHWEST, NIGERIA

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ABSTRACT

Farmers' land-based decisions relating to climate change mitigation and adaptation depend on the major production motive: land conservation or revenue maximization. This study evaluates the effectiveness of World Bank-led land management strategies in mitigating climate change effects and enhancing adaptation among maize farmers in Northwest Nigeria. Multi-stage and purposive sampling techniques were employed; 540 maize farmers were randomly selected. The specific objectives; describe the sociocultural, determine the effects on maize farmer's production output. Results showed that the decision option of 61% of the farmers with a mean farm size of 2.54 hectares and maize value of N3,071,185.70k were classified unsustainable, while the decision option of the remaining 39.44% were classified sustainable, with a mean farm size of 1.57 hectares and maize value of N1,209,461.95k. The percentage outputs as normalized by 1.56 hectares were 0% for sustainable land-based option and 56.95% for unsustainable land-based option. The coefficients of labour (-1.147) and amount spent on manual weeding (-3.926) of the estimated SUR equations for sustainable land-based decision option were negative and statistically significant at 1% level. Thus, stakeholders in sustainable land management in collaboration with World Bank should develop simple labour-saving, sustainable motorized weeding tools to encourage sustainable land-based practices in maize farming. Considering the high value of maize generated under unsustainable land-based decision option due to inorganic fertilizer use and the need to reduce greenhouse gas emission, extension workers and stakeholders in agronomy and soil management should educate farmers on yield enhancement through appropriate and efficient use of organic manure.

Keywords: Sustainable, Mitigation, Adaptation Climate Change, Technology Adoption

INTRODUCTION

Globally, maize is a very important staple food as in Nigeria, and widely grown across all the 36 States, with an estimated 12.7 million MT produced in 2021 (FAOSTAT, 2021). Maize is a major cereal and one of the most important food crops in Nigeria (Kamara *et al.*, 2020), and a major commercial crop for livestock feed (Olasehinde *et al.*, 2023). In maize farming, shorter crop growing cycles, resulting from warmer temperatures, affects the grain filling and therefore the crop productivity due to the reduction in time for biomass accumulation and yield formation (Ciscar *et al.*, 2018). High CO₂ concentrations affect the time of flowering (Shrestha *et al.*, 2018), the protein content of C₃ cereal grains (Zhou *et al.*, 2018), the cereal grain yields (Eyshi *et al.*, 2015), and reduce the plant uptake of nitrogen (Oseni & Masarirambi, 2011).

Climate change is considered one of the most challenging global issues (Tangonyire & Akuriba, 2020) due to the increasing concentration of greenhouse gases (GHG) such as carbon dioxide (CO₂), nitrous oxide (N₂O), and methane (CH₄) (Rosegrant *et al.*, 2008) that result in changes such as rainfall disturbances (rainfall delays, early cessation, bad rainfall distribution), shortening of the small dry season, increasing temperature, sometimes violent winds and other extreme events such as floods. In Nigeria, especially the Northern part, the most devastating impacts of climate

change is frequent drought stemming from lower amount of precipitation (Amanchukwu *et al.*, 2015). Recurrent drought and erratic rainfall distribution adversely affects soil productivity and water holding capacity of the soil (Mengistu *et al.*, 2015). Farmers in this region adapt to these changes by cultivating drought-tolerant varieties and changing planting and harvesting dates (Oyerinde & Osanyande, 2010), planting trees, cultivating early-maturing crop and using improved crop varieties (Anyola *et al.*, 2013). Modifying crop calendars helps farmers to take advantage of early season moisture conditions (Yegbemey *et al.*, 2014). Adaptation to climate change is a two-stage process, and accounts for both perception and adaptation (Lokonon & Mbaye, 2018). Farm practices that contribute to climate change adaptation and mitigation in cropland include increasing soil organic matter, erosion control, improved fertilizer management, and improved crop management (Intergovernmental Panel on Climate Change (IPCC), 2014). Regrettably, many of the adaptation practices especially use of agrochemicals increases GHG emission and in turn, contribute to climate change (UNEP, 2016). The widespread overuse of synthetic nitrogen-based fertilizer, herbicides and pesticides are the major sources of GHGs from agricultural lands, and these emissions contribute to climate change and hence accelerate agricultural land degradation (Amikuzuno & Donkoh, 2012). Greater attention is being given to

