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Impacts Of The Adoption Of Recommended Rice Production Practices On Farmers' Livelihood In Two Selected Local Government Areas Of Kogi State, Nigeria

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Abstract
Recommended rice production practices (RRPP) adoption becomes very important if farmers, are to achieve sustainability in rice production. Therefore, this research describes the socioeconomic and institutional profile of the rice farmers; describes the level of adoption of RRPP; determines the impact of the adoption of RRPP on the livelihood of rice farmers and identifies the constraints faced by rice farmers and its level of severity. A multistage sampling techniques was used to select 201 respondents as adopters and 201 respondents as non-adopters from the same communities. The study relied mainly on primary data collected through a structured questionnaire. Descriptive statistics and inferential statistics were used to achieve the stated objectives. Results on socioeconomic characteristics revealed that, the adopters of RRPP were in their active age with the mean age of 39 years, and a majority (87.6%) were married. The result on level of adoption showed that, the RRPP were highly adopted (89.5%). On impact of RRPP on the livelihood of rice farmers, it was revealed that farmers who keyed into the programme had improvement in rice yield, income, and level of living of about 3412.93kg/ha, ₦30,696.51 and ₦75,247.39 respectively. It was concluded that the adoption of RRPP had improved the skills of rice farmers which invariably increased their livelihood more than the non-adopters. Constraints such as the high cost of agro-chemicals, scarcity of farm machinery and high cost of inputs were very severe. In conclusion, the adoption of RRPP had a significant impact on the adopters' livelihood. Therefore, the programme should be improved to meet the current change in climate, it should also replicated in other areas in the State and beyond.
Keywords: *Impact, Adoption, Rice, Production, Practice, Kogi State*

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I. Introduction

Rice (*Oryza Sativa*) farming is a vital industry in Nigeria but a large number of rice farmers operate on a small scale with farm size of between 1 hectare to 4.99 hectares (Bello *et al*., 2021). At the third Agricultural Conference and Exhibition of Daily Trust Newspaper, with the theme: Repositioning Rice, Sugar & Dairy Production for Optimal Yield, in Lagos, stakeholders ascribed low performance, especially in rice production to government's policy summersault, resulting to lack of clear information on what farmers need to do to boost local production, adding that there is urgent need for all the players to put government on its toes (Gbenga, 2019; Enechi and Ojiagu, 2021). The aforementioned issues coupled with the ever-increasing population make it imperative to explore an innovative approach to increase Nigeria rice production. Recommended rice production practices (RRPP) are a set of specified activities and processes designed to intensify rice production for a better yield. RRPP were developed and disseminated by the National Cereal Research Institute (NCRI) in Kogi State and across Nigeria for over five years through different agricultural programmes (NCRI, 2018). The practices include: Nursery practices, Transplanting date (8-12 days), plant spacing (20cm X 20cm), Weeding (10 Days after transplanting using herbicide and/hoe), fertilizer application (4bags of NPK and 2bags of Urea/ha), method of fertilizer application (basal and drilling), water requirement (3mm-5mm of water/day), diseases and pest control (spray pesticides 30-40 days after transplanting). These practices were considered best for lowland rice varieties such as FARO 44, 60 and 67, and were disseminated using demonstration farms in farming communities at different locations in Kogi State (Mahmud, 2023). Adopting these practices is inevitable because of their yield potential. Rice farming practices that are more promising than traditional practices show effectiveness of agricultural research which needs to be documented through the conduction of impact assessments to enables any modification that can further improve the practices (Meuwissen *et al*., 2019). Changes in yield, income and level

of living which are indicators of farmers' livelihood are benefits that could be derived from adopting RRPP (Onuwaroh *et al.,* 2017). The skills, assets and activities that rural people require to live are referred to as rural livelihood. It is considered sustainable when livelihood sources can withstand stress and recover from shocks while maintaining or improving its current and future standard (Scoones, 2009). Most rural communities of Nigeria depend on farming as sources of livelihood (Odoh *et al.,* 2019). Despite the introduction of RRPP to farmers in Kogi State, They are still using traditional practices thereby facing problems of low yields and poor livelihood. Hence confirming the correlation between small farms, low productivity and poor livelihood, which is the empirical gap the study intends to fill, using rice farmers in Kogi State.

