



FACTORS INFLUENCING THE ADOPTION OF CLIMATE SMART AGRICULTURAL PRACTICES AMONG IRISH POTATO FARMERS IN PLATEAU STATE, NIGERIA

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ABSTRACT

The study examined the factors influencing the adoption of climate smart (CSA) agriculture among Irish potato farmers in Plateau State, Nigeria. A multi-stage sampling technique was used in selecting 390 respondents. Data were collected using structured questionnaire and analysed using descriptive and inferential statistics. The results revealed that more than half (51.5%) of the respondents were male with a mean age of 40.36 years. Majority (66.3%) of the respondents were married, and 52.8% had tertiary education. The mean household size, farm size and farm experience of the respondents were 6 persons, 1.4ha and 15 years respectively. Perception of respondents on climate change was the poor yield of potato (4.58). The result further revealed that farm size ($P<0.01$), age ($P<0.05$), and income ($P<0.1$) were the major factors that significantly influenced the adoption of climate smart agricultural practices. The major constraints to adoption of CSA were inadequate information from meteorologists (86.5%), inadequate information from research centers (79.8%), and inadequate capital (76.5%), which were ranked 1st, 2nd, and 3rd, respectively. The study concluded that adoption of CSA was influenced by factors such as age, farm size, income and yield. The study recommended that policy makers are to note farmers concerns on climate variability, small scale irrigation as CSA practices be given emphasis, private sectors should establish extension services, meteorological centers and farmers advised to form cooperatives to help them acquire low interest loans in acquiring farm inputs.

Keywords: Adoption, Climate, Change, Smart, Agriculture.

INTRODUCTION

Agricultural sector influences the economic growth process, increases the supply of food and fiber for domestic consumption (Sasu, 2023). It generates foreign exchange through exports, increasing domestic saving and rural purchasing power (Uche *et al.*, 2023). In the year 2023, Agriculture account for a significant portion of 22.91% of Nigeria's Gross Domestic Product (GDP) as a key activity for the country's economy after oil (NBS, 2023). For instance, in the year 2023, agriculture accounted for 19.63% Gross Domestic Product (GDP) of Nigeria (NBS 2023). The confluence of economic meltdown and food security has placed enormous emphasis on resilience across the globe. Nigeria like many countries is facing the double burden of economic recession and food insecurity, and the critical role of the agricultural sector in the Nigerian economy cannot be overemphasized. (Nwachukwu, 2023).

In recent times, climate poses a great challenge to agriculture (Okelana, 2022). Climate is the long-term pattern of weather that a particular area experiences from over a



long period of time, for example between 30 to 35 years. (Cowling and Jaeger, 2021). Climate change is one of the most pressing challenges of our time, with far reaching impacts on the environment, societies, and economies. Bulus and Nimfa (2017), reported that the variation of weather (Rainfall, Temperature, Extreme events has negatively affected Potato quality production in Plateau State, Nigeria. Also, as a traditional method of being climate Smart in the area of Potato production in Plateau State, the farmers inter crop Potato with Maize, and the chemical fertilizers which were initially applied for potato will also be used for the Maize, reducing the effects of its toxicity in the soil, i.e. reducing the greenhouse gas emission (GHGs) (Tiamiyu *et al.*, 2019).

Climate-smart agriculture (CSA) is an integrated approach that uses a set of agricultural practices and technologies which boost adaptation, resilience and productivity as well as reduce/stem down Green House Gasses (GHGs) emissions. Generally, it is built on: existing agricultural knowledge, technologies and sustainability principles (Zaman, *et al.*, 2021). The agricultural policy ambitions of the Nigerian government cannot be met without climate-smart agriculture (Alalade *et al.*, 2023). In order to create adaptation methods in order to deal with the challenges and risks of climate variability in the agricultural sector, farmers' awareness and perception of climate variability and adoption of Climate-smart agriculture (CSA) is very essential (Abubakar, *et al.*, 2022). Such knowledge is essential in Nigeria since the key predictor of how well agriculture can be carried out is climate, and changes in climate (rainfall, temperature, extreme events) have significant effects not just on the agricultural sector but also on other sectors particularly potato crop in Plateau State, Nigeria. (Olagunju *et al.*, 2022).

