



## EFFECT OF USAGE OF CLIMATE SMART AGRICULTURAL PRACTICES ON RICE FARMERS' INCOME IN NIGER AND KWARA STATES, NIGERIA

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### ABSTRACT

The study evaluates the effect of usage of climate smart agricultural practices on rice farmers' income in Niger and Kwara States, Nigeria. Multi-stage sampling technique was used to select 788 respondents for the study. Data were collected through the used of structured questionnaire and analysed using both descriptive and inferential statistics such as percentages and means and propensity score matching (PSM). The result indicated that the majority (with a pooled mean score of (40.8) of the respondents were in their active years of production, and have relatively large household size (9 persons). RBCAPs usage had a positive and significant effect on rice farmers income in the study area, with an average treatment effect on treated (ATT) of ₦ 135,119.96k in terms of income obtained from rice production per hectare by the respondents who use of RBCAPs. The study concluded that RBCSAP users had increased income among small scale rice farmers. The study therefore recommended Female household heads need to be encouraged to key into the practice in order to improve their income base. Income of the users increased by ₦135119.96k per hectare as a result of usage of RBCAPs, it is therefore recommended that the usage be sustained.

**Keywords:** Climate Smart Agricultural Practices, Rice Farmers, RBCAPs, PSM

### INTRODUCTION

Most African economies depend heavily on this sector. Often the biggest contributor to the GDP, around two thirds of industrial value-added is derived from agricultural raw resources. In most African nations, where 70–80% of the population lives in rural regions, agriculture continues to be a major source of employment and a vital component of pro-poor economic growth (FAO, 2012). The majority of Nigerians rely mostly on agriculture as their source of income, making it the country's principal economic engine. Even though two-thirds of the Nigerian population are engaged in agriculture, which still accounts for the majority of the country's economy, the performance of this sector has been severely handicapped by production hurdles (FAO, 2020). The Federal Government of Nigeria, the World Bank-funded National Fadama Development Project (NFDPP), Competitive African Rice Initiative (CARI), Centre for Climate Change and Fresh Water Resources (CCCCFR), Agricultural Research Council of Nigeria (ARCN) and Federal Environmental Protection Agency (FEPA) have organized national training workshops to increase agricultural products including rice, disaster management, early warning systems (Dodo, 2015). Rice production in Nigeria amount to 3.7 million tons per year on the average, with the North Central Zone being one of the major producers. Rice production in the North Central zone amounts to 44% of the total output in the year 2019 (Akpokodje *et al.*, 2019). In as much as there is a huge agricultural production potential in the North-Central zone, several production constraints still exist. Udemezue, (2018) opined that Countries in Sub-Saharan Africa have an uneven and lopsided distribution of rice production and consumption. In 2017, West African nations produced



64.2% of the world's rice, consumed 61.9% of it, and left a surplus of 2.3%. However, in Nigeria there was an annual rice supply deficit of 1.8 million metric tons hence Nigeria is import-dependent because the annual production of 3.2 million metric tons at that time could not meet the average annual consumption of 5 million metric tons (Ebenehi et al., 2024). There is now a 3 million metric ton supply gap in Nigeria due to the fact that only roughly 57% of the country's 6.7 million metric tons of rice consumption each year is produced locally.

Rice production had suffered a lot of setback occasioned by both natural and physical phenomenon such as whimsies of weather, flood, drought and other uncertainties exacerbated by severe land degradations brought on by climate change, including dune development from wind erosion, drought, and desertification. Apart from altering agricultural practices, climate change also brings forth an increase in pests and diseases, which can make storage more difficult when necessary due to rising temperatures. If a disease was previously unable to flourish, it usually spreads to that location. North-Central Nigeria which is the food basket of the nation has suffered flood incidents of the diverse magnitude in recent times. These have caused the loss of farms, other things valued at many thousand dollars, and life. Crop yield is directly impacted by climate because of variations in rainfall patterns. The North-central zone is, thus, vulnerable to the unfavourable consequences of climate change. Therefore, it is essential to address the effects of climate change and the harms it creates. The vulnerability of the Nigerian agricultural sector to climate change is of particular interest to policymakers because agriculture is a key sector in the economy accounting for between 60-70% of the labour force and contributing between 30-40% of the nation's GDP (Ajetomobi *et al.*, 2011; FAO, 2020). Although relevant institutes have been promoting the RBCSAP in their adoption efforts to attain dependable disaster risk reduction however, little is known about farmers' knowledge of these practices. Not much is also known for certain which farmers in the zone are using these practices and which do not. Additionally, nothing is known about the farmers' perspectives on how climate change would affect their capacity to produce rice in the research area. The limited studies that have been done have revealed a significant disparity in farmers' awareness and implementation of RBCSAP (Tiamiyu *et al.*, 2018).