Studies on adoption have been carried out on improved rice production practices and these include Ejembi *et al*. (2018), Adisa *et al.* (2019), Abubakar *et al.* (2020), and Ojo *et al*. (2021). Most of these studies focus on the profitability and determinants of technology adoption. At present, there is insufficient literatures regarding the impact of the adoption of RRPP in a particular study area. Therefore, this study attempts to find out the impact of such practices on farmers' livelihood in Kogi State, Nigeria. The research objectives are to: (i) describe the socioeconomic and institutional profiles of the rice farmers in the study area, (ii) describe the level of RRPP (iii) determine the impacts of the adoption of RRPP on the livelihood of rice farmers and (iv) identify the constraints faced by rice farmers and its level of severity.

II. Methodology

The research was carried out in Kogi State, Nigeria. Kogi State lies on latitude 71' 49^{o} North and longitude 61' 45^{o}East. This geographical location promotes farming activities and has an average maximum temperature of 33.2^{o}C and an average minimum of 22.8^{o}C (Nigerian Meteorological Agency, 2022). The two distinct weather in Kogi State are; dry season, starts from November to February and rainy season, starts from March to October, with annual rainfall that ranges from 1016mm to 1524mm (Sunday and James, 2020). The study area (Lokoja and Kogi-Koto Karfe) has a population 662,809 people in the 2006 census (NPC, 2006) and an estimated population of 910, 334 people (NPC, 2023). Economically, Kogi State is largely an agricultural area consisting of coffee, cashew, ground nut, cocoa, oil palm, rice and yam. Other key industries are crude oil extraction and livestock (cattle, goats, sheep and poultry).

The respondents for the study were selected using a multistage sampling techniques. Kogi State consists of three senatorial districts namely: Kogi-West zone, Kogi-East zone and Kogi-Central zone. Firstly, two Local Government Areas were purposively selected (Lokoja and Kogi/Koto Karfe) from the Kogi-West zone. This is because of their closeness to the confluence river which makes their farm land favourable for rice production in both rainy and dry seasons. Most of them are also smallholder farmers that depend mostly on rice production as their livelihood. Simple random sampling was used to select five communities from each of the selected LGAs in the second stage, making ten communities for the research. Kogi State Agro Processing, Productivity Enhancement and Livelihood Improvement Support (APPEALS) project documented 405 rice farmers in the selected communities which were participants of the APPEALS project adopted communities. They form the sample frame for adopters of RRPP, from which 201 rice farmers (49.6%) were selected as respondents using Slovin's formula (1960). The same number (201) of rice farmers was selected from the communities to make the respondents for non-adopters. This makes 402 respondents. The respondents were randomly selected from the list.

For this study, primary data was used. The data was obtained using a structured questionnaire which was administered to the selected sample size in the study area using Kobocollect. Information collected includes all the stated objectives. Two enumerators were employed for the data collection which were supervised by the researcher.

Descriptive statistics such as frequency, percentage, mean, standard deviation and 5-point likert scale were used to summarize and achieve objectives i, ii and iv while Propensity Score Matching (PSM) method was used to achieve objective iii. In estimating the impact of RRPP on the livelihood of rice farmers, the self-selection bias problem must be addressed (Willy *et al*., 2014). The self-selection problem is solved by implementing PSM, which involves the use of a binary model to generate propensity scores for each farmer in the study. In PSM, each farmer receiving treatment (adopters) is matched with untreated farmers (non-adopters) based on observable covariates, such that treatment is randomly assigned and then measures the average differences in yield, income and level of living.

The PSM can be expressed as;

$P(X) = Pr [D = 1|X] = E[D|X]; p(X) = F\{h(Xi)\}$

Where;

P(X) is a propensity score

Pr is the probability of adopting RRPP (taking a treatment, D = 1 and 0 otherwise) conditional on the vector of observed covariates (pre-treatment characteristics)

X and F{.} = normal or logistic distribution.

A probit model was used in the study to estimate the predicted probabilities (propensity scores) of adopting rice production practices, the Probit model is expressed as;

$Pr(D = 1|X) = G(z) = X' \beta - 1\ \emptyset(z)dZ = \emptyset\ (X' \beta)$

Where G(z) is a function taking values between 0 and 1, $\emptyset$ is the standard normal probability density function, z is the vector of covariates and $\emptyset$ is the standard normal cumulative distribution function. The empirical probit model estimated is expressed below;

$Y*_i = bX_i + u_i$, u_i ~N(0, 1), i = 1 ... ., N and $Y_i = 1$ if $Y*_i > 0$ and 0 if $Y*_i < 0$

After the estimation of propensity scores, the average treatment effect on the treated (ATT) under four matching methods such as: Nearest to neighbour matching, Radius matching, Kernel matching and Stratification matching was calculated. The average treatment effect is defined as the mean difference between the treatment group matched with the control group, who are balanced on the propensity scores and fall within the regions of common support.

