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Maize Farmers' Perception of Land-based Decisions for Climate Change Mitigation, Adaptation and World Bank Intervention in Northwest, Nigeria

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ABSTRACT
Understanding the nexus between land-based decisions, climate change and adaptation is vital in developing effective land-based climate change mitigation policies and adaptation measures. Although mitigation and adaptation are human-mediated processes, current global-scale modelling tools have no justification for societal learning and other human responses to ecological change. The study assessed maize farmers' perception of land-based decisions for climate change mitigation, adaptation and World Bank intervention in Northwest, Nigeria. A multi-stage sampling procedure was used to select 540 maize farmers. Data collected and analyzed using questionnaire and descriptive statistics. Results revealed (57%) of the maize farmers had education, (56%) had 41- 50 years farming experience, with mean score of 38 years. Also, revealed (74%) had, while, 26% had no contact/visit with extension agents. Furthermore, the decision option of 60.56% of the farmers with a mean farm size of 2.54 ha., maize value of N3,071,185.70k classified unsustainable, while the decision option of the remaining 39.44% were classified sustainable, with a mean farm size of 1.57 ha., maize value of N1,209,461.95k. The percentage outputs as normalized by 1.56 ha. were 0% for sustainable land-based option and 56.95% for unsustainable land-based option. 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/ soil management should educate farmers on yield enhancement through appropriate and efficient use of organic manure. Thus, SLM stakeholders and World Bank should develop labour-saving, motorized weeding tools for sustainable land-based practices.

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INTRODUCTION

Globally, agricultural technological transfer or extension service delivery is concerned with communicating intervention, research findings and improved agricultural practices to maize farmers. A general perception of agricultural extension systems in Nigeria is that they have not been able to spawn and stimulate much adoption of agricultural technologies and improvement of agriculture and rural life (Khalid, 2014; Naswem *et al.,* 2018).

Maize is a very important staple food in Nigeria, and widely grown across all the 36 States, with an estimated 12.7 million MT produced in 2021 (FAOSTAT, 2021). 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 maize farmers to adopt climate change land-based mitigation and adaptation practices, and how best to produce under various land management options.

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 (CO_2), nitrous oxide (N_2O), and methane (CH_4) (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 socioeconomic characteristics of maize farmers of World Bank intervention projects,
ii. examine the maize farmers' perception of the land-based decision options for climate change mitigation and adaptation, and
iii. assess the extent of maize farmers' utilization of agricultural extension services in the study areas.

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 2^0 and 14^0 N and longitudes 07^0 and 60^0 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 17^0 and 38^0C, although high temperatures of up to 42^0 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

Data collected were analyzed using descriptive statistics such as percentage, and mean. Descriptive statistics include measures of variability (range, variance), measures of frequency (count, per cent), measures of position (mean score, percentile ranks, Likert ranks) the minimum and maximum values of the variables (Research guide, 2024). The perception analysis on the level of adoption of IPhT4RP was used to draw inferences of the women rice processors' view and were then categorized as follows: 1.00-1.49 = Non-adopters; 1.50-2.49 = Least adopters; 2.50-3.49 = Moderate adopters; 3.50-4.49 = High adopters and 4.50-5.00 = Very High adopters. And, were measured through a 5-point Likert-type scale as applicable to this study and the mean was tabulated and presented.

RESULTS AND DISCUSSION

Socioeconomic Characteristics 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	
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.

Socioeconomic Characteristics of Maize Farmers of World Bank Intervention Projects

Cooperative Membership, Credit Access, Annual Income

The results presented in Table 3 revealed that the majority (78%) of maize farmers in World Bank intervention projects were members of a cooperative society, while 90% had no access to credit, with a mean annual income of N592, 407.90k in the study area. The result also revealed that their years of farming experience (41–50 years) could be linked to the year of cooperative membership.

It implies that being a major beneficiary of World Bank intervention projects was a result of belonging to a group. The study's findings align with Mbarouk *et al.* (2024), who found that a considerable effect on the ability to join cooperatives is beneficial. The implication is that access to real-time information is highly contextual. This, in turn, can enhance their potential yield and food security. Despite not having access to credit. It can be argued that maize farmers who do not belong to a cooperative are more likely to have a low standard of living due to inadequate food.

Table 3: Distribution of Maize Farmers based on Sources Economic Capacity

Variables	Frequency	% Distribution	Mean
Cooperative Membership			
Yes	419	77.59	
No	121	22.41	
Credit Access			
Yes	54	10.00	
No	486	90.00	
Annual Income (Naira)			592,407.9
0 – 100,000	2	0.37	
100,001– 200,000	8	1.48	
200,001– 300,000	3	0.56	
300,001– 400,000	18	3.33	

Variables	Frequency	% Distribution	Mean
400,001 – 500,000	39	7.22	
500,001 – 600,000	301	55.74	
600,001 – 700,000	82	15.19	
700,001 – 800,000	37	6.85	
800,001 – 900,000	1	0.19	
900,001 and above	49	9.07	

Source: Field Survey data, 2022

Level of Climate Change Perception, Land-based Mitigation and Adaptation Among
Maize Farmers of World Bank Intervention Projects

The results presented in Table 4 revealed that the maize farmers in the study area had a perception for change in climate, pattern of weather changing, practices on mitigating and adapting to climate change, and knows about climate change, with mean scores (5.47), (5.46), (5.42) and (5.17) were highly aware, respectively. The study's findings align with Eyshi *et al.* (2015), who reported that high temperatures during flowering and/or grain-filling phases have large negative impacts on cereal grain yields. This is an indication that maize farmers in the study area could benefit more from the land-based mitigating and adapting strategies as the adopt these applications in their farming activities.

