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Impact of NERICA Rice Project on the Productivity of Rice Farmers in Kaduna State of Nigeria.

[1]Gambo, B. K., [1]Manza E.A.G, [1]Kassim I.A., [2]Ahmed B, and [3]M. Dalhatu.

1. *Department of Agricultural Economics and Extension, Kaduna State University, Kafanchan Campus, Kafanchan, Kaduna State*
2. *Department of Agricultural Economics, Ahmadu Bello University, Zaria*
3. *Department of Agricultural Technology, Umaru Ali Shinkafi Polytechnic, Sokoto State*

Corresponding Author: bellokudan@gmail.com. Phone Contact: 07064441053

Abstract

This research evaluated the impact of the adoption of NERICA rice technology on the productivity of rice farmers in Kaduna State. Baseline production data for 2004 was obtained for both the participants and the non-participants. Additional two sets of 2010 end-line data were gathered from each group, making a total of four data sets. Three out of the four data sets were obtained as secondary data. The only set of primary data that was collected by the researchers was end-line data of the participants. The sample sizes of both the participants and non-participants were 100 farmers each. This makes a total sample size of 200 farmers. The data collected were analyzed using descriptive statistics, Double Difference Estimator (DDE) analysis and Z - test. The result of the analysis revealed that the mean adoption intensity of NERICA rice was found to be 0.66, implying that 66% of the land area cultivated for rice by the participants was devoted to NERICA rice. The DDE result revealed that the NERICA rice adoption had a positive impact on productivity of farmers as it increased yield by 25.67%. Conclusively, NERICA rice has higher productivity than other rice varieties. The recommendations made include the project should engage in NERICA seed multiplication arrangements using contract farmers; the participants need to organize themselves to form co-operatives; the Kaduna State Government need to engage in massive land clearing exercise from the total arable land of 2.02 million hectares so that additional farms could be prepared and rented out to the farmers at an affordable rate and also there is the need to implement a group extension system which economizes on staff and resources as against the present extension system.

Keywords: Adoption Intensity, Double Difference Estimator, non-Participants, Participants, Productivity

Introduction

Nigeria has diverse ecological zones which comprise the semi arid Sudan, Guinea Savannah, Derived Savannah, Forest and Mangrove zones. According to Azih (2008) the type of ecology and the rainfall trends in any particular region dictate the type of farming system, the people's food preferences and the pattern of natural resource utilization in that region. Agriculture, since independence, holds the key to Nigeria's rapid economic transformation, poverty alleviation, stable civil service, good governance as well as national food security.

NERICA rice was achieved as a result of the crossing of the indigenous African rice *(Oryza glaberima)* and foreign Asian rice (*Oryza sativa)* by the then West African Rice Development Association (WARDA) scientists (Kassim *et al*., 2010). The name NERICA was trade marked by WARDA in 2004. The Multinational NERICA Rice Dissemination Project (MNRDP) is running in six States – Kaduna, Ogun, Nasarawa, Ondo, Taraba and Ekiti (Kassim *et al*., 2010).

In Kaduna State, the Project is jointly sponsored by the African Development Bank (ADB), the Federal Government of Nigeria (FGN) and the Kaduna State Government (KDSG) through the Kaduna State Agricultural Development Project (KADP). The implementation of the Project in the State started with baseline survey of one hundred randomly selected rice farmers in 2004. Many farmers adopted the variety due largely to intensive extension services of the Kaduna State Agricultural Development Project (Nyam, 2010). The main objective of the project was to boost domestic rice production, enhance food security, alleviate poverty and achieve import substitution

via facilitation of rapid diffusion and adoption of high - yielding upland NERICA rice varieties. The Project had four components, namely: technology transfer, production support, capacity building and project co-ordination (Nyam, 2010).

Furthermore, rice is a favourite food among youths and children in the study area. It is eaten very frequently by many other age brackets (young, adult and the elderly). The demand for rice therefore exceeds supply in Kaduna State just as it is in Nigeria as a whole (Nyam, 2010). Thus, rice attracts more price than other grains because of its high demand. Higher price is an incentive to farmers to produce or process more rice for marketing. From the 2010 Annual Agricultural Production Survey (APS) conducted in Kaduna State, in terms of productivity rice ranked second to other major food crops (Table 1). The greater productivity of maize might be due to the fact that maize is being produced in commercial quantity with a support from the World Bank donor project called Commercial Agriculture Development Project (CADP).