Most studies in agricultural extension have also tended to focus attention on the benefits of adoption by farmers while neglecting the effect of usage of improved production technologies on farmers' livelihood (Adisa *et al.*, 2019). Not much information is available on the effect of usage of rice-based climate smart agricultural practices on farmers' livelihood in Niger and Kwara States. Since changes in agricultural communities come about partly by the use of recommended agricultural practices, it becomes necessary to study the usage of RBCSAP and its effect on rice farmers' yield and income and to also identify the various problems associated with the usage of these practices. It is against these backdrop that this research work, intends to investigate the effect of usage of rice based climate smart adaptation practices (RBCSAPs) The broad objective of the study is to assess the effect of usage of RBCSAP on farmers' livelihood in Niger and Kwara States, Nigeria. The specific objectives were to:

- i. describe the socio-economic characteristics of user and non-user of RBCSAP in the study area; and
- ii. estimate the effect of the usage of RBCSAP on farmers' income among user and non-user of RBCSAP in the study area.



## **METHODOLOGY**

### **Area of Study:**

The study was conducted in North-Central geopolitical zone of Nigeria. The zone is located between latitude 6°30'N–11°20'N and Longitude 2°30'E–10°30'E and covers about 296,898 km<sup>2</sup> of the country's total land mass representing about 32% of the land area of the country. The zone is blessed with a projected population of 20,266,257 million (projected from the NPC, 2006). This comprises six States namely: Kwara, Niger, Nasarawa, Plateau, Benue, Kogi and Abuja the Federal Capital Territory. North central Nigeria is bordered in the North by the republic of Niger in the east, by republic of Cameroon and in the west by Benin republic (Ideki and Weli, 2019). The zone is characterized by a Tropical Continental Climate marked by a wide variation of annual temperature regime and a restricted rainfall, with temperatures and rainfall varying with location and period of the year (Iorliam *et al.*, 2014). The mean annual temperature ranges from 24°C to 37°C, while the mean annual rainfall ranges between 1,200mm and 1500mm. The vegetation of the zone is characterized by scattered tall trees and shrubs typical of southern guinea savannah vegetation. Different crop types such as tuber crops, cash crops, rice survive well in the zone (Okeke and Okeola, 2019).

### **Sampling Procedure and Sample Size:**

A multistage sampling procedure was used to select the sample for this study. At the first stage was a purposive selection of Niger and Kwara States. This was due to the high concentration of rice farming in the two States among the North-Central States. The second stage involves a purposive selection of two major rice-producing Local Government Areas (LGAs) from each State. The third stage also involves the purposive selection of four major rice-producing communities from each of the four LGAs selected. In the fourth stage, 394 users of CSAP using proportionate sampling were randomly chosen. The sample size was determined from the list of registered rice farmers obtained from ADP through Taro Yamane's formula. In the fifth stage, the same number of non-users of CSAP were randomly selected in the study area, making a total of 788 respondents.

### **Method of Data Collection**

Primary data was used for the study and this was collected through the use of well-structured questionnaire; administered by well-trained enumerators that have better understanding of their local language. The data information collected include socio-economic characteristics, effect of usage of CSAP on rice farmers' income in the study area.

### **Analytical Technique**

Descriptive Statistics, was used to achieve objective (i) which is to describe the socio-economic characteristics of rice farmers using the RBCAPs while objective (ii) which is to assess the effect of the RBCAPs usage on income of rice farmers.

Propensity score matching (PSM) refers to the pairing of treatment and control units with similar values on the propensity score, and possibly other covariates, and the discarding of all unmatched units (Ebenihi *et al.*, 2024).

### **Propensity Score Matching (PSM)**

In analyzing the effect of RBCAPs usage on the income of its users, the method of matching based on propensity scores was applied. Analyzing the effect of the RBCAP usage requires the establishment of the requisite counterfactual that represents what would have happened had the farmers not used not used RBCAPs (Ebenihi *et al.* 2024). The establishment of this counterfactual often poses problems where there is no baseline data. Under such circumstance, appropriate estimation of the counterfactual is established by way of a comparative group that does not participate in the intervention.