alternative management models through Sustainable Land Management practices (SLM) (Branca *et al.*, 2013), and involving the physical soil conservation practices, soil fertility improvement, agro-forestry and forage development schemes, have been widely implemented (Adimassu *et al.*, 2016), while simultaneously assuring the long-term productive potential of these resources and the maintenance of their environmental functions and balanced soil organic matter (SOM)-nutrient cycle (Altieri & Nicholls, 2017; Liniger *et al.*, 2011), improve productivity under climate uncertainty (Nkonya *et al.*, 2016), enhance carbon sequestration (Khanal *et al.*, 2018), SLM practices such as cover cropping and minimum tillage effectively suppress weed growth (Price & Norsworthy, 2013). Rapid incorporation of manure into cropland reduces loss of nitrogen to the atmosphere (Woodfine, 2009). Field margins such as shelterbelts and hedges, increase carbon storage through retention of sediment from agricultural runoff (Eagle *et al.*, 2012).

The Northwest States in Nigeria have benefited from several World Bank intervention programmes, such as National Fadama Development Projects, Commercial Agricultural Development Project (CADP), and the ongoing APPEALS (Agro Processing, Productivity, Enhancement and Livelihood Support) projects. The projects provide support to small and medium scale commercial maize farmers to increase productivity through the introduction of improved technologies, creation of a conducive investment climate and provision of infrastructure in maize and other food crops (Gambo *et al.*, 2015), and sensitizing farmers to adopt climate change land-based mitigation and adaptation practices, and how best to produce under various land management options. As a result of the foregoing benefits of sustainable land management practices, this study assesses the effects of land-based decisions for climate change mitigation and adaptation of maize farmers of the World Bank intervention projects in Northwest, Nigeria. The specific objectives were to;

- i. Describe the sociocultural characteristics of maize farmers of World Bank intervention projects in the study area;
- ii. Determine the effects of land-based decision options for climate change mitigation and adaptation on maize farmer's production in the area.

MATERIALS AND METHODS

Study Area

This study was conducted in the North West States, Nigeria. North West is one of the six geopolitical zones, comprising seven (7) States, namely, Kaduna, Katsina, Sokoto, Zamfara, Kano, Jigawa and Kebbi States (NARSP, 1997); which lies between latitudes 2° and 14° N and longitudes 07° and 60° south of the Greenwich meridian, covers an area of 216,065 sq km. The major ethnic groups are the Hausa and Fulani. About 80 percent of the population are farmers, pastoralists, agro-pastoralists or small-scale entrepreneurs. The mean annual rainfall ranging from 500mm to nearly 1200mm, characterized by rainfall variability especially late onset and early cessation of rains, often resulting in shorter growing season. The mean annual temperature ranges between 17° and 38°C, although high temperatures of up to 42° occur during April/May. The North-West zone of Nigeria is the leading producer of cereals (sorghum, millet, maize), legumes, and vegetables, such as tomato, onion, and pepper (NARSP, 1997).

Sampling of Data Collection

Multi-stage and purposive sampling techniques were employed and five hundred and forty (540) maize farmers were randomly selected. The land-based mitigation and adaptation options available to the farmers were first identified, and farmers were then categorized based on their adoption decisions: sustainable land-based options (zero use of agrochemicals) and unsustainable land-based options (farmers that rely on agrochemicals). Sustainable options are those options that ensure long-term productivity potential of land, water, biodiversity and environment, while maintaining the ecosystem functions.

Method of Data Collection

A questionnaire survey instrument was used for the data collection through structured interview guides and direct administration to the maize farmers of World Bank intervention projects to facilitate novelties. Data used consists of secondary data collected based on a review of intervention received by beneficiaries in Northwestern Nigeria.