Table 4: Distribution of Maize Farmers based on Level of Awareness of Land-based Decision on Climate Change Mitigation and Adaptation

Climate Change Awareness	HA	A	U	HnA	NA	WS	WMS	Ranking
Aware of the changes in climate	2683	2148	1611	1074	537	29525	5.468	1st
Pattern of weather generally changing	2680	2144	1608	1072	536	29484	5.460	2nd
Knows about climate change	2540	2032	1524	1016	508	27940	5.174	4th
Aware of practices on farmland that help in mitigating and adapting to climate change	2660	2128	1596	1064	532	29260	5.418	3rd

Source: Field survey 2022. Multiple choice: Likert-type scale: HA=Highly aware, A=Aware, N=Neutral, HnA=Highly not aware,
NA=Not aware. Weighted score (WS) and Weighted Mean Score (WMS) *Neutral (mean score < 2.50), **Aware (mean score between 2.50 to 4.49) ***Highly aware (mean score ≥ 5.0

Identification and Categorization of Maize Farmers by Land-based Practices for Climate Change Mitigation and Adaptation

The results presented in Table 5 showed that the majority (56.48%) of the sampled maize farmers adopted minimum tillage, mulching (89.44%), soil/stone bunds (74.81%), use of organic manure (93.70%), crop residue/green grass incorporation (76.30%), intercropping with nitrogen-fixing crops (55.74%), and early maturing maize (94.07%) for climate change land-based mitigation and adaptation.

Farmers were further categorized based on their land-based decision options as shown in Table 5. Results showed that the majority (60.56%) farmers' decision on adoption were classified unsustainable land-based option, while the adoption decision of the remaining 39.44% were classified sustainable land-based option. This implies that most farmers of World Bank intervention projects adopted unsustainable land-based practices for climate change mitigation and adaptation. This could be linked to the need to improve soil fertility and suppress weeds using inorganic fertilizer and herbicides. This decision option increases agricultural emission and hence climate change. According to Mengistu *et al.* (2015), Nedessa *et al.* (2015) and Khanal *et al.* (2018), integrating sustainable land management practices such as minimum tillage, mulching, soil/stone bunds, use of organic manure, nitrogen-fixing crops, etc., into the broad farm management system ensures long-term productivity potential of the farmland.

Table 4: Distribution of Farmers based on Decision options for Climate Change Mitigation and Adaptation

Land-Based Category	Sustainable Land Management	Frequency	% Distribution
Minimum Soil Disturbance	Minimum tillage	305	56.48[a]
	Mulching	483	89.44[a]
Soil Erosion Control	Terraces	162	30.00
	Soil/stone bunds	404	74.81[a]
Soil fertility management	Use of organic manure	506	93.70[a]
	Crop residue/green grass incorporation	412	76.30[a]
	Cover crops	198	36.67
	Crop rotation with nitrogen-fixing crops	5	0.93
	Intercropping with nitrogen-fixing crops	301	55.74[a]

Land-Based Category	Sustainable Land Management	Frequency	% Distribution
Crop Variety Options	Drought-tolerant	10	1.85
	Flood-tolerant	0	0.00
	Early maturing maize	508	94.07[a]
Decision Options for Climate Change Mitigation and Adaptation			
Sustainable Land-based Option		213	39.44($^{b}LMI_i \geq 0.5$)
Unsustainable Land-based Option		327	60.56($^{b}LMI_i < 0.5$)
Total		**540**	**100.00**

[a] Major Practices (multiple response, $\geq 50\%$)
[b] Land Management Index for the i[th] farmer
Source: Field Survey data, 2022

Maize Farmers' Output under Various Land-based Decision options for Climate Change Mitigation and Adaptation
The results presented in Table 5 shows the mean maize output of farmers under various land-based decision options for climate change mitigation and adaptation. 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 (₦1,209,461.95k), 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 (₦3,071,185.70k). 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.

Table 5: 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**

Source: Field Survey data, 2022
[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

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).

