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Climate Change Adaptation Strategies and Farm Profit of Watermelon Farmers in Iwo ADP Zone of Osun State, Nigeria

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Abstract

Climate change impacts the world in many ways, and agriculture is one sector affected. The broad objective of the study is to assess the effect of climate change adaptation strategies on farm profit among watermelon farmers in the Iwo ADP zone of Osun State, Nigeria. The primary source of information for the study was data collection instruments of nicely composed questionnaires. Information captured includes farm inputs and costs, farm outputs and prices, climate adaptation strategies such as mulching, covering with sac, irrigation system, and cultivation of improved varieties. Data were subjected to evaluation with descriptive statistics and multiple regressions. It was revealed from the study that the common age of the farmers was 46.88±2.04 years, the majority (85.8%) were male with an average family size of 5±1 persons. The average years of farming practices was 13.4 ±2.30 years and the mean farm size was 2.70± 0.2 acres. The study's findings revealed that important climate change adaptation management techniques utilized by the farmers include mulching, use of agrochemicals, covering with sac, and use of an irrigation system. The gross farm income per acre is estimated at ₦153,074.6 and a BCR of 1.4. Multiple regression analysis revealed the factors influencing the profit include gender ($p \leq 0.05$), farm size ($p \leq 0.01$), farming experience ($p \leq 0.01$), access to credit ($p \leq 0.05$), and climate change adaptation ($p \leq 0.01$). The study concluded that the use of climate change adaptation techniques increased the level of farm profit.

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Introduction

Climate change is characterized by changes in long-term weather patterns; it presents serious obstacles to many different industries globally. The long-term patterns of temperature, precipitation, humidity, and wind in a certain location are referred to as the "climate" (Prakash, 2021), whereas "change" refers to modifications in these patterns over long periods that are frequently caused by both natural and human activity (Corwin, 2021). Climate change refers to a huge variety of adjustments, including versions in temperature, styles of precipitation, and the frequency and severity of excessive climate activities like hurricanes, droughts, and heat waves (Bell *et al*., 2018; AghaKouchak *et al*., 2020; Robinson, 2021; Olaoluwa *et al*., 2022).

Climate change impacts the world in many ways, and agriculture is one susceptible sector (Agovino *et al*., 2019; Malhi *et al*., 2021). According to Pawlak and Kolodziejczak (2020), agriculture is essential to both economic stability and global food security. Successful crop production in agriculture is highly dependent on meteorological conditions (Malhi *et al*., 2021). Changes in growing seasons (Ruane and Rosenzweig, 2019), adjustments in rainfall styles, au upward push within the frequency of excessive climate activities (Durodola, 2019), and an increase in pests and illnesses (Skendžić, *et al*., 2021) are just a few of the ways that climate change is affecting agriculture. Traditional agricultural methods are disrupted, crop yields and quality are threatened, and livelihoods, food security, and rural economies are put in jeopardy globally by these developments.

Nigeria, being mostly an agrarian country, is not left out of the consequences of extreme weather variations (Dabara *et al*., 2019; Effevottu and Ihuoma, 2019). There have been notable variations in temperature and precipitation levels in Nigeria over the past few decades, according to empirical research (Gbode *et al*., 2019; Ilori and Ajayi, 2020; Shiru *et al*., 2019, 2020; Raimi *et al*., 2021). Consequently, average temperatures have surged upward and rainfall patterns have grown more unpredictable, resulting in an additional magnitude of occurrences of droughts and floods across the nation (Durodola, 2019; Shiru *et al*., 2020). These climate-induced changes pose substantial challenges to Nigeria's agricultural sector (Wahab and Popoola, 2018), which employs a sizeable part of the populace and contributes appreciably to the nation's Gross Domestic Product (GDP) (Osabohien *et al*. 2019; Busari *et al*. 2020). Adaptation strategies have become essential tools in the fight against climate change, helping to reduce its negative effects on agricultural systems and increase resilience. In order to reduce susceptibility and increase agricultural systems' ability to adapt to changing climatic circumstances, a variety of techniques, technologies, and policies are included in adaptation plans (Wahab and Popoola, 2018; Bedeke, 2023). Crop diversification, drought-resistant variety adoption (Magesa *et al*., 2023), water conservation measures (Marie *et al*., 2020), and agroforestry practices (Gifawesen *et al*., 2020; Ogunkalu *et al*., 2022) are a few examples of these strategies. The need for agricultural adaptation strategies arises from the requirement to protect food production, offer meal security, and hold rural livelihoods in adjustment and coping with extreme weather variations. In particular, strategies for adaptation are essential for watermelon because of the crop's susceptibility to weather conditions like temperature, humidity, and rainfall (Tunde, 2019).