Method of Data Analytical Techniques

The data for the study were analysed using the index of land management (LMI) constructed from the total number of sustainable land management options available for each farm operation in the area. Following Kassie (2016), and Eririogu *et al.* (2019), the Land Management Index (LMI) was derived using the following:

$$L_i = \left(\sum_{i=1}^{n_j} \frac{S_i}{N} \right) \quad (1)$$

Where,

L_i = Index of land management for the i^{th} farmer.

S_i = Sustainable land management practices for climate mitigation and adaptation adopted by the i^{th} farmer.

n_j = Level of sustainable land management adopted for the j^{th} farm operation.

N = Total number of sustainable land management practices adopted for all farm operations

However, farmers' decision options were categorized based on the level of sustainable land management practices adopted, derived as:

$$D_i = \begin{cases} 0, & L_i < 0.5 + \text{Agrochemical use} \\ 1, & L_i \geq 0.5 + \text{Zero Agrochemical use} \end{cases} \quad (2)$$

In this case, $L_i < 0.50 + \text{Agrochemical use} \rightarrow 0$, is an indication that farmers in this category are mitigating and adapting to climate change by adopting unsustainable land-based option, while $L_i \geq 0.50 + \text{Zero Agrochemical use} \rightarrow 1$, is an indication that farmers in this category are mitigating and adapting to climate change using sustainable land-based option. The effects of land-based decision options for climate change mitigation and adaptation on maize production were analyzed using Seemingly Unrelated Regression (SUR) technique. The SUR equation is stated as Zellner (2006):

$$\begin{cases} Y_{i1} = X_{i1}\beta_{i1} + \varepsilon_{i1} \\ Y_{j2} = X_{j2}\beta_{j2} + \varepsilon_{j2} \end{cases} \quad (3)$$

Where,

Y_{i1} = Value of Maize output of the i^{th} farmer mitigating and adapting to climate change using sustainable land-based decision option (naira)

X_{i1} = Vector of stacked independent variables

Where,

X_1 = Farm size (hectares)

X_2 = Value of labour used (man-days).

X_3 = Farm location (dummy variable 1 = close to a river/stream/lake; otherwise = 0)

X_4 = Amount spent on organic manure (naira).

X_5 = Amount spent on land tilling (naira)
 X_6 = Value of materials used for mulching or amount spent on family/hired labour for mulching (naira)
 X_7 = Amount spent on family/hired labour to construct soil/stone bunds for erosion control (naira)
 X_8 = Amount spent on terraces/contour water harvesting/watering (naira)
 X_9 = Amount spent on family/hired labour for manual weeding
 e_{i1} = error terms
 Y_{j2} = Value of maize output of the jth farmer mitigating and adapting climate change using unsustainable land-based decision option (naira)
 X_{j2} = Vector of stacked independent variables for the jth farmer adopting unsustainable land-based decision option
 Where,
 X_1 = Farm size (hectares)
 X_2 = Value of labour used (man-days).
 X_3 = Farm location (dummy variable 1 = close to a river/stream/lake; otherwise = 0)
 X_4 = Amount spent on inorganic fertilizer (naira).
 X_5 = Amount spent on land tilling (naira)
 X_6 = Value of materials used for mulching (naira)
 X_7 = Amount spent on erosion control system (naira)
 X_8 = Amount spent on irrigation (naira)
 X_9 = Amount spent on herbicides (naira)
 e_{j2} = error terms

Test of Hypotheses

Hypothesis 1

The null hypothesis 1 was realized from the results of equation (3) using the chi-square statistics.