The ATT is specified as: $ATT=E\ \{Y_1\ (D=1) – Y_0\ (D=0)\ T - 1\}$.

Where;

Y(1) and Y(0) are outcome indicators (in our case, yield, income and level of living score of treated and untreated households respectively).

D is a dummy variable

D = 1 if farmers are adopters

D = 0 if farmers are non-adopters

T = A treatment indicator.

III. Results And Discussion

Results on Table 1 revealed that the majority (45.35%) of the adopters and non-adopters (29.8%) age were between 30-39 years with a mean of 34.3 years and 35.5 years respectively. This implies that quite a large number of the respondents were young and were in their productive age, and they could be ready to harness their potentials in rice farming. This finding is in line with the study of Olorunfemi *et al*. (2020), who reported that livestock farmers in Kogi State were in their active age, which played major role in the adoption of livestock production technology in the State.

The results on Table 1 revealed that the proportion of males is higher in the adopters group (79.6%) than the non-adopters group (73.6%). The implication is that, the presence of more male rice farmers among the respondents could be as a result of the cultural believe in the study area where ownership of land favours men than women and this encourages men to go into farming than women. More males in the study area could also signifies the role of women as wife in the family, which could take much of their time to engage in farming activities. This result agrees with the work of Onuche and Oladipo (2021), who found that males were more into farming than females in Kogi State.

The results presented in Table 1 revealed that the majority (87.6%) of the adopters and non-adopters (83.1%) were married. This implies that a large number of the adopters were saddled with family responsibilities and also had at their disposal family labour. This responsibilities could lead to a farmer to adopt high yielding rice production practices in other to have an improved level of living. This result is in conformity with the work of Muhammed *et al*. (2019), who found out that the majority of the cassava farmers in Kogi State were married.

The result on household size of the respondents revealed that the majority (56.2%) of the adopters had a household size ranging between 1-10 members with a mean of 6 members while majority (55.7%) of the non-adopters had household size ranging between 11-20 members with a mean of 14 members. The implication of this result is that family labour which would be beneficial for the rice farmers in carrying out rice farming activities is readily available for adopters and non-adopters. This is in consonance with the study of Olorunfemi *et al*. (2020), who revealed in their work that farmers in Kogi State have considerably large household size.

Furthermore, Table 1 revealed that, majority (65.7%) of the adopters had a farm size ranging between 3-4 hectares with a mean of 3.5 hectares, while majority (70.6%) of the non-adopters had farm size ranging between 1-2 hectares with a mean of 1.5 hectares. This implies that the respondents operates small-scale farm; for adoption of new farming practices to yield high benefits, it needed to be used on a relatively large portion of land. This result disagreed with the work of Onuche and Oladipo (2021), who found that farmers in Kogi State have relatively large farm sizes. The contrast could be because the study of Onuche and Oladipo generally focused on farm households in rural areas in Kogi State, while this study was specific to rice farmers in two selected local governments in Kogi State. The findings of these results agreed with the work of Adisa *et al*. (2019), who reported that the majority of rice farmers in Kogi State operates in small-scale.

Following the results on Table 1, majority (35.3%) of the adopters had farming experience ranging between 11-20 years with a mean of 15.2 years while, majority (34.8) of the non-adopters had farming experience ranging between 21-30 years with a mean of 20.6 years. This indicates that the respondents were quite experienced in rice farming. The implication of this finding is that the experience of the respondents in rice production is

sufficiently much to bring about improvement and efficiency in the rice production practices. This finding is in line with the work of Adebayo *et al*. (2021), who found that improved rice varieties adopters in Ogun State had many years of experience in rice farming.

Education is an important factor in adoption of new farming practices as it makes humans to be more flexible to changes around them. According to the result as seen on Table 1, majority (41.8%) of the adopters had secondary education, while majority (37.8) of the non-adopters had primary education. This implies that a large number of adopters of recommended rice production practices had at least secondary education, which translates into their quick comprehension of the recommended rice production practices package and high level of adoption of the practices, as most of the respondents can read and write. The findings of the results are in correspondence with the work of Aliu *et al*. (2017), who reported that the majority of the soya bean farmers in Kaduna State were literate with one form of education or another.

The results on the income of farmers from rice production were also presented on Table 1. The result revealed that, majority (51.2%) of the adopters had farm income ranging between ₦800000- ₦1000000, with a mean ₦9120000.3 while, majority (36.3%) of the non-adopters had farm income ranging between ₦200000-₦499000, with a mean of ₦328654.4. This implies that, with the amount of money gotten from rice farming, the adopters of recommended rice production practices could have an improved level of living than non-adopters. Such amount of income could enable them to navigate through the vast innovations available to improve their farming system. This is in line with the work of Ogunremi *et al*. (2023), who reported that fishermen in Kogi State have made sustainable daily income from their fish farming.