Potato is one of the food crops grown in Plateau State, Nigeria, but it is not being grown fast enough in relation to the major problems farmers are experiencing in its production. These include drought, flood, extreme temperatures, drastic changes in rainfall patterns and rise in temperatures. All these factors pose unfavorable growing conditions into the cropping seasons. These changes modify growing seasons and subsequently reduce yield. Production is greatly dependent on environmental factors provided by nature and the optimum combination of these factors plus production inputs determine yield (Adekunmi, 2022).

Apart from the works of Bulus and Nimfa (2017) on "effects of climate change on Irish potatoes in Plateau State", similar works by Henri-Ukoha (2019) on "financing climate change smart agriculture: a panacea for sustainable food production in Nigeria", Goni (2021) on "analysis of extension services delivery on improved potato in Northern zone of Plateau State, Nigeria", Adamu *et al.*, (2022) on "analysis of factors influencing the adoption of potato planting material technologies in Plateau State, Nigeria", Malum and Habakkuk (2023) on "potential yield of Irish potatoes under surface irrigation in Semi-Arid Zone of Benue Valley of Makurdi, Nigeria" and Gabriel *et al.*, (2023) on "State of climate smart agricultural (CSA) Practices in the North Central and Northwest zones Nigeria", did not address climate smart agriculture respectively in the study area, creating dearth of literature with regard to climate change. It against this backdrop that the was conducted and specifically the research aimed to;

- i. describe the socio-economic characteristics of potato farmers in the study area;
- ii. determine the factors influencing the adoption of climate smart agriculture;
- iii. describe the constraints to the adoption of climate smart agriculture among the respondents in the study area.



MATERIALS AND METHODS

The Study Area

The study was conducted in Plateau State, Nigeria. The State has 17 Local Government Areas, divided into 3 zones- Northern, Central and Southern zones. It is located between Latitudes 80° 24' N to 10° 30'N and Longitudes 80° 32' and 100° 38' East (NBS, 2022). Plateau State is Primarily an agrarian community having a land mass of 26,026km² with a projected population of 4,717,300 (PLSG, 2021; NBS, 2022). The mean annual rainfall stands at 1200 mm, with a mean temperature of about 22⁰c (Binbol *et al.*, 2020). The State is bounded to the North by Bauchi State, North-West by Kaduna State, West by Nassarawa State and South-East by Taraba State. The major food crops produced in the State are Cereals like Maize, Sorghum, Millet, Acha, Root and tubers like Yam, Cassava, Sweet potato, Irish potato, Livingstone potato, Leguminous crops like Ground nut, Soya beans, Cowpea, vegetables such as Cabbage, Lettuce, Cucumber, Radish, Carrots, Sweet pepper, Egg plants, Chili peper, Tomatoes, Strawberry, Green beans, Persely, tree crops like Apple, Avocado, Olives among others. The State has area has high concentration of Irish potato farmers in the Central and Northern zones. The major economic activities of the people are production and marketing of potato (Adamu, *et al.*, 2022).

The major tribes found in the State were Ngas, Berom, Fer, Hausa, and Fulani to mention a few. About two third of the land area is arable. Cereal production on the Plateau represents about 43% of all the agricultural produce; root and tubers represent about 21%. The least is Forest products which represents 13% (Oladimeji *et al.*, 2020). Indeed, the study area, being a temperate area, it favours the production of temperate crops like Potato (*Solanum tuberosum* L), avocado pear, apple, cabbage and radish just to mention but few. It is on this backdrop that the crop in question i.e. potato is being researched upon. The main commercial activities of the people are farming mining and trading (McKenna, 2023).