Perception of Maize Farmers to Land-based decision on Climate Change Mitigation and Adaptation
The results presented in Table 6 showed there are variations in the maize farmers' perception of the climate change mitigation and adaptation in the study area. The mean score (5.38) found for pesticide incidence among maize farmers ranked 1st. This statement indicated that the maize farmers perceived the pesticide incidence as important in the utilisation of land-based mitigating and adapting strategies, meaning that the maize farmers are adopters and strongly agree to sharing the knowledge among farmers in the study area. This implies that the majority some of the maize farmers adopted the strategies based on their relative advantages (Wanyoike, 2014). This is also in line with the findings of Tangmunkongvorakul *et al.* (2019), who established that if farmers have a favourable perception of the yield, it would positively influence the usage of the tools in farming activities.
The result also revealed that the maize farmers had a mean score of 5.15 for cessations. The amount of rainfall before the crop life cycle ranked 2nd. This statement recorded is an indication that, the maize farmers perceived that cessations of rainfall could lead to a reduction in production outputs and increased costs of purchasing inputs for maize farming based on the money earned as a result of the limited rainfall, and strongly agreed to use the land-based mitigation and adapting

strategies in farming activities. It is suggested that the maize farmers' ability to access early variety inputs directly and reduce losses. The use of smart-agriculture tools for farming practices contributed to their cost-effectiveness.

The result further showed that the mean score (5.12) obtained for intensified soil degradation ranked 3rd. Based on the maize farmers' statement recorded, this indicated that the perceived knowledge of intensified soil degradation was a result of climate change, and they strongly agreed to use the land-based strategies in farming activities. This is an indication that the maize farmers use their knowledge gained in the study area to control soil degradation. This finding is also supported by the study of Ifeanyi-obi and Corbon (2023), who found that farmers had adequate knowledge and utilized it for their farm business.

The result revealed that the maize farmers use the land-based strategies for weed incidence with a mean score (4.88), which ranked 4th. The utilization of the mitigation and adaptation practices in farming activities, mostly when there is high temperature, with a mean score of 4.43, ranked 5th. This implies that the sampled maize farmers strongly agreed with the use of land-based decision on climate change mitigation and adaptation for maize farming in the study area. The implication of this is that there will be sustainability with farmers having more knowledge of the strategies.

Table 6: Distribution of Maize Farmers Based on Level of Perception of Land-Based Decision on Climate Change Mitigation and Adaptation

Climate Change Perception	SA	A	U	SD	D	WS	WMS	Ranking
Reduced river level	215	172	129	86	43	2365	4.378	6th
Poor yield and crop failure	2070	1656	1242	828	414	2277	4.217	7th
Pest incidence	265	212	159	106	53	2906	5.381	1st
Weed incidence	240	192	144	96	48	2640	4.888	4th
Flooding	735	588	441	294	147	1497	1.497	14th
Intensify soil degradation	2515	2012	1509	1006	503	2767	5.123	3rd
Inconsistency in rainfall/shortage of rainfall	2040	1632	1224	816	408	2274	4.211	8th
Cessations of rainfall before crop life cycle.	2440	1952	1464	976	488	2782	5.151	2nd
Mostly hot weather	2005	1604	1203	802	401	2268	4.084	9th
Soil erosion	1760	1408	1056	704	352	1936	3.585	11th
High wind velocity	1890	1512	1134	756	378	2079	3.850	10th
Pollution of rivers/streams	435	348	261	174	87	4790	1.086	15th
Drought	1905	1524	1143	762	381	1905	3.528	12th
Mostly high rainfall	370	296	222	148	74	4070	1.054	16th
Mostly low temperature	115	92	69	46	23	1265	2.343	13th
Mostly high temperature	2175	1740	1305	870	435	2393	4.431	5th
Number of Observation						**≥5.00 VHA**		

Source: Field survey 2022. Multiple choice: Likert-type scale: SA=Strongly agree, A=Agree, U=Undecided, SD=Strongly Disagree, DA=Disagree. Weighted score (WS) and Weighted Mean Score (WMS)
**Disagreed (mean score < 2.50), **Undecided (mean score between 2.50 to 3.49) ***Strongly Agreed (mean score ≥ 5.00). Very High Adopters (VHA)*

CONCLUSION

It can be concluded that the maize farmers participating in World Bank-intervention projects. They are predominantly in their prime working age, male, possess secondary education, and are married. Have substantial farming experience and primarily utilize inherited farmlands. These farmers demonstrate awareness of climate and weather patterns and changes and tend to adopt unsustainable land-based mitigation and adaptation strategies. Such practices are associated with increased maize output and higher crop value compared to those employing sustainable land-based decision options. Respondents expressed strong agreement regarding the importance of land-based decision-making for climate change mitigation and adaptation in maize farming. The empirical results underscore the significance of the high maize value generated through unsustainable land-based practices, particularly. Used inorganic fertilizer and highlighted the necessity of reducing greenhouse gas emissions. There is a critical need for capacity building, integrated pest management (IPM) and safety policy, climate-smart water and varietal security, soil health management and degradation reversal credits, as well as the rapid dissemination of adaptation techniques to farmers via extension workers and other stakeholders.

Data Availability Statement/Supporting Information

Data associated with the study and additional supporting information may be found online in the supporting information section.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest to disclose.

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