Result on Table 1 revealed that, 56.7% and 80.1% of the adopters and non-adopters had no access to credit respectively. The result also revealed that, majority (79.3%) of the adopters received credit ranging between ₦100000-₦499000 with a mean of ₦255172.4 while, majority (65%) of the non-adopters received credit <₦100000 with a mean of ₦40320.4. This implies that adopters of recommended rice production practices have access to financial support but may be constrained by poor assets which usually serve as collateral for loans from financial institutions. Banks and other lending agencies have stringent conditions attached to their services such as high interest rates. This is in agreement with the work of Silong and Gadanakis (2020), who found that quite a large number of the rural livestock farmers accessed credit for livestock production in Nigeria.

The result on membership of cooperatives revealed that, majority (98.5%) of the adopters were members of cooperative(s) while only 39.8% of non-adopters were members of cooperative(s). This result implies that most of the adopters of recommended rice production practices were in cooperative societies for many years. Membership of cooperative societies could influence farmers to adopt new farming practices, thereby increasing the level of adoption of recommended rice production practices. This is consonance with the study of Adisa *et al*. (2019), who reveals that most of the rice farmers in Kogi State were members of cooperative society which contributed to their source of information.

The result on access to extension agents revealed that, majority (98%) of the adopters had access to extension agents while only 44.1% of the non-adopters had access to extension agents. this result is an indication that the adopters may be exposed to agricultural information many times, which could lead to the adoption of recommended rice production practice. This is consistent with the study of Olarinde *et al*. (2020), who reported that adopters of crop production practices of FADAMA project in South West had three times extension visit in a month.

Table 1: Socioeconomic and institutional profiles of rice farmers

	Adopters (n=201)			**Non-adopters (n=201)**		
Variables	**Freq.**	**%**	**Mean**	**Freq.**	**%**	**Mean**
Age						
20-29	15	7.5		11	5.5	
30-39	91	45.3	34.3	60	29.8	35.5
40-49	40	19.9		52	25.9	
50-59	30	14.9		43	21.4	
≥ 60	25	12.4		35	17.4	
Sex						
Female	41	20.4		53	26.4	
Male	160	79.6		148	73.6	
Marital status						
Divorced	4	2		9	4.5	
Married	176	87.6		167	83.1	
Single	18	9		19	9.5	
Widow	3	1.5		6	2.9	
Household size						
1-10	113	56.2		70	34.8	
11-20	73	36.3	6	112	55.7	14

21-30	15	7.5		18	9	
31-40				1	0.5	
Farm size						
1-2	36	17.9		142	70.6	
3-4	132	65.7		46	22.9	
5-6	30	14.9	3.5	13	6.5	1.5
≥ 7.00	3	1.5				
Farming Experience						
1-10	63	31.3		22	11	
11-20	71	35.3		57	28.3	
21-30	30	14.9		70	34.8	
31-40	20	10	15.2	26	13	20.6
41-50	16	8		25	12.4	
51-60	1	0.5		1	0.5	
Educational level						
Non-formal Education	17	8.5		59	29.4	
Primary Education	37	18.4		76	37.8	
Secondary Education	84	41.8		41	20.4	
Tertiary Education	63	31.3		25	12.4	
Farm income						
< 200000	5	2.5		11	5.5	
200000-499000	6	3		73	36.3	
500000-799000	8	4	9120000.3	52	25.9	328654.4
800000-1000000	103	51.2		65	32.3	
≥1000000	79	39.3				
Access to credit						
No	114	56.7		161	80.1	
Yes	87	43.3		40	19.9	
Amount of credit received						
< 100000	5	5.8		26	65	
100000-499000	69	79.3		13	32.5	
500000-899000	13	14.9	255172.4	1	2.5	234000.0
≥ 900000	3	3.4		2	6.7	
Membership of cooperative society						
No	3	1.5		111	60.2	
Yes	198	98.5		90	39.8	
Access to extension agents						
No	4	2		152	55.9	
Yes	197	98		120	44.1	