## RESULTS AND DISCUSSION

### Socioeconomic characteristics of users and non-users of RBCSAP in Niger and Kwara states

According to Table 1, the average age of users and non-users RBCSAP in Niger State were 43 years respectively, meaning that users and non-users were within the same age bracket. In Kwara State, mean age was 38 years among users and 43 years among non-users. This implies that users were older than non-users in Kwara. Mean age was 41 years for users and 43 years for non-users in the pooled data. The average age of the respondents in the study area is significant because it shows that the rice farmers were still within the productive age range and have the ability to meeting the energy requirements for rice production. This is in line with Bai *et al.* (2024) who found that the majority of rice farmers are in their active years, capable of high labor productivity that will ensure rice food security, and possibly ready to accommodate climate change variability

On the distribution of respondents by sex is presented in Niger State, male rice farmers were 85.2% among users and 89.5% among non-users as compared to 14.8% female rice farmers among users and 10.5% among non-users. Male rice farmers were 79.4% among users and 75.8% among non-users while female rice farmers were 20.6% among users and 24.2% among non-users in Kwara State. There were more female rice farmers in Kwara than in Niger. From the pooled results, male rice farmers constituted 82.7% among users and 83.8% among non-users. Female rice farmers were 17.3% among users and 16.2% among non-users of RBCSAP in the two States. This finding implies that rice farmers both in Niger and Kwara states are dominated by male farmers. This finding is consistent with Omotesho *et al.* (2021) and Adesiji *et al.* (2022) who reported that more male farmers are involved in rice production than female farmers in Kwara State, Nigeria.

The results showed that there are more female rice farmers in Kwara than in Niger and that women participate during rice production in a variety of ways, including marketing and processing of rice, in addition to supporting roles in some areas. The implication is that rice farmers shouldn't be thought of as being only men, but rather that people should acknowledge the existence of female rice farmers in the study area. When deciding how to design, carry out, and evaluate development interventions for rice production, this should be a key factor. Regarding women's role in agriculture and how gender affects a society's adoption of new technology, Nidhi (2023) found that women contribute to a variety of duties, including clearing land, land-tilling, planting, weeding, applying fertilizer and manure, harvesting, processing food, threshing, winnowing, milling, transporting, marketing, and managing cattle. Gender equality in the adoption of agricultural technology in underdeveloped nations may continue to be a mirage without gender sensitivity in agricultural innovations, which is necessary for greater agricultural growth.

Findings on Table 1, also reveals that a large fraction (94.3%) of the rice farmers were married among users of RBCSAP than non-users (93.4%) in Niger state. However, non-users had a slightly greater percentage of single respondents (6.6%) than users (5.7%). The percentage of married respondents among non-users (86.7%) was greater than that of users in Kwara State. Similarly, single respondents were 26.7% among users and 13.3% among non-users. Kwara State had more single respondents among users (26.7%) and non-members (13.3%) than Niger (5.7% and 6.6%) while Niger had more married respondents (94.3% and 93.4%) than Kwara (73.3% and 86.7%).

Pooled results show that 85.5% of the respondents were married among users as compared to 90.6% among non-users. Respondents that were single by marital status constituted 14.5% and 4.8% among users and non-users of RBCSAP respectively. Farmers





who are married to a greater extent have family members who can help out on the farm, especially if the agricultural technique in question requires a lot of labour. Ebenehi *et al.* (2024) reported that the majority of rural regions are agrarian in occupation and that the capability of the families to offer the essential labor in the farm rests in large part on the marital status of the households, marital status is among the most significant factors determining family labour in the rural area. This outcome is consistent with Omotesho *et al.* (2021) finding that most rice farmers are married persons. Due to the large percentage of married respondents, there may be a greater release of family labor, increasing the number of hands available for useful tasks on the rice farms of the respondents.