Sampling Technique and Sample Size

A multi-stage sampling technique was adopted for this study. In the first stage, a purposive sampling of two (2) zones comprising Central (Pankshin, Mangu and Bokkos) and Northern zones (Barkin-Ladi, Jos South and Riyom) were selected. In the second stage three (3) Local Government Areas (LGAs) were purposively selected from each zone giving a total of six. This was due to their prominence in Potato (*Solanum Tuberosum* L.) production in the area. The selected LGAs includes Pankshin, Mangu and Bokkos (central zone) and Barkin-Ladi, Jos South and Riyom (Nortern zone). In the third stage, two (2) districts were purposively selected from each LGA making a total of 12 districts. In the fourth stage, two (2) villages were purposively again selected in each district based on their prominence in potato production, giving a total of 24 communities. In the final stage, a total of 394 Potato farmers were selected randomly and proportionately (5%) as presented in Table 1. However, only 392 questionnaires were returned after data collection. The procedure was adopted from Onyemma *et al.* (2020) as stated below:

$$n = \frac{N}{1+N(\alpha)^2} \quad \dots(1)$$

Where;

N = sample frame for the three Local Government Areas

n = sample size

α = margin of error (fixed at 5%)

$$n = \frac{5,232}{1+5,232(0.05)^2}$$

$$n = \frac{5,232}{1+5,232 \times 0.0025}$$

$$n = \frac{5,232}{1+12.325}$$

$$n = \frac{5,232}{13.325} = (394)$$

Table 1 Sample Size Selection Plan

Zones	LGAs	Districts	Villages	Sampling frame	Sample size (5%)
Central	Pankshin	Pankshin	Tambes	144	11
			Bwarak	142	11
		Fer	Fer	141	10
			Takas	143	11
			Sub-Total	570	43
	Mangu	Mangun	Mangun	315	24
			Tokchar	315	23
		Kerang	Kerang	315	24
			Bwonpe	315	24
			Sub-Total	1,260	95
	Bokkos	Bokkos	Maikatako	403	31
			Butura	403	30
		Daffo	Daffo	402	30
			Mbar	402	30
			Sub-Total	1,610	121
Northern	B-Ladi	Heipang	Heipang	195	16
			Kassa	195	15
		Fan	Fan-loh	195	15
			Sangasa	195	13
			Sub-Total	780	59
	Jos S outh	Gyel	Kull	168	13
			Gura-Ryom	168	13
		Vwang	K-Vom	167	12
			Hwak	167	12
			Sub-Total	670	50
	Riyom	Riyom	Tahos	86	7
			F/Lamba	86	7
		Bachit	Bachit	85	6
			Rim	85	6
			Sub-Total	342	26
Grand Total				5,232	394

Source: Field Survey

Method of Data Collection

Data were collected through the use of structured questionnaire. The questionnaire were categorized into eight sections, each of which aimed at a particular pre-determined objective of the study.

Method of Data Analysis

Data collected were analyzed using descriptive and inferential statistics. The descriptive statistics used were means, frequency distribution, percentages and mean ranking

which was used to achieve objectives i and ii. The inferential statistics used in this study was the logit regression, which was used to achieve objective ii, that is to determine the factors influencing the adoption of climate smart agriculture on potato production. The model is implicitly specified as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \varepsilon \quad \dots(4)$$

Where;

β_0 = Intercept

$\beta_1 - \beta_{14}$ = Regression coefficients

Y = Adoption of climate smart Agriculture (1=Adoption, 0=No Adoption)

X_1 = Age (years)

X_2 = Sex (Male=1, Female=2)

X_3 = Educational level (Primary=1, Adult education =2, Secondary =3, Tertiary=4, Arabic=5)

X_4 = Farm size (hectares)

X_5 = Household size (Number of persons)

X_6 = Farming experience (Years)

X_7 = Income (₦)

X_8 = Access to Extension Service (Yes=1, No=0)

X_9 = Membership of Cooperative society (Yes=1, No=0)

X_{10} = Output (Kg)

ε = Error term

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Respondents

Sex, Age, Marital Status, and Educational Level of the Respondents

Socio-economic characteristics of either farmers or any people consists of age, sex, marital status, educational qualification, farm size owned and cultivated, years of farming experience, household size, access to credit, membership of cooperative societies and source of labour, among others (Popoola, 2022). The results in Table 2 revealed that 51.5% of the respondents in the study area were male while 48.5% were female. This implies that there are more male farmers involved in potato production than female farmers in the study area. However, there are substantial proportion of female farmers. This is in tandem with the findings of Hudu *et al.*, (2018); Obi-Egbedi and Gulak (2020), and Adamu *et al.*, (2022) which stated that Potato farming was dominated by male farmers where this could be attributed to the tedious nature of potato farming and female farmers' restricted access to production inputs; particularly land ownership due to cultural barriers. Male farmers also made up the larger part of those at high profitability level.