Level of adoption of RRPP by farmers

In Table 2, the results revealed that, improved varieties of rice and nursery practices were 99% and 98.5% respectively. They both ranked 1st and 2nd. Also transplanting date (97.5%) ranked 3rd, plant spacing (97%) ranked 4th followed by weeding (89.1%) which ranked 8th. In addition, the rate of fertilizer application (94.5%) ranked 5th while method of fertilizer application (93%) ranked 6th. Also, water requirement (82.6%) and diseases and pest control (91.5%) ranked 9th and 7th respectively. This implies that, most of the RRPP were adopted by the respondents. Furthermore, Table 2 presents the results on the level of adoption of RRPP. Using index score to interpret the result. It portrayed that, the adoption index of most (89.5%) of the respondent ranges from 0.81-1.00 which indicates that, a large number of rice farmers completely adopted the RRPP extended to them. This implies that, 89.5% of adopters adopted seven or all the nine RRPP. These set of farmers can be categorized as innovators and early adopters who are mostly risk-takers. It indicates that the rice production practices were successfully disseminated due to the fact that large number of farmers who fully engaged the practices. This findings agrees with the work of Victory *et al.* (2022) which pointed out that climate-smart agricultural practices introduced to farmers in Oyo State were highly adopted by smallholder farmers.

Table 2: Farmers distribution according to level of adoption of RRPP

Recommended rice production practices	*Freq.	Percent	N
Improved varieties of rice (FARO-67)	199	11.7	1st
Nursery preparation	198	11.7	1st
Transplanting date (21-28) days after planting	196	11.6	3rd
Plant spacing (20cm X 20cm)	195	11.5	4th
Fertilizer application (4bags of NPK and 2bags of Urea/ha)	190	11.2	5th
Method of fertilizer application (Basal)	187	11.0	6th

Diseases and pest control (Spray pesticides 30-40 DAT	184	10.9	7th
Weeding date/control (2 weeks after transplanting using herbicide and/hoe)	179	10.6	8th
Water requirement (3mm-5mm of water/day)	166	9.8	9th
Level of adoption of recommended rice production practices	**Index**	**Freq.**	**Percent**
Low adoption	0.00-0.20		
Slightly adopted	0.21-0.40	1	0.5
Moderately adopted	0.41-0.60	5	2.5
Adopted	0.61-0.80	15	7.5
Highly adopted	0.81-1.00	180	89.5
Total		**201**	**100**

**Multiple responses allowed*

Impacts of adoption of RRPP on the livelihood of farmers

Income distribution and inequalities (Gini coefficient) among the respondents

The result in Table 3 shows that, the spread of income (GC) among adopters of RRPP was 0.644. This indicates close inequalities and low levels of equalities in income distribution among the adopters. The GC for adopters are all tending towards unity which signifies that, there is higher income inequality among the adopters. This implies that there is little gap in the annual income of middle and low adopters. This could be because majority of the farmers are in cooperative societies and also might have participated in one agricultural programme or the other which may provide them with inputs such as fertilizer, seeds and agro-chemicals to aid their adoption of the practices. Also, the GC of non-adopters was 0.371, implying a low inequality between the non-adopters. The sharp differences in the Gini coefficient between adopters and non-adopters of RRPP could be tied to the differences in their socioeconomic and institutional backgrounds which helps farmers to have access production resources. This align with the work of Abdulazeez *et al.* (2019), who found that, the Gini coefficient of beneficiaries was more than the non-participant of Kogi Accelerated Rice Production Programme (KARPP).

Table 3. Income distribution and inequalities (Gini coefficient) among the adopters and non-adopters

	Adopters				**Non-adopters**			
Income	**Freq.**	**%**	**Average mean**	**G.C**	**Freq.**	**%**	**Average mean**	**G.C**
<200000	5	2.5	53400	0.55	11	5.5	136166.7	0.21
200000-400000	6	3	148800	0.53	73	36.6	236916.7	0.14
500000-799000	8	4	100400	0.43	52	25.9	512250	0.06
>800000	182	90.5	3700000	0.63	65	32.3	804166.7	0.18
Total	**201**	**100**	**G.C = 0.644**		**201**	**100**	**G.C = 0.371**	

Note: G.C = Gini Coefficient

Impacts of adoption of RRPP on yield, income and level of living of rice farmers

This section is on the impact of RRPP on the livelihood of farmers. Indicators of livelihood such as yield, income and level of living were used as a proxy to measure and estimate livelihood of rice farmers using four matching methods such as near-neighbour matching, radius matching, kernel matching and stratification matching. The interpretation was basically done using the value from the matching methods, Average Treated effect on the Treated (ATT), Standard Error and T-value. The matching method with low standard error signifies less bias, and was employed to interpret the differences in yield, income and level of living. Table 4 highlights the balancing properties between the treatment and control which was based on the low pseudo R^2, lower mean standardized bias value comparison of before and after matching in correspondence with high total bias reduction.