The household size of respondents in Niger state as shown in table 5 indicated that 12.2% of users of RBCSAP had a household size of less or equal to 5 persons, 52.8% of the users had between 6-10 persons, 0.6% of the users had a household size of 11-15 persons, about 3.9% had a household size between 16-20 persons and only 0.4% had a household size above 20 persons. However, 19.7% of non-users had a household size of less or equal to 5 persons, 54.1% of the non-users had between 6-10 persons, about 22.7% of the non-users had a household of 11-15 persons and 3.5% of the non-users had a household of 16-20 persons. None (0.0%) of the non-users in Niger had a household more than 20 persons. In Kwara State, most (42.4%) of users had household size between 6-10 persons, about 27.3% had a size between 1 to 5 persons, 17.6% had household size between 11-15 persons and only 12.7% of the users in Kwara had a household of more than 15 persons. While a significant proportion (40.0%) of non-users had household size between 6-10 persons, about 34.0% had a size between 1 to 5 persons, 21.8% had household size between 11-15 persons and only 4.2% of the non-users in Kwara had a household of more than 15 persons. The average household size of users of RBCSAP in Niger State was 10 persons and non-users was 9 persons, meaning that users had larger household size than non-users. In Kwara State, average household size was 9 persons among users and 8 persons among non-users. This implies that users had larger household size than non-users in Kwara State. Comparing both States, it could be deduced that household size of users and non-users of RBCSAP in Niger state is relatively larger than of users and non-users in Kwara state, while users had larger household size than non-users in both States.

Pooled results show that 48.5% of the users had household size between 6-10 persons, about 18.5% had a size between 1 to 5 persons, 25.1% had household size between 11-15 persons and only 7.9% of the users had a household of more than 15 persons. While most (48.2%) of non-users had household size between 6-10 persons, about 25.6% had a size between 1 to 5 persons, 22.3% had household size between 11-15 persons and only 3.9% of the non-users had a household more than 15 persons. The average household size was 10 persons among users and 9 persons among non-users in the pooled data. This implies that both users and non-users of RBCSAP in the study area had a large household size. In Nigerian rural areas where farming is a significant occupation, a large household size provides a source of family labor. This result is consistent with a study by Omotesho *et al.* (2021) that found that high household size may give rice farmers the opportunity to farm since it will allow them to use family labour and so tend to minimize the cost of hiring labor for rice output. In the same vein, a big household size might exacerbate the poverty of a farming family, especially if it included a lot of dependents and there were more mouths to feed.

About 48.0% of RBCSAP in Niger State had secondary education followed by 25.8% with no formal education, 13.5% with primary education and 12.2% with tertiary education. A similar trend was observed among non-users in that 38.0% had secondary education while

those with no formal education were 36.7%, those with primary education were 17.0% and those with tertiary education were 8.3% as well. In Kwara State, 47.9% of users had secondary education followed by 19.4% with tertiary education, 16.4% with no formal education and 18.8% with primary education. The trend was similar among non-users as 44.2% had secondary education while 25.5% had tertiary education, 16.4% with no formal education and 13.3% had primary education. Pooled results showed that 48.0% of users and 40.6% of non-users had secondary education. About 21.8% of users and 28.1% of non-users had no formal education while 15.2% of users and 15.5% of non-users had tertiary education. However, 14.5% of users and 15.5% of non-users had primary education. Farmers with formal education are more likely than those without formal education being able to understand and use RBCSAP. This result is consistent with Adesiji *et al.* (2022) findings that 36.3% of rice farmers in Kwara State had non-formal education and that the proportion of respondents with university education was remarkably low (16.3%).

Table 1 also indicates that users (27.5%) of RBCSAP had their year of experience between 1 to 10 years, only 36.3% had between 11 to 20 years, 7.9% had between 21 to 30 years. 18.3% had between 31 to 40 years and 10.0% had between 41 to 50 years. However, 24.9% of non-users had their year of experience between 1 to 10 years, only 27.5% had between 11 to 20 years, 16.6% had between 21 to 30 years. 15.7% had between 31 to 40 years and 15.3% had between 41 to 50 years. In Kwara State, more than half (51.5%) of users had their year of experience between 1 to 10 years, only 26.1% had between 11 to 20 years, 13.3% had between 21 to 30 years. 7.3% had between 31 to 40 years and 1.8% had between 41 to 50 years. While 39.0% of non-users had their year of experience between 1 to 10 years, only 43.6% had between 11 to 20 years, 11.5% had between 21 to 30 years. 2.4% had between 31 to 40 years and 3.5% had between 41 to 50 years. The average years of experience in rice farming of users and non-users of RBCSAP in Niger State were 21 and 23 years respectively, meaning that non-users had more years of experience in rice farming than users. In Kwara State, average years of experience in rice farming was 14 years among users and 15 years among non-users. This implies that non-users had more years of experience than in rice farming users in Niger. Comparing both States, it could be deduced that years of experience in rice farming of users and non-users of RBCSAP in Niger State is relatively higher than of users and non-users in Kwara State.