There is a paucity of research records on the climate change on watermelon in Nigeria, little or no research efforts dissipated on the relationship between climate change impacts on farm income. However, large numbers of studies were conducted on climate change impact on agriculture at large. Tunde (2019) conducted a study on the vulnerability of vegetables to the effect of climatic variability and the administration strategies in the guinea savanna area of Nigeria.The outcomes of the study showed that the climatic elements examined fluctuated with the exception of temperature that is stable and keeping rising over the years and the year 2001 witnessed the highest (40.06ºC). The study confirmed the high-quality correlation between some greens and rainfall and temperature while exploration of irrigation facilities and water harvesting applied sciences were recommended. Solankey *et al.* (2021) research the hindrances and possibilities in vegetable cultivation in altering climate environments. They affirmed that climate instability is not so an awful lot damaging however excessive occasions such as irregular rainfall patterns, excessive and low temperatures are tough to forecast and minimize crop productivity. Any surprising adjustments in climatic elements like alternate temperature, and erratic precipitation can affect the special boom ranges of plant boom like pollination, flowering, fruit setting, improvement and ripening due to the fact of succulent (have 90% water) and touchy nature of vegetables towards weather variations. In consideration of the background of this research, the study aimed at examining various climate change coping strategies utilized by watermelon farmers in the Iwo ADP zone of Osun State and analyse the effects of climate change adaptation strategies practiced on farm profit.

Materials and Methods

Study Area

This study was executed in the Iwo Agricultural Zone of Osun State, Nigeria. The vicinity is one of the three (3) Agricultural Development Project (ADP) zones which include Osogbo, Iwo and Ife/ Ijesha in the state. Iwo area is geographically coverage in land area of 245 km^2 and has statistical data of 191,348 people (National Population Commission (NPC), 2006). The zone is made up of seven Local Government Areas (LGAs) which include Iwo, Irewole, Ejigbo, Ayedire, Ayedaade, Isokan and Ola-Oluwa. The common means of livelihood in the zone is agricultural production notably agronomy practices and livestock production in a small and medium scale and are predominantly Yoruba by tribe. The area enjoys a tropical climate with prominent wet and dry seasons. The rainy season generally occurs between April and October while the dry season occurs between November and March. The area is at the advantage of tropical weather with distinguished moist and the dry seasons. The rainy season usually arises between April and October at the same time as the dry season arises between November and March.

Sampling procedure and sample size

A multi-stage sampling procedure was explored for selection of the population sample. in the first step, the Iwo ADP zone was purposively selected among the three (Iwo, Osogbo and Ife/Ijesha) zones in the state as the zone is prominent in large quantities of the output of watermelon. The next step was random choice of three (3) blocks among the seven (7) blocks in the Iwo zone. The third step was a random choice of six (6) cells from the selected block in the second step. The last step was a random choice of ten (10) watermelon farmers from each town to make a total of 120 watermelon farmers as the sample population. The sample frame is obtained from the list of watermelon growers associations sourced from the zonal office of ADP at Iwo.

Data collection sources

The primary source of sourcing information was utilized to elucidate information from watermelon farmers with the resource of a well-prepared questionnaire which was administered, collated and analyzed. The questionnaire captures the socio-financial descriptions of the watermelon farmers, various climate change coping techniques, information on quantities of inputs applied and their costs. Information sourced also includes quantities of produce and market cost.

Analytical techniques

Analytical methods applied include descriptive records including mean, standard deviation and multiple regression evaluation.

Gross profit analysis

To estimate the gross farm income of watermelon production, gross profit analysis was applied following Nariswari and Nugraha, (2020). The analysis was given as:

TFR (Total Farm Revenue) = Price x Quantity

GFI (Gross farm income) = TFR (Total Farm Revenue) – TVC (Total Variable Cost)

Model specification

Multiple regression evaluation was used to establish the impact of weather variations coping techniques on farm earnings. The empirical model is specified as:

$Y= \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5 + \beta_6X_6 + \beta_7X_7 + \beta_8X_8 + et$

Where;

Y = Farmers' income (₦)

X_1 = Age (years)

X_2 = Duration of formal schooling (years)

X_3 = Gender (Male =1, Female = 0)

X_4 = Residential occupants (number of persons)

X_5 = Farm size (acres)

X_6 = Duration of cultivation (years)

X_7 = funding access (Yes = 1, 0 otherwise)

X_8 = Climate change adaptation strategies (aggregate scores)

et = Random error term

Results and Discussion

Socio-economic descriptions of the watermelon farmers

Table 1 presents the age distribution of the farmers. The result shows the considerable number (64.1%) of the farmers was above the age of 40 years. The common age is discovered to be 46.88±2.04 which implies that the farmers are older and this old age might have a negative effect on their productivity and adoption of beneficial climate adaptation strategies. This output of the research is contrary to Adeoye *et al*., (2020), and Ndanitsa *et al*. (2021) who established that watermelon farmers are middle-aged. Results on gender participation in watermelon cultivation in Table 1 indicates a predominantly males population (85.8%), with females comprising only 14.2% of the total respondents. This showed that males were more involved in watermelon farming than females maybe due to the hectic nature of the cultivation and or the perceived norm that women belong to the home as home builders. This conforms with Adeoye *et al*., (2020); Ndanitsa *et al*., (2021) and Anthony *et al*., (2023) report of male dominance in watermelon farming. It is revealed from the results in Table 1 that the majority (85.8%) of the farmers are educated which indicates that a level of literacy might assist them in the adoption of advanced agricultural techniques that can improve their farming output.

Analysis in Table 1 establishes that a larger number (87.5%) of the farmers have household members which are more than three persons. The average number of residential occupants of the watermelon farmer is 5±1persons. The result suggests a large household size among watermelon farmers and may be an advantage for them in reducing farm costs on labour as household members can also serve as labour. The result on duration of cultivation shows that more than half (56.7%) of the farmers have more than ten years of duration of cultivation. The mean year of duration of cultivation is approximately 13.4 ±2.30 years. This indicates that the watermelon farmers have a substantial level of knowledge in watermelon farming and may possess the technical know-how and make the right decision. Consistently, Anthony *et al*., (2023) in their study reported farming experience of over 10 years among watermelon farmers. According to the results in Table 1, more than half (62.5%) of the farmers grow crops which less than 3 acres of land. The average farm size is 2.70± 0.2 acres. The consequence of this output of the research is that the farmers are small holders and this small acreage cultivation may hinder farm expansion and thereby limit farm earnings. This output of the study is similar to the results of Adeoye *et al*. (2020); Okeke *et al*. (2020) who discovered a considerably low farm size of watermelon farmers in southwest Nigeria.

A considerable number (90.8%) of the farmers lack access to farm funding which may limit farm expansion. This the outcome of the work is similar to the findings of Ndanitsa *et al*. (2021) who discovered that watermelon farmers do not have access to credit. The majority (92.5%) of the farmers sourced their capital from personal savings which are consistent with the findings of Adeoye *et al*. (2020) who found that watermelon farmers mostly utilize their individual savings to finance their agricultural productions. The outcome of the research in Table 1 indicates limited access to extension services among watermelon farmers, with only 4.2% of farmers receiving extension services. This might affect the adoption of improved farming practices. Anthony *et al*. (2020) also reported poor access to extension services among watermelon farmers.

Table 1. Socioeconomic attributes of the watermelon Growers

Characteristics	Frequency	Percentage (%)
Age		
≤ 30	3	2.5

31-40	40	33.3
41-50	36	30.0
51-60	25	20.8
≥ 61	16	13.3
Mean = 46.88	S.D = 2.04	
Gender		
Male	103	85.8
Female	17	14.2
Level of education		
No formal education	17	14.2
Primary education	50	41.7
Secondary education	47	39.1
Tertiary education	6	5.0
Residential occupants		
1-3	14	12.5
4-6	89	74.2
7-9	12	10.0
>10	4	3.3
Mean = 5.00	S.D = 1.00	
Duration of cultivation (years)		
<5	23	19.2
5-9	29	24.2
10-14	26	21.7
15-19	17	14.2
>20	25	20.8
Mean = 13.38	S.D = 2.30	
Farm size (acres)		
<3	75	62.5
3-5	31	25.8
6-9	9	7.5
>10	5	4.2

Mean = 2.70	S.D = 0.20	
Farm credit utilization		
No	109	90.8
Yes	11	9.2
Source of capital		
Personal savings	111	92.5
Friends and relative	55	45.8
Money lenders	1	0.8
Bank	7	5.8
Cooperatives/thrift	63	52.5
Access to Extension services		
No	115	95.8
Yes, monthly	5	4.2

Source: Field Survey Data (2024).

Climate change perception

Table 2 indicates the distribution of the farmers based on their perception of climate change. Table 2 reveals that all farmers (100.0%) are aware of climate change, with the majority recognizing higher temperatures (95.0%) and erratic rainfall patterns (85.0%). 81.7% recognize increased rainfall 16.7% recognize decreased rainfall while a few (5.0%) recognize lower temperature. Wahab and Poopola (2018) also reported that high temperature is perceived as a major component of climate change. Furthermore, most (70.0%) have made adjustments to reduce the impact on their farms while few (30.0%) were indifferent.

Table 2. Distribution of the farmers based on climate change perception

Variable	Frequency	Percentage
Awareness		
Aware	120	100.0
Forms		
Higher temperature	114	95.0
Lower temperature	6	5.0
Increased rainfall	98	81.7
Decreased rainfall	20	16.7
Delayed/erratic rainfall pattern	102	85.0
* **Multiple response**		
Any adjustment to reduce impact on the farm		
Yes	84	70.0
Indifferent	36	30.0

Source: Field survey (2024).

Climate change adaptation strategies

Table 3 presents the distribution of the farmers on based climate change adaptation strategies. Using the Weighted Mean Score (WMS), mulching (1.7) was the most climate change adaptation strategies. This is because watermelon needs moisture and mulching helps to conserve soil moisture and regulate temperature which makes it an important strategy. Mulching is closely followed by the use of agrochemicals (1.6), covering with a sac (1.6) and use of an irrigation system (1.6). Conformably, Wahab and Poopola (2018) reported irrigation as a major adaptive measure used by farmers to reduce the effect of climate variability. The use of agrochemicals suggests that the farmers use agro-chemicals to boost the soil health if devoid of necessary nutrients. Also, irrigation system is largely used. As observed on their farms, some of them fetch water in drums/plastic which they use later if the temperature is high. Few of them have sheds with roofing that can collect water into drums. The farmers regard this as an irrigation system since it also involves managing and storing water and or water resources for later use while few are automated. Also, when there is high temperature, the farmers indicate that they use sacs to cover already germinated watermelon, so as to prevent discoloring and dehydration. This protects crops from adverse weather conditions and pests. Other climate change adaptation strategies management practices include; the application of urea (WMS=1.4), instant sales to fruit processors (WMS=1.2), use of foliar fertilizer (WMS=1.2), use of improved varieties (WMS=1.0), intercropping (WMS=0.9) and contour farming (WMS=0.8).

Table 3. Distribution of the farmers based on the climate change adaptation strategies

Strategies	Frequently	Often	Occasionally	Never	WMS
Mulching	21(17.5)	51(42.5)	39(32.5)	9(7.5)	1.7
Use of agrochemical	17(14.2)	55(45.8)	35(29.2)	13(10.8)	1.6
Covering with sac	12(10.0)	60(50.0)	34(28.3)	14(11.7)	1.6
Use of irrigation system	14(11.7)	65(54.2)	23(19.2)	18(15.0)	1.6
Application of urea	11(9.2)	54(45.0)	26(21.7)	29(24.2)	1.4
Instant sale to processors	7(5.8)	28(23.3)	62(51.7)	23(19.2)	1.2
Use of foliar fertilizer	6(5.0)	42(35.0)	43(35.8)	29(24.2)	1.2
Use of improved varieties/climate resistance	5(4.2)	34(28.3)	42(35.0)	39(32.5)	1.0
Intercropping	1(0.6)	16(13.3)	77(64.2)	26(21.7)	0.9
Contour farming	4(3.3)	26(21.7)	32(26.7)	58(48.3)	0.8

Source: Field survey (2024).
* Multiple response.

Gross profit of watermelon per acre

Table 4 indicates the costs and returns of watermelon farming in the study area. The Table shows that the mean revenue from sales is ₦540,717.9, the total gifted is ₦5,700.6 and total consumed is ₦8,206.0 and the total revenue (Sold+gift+consume) is ₦554,624.5. The total variable cost is ₦401,549.9 with land preparation, labour cost and fertilizer cost accounting for 35.8%, 25.0% and 18.3% of the total variable cost respectively as the major costs incurred. The gross farm income per acre is estimated at ₦153,074.6 ($101.23) and a BCR of 1.4. This indicates that for every ₦1 invested in variable costs, there is a return of ₦1.4. A BCR greater than 1 signifies that watermelon farming is profitable. Similarly, Adeoye *et al*., (2020) reported a BCR of 1.24 which is low compared to this study Alabi *et al*. (2021); Ndanitsa *et al*. (2021) and Anthony *et al*., (2023) also reported that watermelon farming is profitable.

Table 4. Gross profit analysis of watermelon per acre

Items	Quantity (sack)	Unit Price (₦)	Mean (₦)	%TVC
Sold	18.6	4547.3	540717.9	
Gift			5700.6	
Consume			8206.0	
Total Revenue			**554624.5**	
Variable cost				
Planting cost			9168.7	2.3
Land preparation cost			143769.3	35.8
Fertilizer cost			73358.5	18.3
Herbicides cost			57277.7	14.3
Labour cost			100434.8	25.0
Water cost			9724.2	2.4
Transportation cost			5057.7	1.3
Storage cost			2759.0	0.6
Total variable cost (TVC)			**401549.9**	
Gross Farm Income (TR-TVC)			**153074.6**	
BCR			**1.4**	

Source: Data analysis (2024).
*1USD = ₦1, 512.14 (Exchange rate of naira to USD at the period of the study.

Regression analysis

Table 5 shows the regression result on the impact of climate change adaptation techniques on farm profit. Age, duration of formal education, gender, residential occupants, farming experience, access to credit and employed climate change adaptation techniques aggregate was regressed against farm income from watermelon farming. The R^2 showed that the independent variables account for 69.8% of the entire variant in the established variable of the model and a significant F-value of 12.012 showed that the reference equation of the research is adequate. The result showed that the coefficient of gender has a significant negative influence on farm income, as indicated by the negative coefficient and significant at a 5% level of significance. This suggests that being female may be associated with lower farm income, possibly due to differences in access to resources or support. As such, male farmers will have a higher income than the females farmers by 0.492 units.

The result also showed that the coefficient of farm size has a significant positive influence on farm earnings, and was significant at 1%. This indicates that a unit increase in farm size will result in a 0.202 unit increase in farmers' profit. Notably, larger farm sizes are associated with higher farm earnings. However, this is related to the time horizon of the production in which the conditions to which the production process is subject, whether they are long-run conditions where the farm size can be changed, or short – run conditions where the farm size cannot be changed. The coefficient of farming experience was positive and significant to farm income at 1%. This showed that an additional increase in farming experience by a year will result in a corresponding 0.036 increase in farmers' income. This is due to the fact that experienced farmers have a tendency to have better skills, knowledge, and practices that enhance farm profitability. Adeoye *et al*., (2020) and Okeke *et al*., (2020) also confirmed that years of farming practices affect watermelon output positively. The coefficient of the access to credit of -0.681 had an inverse and statistically significant with farm income at a 5% level. This counterintuitive result could suggest that farmers taking loans might be struggling to repay them or that the credit received is not being used effectively. The coefficient of climate change adaptation techniques was positive and significant at a 1% level of significance. This showed that the climate change adaptation techniques employed by the farmers are effective and raise farm income. As such, engaging in more techniques can result in more income.

Table 5. Regression analysis showing the effect of climate change adaptation techniques on farm profit

Variables	Coefficient	Std. Error	t value	p value
Intercept	13.340	0.719	18.561	0.000**
Age	0.001	0.010	0.130	0.897
Years of education	0.023	0.021	1.093	0.277
Gender	-0.492	0.225	-2.186	0.031**
Household size	-0.060	0.052	-1.154	0.251
Farm size	0.202	0.043	4.697	0.000***
Farming experience	0.036	0.011	3.320	0.001***
Access to credit	-0.681	0.274	-2.485	0.015**

Climate change adaptation techniques	0.011	0.015	2.690	0.011***
R^2	0.698			
Adj. R^2	0.488			
F value	12.012**			

Source: Data Analysis (2024).
*** Significant at 1%, ** Significant at 5%, * Significant at 10%.

Conclusions

The study has discovered that watermelon growers in the Iwo ADP zone of Osun State employed some climate change adaptation management techniques to reduce the effect of climate change which include mulching, use of agro-chemical, and covering with sac among others. These strategies have been showing to increase the income from watermelon farming as revealed by the regression analysis. Furthermore, the regression analysis also revealed that gender, farm size, farming experience, access to credit, and climate change adaptation strategies significantly impact farm income. The positive and significant nature of variables of farm size and farming experience indicates that larger farm sizes and greater experience contribute to higher farm income. The positive impact of climate change adaptation techniques highlights the importance of these practices in enhancing farm profitability. Based on the discoveries of this study, there is a need for credit service facilities provision in the coverage area of the research. This will assist watermelon farmers to expand their scale and also invest in risk management strategies. Also, extension services delivery is ineffective and there is need for continuous education and support for farmers in implementing effective climate change adaptation strategies that can help them reduce income.

Conflict of Interest

The authors confirm that there are no conflicts of interest in this research.

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