Table 1: Position of rice production in Kaduna State as at 2010

CROP	Production(Ton)	Area (Ha)	Yield (Ton/Ha)	Yield Ranking
Maize	798600	331140	2.41	1st
Millet	153590	115460	1.33	4th
Sorghum	478380	273170	1.75	3rd
Rice	359270	163260	2.20	2nd

Source: KADP-APS (2010)

The broad objective of this study is to evaluate the impact of the NERICA dissemination project in Kaduna State. The specific objectives are to:

a. estimate the adoption intensity of NERICA rice farmers in Kaduna State,
b. determine the impact of the adoption of NERICA rice on the productivity of rice farmers in Kaduna State.

Moreover, a null hypothesis - there is no significant difference in productivity between NERICA producers and non-NERICA producers was tested.

Methodology

Description of the Study area

Kaduna State lies between latitudes $09^0\,02^1$ and $11^0\,32^1$ North and Longitudes $96^0\,15^1$ and $08^0\,60^1$ East of the Greenwich meridian. The State has a total land area of about 4.5 million hectares (approximately 48,473.2 km^2), with an estimated total arable land of about 2.02 million hectares comprising 1.94 million hectares upland and 0.08 million hectares of lowland (KADP, 2009). By the 2006 census figure, the State population was 6,066,512, with an annual growth rate of 3%, the projected figure in 2017 is 8, 397,471 out of which 75% (6,298,103 people) are engaged in agricultural production as a means of livelihood and employment (KADP, 2009).

The State consists of twenty three Local Government Areas (LGAs). It shares common borders with the Federal Capital Territory (FCT), Abuja and seven other States, namely, Kano, Katsina, Niger, Bauchi, Plateau, Nasarawa and Zamfara States (KADP, 2009).

There are two distinct seasons in the State, namely, wet and dry seasons. The wet season generally lasts from April to October while the dry season lasts between November and March. The average rainfall is about 1,482 mm while temperature ranges from 35^0 C to 36^0 C during the humid period to as low as 10^0 C to 23^0 C during the harmatan periods of November to February (KADP, 2009).

The State falls within the Southern and Northern Guinea Savannah ecological zones, characterized

by woodlands with grasses of different species. The soil is developed from undifferentiated complex igneous and metamorphic rocks. The fine top soil coupled with reasonable organic matter in it enhances the fertility status of the soil. The physical properties of the soil are moderately good and allow continuous cropping of a wide variety of crops such as maize, rice, sorghum, cassava, cowpea, soyabeans, ginger and cotton. The State also has a good grazing land for rearing cattle, sheep, goats and poultry. Moreover, there are dams, streams and rivers for fish culture and irrigation (KADP, 2009).

Sampling Procedure

This is an impact evaluation study that compares and contrasts the outcomes of two groups of farmers – treatment group (participants) and control group (non-participants). The treatment group is the one hundred upland rice farmers randomly selected in 2004 for baseline studies before the take off of the NERICA rice Project in the State. A multistage random sampling technique was used for the selection of the treatment group. At first stage, 20 Local Government Areas (LGAs) from the 4 ADP Zones in the State were purposively selected out of the 23 LGAs in the State. Kaduna South, Kaduna North and Zaria LGAs were not selected as they were considered as urban areas with minimum participation in farming. At the second stage, the list of districts in each LGA was obtained, and then a table of random numbers was used for the random selection of one district from each LGA. This made a total of 20 districts. At the third stage, the list of villages under each district was obtained, and then a table of random numbers was used again for the random selection of one village from each district. This made up a total of 20 villages. At the fourth stage, the names of rice farmers in each village were obtained from the office of the village Block Extension Agent (BEA) and a table of random numbers was also used for the random selection of 5 farmers from each village. This made a total of 100 farmers (Table 2).