Across all matching algorithms (NNM, KM, RM, SM), bias reduction is substantial, with the highest bias reduction observed in Kernel Matching (KM) and Stratification Matching (SM). The pseudo R2 values dropped significantly after matching, indicating an improved model balance. The Mean Absolute Bias is much lower after matching, confirming that the treated and control groups are more comparable post-matching. This indicates that the distinction between the adopters and non-adopters in observed factors that could explain adoption of RRPP and as well as biased estimates for the outcome variables (yield and income) are properly controlled before estimation of the treatment effect. Kernel Matching (KM) and Stratification Matching (SM) showed the best performance in reducing bias for both yield and income, put forward that the most reliable estimates of treatment effects in the adoption context may be given by these methods.

Table 4: Propensity Score Matching balancing properties before and after matching

		Pseudo R^2		**Mean Absolute Bias**		
Matching algorithm	**Outcome indicators**	**BM**	**AM**	**BM**	**AF**	**Absolute Bias Reduction**
NNM	Yield(kg/ha)	0.257	0.087	20.431	9.417	53.901
	Income (₦)	0.262	0.021	21.371	10.958	48.725
KM	Yield(kg/ha)	0.278	0.039	20.516	5.322	74.059

	Income (₦)	0.271	0.092	22.935	8.793	61.661
RM	Yield(kg/ha)	0.391	0.032	29.149	15.392	54.057
	Income (₦)	0.342	0.028	31.224	15.018	51.018
SM	Yield(kg/ha)	0.362	0.034	17.158	4.594	73.225
	Income (₦)	0.291	0.020	19.713	6.896	65.018

Note: BM=Before Matching AM=After Matching

Table 5 indicates that Nearest Neighbour Matching and Stratification Matching show statistically significant and substantial positive impacts on the yield of the adopters. Both matching methods were significant at a1% level of probability with high t-values (3.08 and 6.06) indicating strong evidence that adopting RRPP significantly increases yields. Among the two significant methods stratification matching had less (126.48) standard error compared to nearest neighbour matching (310.67). This means, there was less bias due to selection in terms of stratification matching compared to that of nearest neighbour matching; this makes stratification matching more balanced and fit to explain the differences in yield between adopters and non-adopters. Under stratification matching, adopters had a mean yield of 3412.93kg/ha and non-adopters had 2647.06kg/ha with yield differences of 765.87kg/ha which is significant at a 1% level of probability. This implies that, adopters of RRPP had 765.87kg/ha over the non-adopters. The Radius Matching and Kernel Matching values which were not statistically significant could be because the differences in farmers' characteristics (e.g, education, access to credit) and the context in which the RRPP were adopted (e.g., soil quality, access to resources, local climate). Such contextual differences can affect the effectiveness of the practices, leading to variable impacts on yield and contributing to the non-significant results in some matching methods.

Depending on the matching method used, the adoption of the practices can have a substantial positive impact on farmers' yields. Stratification matching methods provide more reliable and significant estimates, indicating that these practices results in a noticeable increase in yield which can lead to high income for the adopters. This collaborated with the work of Bello *et al*. (2021), who reported that, in Nigeria, adoption of improved rice varieties increase yield of farmers.

Table 5: Estimating the impact of the adoption of RRPP on the yield (Kg/ha) of farmers

Variables (ATT)	NN-Matching	Radius Matching	Kernel Matching	Stratification Matching
Adopters' mean yield	2618.18	2618.18	2740.26	3412.93
Non-adopters' mean yield	1661.61	2580.25	2675.28	2647.06
Differences in yield	956.57	37.93	64.97	765.87
SE	310.677	525.49	434.54	126.48
t-stat	3.08***	0.07	0.15	6.06***

****= Significant at 1% ATT= Average treatment effect on the Treated, NN=Nearest Neighbour*

Results on impacts of adoption of RRPP on the income of farmers revealed that, the four matching method was statistically significant with Stratification Matching having the lowest standard error (1011.26) which was significant at 1% level of probability with t-values of 5.36, indicating strong evidence that adopting RRPP significantly increases rice farmers' income. The mean income under stratification matching point out that adopters had a mean income of ₦30,696.51 and non-adopters had ₦16,716.41 with income differences of ₦13,980.01. This implies that, adopters of RRPP had a mean income of ₦13,980.01 than the non-adopters. Furthermore, it can be deduced from the result that, there was a homogenous society in terms of farmers' characteristics because they seemed to show little bias towards either of the methods used. This agrees with Francois *et al*. (2023), who portrayed that Transforming Irrigation Management in Nigeria-System of Rice Intensification (TRIMING-SRI) Project in Bakolori scheme had a tremendous impact on the livelihood of the rice farmers.