Hypothesis 2

The null hypothesis 2 was realized using the Z-statistics. The Z-statistics is stated as:

$$Z = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \quad (4)$$

Where,

Z = the value to be tested

\bar{X}_1 = Mean of maize output of farmers adopting sustainable land-based decision option for climate change mitigation and adaptation (naira)

\bar{X}_2 = Mean of maize output of farmers adopting unsustainable land-based decision option for climate change mitigation and adaptation (naira)

S_1^2 = Variance of maize output of farmers adopting sustainable land-based decision option for climate change mitigation and adaptation

S_2^2 = Variance of maize output of farmers adopting unsustainable land-based decision option for climate change mitigation and adaptation

n_1 = number of observations for maize farmers adopting sustainable land-based decision for climate change mitigation and adaptation

n_2 = number of observations for maize farmers adopting unsustainable land-based decision option for climate change mitigation and adaptation

RESULTS AND DISCUSSION

Sociocultural profile of maize farmers of World Bank intervention projects in the study area.

Sex, age, education, marital status, and household size of the maize farmers

The results presented in Table 1 revealed that the majority (73%) of the sampled farmers were male and major beneficiaries of World Bank intervention projects in the study area. The mean age of 49 years indicates the sampled maize farmers are within the active prime age bracket of 40 – 50 years; the majority (57%) attained secondary education in the study area. This implied that a high proportion of the maize farmers studied were in their productive and economically active age of 29-50 years, and doing well at the age bracket of 51-61 years in the study area. The study's findings are consistent with Afolabi *et al.* (2025), who argued that farmers' age and educational status are significant variables that are directly or indirectly influenced by participation in any type of intervention projects. In many intervention project studies, age and education are significant determinants in decision-making for climate change mitigation and adaptation. The implication is that the farmers who benefited from the World Bank intervention projects are undoubtedly young, highly capable individuals who possess the necessary knowledge and understanding to make informed decisions regarding the intervention to support their maize production.

The results of marital size status showed that high proportion (92%) of the maize farmers sampled were married in Northwest, Nigeria. The high percentage of married is an indication that marriage is an institution that is highly valued across the Northwest agroecological regions where the study was conducted (Kaduna, Katsina, Sokoto, Zamfara, Kano, Jigawa and Kebbi States). This finding corroborated the findings of Awoyemi and Aderinoye-Abdulwahab (2019), Ndagana *et al.* (2020), as well as Bolarin *et al.* (2022), who found that most farmers in the study area were married. This implied that the demand for labour can be the reason for the high proportion of the maize farmers' marital status in the study area. The implication is that the married would supply more labour, increase manpower, contribute more to the land-based strategies for climate change mitigation and adaptation in maize farming activities and increase their productivity.

The results of household size status revealed that above average (53%) of the maize farmers in the study area had a household size of 11-20 persons. Additionally, 28% of maize farmers studied had a household size of 21-30 persons. The households with 1-10 persons constituted 11%, while, 7% of the maize farmers constituted the households with 31-40 persons. Also, the mean score was 19 persons feeding in the same pot per household in Northwest, Nigeria. The results corroborate the findings of Awoyemi and Aderinoye-Abdulwahab (2019), and Nenna (2020), who found that among farming households, the farmers had a large household size are 7-9 persons feeding in the same pot in South East, and South West, Nigeria. While disagreeing with the findings of Olaniyi and Ismaila (2016), who reported that household size with modal class is between 4-6 members in the study area. This implied that the average household size in Northwest, Nigeria is about 19 persons per household. The implication is that the greater household size of a maize farmer, the greater the supply of available labour, thereby, reducing the cost of labour, man-hours, and stress expended on maize farming activities as well as resulting in increase in number of bags in terms of yield per ha. Customarily, in the study area household size is used in agrarian society to determine the farmland size, availability of labour and level of productivity. This argument was supported by the Omoare and Oyediran (2015), who asserted that large households are essential in rural communities because they provide human resources for agriculture and other household activities.