As earlier stated, Age is referred to as the stage of development of an individual and it is one of the important determinants of human reasoning, decision making and responsibility. Age of the household head predisposes a farmer to better farming technologies through "learning by doing" and better management skills (Britanica, 2023). The results in Table 2 showed that 42.8% and 19.4% of the respondents fell within the age range of 41 and above and 31-35 years, respectively. The results also revealed that 18.6%, 15.6% and 3.6% fell within the age bracket of 36-40, 26-30 and 20-25, respectively. The mean age of the respondents was 40. This again is in tandem with the findings of Obi-Egbedi and Gulak (2020) and Adamu *et al.*, (2022) whose findings also revealed the mean age of 40 years. This implies that Potato farming in Plateau State of Nigeria was dominated by an agile workforce

that could handle any of the cultural operations in potato production while the older people get weaker by virtue of their age to work actively on the farms.

The results in Table 2 showed that majority (66%) of the respondents were married. The results also revealed that 14.3%, 11.2%, 8.2% were single, widowed and divorced, respectively. The implication of the higher percentage of the married could not be unconnected with the fact that potato farming is a serious activity for the responsible people and not only for the heads of the household or the house wives but, all members of the house could participate. This also implies that majority of the respondents are responsible for one or more family members and will want to adopt innovations to boost production so as to meet up with the food needs of their families. These findings corroborated with that of Hudu *et al.* (2018) and Girei *et al.* (2020) which revealed that most of the potato farmers were married in Plateau State, Nigeria.

The result in Table 2 further revealed that more than half (52.8%) of the respondents had tertiary education. The implication of this is that the farmers could make right judgments and decision to choose the right technology based on their high educational level. This again corroborated with the findings of Girei *et al.* (2020), and Bedima *et al.* (2024) where most of the potato farmers in Plateau State had tertiary education. However, the finding disagrees with that of Goni (2021) which showed that most of the potato farmers in Plateau State had secondary education.

Table 2: Distribution of Respondents based on Sex, Marital Status, Educational Level and Household Size (n=392)

Sex	Frequency	Percentage	Mean
Male	202	51.5	
Female	190	48.5	
Age			
20-25	14	3.6	
26-30	61	15.6	
31-35	76	19.4	
36-40	73	18.6	40.36
41 and above	168	42.8	
Marital status			
Single	56	14.3	
Married	260	66.3	
Widow	44	11.2	
Divorced	32	8.2	
Educational level			
Quranic education	3	0.8	
Primary education	87	22.2	
Secondary education	95	24.2	
Tertiary education	207	52.8	

Source: Field Survey, 2024

Household Size, Farming Experience and Farm Size

As shown in Table 3, 47.4% and 24.7% of the respondents had 6-10 and 1-5 family members, respectively with a mean household size of 6 persons. The result also showed that 22.7% and 5.1% of the respondents had a family size of 11-15 and 16 and above. This

implies that high household size will save the cost of hired labour maximizing profit and minimizing cost. This finding corroborates with those of Johnson, *et al.*, (2021); Genet and Feyso (2020), Goni (2021), Adamu *et al.* (2022) and Bedima *et al.* (2024) which stated that majority of potato farmers in Plateau State, Nigeria had a mean household size of 6 persons. This implies that farmers who had a fairly large household, will increase the availability of free family labour which could serve as an insurance against short falls in supply of farm labour.