Table6: Estimating the impact of the adoption of RRPP on the income (₦) of farmers

Variables	NN-Matching	Radius Matching	Kernel Matching	Stratification Matching
Adopters' mean income	88983.27	88983.27	88935.61	30696.51
Non-adopters' mean income	56318.41	54801.73	54793.87	16716.41
Differences in income	32664.86	34181.54	34141.74	13980.01
SE	2818.71	1555.32	2449.55	1011.26
t-stat	11.59***	21.98***	13.94***	13.82***

****= Significant at 1%, ATT= Average treatment effect on the Treated, NN=Nearest Neighbour*

Impacts of adoption of RRPP on the level of living of farmers revealed that, the four matching methods were statistically significant with Kernel Matching having the lowest standard error (2369.87) which was significant at a 1% level of probability with t-values of 12.81, this gives the credit to the fact that the adoption of

the practices positively rice farmers level of living. The mean level of living which was computed on its monetary term showed that, under the kernel matching method, adopters had a mean level of living of ₦ 75,247.39 and non-adopters had ₦44,882.89 with differences of ₦30,364.51. This implies that, adopters of RRPP had a mean level of living of ₦30,364.51, more than the non-adopters The finding is in concert with Daniela *et al.* (2017) report that improved rice technologies, including high-yielding varieties and better agronomic practices, can boost rice yields. Higher yields results in more rice to sell or consume, leading to increased income for farmers and their overall level of living.

Table 7: Estimating the impact of the RRPP on the level of living (₦) of farmers

Variables	NN-Matching	Radius Matching	Kernel Matching	Stratification Matching
Adopters' mean level of living	75261.19	75261.19	75247.39	32686.57
Non-adopters' mean level of living	44527.36	44527.36	44882.89	19353.23
Differences in level of living	30733.83	30733.83	30364.51	13333.33
SE	2856.96	2856.96	2369.87	2489.62
t-stat	10.76***	10.76***	12.81***	5.36***

****= Significant at 1%, ATT= Average treatment effect on the Treated, NN=Nearest Neighbour*

Assets distribution among adopters and non-adopters

Results on the numbers of assets owned by households among adopters and non-adopters of RRPP presented in Table 8 depict that, household assets and livestock assets owned by adopters were more in numbers than that of the non-adopters. The results unveiled a 10% distinction in the houses owned by adopters and non-adopters. This implies that, the adopters built or renovated 5 houses than the non-adopters. Also, household assets such as furniture, car, and amount of school fees paid, motorcycle, cell phone, television and radio shows 5.1%, 60%, 74.4%, 10.2%, 8.4%. 10.7% and 44.9% differences respectively. The implication is that, the adopters of RRPP were better of in terms of the number of these items available at their disposal to improve their level of living. In addition, the adopters had 14.9%, 21.6%, 66.6%, 2.6%, 8.4%, 47% and 3.6% differences in farm implement like sprayers, grinding machines, planters, land, hoes, wheel-barrows and cutlasses respectively. This implies that the adopters had more efficiency in terms of farm labour than the non-adopters with such farm implements at their disposal. These could increase the area of land for rice farming thereby, increasing their income and level of living.

Furthermore, adopters of RRPP also had more livestock assets than the non-adopters. Livestock assets such as bull, cow, goats, sheep, ducks, chickens, turkey and rabbits shows 51.4%, 9.8%, 28.2%, 13.2%, 88.6%, 43%, 16.2% and 62% differences respectively. This acknowledges that, the adopters also had more livestock than the non-adopters it indicate that, the adopters had a good livelihood diversification that can improve and sustain their rice farming. Livestock can serve as a source of food in the form of meat, but it also a source of capital to carry out farming operations. This significant role could help farmers stay ahead of some constraints like lack of credit facility and an unstable or low market. Money sourced from the sales of livestock could improve farmers' financial stability thereby not selling their farm produce during farming season when the price is low. The findings agrees with the work of Abdulazeez *et al.* (2019), that, participants in the Kogi Accelerated Rice Production Programme (KARPP) had an improved level of living taking into consideration the assets (such as cell phones, cars, motor-cycles, radios, televisions, farm equipment and livestock) they acquired.