The treatment group multistage random sampling technique was selected in a similar manner. This explains the variation in the number of districts per LGA and the variation in the number of villages per district as well as the variation in the number of farmers per village.

The control group (non – participants) for this study was selected from the non - NERICA rice farmers of the Second National Fadama Development Project (FADAMA II) baseline survey of 2004. In the selection of the control group (non-participants), two stages of the proportional random sampling technique were used. This was because of the disproportionate number of LGAs and farming families in the ADP zones. The first stage was the proportional selection of LGAs from the ADP Zones. The second stage involved selection of 25% of the farmers from the sample frame of 400 FADAMA II Project farmers. This was done so that the control group will be equal in size (100) with the treatment group (Table 3).

The FADAMA II baseline survey data was used to determine the average yield in the control group before the technology. Likewise, the data for the Implementation Completion Report (ICR) was used as an end - line data to compute the average yield in the control group after the technology. With the treatment and the control group of 100 farmers each, the sample size for this study was 200 farmers.

It should be noted that FADAMA project beneficiaries were not necessarily FADAMA (lowland) farmers. In fact, the participants of FADAMA II project involved all sorts of farmers – rainfed crops farmers, irrigated crops' farmers, upland crops' farmers, lowland crops' farmers, disabled persons, hunters, bricklayers, fishermen, women processors and many others.

Table 2: Distribution of participants (treatment group) in the study area.

	ADP ZONE	LGAs Selected	Districts Selected	Villages Selected	Farmers Selected
1.	Samaru-Kataf	Jema'a	Asso	Girira	5
		Zangon Kataf	Madakiya	Attat	5
		Sanga	Gimi	Sabon Gida	5
		Kaura	Kukum Daji	Zakwa	5
		Kagarko	Jere North	Gidan Jibo	5
		Kachia	Gumel	Ung. Rimi	5
		Jaba	Daddu	Kuryas	5
2.	Lere	Igabi	Kerawa	Kafin Sani	5
		Kauru	Gwaraji	Girku Sabuwa	5
		Lere	Garu	Dandaura	5
3.	Birnin Gwari	Kajuru	Katuru	Gyegyere	5
		Chikun	Kujama	Kujama	5
		Birnin Gwari	Randagi	Randagi	5
4.	Maigana	Giwa	Gangara	Yalwa	5
		Kudan	Hunkuyi	Jaja	5
		Ikara	Furana	Danlawan	5
		Makarfi	Mayere	Mayere	5
		Kubau	Damau	Bugau	5
		Sabon Gari	Basawa	Basawa	5
		Soba	Maigana	Rahama	5
			TOTAL		**100**

Source: Field Survey (2004).

Table 3: Distribution of non-participants (control group) in the study area.

	ADP ZONE	LGAs Selected	Sample frame of FADAMA II Farmers	Number of farmers Selected.
1	Samaru- Kataf	Zangon Kataf	60	15
		Kagarko	40	10
2	Lere	Kauru	60	15
		Lere	40	10
	Birnin Gwari	Birnin Gwari	60	15
		Kajuru	40	10
4	Maigana	Kubau	20	5
		Soba	20	5
		Giwa	30	7
		Makarfi	30	8
		TOTAL	**400**	**100**

Source: Field Survey Data.

Method of Data Collection

The researchers with the help of Extension Agents (EAs) administered 100 questionnaires to the NERICA Project farmers (treatment group) to generate an end-line data. The end-line data covered farm production aspects as follows:

i. Total farm output of NERICA paddy rice in kg.
ii. Land area of NERICA paddy rice and other local rice varieties cultivated in hectares.

Similar data were also captured from non-participants (control group) to achieve the objective of comparing costs and returns for NERICA and non-NERICA rice farmers.

Analytical tools

The analytical tools used in achieving the objectives and hypotheses of the study included Descriptive statistics, Double Difference Estimator (DDE) and Z – test.

Descriptive statistics

Descriptive statistics in the form of measures of central tendency such as Mean, Maximum, Minimum and Standard Error were used to achieve the objectives of the study.