Pooled results show that 37.5% of the users had year of experience between 1 to 10 years, only 32.0% had between 11 to 20 years, 10.2% had between 21 to 30 years, 13.7% had between 31 to 40 years and 6.6% had between 41 to 50 years. While a notable proportion (30.7%) of non-users had year of experience between 1 to 10 years, only 34.2% had between 11 to 20 years, 14.5% had between 21 to 30 years. 10.2% had between 31 to 40 years and 10.4% had between 41 to 50 years. The average years of experience in rice farming was 18 years among users and 20 years among non-users in the pooled data. This suggests so many of the farmers are "old" hands" at growing rice. The best teacher, so the saying goes, is experience. In order to adopt RBCSAP quickly, it may be advantageous to have long farming expertise. This will boost rice production. This assertion is in line with Adesiji *et al.* (2022) who stated that the long the farming experience of rice farmer the more improvement in their performance in rice operations. If rice farmers have more experience, they might become more knowledgeable and embrace production technology (Omotesho *et al.* (2021).

Also in Niger State, 44.5% of users and 46.7% non-users of RBCSAP cultivated 1 hectare of land. The same size of rice field was cultivated by 73.3% of users and 78.2% of non-users of Rice Based Climate Smart Agricultural Practices in Kwara State. The pooled data showed that majority of users (56.6%) and non-users (59.9%) cultivated 1 hectare of



land. In Niger State, the average size of rice field cultivated by users and non-users was 2.0 hectares.

There was no significant difference in the size of rice field cultivated by the two groups of farmers in Niger State. In Kwara State, the average size of rice field cultivated by users was 1.0 hectares while the average holding for non-users was 1.0 hectares. For the pooled data, mean size of rice field for users was 2.0 hectares and that of non-users was 2.0 hectares. The mean farm size of users and non-users of RBCSAP in Niger States was higher than that of users and non-users in Kwara States. This implies that most users and non-users of RBCSAP in the study area were small-scale farmers. Farm size is connected to level of capital and social position of the farmers and it can affect the level of use of RBCSAP. Farm size may also be beneficial or negative impact on the adoption of technology depending on the farmers' wealth and social standing. This result was corroborated by Omotesho *et al.* (2021) who discovered that 64.55 percent of users of CSAP in North-Central Nigeria have less than 2.5 hectares of farmland.

**Table 1:** Distribution of Users and Non-users of RBCSAP in Niger and Kwara States by Age

Variables	Niger State		Kwara State		Pooled	
	Users of CSAP	Non-users of CSAP	Users of CSAP	Non-users of CSAP	Users of CSAP	Non-users of CSAP
<b>Age (years)</b>						
≤ 20	3(1.3)	6(2.6)	3(1.8)	2(1.2)	6(1.5)	8(2.0)
21-30	18(7.9)	24(10.5)	52(31.5)	20(12.1)	70(17.8)	44(11.2)
31-40	78(34.0)	53(23.1)	51(30.9)	52(31.5)	129(32.7)	105(26.6)
41-50	90(39.3)	94(41.1)	33(20.0)	59(35.8)	123(31.2)	153(38.8)
>50	40(17.5)	52(22.7)	26(15.8)	32(19.4)	66(16.8)	84(21.3)
Mean	42.83	43.36	38.09	42.58	40.85	43.04
Std. Dev	8.609	9.907	11.382	10.549	10.127	10.177
Male	195(85.2)	205(89.5)	131(79.4)	125(75.8)	326(82.7)	330(83.8)
Female	34(14.8)	24(10.5)	34(20.6)	40(24.2)	68(17.3)	64(16.2)
<b>Marital Status</b>						
Single	13(5.7)	15(6.6)	44(26.7)	22(13.3)	57(14.5)	37(9.4)
Married	216(94.3)	214(93.4)	121(73.3)	143(86.7)	337(85.5)	357(90.6)
<b>Household Size (persons)</b>						
5 and below	28(12.2)	45(19.7)	45(27.3)	56(34.0)	73(18.5)	101(25.6)
6-10	121(52.8)	124(54.1)	70(42.4)	66(40.0)	191(48.5)	190(48.2)
11-15	70(30.6)	52(22.7)	29(17.6)	36(21.8)	99(25.1)	88(22.3)
16-20	9(3.9)	8(3.5)	10(6.1)	4(2.4)	19(4.8)	12(3.1)
Above 20	1(0.4)	-	11(6.6)	3(1.8)	12(3.1)	3(0.8)
Mean	9.48	8.76	9.44	8.08	9.46	8.48
Std. Dev	3.769	3.490	6.408	5.061	5.038	4.227
<b>Level of Education</b>						
No Formal Education	59(25.8)	84(36.7)	27(16.4)	27(16.4)	86(21.8)	111(28.1)
Primary Education	31(13.5)	39(17.0)	26(15.8)	22(13.3)	57(14.5)	61(15.5)
Secondary Education	110(48.0)	87(38.0)	79(47.9)	73(44.2)	189(48.0)	160(40.6)
Tertiary education	28(12.2)	19(8.3)	32(19.4)	42(25.5)	60(15.2)	61(15.5)
<b>Farming Experience (years)</b>						
1-10	63(27.5)	57(24.9)	85(51.5)	64(39.0)	148(37.5)	121(30.7)
11-20	83(36.3)	63(27.5)	43(26.1)	72(43.6)	126(32.0)	135(34.2)
21-30	18(7.9)	38(16.6)	22(13.3)	19(11.5)	40(10.2)	57(14.5)
31-40	42(18.3)	36(15.7)	12(7.3)	4(2.4)	54(13.7)	40(10.2)
41-50	23(10.0)	35(15.3)	3(1.8)	6(3.5)	26(6.6)	41(10.4)
Mean	21.18	23.59	14.06	14.93	18.20	19.96
1	102(44.5)	107(46.7)	121(73.3)	129(78.2)	223(56.6)	236(59.9)
2	88(38.4)	68(29.7)	35(21.2)	35(21.2)	123(31.2)	103(26.1)
3	28(12.2)	34(14.8)	5(3.0)	1(0.6)	33(8.4)	35(8.9)
4	9(3.9)	12(5.2)	1(0.6)	-	10(2.5)	12(3.0)