The findings also revealed that 46.4% of the respondents had farming experience of 10-19 years with a mean farming experience of 15 years. The finding also showed that 25% and 16.6% of the respondents had 20-29 years and less than 10 years of farming experience, respectively. The implication of this results is that the farmers had some ample experience in farming and so, can take any decision to accept or adopt any new technology or innovation that may come their way without any prejudice. These findings are in tandem with that of Girei (2020), and Malum and Habakkuk (2023) which stated that farmers with farming experience between 10-15 years are likely to make decisions that would increase their output and income.

As shown in Table 3, Most (84%) of the respondents had a farm size of 1-2ha and 9.7% owned less than 1ha of land with a mean farm size of 1.4ha. On the other hand, 4.5%, 1.5% and 0.3% had a farm size of 2.1-3ha, 3.1-4ha and 4.1ha and above, respectively. This implies that most of the farmers in the study area were small scale farmers. This finding agrees with Bulus and Nimfa (2017) who stated that most potato farmers in Plateau State cultivated 1ha and above. Etim and Etim (2019) reported that positive relationship exists between farm size and CSA technologies. They also attested that the early adopters of technologies belong to large farm owners. Participating in CSA activities among smallholder farmers is also hindered by land fragmentation, which makes it difficult to gain from the economies of scale.

Table 3: Distribution of Respondents based on Farming Experience, Primary Occupation and Farm Size (n=392)

Variable	Frequency	Percentage	Mean
Household size			
1-5	97	24.7	6.0
6-10	186	47.4	
11-15	89	22.7	
16 and above	20	5.1	
Farming experience (years)			
<10	65	16.6	15 years
10-19	182	46.4	
20-29	98	25	
30 and above	47	12	
Farm Size (ha)			
<1	38	9.7	1.4 ha
1-2.0	329	84.0	
2.1-3.0	18	4.5	
3.1-4.0	6	1.5	
4.1 and above	1	0.3	

Source: Field Survey, 2024



Factors Influencing the Adoption of Climate Smart Agricultural (CSA) Practice

The results of logit regression revealed that Wald χ^2 of 25.74 indicate overall model significance. Probability $>\chi^2$ of 0.0041 indicates rejection of null hypothesis, suggesting that the model has significant predictors. On the other hand, the Pseudo R^2 of 0.0663 indicate moderate model fit of 6.63%. Four (4) variables were significant factors that influence the adoption of CSA practices in the study area. These include age, farm size, income and yield. According to the results, age ($r = -0.388001$, $P < 0.05$) was a positive predictor of adoption of CSA as older farmers are not likely to adopt CSA practices compared to young and agile farmers. Thus, for every unit increase in age the likelihood of adopting CSA practices significantly reduces. This finding is agreement with Kalu an Mbanasor (2023) who stated that older farmers above the age of 55years do not easily adopt new technologies. Age has a significant negative effect on CSA adoption, potentially due to less experience or risk aversion. The logistic regression also revealed a positive coefficient of farm size ($P \leq 0.01$) influencing the adoption of CSA practices. The positive coefficient indicates that larger farm sizes are associated with high adoption of CSA practices. Meaning that for every unit increase in farm size the likelihood of adopting CSA practices increases. This finding corroborates with that of Malum and Habakkuk (2023) who stated that farmers with larger farm size were not able to adopt any new technologies that came to them, contrary to the findings of Kassa and Abdi (2022) who stated that that farmers with larger farmlands adopted more CSA techniques, indicating encouragement to them. This may be attributed to farmers cultivating more farmland than they can manage; thus, leading to inefficiency in production and consequently affecting their profitability. The results also suggests that higher income was likely to adopt CSA practices. This is because for every unit increase in income the odds/likelihood of adopting CSA practices decreases for income. This is in tandem with the findings of Wu (2022) who's finding showed that the status of fund borrowing (loan) is significantly positive at the 5% level, indicating that the availability of borrowing has a negative significant positive impact on the adoption of new technologies by farmers.