Table 1: Distribution of Maize Farmers Based On Sex, Age, Education, Marital Status, Household Size

Variables	Frequency	% Distribution	Mean
Sex			
Male	393	72.78	
Female	147	27.22	
Age (years)			49
18 – 28	7	1.30	
29– 39	28	5.19	
40– 50	320	59.26	
51– 61	136	25.19	
62 – 72	49	9.07	
Education			
No formal education	42	7.78	
Primary	171	31.67	
Secondary	307	56.85	
Tertiary	20	3.70	
Marital Status			
Single	49	9.07	
Married	491	90.93	
Household Size			19
0 – 10	60	11.11	
11 – 20	288	53.33	
21 – 30	152	28.15	
31 – 40	40	7.41	

Source: Field Survey data, 2022

The results presented in Table 2, the farm size (ha), revealed that above average (57%) of the sampled maize farmers cultivate 2.1-3 hectares of land for maize, majority (71.30%) inherited their farm land, with a mean score of 2.37 hectares for total farmland cultivated in the study area. The farm locations of majority (70.56%) were not found close to a river, stream or lake. This implied that most of the maize farmers studied were smallholder farmers and cultivated a small piece of land, which might be a result of difficulty in accessing land or communal barriers. This result confirms

the studies of Afolabi *et al.* (2025), Kolade and Harpham (2014), and Nenna (2020), which found that farming activities are dominated by smallholder farmers in the North-West, North-Central, South-West and South-East Nigeria. The implication is that access to arable farmland is highly contextual. This, in turn, affects their potential yield and their being food insecure. It can be argued that maize farmers who own smaller farmland sizes are more likely to have a low standard of living due to low food supply without the World Bank intervention project.

Table 2: Distribution of Maize Farmers Based On Farm Size, Mode of Land Acquisition, Farming Experience, Extension Contact/Visit

Variables	Frequency	% Distribution	Mean
Farm Size (Hectares)			2.37
0 – 1	90	16.67	
1.1 – 2	72	13.33	
2.1 – 3	310	57.41	
3.1 – 4	20	3.70	
4.1 – 5	48	8.89	
Mode of Land Acquisition			
Inherited	385	71.30	
Purchased	89	16.48	
Rented	39	7.22	
Communal land	27	5.00	
Nearness to river/stream/lake			
Yes	159	29.44	
No	381	70.56	
Farming Experience			38
0 – 10	8	1.48	
11 – 20	42	7.78	
21 – 30	65	12.04	
31 – 40	125	23.15	
41 – 50	300	55.56	
4.1 – 5	48	8.89	

Variables	Frequency	% Distribution	Mean
Extension Contact/Visit			
Contact/Visit	398	73.70	
No Contact/Visit	142	26.30	

Source: Field Survey data, 2022

The results in Table 2 of farming experience revealed that 56% of the studied maize farmers had farming experience of 41 - 50 years in the study area, with mean score of 38 years for farming experience. The study's finding disagrees with the findings of Amponsah *et al.* (2018), who found that the majority of respondents had fewer years of experience and knowledge in maize farming. Also, the results of extension contact/visit showed that majority (74%) of farmers of World Bank intervention projects had contacts/visit with the extension workers. This implied that the sampled maize farmers in the study area are well-grounded in the farming activities, thus, would be more interested in the intervention project of the World Bank to aid farming activities.

Maize Farmers' Output under Various Land-Based Decision Options for Climate Change Mitigation and Adaptation

The results presented in Table 3 shows the mean maize output of farmers under various land-based decision options

Table 3: Distribution of Maize Farmers' Output Under Various Land-Based Decision Options for Climate Change Mitigation and Adaptation N=540

Items	Sustainable option	Unsustainable option
Mean Farm Size (Ha)	1.57	2.54
Mean Output (Bags) ^a	50.51	128.26
Mean Value	1,209,461.95	3,071,185.70
Normalized Output by Ha (Bags)	50.51	81.72
%Output Normalized by 1.57 Ha	0	56.95
Z-statistics	3.164 ^b	
Leveled Observation ^c	213	213

^a Mean unit price per bag (N23,945)

^b Significant at 5% level

^c Number of observation was leveled due to unequal number of farmers in each decision category