5	2(0.9)	7(3.1)	3(1.8)	-	5(1.3)	7(1.8)
6	-	1(0.4)	-	-	-	1(0.3)
Mean	1.78	1.90	1.36	1.22	1.61	1.61
Std. Dev	0.871	1.079	0.742	0.433	0.844	0.929

**Source:** Field Survey 2023, Figures in parenthesis are percentages

### Factors Influencing Usage of RBCSAP

As explained in the methodology section, the first step of the econometric approach is to estimate the propensity score, that is the probability to use RBCSAP is conditional on observable variables. To generate the propensity scores for the matching process, the probability of a household to use RBCSAP was estimated using the Logit model. The variables included in the model are age, gender, marital status, household size, educational level and farming experience.

The model as revealed in Table 2 was statistically significant and the regression coefficients gives the change in the z-score for a unit change in the predictors. Moreover; the value of Pseudo- $R^2$  (0.6259) indicates that there was no systematic difference in the distribution of covariates between users and non-users in the study area. Furthermore, the Pseudo R-square indicates that about 62 % of the variation in the usage decision model can be explained through the included explanatory variables. The overall model is statistically significant at a P-value of 0.000. Hence, the chosen observable characteristics adequately explain the probability of usage of RBCAPs.

Among the factors assumed to affect the household of usage of RBCAPs in the study area, age, gender, marital status, household size, educational level and farming experience were statistically significant. On the other hand, while the marital status, household size, and farm experience positively affected decision to use RBCAPs, the age and educational level negatively affected decision to use RBCAPs, both were statistically significant between beneficiaries and non-participants. This agrees with a study by Ebenhi *et al.* (2024).

The Logit estimates indicate that marital status, Household size and farm experience positively and significantly affects the probability of participation on WASIL extension programme at 1 % level of significance with a P-value of 0.000 respectively. This implies that as the age of the household head increases by 1 year up to a certain level, house hold size and farming experience increases the probability of RBCAPs usage would increase by 1% other variables in the model remaining constant. Ebenhi *et al.* (2024) who also established a positive relationship between age and participation in West African Soy Limited Extension Programme. According to them, older farmers are more experienced which allows them to assess the attributes of an improved technology relative to younger household heads.

The findings on Table 2 also show that gender of household heads is negatively and significantly (at 1 % level) affects the probability of use of RBCAPs. This implies that male headed households are more likely use RBCAPs than female headed households. This is due to land ownership where female-headed households have limited land and resource access and males have more exposure to other social and economic activities. However, this result is contrary to the study conducted by Tiamiyu *et al.*, (2018) Who found that female headed households are more likely to participate in an intervention programme.