Adoption intensity will be measured using the following equation (Gambo, 2013):

Adoption intensity (A_i) = $\frac{\text{Area of land under NERICA rice technology (ha)}}{\text{Total Area under NERICA plus other rice varieties (ha)}}$ …… (1)

Since this study worked with a treatment group i.e. farmers who adopted and a control group i.e. farmers who did not adopt, we therefore concentrated on the measurement of adoption intensity for the treatment group only.

Double Difference Estimator

The difference in difference (or "double difference") estimator is defined as the difference in average productivity of the participants before and after the intervention *minus* the difference in average productivity of the non-participants "before" and "after" the intervention. It is literally a "difference of differences"(Albouy, 2010). The model is specified as:

$DDE = (\bar{Y}_1^T - \bar{Y}_0^T) - (\bar{Y}_1^C - \bar{Y}_0^C)$……... (2)

Where:

DDE = Double Difference Estimator

$\bar{Y}_1^T$ = Average productivity of rice among the participants after NERICA intervention (end-line).

$\bar{Y}_0^T$ = Average productivity of the participants before NERICA intervention (baseline).

$\bar{Y}_1^C$ = Average productivity of the non-participants after NERICA intervention (end-line).

$\bar{Y}_0^C$ = Average productivity of the non- participants before NERICA intervention (baseline).

Difference in difference estimator was estimated in Table 4.

Table 4: Double Difference Estimator (DDE) Model

	Pre	**Post**	**Post – Pre-difference**
Treatment (T)	$\bar{Y}_0^T$	$\bar{Y}_1^T$	$\bar{Y}_1^T - \bar{Y}_0^T$ (single difference)
Control (C)	$\bar{Y}_0^C$	$\bar{Y}_1^C$	$\bar{Y}_1^C - \bar{Y}_0^C$ (single difference)
T-C Difference	$\bar{Y}_0^T - \bar{Y}_0^C$ (single difference)	$\bar{Y}_1^T - \bar{Y}_1^C$ (single difference)	$(\bar{Y}_1^T - \bar{Y}_1^C) - (\bar{Y}_0^T - \bar{Y}_0^C)$ (double difference)

Source: Albouy (2010).

Specification of the Z – test (test of difference between two means)

One sided Z-test at 5% level of significance was used in testing the null hypothesis that stated: There is no significant difference in rice productivity between participants and non-participants in NERICA rice production

The model is specified as follows:

$$z = \frac{\bar{Y}_T - \bar{Y}_C}{X_T + X_C} \quad \text{…….. (3)}$$

Where:

$\bar{Y}_T$ = Mean productivity (kg/ha) of the participants after NERICA intervention.

$\bar{Y}_C$ = Mean productivity (kg/ha) of the non - participants after NERICA intervention.
X_T = Standard deviation of productivity (kg/ha) of the participants after NERICA intervention.
X_C = Standard deviation of productivity (kg/ha) of the non - participants after NERICA intervention.

In a nutshell, the knowledge gap in impact assessment/evaluation that this study has filled in is variation in terms of rice productivity changes as a result of the dissemination of the new NERICA rice technology. The baseline data of MNRDP in Kaduna State was available and this study applied the principle of DDE and determined the average change in productivity of the participants before and after adopting the technology on one side (first single difference), and average change in productivity of the non – participants before and after the dissemination of the technology on the other side (second single difference). This means that the difference of the two differences (double difference) was computed in the long run to achieve the objective of average change in rice productivity.

Results and Discussion

NERICA Rice Adoption Intensity of the Participants

The result presented in Table 5 shows the adoption intensity of the participants. The mean adoption intensity was found to be 0.66. This implies that 66% of the participants' rice land area was devoted to NERICA rice. Majority of the participants (45%) had their adoption intensity ranging between 0.61 – 0.80. This was followed by 28% of the participants with adoption intensity of 0.41 – 0.60. The least percentage (7%) of the participants had their adoption intensity between 0.21 – 0.40. The implication of the results is that the objective of the NERICA rice project to facilitate rapid diffusion and adoption of high - yielding upland NERICA rice varieties achieved. Saka *et al*. (2005) found the average adoption intensity of NERICA rice in Ondo, