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Influence of Climate-Change Adaptation and Mitigation on Maize Yield in South-East Nigeria

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Abstract
Yield and quality of crop produced depend on the quality of seed planted. This assertion is true under a conducive agroecological climate which is gradually fading away due to climate-change (CC) challenges. The use of adaptation and mitigation (AM) strategies expected to reduce its effect is low. Therefore, this study examined effect of CC AM on maize yield in south-east Nigeria. Multi-stage sampling procedure was adopted in selecting sample for the study. First stage adopted simple random sampling technique to select three States. Second stage used purposive sampling technique to select three Local Government Areas (LGA) from each state. Third stage applied, simple random technique to select three communities from the LGAs. Fourth stage applied a simple random technique to select 300 maize farmers for the study. Data was analyzed using AM index, independent t-test and linear regression analysis. Mean yield of maize for high adaptation was 958.30 kg per plot and433.54 per plot for low adaptation, the t value 5.4E+03 was significant at 1% while the mean yield of maize for high mitigation was 845.42 kg per plot and573.84 kg per plot for low mitigation strategies usage with t value=990.22 and significant at 1%.Determining the effects of the socioeconomic factors on maize yield with respect to (wrt) CC adaptation and mitigation organic manure ($p < 0.001$), frequent weeding ($p < 0.001$), late planting ($p < 0.01$) row /ridge planting ($p < 0.01$) and early planting ($p < 0.01$), farm size ($p < 0.0001$), afforestation ($p < 0.0001$); Taunya farming ($p < 0.001$); and frequent weeding ($p < 0.0001$) positively and significantly influenced maize yield.
The study recommends provision of infrastructural facilities for CC mitigation and adaptation, farmland availability and use of sustainable agricultural practices to improve yield.

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Keywords: Climate-change, Adaptation, Mitigation, Maize yield

1. Introduction
Agriculture is an important component of human society due to its many gains to man. It involves crop production and rearing of livestock for man's benefit. It benefits man in providing food for his survival as well as raw materials for industries and serves as a source of livelihood for many (Okonkwo-Emegha, Umebali, Isibor, 2019). In Nigeria, not less than 65% of the population take to agriculture for employment and about 15% of her Domestic Product comes from agriculture (AGRA, 2015).
Main part of agriculture practiced in Nigeria is crop production (Abbas, 2019). In Nigeria, processes and systems of crop production are highly dependent on climate and weather. In rainforest zone, climate is important resources because farmers largely depend on rainfed agriculture (FAO, 2018). Climate which crops production greatly depends on in recent times has been experiencing change in global or regional patterns due to increased atmospheric carbon dioxide, which is referred to as CC (Ekwuzei, Boreham, Dalton, Heede, Mera, Allen, Frumhoff, 2017).

1.1. Background
Maize is one important crop that is cultivated and consumed globally which is affected by CC. Maize, rice and wheat are global staple food that provide more than fifty percent of global calories intake (World Atlas, 2017).

Wheat, rice and maize are three most explored food crops by mankind, owing to the high value derived from them. Maize is an important multipurpose cereal crop in Nigeria. The crop plays a major role in ensuring food security by providing food for man, to meet his energy and protein requirement in the diet of many people (World Atlas, 2017). Maize comes third as the most cultivated cereal crops in Nigeria apart from wheat and rice, in relation to the number of people feeding on it (Komolafe and Adeoti, 2018). Maize contains protein and crude fibre. Consequently, it provides man with fuel and food and animals with feed (Enyisi, Umoh, Whong, Abdullahi and Alabi 2014: Komolafe and Adeoti, 2018).

The sum of 2.40 million tons of maize was produced in Nigeria in the year 2020 which is a decrease of 1.55% in the amount produced in 2019 (NAERLS 2020). This decrease is said to have resulted partly due to deficit of rainfall in South-West, some parts of South-East and flooding in the North-East and North-West, Nigeria. PWC (2021), noted that maize yield in the country is less than two tonnes per hectare (t/ha) compared to 4.2 t/ha and 4.9 t/ha in Ethiopia and South Africa respectively. It further noted that because of the poor yield, maize production in Nigeria is low and could barely satisfy the enormous maize demand, which is estimated at 12-15 MMT, thereby creating a gap in supply of maize of close to 4 MMT per annum. Unfortunately, poor yield of maize in Nigeria is worsened by (CC) challenges, and it seems to be unsurmountable.

Xin, *et al*, (2021) found that for maize, 1^0 C increase in average temperature could reduce yield by 7%. High temperature reduces the pollen viability, fertilization, and grain formation in maize (HJatfield and Prueger, 2015). If these conditions are not mitigated against, it will result in low yield and food insecurity among maize farmers. In Nigeria maize production, particularly South-East Zone is faced with the effects of CC resulting to farmland degradation, low yield, biodiversity loss and reduction in farm income (United Nations, 2018).

Intergovernmental Panel on CC (IPCC, 2021) defined CC as deviation in the patterns of climate over a long period of time. In the last three decades, the earth's surface has been having successive higher temperature. Temperature rise of 2-6 C is expected in Africa in the next 100 years, and about 1.5-3.0 C rise in temperature by 2050 (IPCC, 2013). This is much more severe than experienced in other continents. CC impacts the global agricultural system negatively (IPCC, 2014; Ye Zong, Kleidon, Yuan, Wang, Shi, 2019). Studies on CC have noted that progressive CC will seriously impact agricultural production negatively, more and more (Kalra and Kumar, 2019). High temperatures and fluctuation in rainfall patterns significantly impact overall crop development, growth and yield (Gupta, Mishra, 2019).

To prevent serious anthropogenic interface with climate system, there has been calls for the atmospheric level of greenhouse concentrations (GHC) stabilization (Gbedemah, Torgborand Kufogbe, 2018). In order to ensure that economic development activities and food production are not threatened or impaired from progressing in a sustainable pattern, it is the expectation of stakeholders that (GHC) stabilization level must be attained within the shortest possible time, which will enable the ecosystem to adjust naturally to CC. Maize farmers in South-eastern Nigeria, interestingly are beginning to implement different kinds of strategies towards adapting and mitigating devastating effects of CC on their farms. Adaptation to climate is modification by human system or nature in response to either expected or actual climatic stimuli which minimizes negative effects and take advantages of the opportunities (IPCC, 2014).

Mitigation of CC is a human intervention tailored towards reducing the sources or enhancing the sinks of GHG (IPCC 2007). This is a global responsibility. Leaving CC without mitigation is dangerous to the agricultural sector. However, with adequate mitigation and (AS) in place, farmers' vulnerability can be adequately reduced (Adeoti *et al*., 2016). To reduce its impacts, CC needs to be promptly perceived as a challenge, and appropriate mitigation strategies deployed (Ozor, Madukwe, Enete, Amaechina, Onokala, Eboh, Ujah and Garforth, 2012; Enete and Amusa, 2021). The extent of yield reduction is a function of farmers' ability to mitigate against CC.

Yield and quality of crop produced depend on quality of seed planted. This assertion is true under a conducive agro-ecological climate which is gradually fading away due to challenges associated with CC. Globally, in recent times, CC has become a treat to maize production, impacting yield negatively (Gupta, Mishra, 2019). Due to the enormous importance of ensuring sustained maize yield and what it portends to Nigerians, any CC challenge that is not addressed will lead to a setback in Nigeria's economic development, particularly that of South-East Zone. Therefore, the knowledge of the effects of the current effort of maize farmers in the study area are deploying to adapt and mitigate CC is crucial to help stakeholders know exactly what the situation is; and be able to make forecast and design any intervention needed.

Although studies was done to know the effects of CC on agriculture in Nigeria (Fonta, 2011; Adeoti *et al*., 2016), as well as studies that have shown empirically, the effect CC variabilities have on maize production; there is however, paucity of research work on the role of the efforts of maize farmers to adapt and mitigate CC, have on the yield of their crop. Consequently, this study will determine the effect of CC AM on maize yield in South-east Nigeria. The specific objectives are as follows:

1. Determine maize yield differentials based on the farmers' level of adaptation and mitigation.
2. Determine effect farmers' socioeconomic characteristics intervening with their climate-change adaptation and mitigation, have on maize yield.
3. Determine the effect of climate-change adaptation on maize yield.
4. Determine effect of climate-change mitigation on maize yield.

Research Hypothesis

Stated in null form, the following hypothesis will be tested:

1. There is no significant difference in yield considering the famers' level of climate-change adaptation.
2. There is no significant difference in yield considering the farmers' level of climate-change mitigation.
3. Maize yield is not significantly affected by climate-change adaptation.
4. Maize yield is not significantly affected by climate-change mitigation.

1.2. Statement of the Problem

Globally, in recent times, CC has become a treat to maize production, impacting yield negatively (Gupta, Mishra, 2019). The situation has worsened maize supply which is presently below the national demand and the country is struggling to bridge this gap with little progress recorded. If nothing is done, yield will continue to decrease, and importation will increase above the one million tons recorded in 2019 and 2020. This will worsen the pressure on Nigeria's foreign exchange. Due to the enormous importance of ensuring sustained maize yield and what it portends to Nigerians, any CC challenge that is not addressed will lead to a setback in Nigeria's economic development, particularly that of South-East Zone. Therefore, the knowledge of the effects of the current effort of maize farmers in the study area are deploying to adapt and mitigate CC is crucial to help stakeholders know exactly what the situation is; and be able to make forecast and design any intervention needed.

Adaptation methods are function of the institutions, customs and policies. Where direct policy responses are lacking, farmers select their (AS) based on their household, farm and socio-economic characteristics. As maize farmers in South-East Nigeria continue to implement different strategies to adapt and mitigate CC; and as various institutional framework are being put in place to encourage them to do more, it has been acknowledged that farmers' socioeconomic characteristics compose the context of any development - in this case, maize farmers' socioeconomic characteristics intervening with their CC AM strategies they deploy to determine the yield of their crop; and also their socioeconomic characteristics playing a role to determine which AM strategy the farmers implement and at what level. The disparity in socioeconomic characteristics and effect of the challenges associated with CC is worse in developing nations such as Nigeria that have little or limited mitigation and adaptation (M&A) techniques. This may therefore, cause differences in yield among the maize farmers depending on their level of CC AM. Currently, it is not certain if the enormous effort being put in by maize farmers to adapt and mitigate CC is making any significant difference in yield when compared to maize farmers who possibly put little effort at adapting and mitigating CC. Hence, this study will look at the yield differentials of maize wrt farmers' level of AM to CC. This will help stakeholders understand if the current CC AM strategies being implemented by maize farmers in the study area, are of any significance in the bid at increasing maize yield.

2. Review of Literature

Maize Production and Yield in Nigeria

The global production of cereals increased by 61 million tonnes, or 2 percent, between 2022 and 2023, driven by an increase in maize output. In 2023 rice, wheat and maize amount to 91%of all cereal produced **(FAO, 2024; Statista, 2025; FAOSTAT, 2025)**

For the past 5 years, world maize production has exhibited significant annual fluctuations as shown in the table below:

Table 1: Five years summary of average global annual

Year	Global Annual Maize Production (*'000;000 metric tonnes*)
2019	1,148
2020	1,125
2021	1,208
2022	1,163
2023	1,184

Source: VON, 2024; Statista, 2025

The data showed a peak production in 2021, followed by a decline in 2022, and a subsequent modest increase in 2023. Factors influencing these trends are climatic conditions, agricultural practices, and global demand.

Maize is a major important cereal food crop cultivated in Nigeria. It is widely cultivated due to its genetic plasticity (Kamara, Kamai, Omoigui, Togola, and Onyibe, 2020). It is grown in almost every ecological zone of the country and all the time of the year due to its photoperiod insensitive. It is a dominant cereal crop in the Sudan and Guinea savannas in Nigeria (Kamara, Kamai, Omoigui, Togola, and Onyibe, 2020). Maize has taken over acreages from millet and sorghum. FAOSTAT, statistics database, (2017) as cited in Kamara, Kamai, Omoigui, Togola, and Onyibe, (2020) asserted that 4.8 million hectares of farmland cultivated produced 10.2 M tons of maize. For the past 5 years, Nigeria maize production has exhibited significant annual fluctuations as presented in table 2, due to various factors such as changes in cultivated area, input costs, and security challenges.

Table 2: Five years summary of average annual production of maize in Nigeria

Year	Annual Maize Production (*'000;000 metric tonnes*)
2019	11.0
2020	12.4
2021	12.75
2022	12.949
2023	Not available

Source: FAO, 2024; Statista, 2025; FAOSTAT, 2025

In 2021, maize production was 12.75 million metric tons, showing a slight increase from 12.4 million metric tons in 2020. The upward trend continued till 2022, with production rising by 1.6% to 12.949 million metric tons. However, in the 2024/2025, the area cultivated to maize declined to 5.1 million hectares, the lowest in 14 years. This sever decline is attributed to increased insecurity, weather variability and higher input costs.

Maize yield in Nigeria average is around 1.5–2.5 metric tons per hectare (MT/ha) this is lower compared to other major maize-producing countries worldwide due to factors such as poor soil fertility, limited access to improved seeds, inadequate mechanization, and erratic rainfall. The United States is one of the top maize producers, with an average yield of 10–12 MT/ha, due to advanced farming technology, irrigation, and improved hybrid seeds. China produces maize at around 6–7 MT/ha, benefiting from research-driven agriculture, better fertilizers, and irrigation systems. Brazil and Argentina achieve about 5–8 MT/ha, with Brazil being a major exporter due to its double-cropping system. South Africa is leading maize producer in Africa, South Africa achieves about 4–6 MT/ha with mechanized farming and hybrid seeds.

3. Theoretical Framework

Theory of Production and Production Function

This work is being propelled by theory of production, since yield of maize emanates from its production. Production economics is concerned primarily with profit maximization problem Obianefo (2019). The producer frequently is interested in allocating resources such that profits are maximized. The producer also attempts to maximize utility. To maximize utility, the farmer is gingered by a desire to make more money to fulfill their wants.

Even though, producers may have other goals, they frequently attempt to maximize their profit to achieving utility. But producers are faced with constraints. If producers are not constrained, they would produce to a point of anything that could be sold above the cost of production. Production economics is concerned with the basic choices that must be made to achieve the objective of profit maximization (Payang, Poyearleng, Ngaisset, and Xia, 2019)

The production function is a relationship between the quantities of inputs used per time and the maximum output possible (Obianefo, 2019; Noori, de Jong, Janssen Schraven, & Hoppe, 2020).). A production function can be an equation that uses the amounts of inputs (e.g. labour and raw materials) to produce an output (Obianefo 2019). The production function explains the characteristics of existing technology per time (Noori, de Jong, Janssen Schraven, & Hoppe, 2020). To explain the firm's technology, the generation of a function for the firm is an important starting point, because the function provides the maximum total output produced by using different and uaring combination of inputs. The average product is determined by the output divided by the total input to produce the output. The marginal product (MP) of an input is determined by the derivative of total output in respect of the change in an input. The function can be slightly more complicated by increasing the number of variable inputs from one to two. Thus, the output becomes a function of two variables while the maximum output is still the relationship between various combinations of inputs (Beattie and Taylor, 1985). The production function (PF) can be explained as

$$q = f(x) \qquad (1)$$

where q is output, $x = (x_1, x_2, \ldots x_n)$ is an n x 1 vector of inputs. The average out-put of the input is $\frac{q}{x} = \frac{f(x)}{x}$. Thus, the marginal out-put of the input is $\frac{dq}{dx} = \frac{df(x)}{dx}$ (Smirnov, 2024). An example of the PF with two inputs can be written as q = f (L, K) where q is the output attainable under current technology at any given labour, L and capital, K (Smirnov, 2024).

PF is based on a set of general assumptions (axioms). The properties of production functions certainly explain the relationship between the output and use of inputs when technology is given (Hyman, 1988).

- Nonnegativity: The value of is non-negative and finite real number (Smirnov, 2024).
- Monotonicity or nondecreasing in x: The additional units of an input that will cause a decrease in output will be disposed. Thus, the MP of the variable inputs are positive at the profit-maximizing level
- Concave in x: MP are non-increasing or approach zero as x increases, according to the law of variable proportion (Smirnov, 2024).
- Nonperiodic: A firm's production activity in one period is independent of production in following period (Beattie and Taylor, 1985).

3.1. Theory of Adaptation

Theory of adaptation to risk is required in this study as it theoretically explain the responses of maize farmers to CC risk in maize production. Therefore, the next theoretical framework for the study is adaptation theory. Adaptation is recognized as an important complementary response to GHG mitigation in addressing the risks of CC. Adaptation consists of deliberate actions to reduce the adverse effect, and harness the benefits of CC. A wide range of adaptation measures can be implemented in response to observed or anticipated CC. Adaptation measures offer the following possibilities to deal with climate risk:

3.2. The Safety-First Model (Uncertainty)

The second theoretical framework for the study is safety first model. This theory is applicable to this study because CC is a source of risk in agriculture. Hence, farmers need to adapt and mitigate those risks and ensure their production is safe. This is to enhances their yield which is key in this study, Risk is the probability that production will fall below a predetermine disaster level. This gives rise to safety first criterial (SFC). Farmers prefer an activity that has a certain return than those which has a risky return. A risk averter starting from a position of certainty is unwilling to take a bet which is actuarially fair (Arrow, 1970).

The Safety-First Model: Roy's (1952) Safety –First criterion advocated the minimization of the probability for outcomes below a certain "disaster" level. This criterion has not received much attention, because it has unrealistic implications for economic equilibrium. It enhances the decision-making process, inducing choices that cannot be explained by, and even contradict, risk-aversion, prospect theory preferences, and loss aversion in general. Roy argues that when making decisions about uncertain prospects, individuals' first consideration is to maximize the probability of reducing disaster, hence the name "Safety First Model".

There are different responses to risk. Risk-averse farmers are the most cautious risk-takers. Their lose emanate from missing economic opportunities for profit. Risk-neutral farmers understand the need to take some chances to continue their business, but before or acting, they analyze the information they have gathered the scenario and realistically reduce risks to acceptable levels. Risk lovers enjoy risks as challenging and exciting and take risks. Many speculators are categorized here. Most time they ignore facts and go ahead and commonly fail because they refuse to take precautions.

The sources and types of risk in maize production are numerous and diverse (Obike, Amusa and Olowolafe, 2018). Kahan, (2017). They are classified into: production risk (heavy rainfall, drought, and diseases and pests); marketing risk (demand for a product/price, cost of inputs, and cost of production); financial risk (loan and its cost); institutional risk (change in policy at the local, national and international levels) and personal/human risk (accidents, illness, civil unrest and death). The scope of this study is production risks posed by CC. These include drought, heavy rainfall, high/low temperature, low /high sunshine and so on. These risks are managed by mitigation and AS adopted by the farmer, which is determined by the farmers socioeconomic characteristics.

4. Methods

- **Population of the Study:** Registered cooperative maize farmers in South-eastern States, Nigeria were the component of the population of the study. The total number were 2,421. This data was elicited from their register.
- **Sampling technique:** The multi-stage sampling procedure was adopted. South-eastern States registered cooperative maize farmers (totaling 1,202) sampling

frame was adopted in selecting sample size for the study. Stage one adopted simple random sampling techniques to select three States in the South-East based on the record of registered cooperative maize farmers. Stage two adopted a purposive technique to select three Local Government Areas (LGA) from each state selected. In stage three, a simple random technique was used to select three communities from each of the LGAs. This gave a total of twenty-seven communities. In stage four, a simple random selection technique was used to pick 300 maize farmers for this study with the aid of well-structured questionnaires.

Analytical review/technique

2.6.1 Independent T-Test

Independent T Test is used for testing the difference of two means (Akinbile, Akinpelu, Akwiwu, Uzoamaka (2013). This is also called unrelated sample of scores. It is used to compare scores from two different groups of participants such as the scores of the sample test given to two different groups (unrelated samples). The samples size may or may not be equal. It compares the mean between two unrelated groups on the same continuous, dependent variable. For example, it could be used to understand whether revenue accruable to cassava producers differ based on their sex.

It will be used to test if there were significant differences in yield between the two farmers' group (farmers with high M&A to CC and those with low M&A)

$$T=\frac{\bar{x}_i-\bar{x}_j}{\sqrt{\frac{s_i^2}{n_i}+\frac{s_j^2}{n_j}}} \quad \text{………………..(1)}$$

Where $\bar{x}_i$= mean yield of farmerswith high level of M&A to CC

$\bar{x}_j$ = mean yield of farmerswith low level of M&A to CC.

S_i= mean yield of farmerswith high M&A to CC

S_j= sample variance for yield farmers

n_i= number of farmerswith low level M&A to CC.

n_j= number of with high M&A to CC

Linear regression analysis

Statistically,_ordinary least squares (OLS) estimates the unknown parameters in a linear equation model, with the intension of minimizing the sum of the squares of the differences in the dataset observed responses in the and those predicted by a linear function of a set of independent variables Akinbile (2015),. The general form or a basic OLS regression equation can be expressed by a simple formula as shown below:

Y_i = β_0+ βx_i +ε_i. In this equation,

Y_i represents the dependent variable,

β_0 represents a constant (intercept),

β represents the coefficient,

x_i represents the independent-variable and

ε_i represents the error term.

While OLS is computationally feasible and can be easily used while doing any econometrics test, there are underlying assumptions of OLS regression. The violation of these OLS assumptions would result in its misuse and give incorrect results. The assumptions are:

1. The OLS model is "linear in parameters."
2. There is a shocastic sampling of observations.
3. The conditional mean should be zero.
4. There is no multi-colinearity (or perfect colinearity).
5. Spherical errors: There is homoscedasticity and no autocorrelation.
6. Error terms should be normally distributed.

Objective 2: Y= β_0+β_{i1}socioeconomic characteristics+ As+ mitigation strategies+ϵ_i

Y= Yield (kg) (dependent variable)

socioeconomic characteristics, As, and mitigation strategies (independent variables)

Socioeconomic characteristics of maize farmers

X_1 = Years of formal education of the farmer (years)

X_2 = Age of the farmer (years)

X_3 = Gender of the farmer (Dummy Male = 1 female = 0)

X_4 = Household size of farmer

X_5 = Marital status of the farmer (Dummy Married = 1 otherwise = 0)

X_6 =Farming experience (years)

X_7 Labour used (Man-days)

X_8 = Extension contacts (Dummy Had contact = 1 otherwise = 0)

X_9 = Farm size (Ha)

Adaptation strategies used by farmers

X_{10} = use drought tolerant maize

$X_{11=}$ intercropping

X_{12} = Change planting date (early planting/Late planting)

X_{13} = dry Planting

$X_{14=}$ Livelihood diversification

X_{15}= Soil conservation,

X_{16}= Minimum tillage

X_{17}= Crop rotation

X_{18}= Irrigation

X_{19}= the integration of climate information into decision-making processes

Mitigation strategies used by farmers

X_{20}= Afforestation.

$X_{21\,=}$ Reforestation

X_{22} = Avoiding veld fires

X_{23}= agroforestry

$X_{24=}$ Soil water conservation technic,

X_{25} = Soil management practices that reduce fertilizer use

Objective 3: Ordinary Least square (OLS) for adaptation

The explicit forms of the functional forms are as follows:

Y= β_0+β_{i1}As +ϵ_i

Y= Maize yield (Tons/ha)

Adaptation strategies

X_1 = use drought tolerant maize

$X_{2\,=}$ intercropping

X_3 = Change planting date (early planting/Late planting)

X_4 = dry Planting

$X_{5=}$ Livelihood diversification

X_6= Soil conservation,

X_7= Minimum tillage

X_8= Crop rotation

X_9= Irrigation

X_{10}= the integration of climate information into decision-making processes

ϵ_i= error term

Objective 4: Y= $\beta_0+\beta_{i1}$mitigation strategies+ϵ_i
Y= Maize yield (Tons/ha)

Mitigation strategies
X_1 = Afforestation.
X_2 = Reforestation
X_3 = Avoiding wield fires
X_4 = agroforestry
X_5= Soil water conservation technic,
X_6= Soil management practices that reduce fertilizer use
ϵ_i= error term

5. Findings and Discussions

5.1 A Yield differential based on the level of Climate-change adaptation methods.

In **Table 3.2** farmers were categorized into high and low As by means of an index based on the number of As used. Farmers that used (1 ≤10) strategies were considered to have low CC adaptation while farmers that used more than 10 As were considered to have high adaptive strategies. Mean yield of maize for high adaptation was 958.30 kg per plot and for low adaptive strategies the mean yield was 433.54 per plot and the t value 5.4E+03 significant at 1%. Therefore, the null hypothesis that there are no yield differentials based on CC level. Ho is rejected and the alternative hypothesis was accepted.

Table 2A: Yield differentials based on the level of Climate-change adaptation strategies.

Variable	**Mean (kg)**	**T Value**	**P(|T| > t)**
High Adaptive Strategies	985.30	5.4×10^3***	0.000
Low Adaptive Strategies	433.54		

Author's computation, 2024

Yield differentials based on the level of climate- change mitigation strategies

In Table 3 B, farmers were categorized into high and low mitigation strategies by means of an index base on the number of mitigation strategies used. Farmers that used (1 ≤ 3) mitigation strategies were considered to have low CC mitigation while farmers that used more than 3 mitigation strategies were considered to have high mitigation strategies. Mean yield of maize for high mitigation was 845.42 kg per plot and for low mitigation strategies the mean yield was 573.84 kg per plot. The T value was 990.22 significant at 1%. Therefore, the null hypothesis that there is no yield differentials based on the level of CC mitigation strategies is rejected and the alternative hypothesis was accepted.

Table 3: B Yield differentials based on the level of climate-change mitigation strategies.

Variable	Mean	T Value	P(|T| > t)
High Mitigation Strategies	845.42	990.22***	0.000
Low Mitigation Strategies	573.84		

Author's computation, 2024

Effects of the socioeconomic factors on maize yield with respect to the Climate-change adaptation and mitigation

Table 4 presented the result of ordinary least square model to determine the effects of the socioeconomic factors on maize yield wrt CC AM. Sixteen variables were included in the model, but only five of the variables were significant at 1% and 5%. Prob > F = 0.0000, R-squared = 0.6757 and Adj R-squared = 0.5665 which revealed that the model is statistically significant. The model showed farm size/area of land cultivated for maize (p <0.0001). This is in line with the work of (Komolafe and Adeoti, 2018; Komolafe, 2023); afforestation (p <0.0001); taungya farming (p <0.001); and frequent weeding (p <0.0001) as the main variables that positively and significantly influenced maize yield. Vila (2021) in their work showed that the combined effect of weeds and environmental change is additive and averagely, weeds reduced crop yield by 28%. Also, Abdullahi, Gautam, Ghosh and Dawson, (2016) discovered that frequent and adequate eradication of weeds provide healthy environment for crop growth and consequently, improve yield immensely.

However, there are other variable that positively co-influence the yield of maize but were significant at (p <0.01). these are farming experience, education, late planting, use of resistant varieties, weather forecast, zero tillage and row /ridge planting.

Table 4: Effects of the socioeconomic factors on maize yield with respect to the Climate-change adaptation and mitigation

Variables	**Coefficient**	**p-value**	**Significance**
Sex	493.1141	0.101	
Farming_Experience	4025.975	0.017	*
Seed Quantity	-3.195966	0.601	
Farm Size/Area Of Land	65.119	0.000	***
Labour	15.41381	0.140	
Education	733.1342	0.013	*
Afforestation	842.0522	0.000	**
Taunya Farming	551.6317	0.004	**
Late Planting	436.4519	0.039	*
Use Of Resistant Varieties	452.464	0.017	*
Weather Forecast	389.508	0.046	*
Zero Tillage	452.464	0.017	*
Row/Ridge Planting	487.3772	0.016	*
Livelihood Diversification	205.7482	0.281	
Use Of Organic Manure	757.4874	0.000	***
Frequent Weeding	729.739	0.000	***

Author's computation, 2024

3.4 Influence of Climate-change adaptation strategies on maize yield

Table 5 showed the sole influence of CC AS on maize yield. The model contains 20 variables, but only two of the variables were significant at 5%. The model shows Prob > F = 0.0144, which implied that the whole model is significant at 10%, and an indication that other important variables were excluded in the model. This is confirmed by the low R-squared = 0.1273 and Adj R-squared = 0.0577. In the initial model that included the socioeconomics characteristic and mitigation strategies the results showed a high value of F, R-squared and Adj R-squared. This situation showed that CC As still have great influence on yield of maize yield. Considering the individual variables, it was discovered that use of organic manure (p <0.001).

Kandil, Abdelsalam, Mansour, Ali and Siddiqui (2020) noted that the compost organic manure application and the potassium content, impacted the crop height, ear size, grains population in rows, grains population /ear, 100- grain weight, straw and yields, protein and K in the grain. Increasing the compost from 5 to 10 ton/ha increased the yield, its components, protein and K contents. Frequent weeding ($p < 0.001$) positively and significantly influenced maize yield than other significant variables such as late planting ($p < 0.01$) row /ridge planting ($p < 0.01$) and early planting ($p < 0.01$) apart from organic manure. This conforms with the findings of Abdullahi, Gautam, Ghosh and Dawson, (2016), that weeds eradication promotes healthy growth environment for crop plant and improvement in maize yield.

Table 5: Influence of Climate-change adaptation strategies on maize yield

Variables	Coefficient	p-value	Significance
Late planting	465.4182	0.028	*
Use of resistant varieties	60.91332	0.801	
Weather forecast	303.3136	0.251	
Repeated sowing	133.2541	0.588	
Drought-resistant crops	54.37496	0.813	
Zero tillage	31.85247	0.915	
Row/ridge planting	433.788	0.048	*
Land rotation	92.59424	0.680	
Fallowing	179.4553	0.457	
Mixed farming	143.5799	0.552	
Early planting	419.4541	0.047	*
Mixed cropping	81.14567	0.745	
Livelihood diversification	170.6226	0.445	
Change of planting date	54.35974	0.821	
Crop substitution	87.92565	0.737	
Crop diversification	125.6617	0.627	
Use of organic manure	804.7656	0.001	**
Frequent weeding	541.4307	0.002	**
Indigenous knowledge (mulching)	243.3929	0.302	
Information from extension agents	31.60797	0.888	
Constant	614.0694	0.096	

Author's computation, 2024

3.5 Influence Climate-change mitigation strategies on maize yield

Table 6 presented the sole influence of CC mitigation strategies on maize yield. six variables were included in the model, but one of the variables was significant at 5%. The model showed Prob > F = 0.0001, it means the whole model is significant at 1%, indication that CC mitigation is a good way to significantly influence maize yield. R-squared was 0.0939 and Adj R-squared was 0.0753 which were low. This indicated that some vital variables were excluded in the model. In the initial model that included the socioeconomics characteristic and AS the results showed a high value of F, R-squared and Adj R-squared. This showed that CC mitigation strategies still have great influence on yield of maize yield.
Considering the individual variable effect, it was noted that afforestation ($p < 0.001$), positively and significantly influenced maize yield than other significant variables such as reforestation ($p < 0.01$) and taungya farming ($p < 0.01$). Baier, Gross, Thev and Glaser, (2023) noted that agroforestry improved median maize output by 0.24 Mg ha−1 (7%) in compared to tree/hedgerow free maize monocultures. In subtropical and tropical regions, the median output increment with agroforestry was 0.30 Mg ha−1 (+16%), and the best results were obtained with nitrogen fixing broadleaved trees (+0.56 Mg ha−1, +60%). Maize output responded well to the tree part pruned and ploughed to the soil (+0.48 Mg ha−1, +24%).

Table 6: Influence of Climate-change mitigation strategies on maize yield

Variables	Coefficient	p-value	Significance
Afforestation	667.0366	0.009	**
Reforestation	94.7369	0.014	*
Avoid wildfire	277.3965	0.165	
Maintain wetland	48.12663	0.806	
Agroforestry	61.55942	0.772	
Taunya farming	56.4972	0.032	*

Author's computation, 2024

4. Conclusion

The study provides empirical evidence that CC AM on influence maize yield in south-east Nigeria with yield differential wrt the level of CC AM strategies. The level of use of AS was influenced positively by experience household size, labour and extension contact, while mitigation strategies was influenced experience and marital status. Farm size, afforestation Taunya farming, organic manure and frequent weeding positively and significantly influence maize yield.
The study highlights the urgent need for CC mitigation policies and AS to be strengthened to prevent further decline in maize production in Nigeria of various strategies, implementation and the innovative practices adopted to ensure women empowerment. Training and development must incorporate the element of un-conscious gender bias that help women leaders overcome barriers (Madsen & Andrade, 2018).
By actively engaging in a critical examination and restructuring of decision-making procedures that may give rise to gender biases, it is possible to diminish the occurrence of errors that undermine the efficacy, competitiveness, and equity of organizations.(Balabantaray & Samal, 2022; Chang and Milkman, 2020)[3, 4, 6, 7, 8, 16].

5. Recommendations

- Farm size/area of land cultivated with maize was statistically significant. It means that to increase maize yield in Nigeria, maize farmers should be encouraged to expand their farmland. Expansion of land cultivated for maize should be policy to be implemented by states governments through acquisition of farmland and allocating same to real maize farmers.
- Use of organic manure should be promoted and availability of this manure before the planting season is a workable policy that needs to be pursued by stakeholders.
- Clearing weeds as at when due is important, the policy of using polyethene cover to prevent weed in maize farms should be embarked upon by maize farmers through the help of the government in availability, accessibility and affordability.
- Implementing stronger environmental protection policies that regulate deforestation, land degradation to preserve soil and water resources, promote afforestation and reforestation programmes to counteract carbon emissions should be pursued by stakeholders to enhance maize yield and promote CC mitigation and improve soil fertility.
- Infrastructural facilities for CC M&A should be provide by government, nongovernmental organizations and other stakeholders. This requires the development and

promotion of climate-smart agricultural practices-drought-resistant varieties of maize planted, conservation agriculture, and efficient irrigation systems as incentives for farmers adopting sustainable farming practices.

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