The result further revealed that education was negatively associated with the probability of participation in WASIL extension intervention programme at 1 % level. The negative effect of education on probability of usage of RBCAPs suggests the strong competing effect of diverting skills of household head to other off-farm employment opportunities (Adesiji *et al.* 2022). This could reduce household head dependency on

agricultural development projects. The result is supported empirically by the fact that most of the study areas are accessible to major urban centres where employment is prevalent. This finding concurs with earlier study of Ebenehi *et al.* (2024) which found out that adoption of technologies increases with increase in years of schooling.

Likewise, farming experience was found to be positive and significantly (at 1 % significant level) influencing the decision to use RBCAPs. This is expected because more experienced farmers may have better skills and access to new information about modern agronomic practices. Also increased farming experience may lead to better assessment of importance and complexities of good farming decision, including efficient use of inputs. This finding is in line with Adesiji *et al.* (2022) who in their various studies revealed that years of farming experience increased agricultural productivity among farming households in Nigeria.

Moreover, household size was statistically significant (at 1% level of significance) and it is positively associated with RBCAPs usage. The possible reason is that household with larger family size can probably have more labour to engage in farming activities. Since households with larger household size can perform various agricultural activities without labour shortage. Hence, households with larger household size can probably choose to use RBCAPs in the area. This suggests that the increase in the household size implies a cheap labour and has a higher chance of RBCAPs usage. This finding is consistent with the study conducted by Ebenehi *et al.*, (2024) that household size positively increases the probability of participation in irrigation farming.

**Table 2:** Logit Model Predicting Probability of WASIL Participation

Explanatory Variables	Coefficient	Standard Error	Z	$P >  z $
Constant	-0.3383	0.4045	-0.84	0.403**
Age	-0.5390	0.00874	-6.16	0.000***
Gender	-0.1712	0.10253	-1.167	0.095**
Marital Status	1.5261	0.12533	-12.18	0.000***
Household Size	0.1105	0.01270	8.70	0.000***
Education	-0.4539	0.5865	-7.74	0.000***
Farming experience	0.0364	0.00964	3.77	0.000***
<b>Goodness of Fit:</b>				
Pseudo R <sup>2</sup>	0.6259			
Prob. > chi <sup>2</sup>	0.000			
LR chi <sup>2</sup> (10)	683.74			

Note; NS= not significant and \*\*\*p < 0.01 \*\*p < 0.10 \*p < 0.05

Source: Field survey, 2023

### Propensity Score Balancing Test

The common support graph was drawn to test the balancing as well as the quality of match. The region of common support was found to be between 0.02 – 0.999.

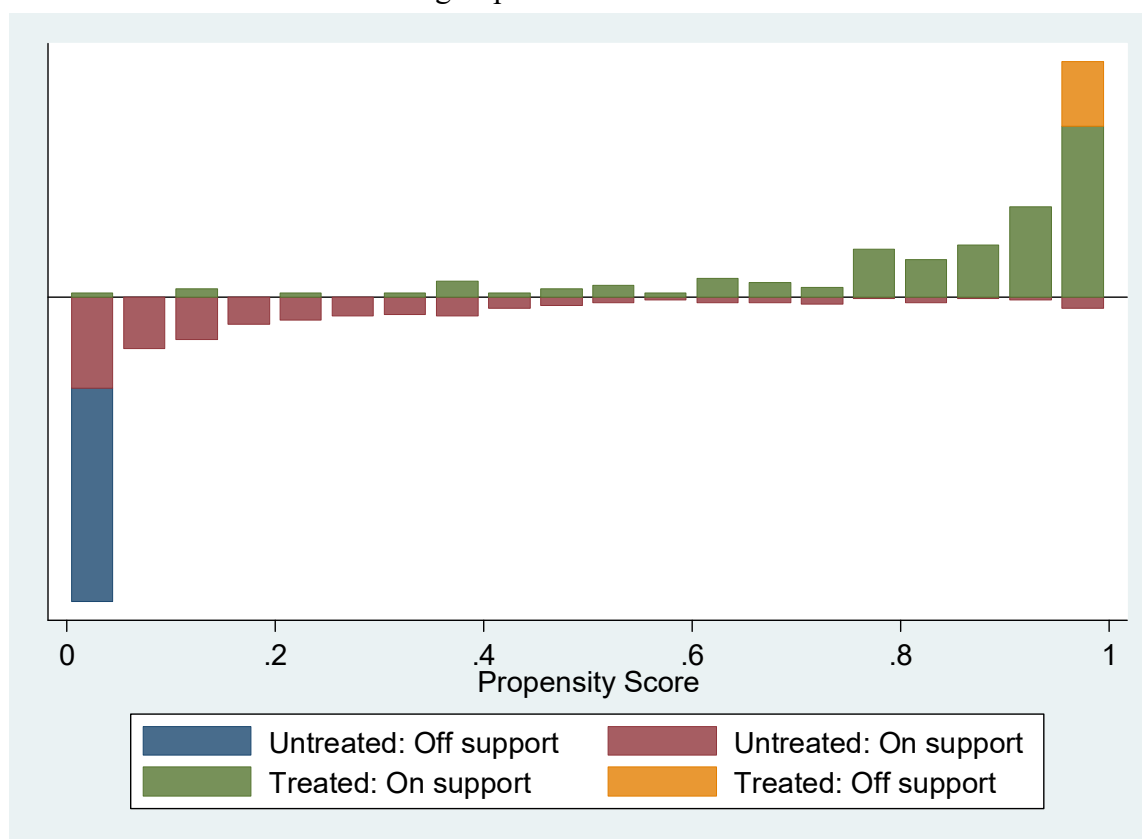
From the graph on figure 1 a considerable overlap of propensity scores exists between the users and Non-users which means that the match is good and the balancing property is satisfied. On the strength of this result, the PSM technique can be deployed to attribute an increase in rice income and rice yield to the usage of RBCAPs. This is because any selection bias due to observed covariates have been eliminated and accounted for.