Source: Field Survey data, 2022

This also implies that unsustainable land-based decision option for climate change mitigation and adaptation generated an additional one million one hundred and fourteen thousand four-hundred-naira three kobo (N1,114,400.03k). This could be linked to the use of inorganic fertilizer and its short term associated improvement in productivity. In line with the findings of Liava *et al.* (2022), who reported that inorganic nitrogen fertilization maximizes the productivity of crops more than organic manure. The study of Urmi *et al.* (2022), argued that overuse of inorganic fertilizers leads to soil health deterioration. On the other hand, the study of Zaman *et al.* (2018), asserted that the integration of organic and inorganic fertilizer improves soil structure and hence increases the macro and micro-nutrient availability, and enhances crops yield. Sultana *et al.* (2021), confirmed that integration of organic and inorganic fertilizer gives higher values for soil N, P, K, and S contents and increases crop yield. The study of Mohammed *et al.* (2019), attributed low productivity among food crop farmers to inadequate supply of inorganic fertilizers and other production inputs. The study by Jaja and Barber (2017), found that inorganic fertilizer is one of the most essential farm inputs for increasing food production, and the quickest practical way to provide sufficient plant

nutrients to restore nutrient-depleted in African soils (Raimi, Adeleke & Ashira, 2017). Results showed that the mean value of maize under sustainable land-based decision option with a mean farm size of 1.57 hectares was one million two hundred and nine thousand four hundred- and sixty-one-naira ninety-five kobo (N1, 209,461.95k), while the mean value of maize under unsustainable land-based option with a mean farm size of 2.54 hectares was three million seventy-one thousand one hundred and eighty-five naira seventy kobo (N3, 071,185.70k). The percentage outputs as normalized by 1.56 hectares were 0% for sustainable land-based option and 56.95% for unsustainable land-based option. This implies that farmers adopting unsustainable land-based decision option for climate change mitigation and adaptation produce an additional 56.95% maize output (producing 50.51 bags for every 1.57 hectares) above their counterparts adopting sustainable land-based decision option.

nutrients to restore nutrient-depleted in African soils (Raimi, Adeleke & Ashira, 2017).

Test of Hypothesis 1:

The Table 3 also showed that the Z-value was 3.164 and was higher than the Z-critical (1.96). Therefore, the null hypothesis that there is no significant difference in maize output resulting from each land management decision options in the area was rejected. The study therefore accepted the alternative hypothesis and concluded that there is a significant difference in maize output resulting from each land management decision options in the area.

Regression of the Effects of Land-based Decision Options for Climate Change Mitigation and Adaptation on Maize Production.

The results presented in Table 4 showed the seemingly unrelated regression results of the effects of land-based decision options for climate change mitigation and adaptation on maize production under World Bank intervention projects. The R-squared values indicated that 50.76% and 67.23% of the variations on the effects of the estimated equations for sustainable land-based decision and unsustainable land-based decision options were contributed

by the independent variables with a (Prob > chi² 218.94) (Prob > chi² 434.92) specified in the model was a good fit, respectively. This implies that about 50.76% and 67.23% of the total variability in maize production under sustainable and unsustainable land-based options were respectively explained by the explanatory variables included in the model. The coefficients of farm size (1.256), farm location (1.147) and amount spent on soil/stone bunds (3.530) for sustainable land-based decision for climate change mitigation and adaptation were positive and statistically significant at 1% level, while labour (-1.147) and amount spent on weeding (-3.926) were negative and statistically significant at 1% level. This implies that an increase in farm size, nearness of farm to river/stream, and amount spent on soil/stone bunds by one percent increase the value of maize under sustainable land-based decision option for climate change mitigation and adaptation by 1.256%, 1.147% and 3.530%, respectively, while an increase in the amount spent on weeding and cost of labour by one percent decrease the value of maize under sustainable land-based decision option for climate change mitigation and adaptation by 3.926% and 1.147%, respectively.