Table 8: Relative proportion of each asset's ownership between adopters and non-adopters, showing who dominates ownership in each category

Household Assets (number acquired)	Adopters Freq.	%	Non-adopters Freq.	%	Percentage Differences
House (new or renovation)	25	55.5	20	44.4	10.0
Furniture	61	52.5	55	47.4	5.1
Car	4	80.0	1	20.0	60.0
Amount of school fees paid	₦36368000	87.2	₦5317000	12.8	74.4
Motorcycle/tricycle/bicycle	70	55.1	57	44.9	10.2
Cell phone	39	54.2	33	45.8	8.4
Television	43	55.5	34	44.8	10.7
Radio	16	72.7	6	27.3	44.9
Sprayer	27	57.5	20	42.6	14.9
Grinding machines	31	60.8	20	39.2	21.6
Planter	5	83.3	1	16.7	66.6
Land	61	51.3	58	48.7	2.6
Hoes	143	54.2	121	45.8	8.4
Wheel barrow	25	73.5	9	26.5	47.0
Cutlass/axes	73	51.8	68	48.2	3.6
Livestock Assets (in number)	**Freq.**	**%**	**Freq.**	**%**	**Percentage**

					Differences
Bull	128	75.7	41	24.3	51.4
Cows	173	54.9	142	45.1	9.8
Goats	547	64.1	306	35.9	28.2
Sheep	276	56.6	212	43.4	13.2
Ducks	61	93.3	3	4.7	88.6
Chickens	1111	71.5	442	28.5	43.0
Turkey	68	58.1	49	41.9	16.2
Rabbits	47	81.0	11	19.0	62.0

Constraints faced by rice farmers in the adoption of RRPP and the level of severity

In Table 9, the results affirm that a majority (99%) of adopters of RRPP faced a high cost of agro-chemicals. This implies that, a reduction in the price of agro-chemical could be an important factor in the adoption of RRPP. This indicates that, the cost of agro-chemicals is why some farmers did not adopt the RRPP. Also, the respondents complained about the scarcity of farm machineries (98%) and the high cost of inputs (97.5%). This entails that, farmers may not highly adopt the RRPP because of the lack of money to purchase inputs (such as fertilizer and seed) and the lack of tractors available for farmers with relatively large farm size to hire. This is in line with the work of Adisa *et al*. (2019), who found that, the high cost of agro-chemicals, high cost of inputs and lack of machinery were constraints to the adoption of rice production technologies in Kogi State.

Furthermore, 90.5%, 85.6% and 83.1% of the rice farmers reported that low market prices, increased labour demand, and incidents of bird attacks were also a constraints faced in adoption of RRPP. This is consistent Loko *et al*. (2022), who identify that bird attacks on rice fields, and inadequate sales market were identified as constraints to rice farming in Edo State. Rice farmers also lamented on lack of regular training (75.1%) and problems of religious beliefs (60.7%). Constraints such as the high cost of agro-chemicals, scarcity of farm machinery and high cost of inputs were very severe. This collaborated with the study byAdnan *et al*. (2019), which asserted that the major constraints to the adoption of green fertilizer are complexity problems, economic problems and poor technical information.

Table 9: Farmers distribution according to constraints faced by rice farmers in the RRPP

Constraints	***Freq.**	**%**	**Weighted score**	**Mean score**	**Remark**
High cost of agro-chemicals (pesticide & insecticide)	199	99.0	230	1.14	Very severe
Scarcity of farm machineries (tractor hiring)	197	98.0	242	1.20	Very severe
High-cost of inputs e.g. seed, fertilizer	196	97.5	258	1.28	Very severe
low market prices	182	90.5	371	1.84	Severe
Insufficient labour demand	172	85.6	385	1.91	Severe
Incident of bird attacks on rice crop	167	83.1	588	1.83	Severe
Lack of regular training	151	75.1	531	2.64	Undecided
Religious beliefs	122	60.7	992	4.93	Not severe

Note: *1=Very severe, 2=Severe, 3=Undecided, 4=Slightly severe, 5=Not severe*

IV. Conclusion And Recommendation

Based on these findings, it was concluded that, the RRPP were highly adopted in Kogi State which signifies that the dissemination of the practices was a success. Also, it was discovered that RRPP adopters had an increase in rice yield of about 3412.93kg/ha while non-adopters had 2647.06kg/ha. There was also an average impact of ₦30,696.51 on the income of adopters while non-adopters had ₦16,716.41. The level of living of the adopters also estimated in naira was improved by ₦75,247.39 against the non-adopters who had ₦44,882.89. Consequently, it was concluded that RRPP adopters had improved skills in rice farming practices which invariably increased their yield, income, level of living and general improvement on their livelihood compared to the non-adopters. In addition, the results affirms that the adoption of RRPP had a positive and significant impact on the adopters' yields, incomes and levels of living. Therefore, it is recommended that the programme should be improved to meet current climate change. The initiative should also be replicated in other areas in the State and beyond.

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