### Estimation of Average Treatment Effect

The second step of the econometric analysis is matching treated households with households from the control group on the basis of their propensity scores. To assess the causal effect of RBCAPs usage on household income and rice yield, two outcome variables were employed; i.e., household income and household rice yield. Accordingly, the ATT, ATU and ATE were estimated to justify the outcome of the analysis. The subsequent sections present the impact of RBCAPs usage on the outcome variables of interest-household income and rice yield.

### Common Support Region

The study imposes the common support condition in the estimation by matching in the region of common support. Based on this condition, the result in Figure 3 shows the distribution of propensity scores for the treated and untreated group and the region of common support. The bottom half of the figure shows the propensity scores distribution for the untreated group, while the upper-half refers to the treated individuals. The densities of the scores are on the y axis. It is very clear, from the observation of this figure, that the common support condition is satisfied as there is overlap in the distribution of the propensity scores of both the treated and the untreated groups



**Figure 1:** Common Support Graph

**Source:** Authors' Analysis 2023

### Effect of RBCAPs Usage on Household Income

The effect of RBCAPs usage on rice farmers' income is presented in Table 3. The result revealed that RBCAPs usage had a positive and significant effect on rice farmers' income in the study area, with an average treatment effect on treated (ATT) of ₦ 135,119.96k in terms of income obtained from rice production per hectare by the farmers who use of



RBCAPs. Likewise, the result of the analysis revealed that the average treatment effect (ATE) on the entire farmers' population that is, picking any farmer at random he or she will earn an income of about ₦ 134,453.261k. This implies that the use of RBCAPs will result to increase in income by about ₦ 134,453.261k per hectare. For the effect on untreated category, ATU value was ₦ 133,980.857k implying that, categories of non-beneficiaries if assume they were treated their income will also increase by ₦ 133,980.857k per hectare. This is consistent with the findings of previous studies Ebenehi *et al.* (2024) who found a positive change in the income of programme beneficiaries when compared with the non-beneficiaries.

**Table 3:** Impact of WASIL Extension Participation on Household Income

Outcome	Sample	Treated	Control	Difference	SE	t-test
	Unmatched	826245.305	722769.607	103475.698	26240.725	3.94***
				135119.96		
Income	ATT	678296.875	813416.855			1.61***
	ATU	820181.857	686201	133980.857	83311.320	
	ATE			134453.261		

**Note:** SE= standard error, \*\* p>0.05 and \*\*\* p>0.01

**Source:** Field survey, 2023

## CONCLUSION AND RECOMMENDATIONS

The RBCAPs has a positive effect on the income of its users in the North central region of Nigeria as it has increased the income of its users among small scale rice farmers. The practice has great potential, which if properly managed and sustained could serve as the spring board for future poverty alleviation and food security initiatives.

Based on the findings the following recommendations were made:

- Female household heads need to be encouraged to key into the practice in order to improve their income base.
- Income of the users increased ₦135,119.96k per hectare as a result of usage of RBCAPs, it is therefore recommended that the usage be sustained.

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