On the other hand, the coefficients of farm size (0.136), labour (0.138), nearness of farm to river/stream (0.048),

amount spent on land tiling (0.055) and amount spent on irrigation (0.039) for unsustainable land-based decision option were positive and significant at 1%, 5% and 10% levels, respectively. This implies that an increase in farm size, labour, nearness of farm to river/stream, amount spent on land tiling and amount spent on irrigation for unsustainable land-based decision option for climate change mitigation and adaptation by one percent increase the value of maize by 0.136%, 0.138%, 0.048%, 0.055% and 0.039%, respectively.

The negative influence of labour costs and amount spent on weeding under sustainable land-based mitigation and adaptation to climate change could be linked to high labour requirement of sustainable land management practices. High labour requirement of sustainable practices, such as manual weeding, increases the production costs and hence decreases the value of maize realized from such practices. Manual weeding is labour-intensive and costly as reported by Ahmed *et al.* (2021). Islam *et al.* (2018), suggested that mechanized weeding can overcome the problem of drudgery involved in manual weeding and would further improve labor and weed control efficiencies.

Table 4: Regression Results of the Effects of Sustainable and Unsustainable Land-Based Decision Options

Sustainable Land-Based Decision for Climate Change Mitigation and Adaptation	Coefficients	Z-statistics
Farm Size (Ha)	1.256 ^c	9.35
Labour (Man-days)	-1.147 ^c	-4.71
Farm Location (Near river/stream/lake =1, otherwise = 0)	1.073 ^c	3.05
Amount Spent on Organic Manure (Naira)	0.0004	0.02
Amount Spent on Land tilling (Naira)	-0.250	-0.52
Amount Spent on Mulching (Naira)	0.0045	0.09
Amount Spent on Soil/stone bunds (Naira)	3.530 ^c	6.79
Amount Spent on Terraces (Naira)	-0.018	-1.04
Amount spent on manual weeding (Naira)	-3.926 ^c	-12.33
Constant	28.876 ^c	11.23
R-Square	0.5076	
Chi-Square value	218.94 ^c	
Observations	212	
Unsustainable Land-Based Decision for Climate Change Mitigation and Adaptation		
Farm Size (Ha)	0.136 ^c	4.24
Labour (Man-days)	0.138 ^c	2.70
Farm Location (Near river/stream/lake =1, otherwise = 0)	0.048 ^a	1.66
Amount Spent on Inorganic Fertilizer (Naira)	-0.052	-0.83
Amount Spent on Land tilling (Naira)	0.055 ^b	2.45
Amount Spent on Mulching (Naira)	-0.0046	-1.35
Amount Spent on Erosion control (Naira)	0.0085	0.32
Amount Spent on Irrigation (Naira)	0.039 ^c	6.45
Amount Spent on Herbicides (Naira)	0.030	0.62
Constant	13.300 ^c	28.77
R-Square	0.6723	
Chi-Square value	434.92 ^c	
Observations	212	

Source: Field Survey data, 2022

^a Significant at 10% ^b significant at 5% ^c significant at 1%;

Test of Hypothesis 2

Table 4 also showed that the chi-square statistics of the SUR equations for sustainable land-based decision (218.94) and unsustainable land-based decision (434.92) for climate change mitigation and adaptation were both significant at one percent (1%) level. Therefore, the null hypothesis that

land-based decision options for climate change mitigation and adaption have no effects on maize production in the study area was rejected. The alternative hypothesis was accepted, and it was concluded that land-based decision options for climate change mitigation and adaption have effects on maize production in the study area.

CONCLUSION

Based on the findings, it was concluded that maize farmers in World Bank-intervention projects are in their prime active age and mainly male. Additionally, with experience in farming practices, and familiar with options for mitigation and adaptation. Furthermore, the empirical results have direct implications for considering the high value of maize generated under unsustainable land-based decision options, particularly due to the use of inorganic fertilizers. In addition, there is a need to reduce greenhouse gas emissions. Thus, the policy recommendations were made: scale up localized research, and future interventions should prioritize soil-specific mapping to ensure the right mitigation strategy is applied to the right landscape. Capacity building, extension workers and other stakeholders in agronomy and soil health and management to ensure farmers are informed on yield enhancement through the appropriate and efficient use of organic manure.

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