Yield had positive coefficient ($P \leq 0.1$) indicating higher yields are associated with significant adoption of CSA practices. This suggest that in every unit increase in yield there is likelihood of increase of adopting CSA practice. That is, higher yield encourages CSA adoption, indicating farmers' value productivity- enhancing practices. This finding is in agreement with that of Henri-Ukoha *et al.*, (2019) who stated that higher yield as a result of adopting any new technology encourages farmers to seek to accept more of any new technology that may be available.

Table 4: Logistic Regression showing Factors influencing the Adoption of Climate Smart Agricultural (CSA) practices

Adoption categories	Coefficient	Std Error	Z	P> z
Sex	0.2314941 ^{NS}	0.2420101	0.96	0.339
Age	-0.0388001**	0.0184867	-2.10	0.036
Education	0.0373829 ^{NS}	0.0533177	0.70	0.483
Household size	0.08468 ^{NS}	0.0527111	1.61	0.108
Farming Experience	0.0032165 ^{NS}	0.0200547	0.16	0.873
Farm Size (ha)	0.4444576***	0.1257308	3.53	0.000
Income	-03.4e-07*	1.67e-07	-1.82	0.069
Access to Extension Agents	-0.2863568 ^{NS}	0.2836112	-1.01	0.313
Access to Cooperative Society	0.1288144 ^{NS}	0.2713785	0.47	0.635
Yield (Kg)	0.0000151*	8.05e-06	1.88	0.060
Constant	1.315411	0.6581804	2.00	0.046
Wald Chi ² (10) = 25.74				
Prob > chi ² = 0.0041				
Pseudo R ² = 0.0663				

Source: Field survey, 2024

Key: Standard Error, ***=Significant at 1% ($P \leq 0.01$), **=Significant at 5% ($P \leq 0.05$) and *=Significant at 10% ($P \leq 0.1$) respectively.

Constraints Faced by Potato Farmers in Adopting CSA Practices

Results in Table 5 revealed the various constraints faced by the respondents in the study area. The major constraints to the adoption of CSA include inadequate information from Meteorologists (86%), inadequate capital (76.5%). Other constraints as revealed by the results include inadequate improved potato varieties (73.5%), technical skills (73.2%), inadequate information from extension workers (73%), prevalence of pests and diseases (71.4%) and high cost of inputs (71.2%). This result implies that if the farmers get the necessary support or guidance, they can adopt more CSA practices. This finding corroborates with that of Bulus and Nimfa (2017) and Damla *et al.*, (2023) who discovered and opined that the farmers had difficulty to adapt to new technologies in North and Central Zones of Plateau State. Also, they stated that lack of technology equipments like weather stations in the study area leads to wrong weather predictions which could impact negatively on Irish potato farming and preservations.

Table 5: Distribution of Respondents according to Constraints Faced in Farming Potato and Adopting CSAs

Constraints	Frequency	Percentage*	Rank
Inadequate information from Meteorologists	339	86.5	1 st
Inadequate information from research centres	313	79.8	2 nd
Inadequate capital	300	76.5	3 rd
Inadequate improved Potato varieties	288	73.5	4 th
Adopting CSA requires technical skills	287	73.2	5 th
Inadequate information from extension workers	286	73.0	6 th
Pest and diseases	280	71.4	7 th
High cost of inputs	291	71.2	8 th

*Multiple response, CSAs= Climate Smart Agricultural Practices

Source: Field Survey



CONCLUSION AND RECOMMENDATIONS

The study concluded that age, farm size, yield and income were the factors significantly influenced the adoption of climate smart agriculture in the study area.

Based on the finding of the study, the following recommendations were made,

- i. There should establishment of mobile apps, SMS alerts, and radio broadcasts to provide farmers with timely and reliable weather forecasts and research updates.
- ii. Introduce subsidized credit facilities, cooperative savings schemes, and grant programs to support farmers in acquiring essential inputs and technologies.
- iii. Develop and distribute high-yielding, disease-resistant potato varieties through research institutions and seed companies, complemented by farmer training.
- iv. Train extension workers on Climate-Smart Agriculture practices and organize workshops to enhance farmers' technical skills and capacity to manage pests, diseases, and high input costs.

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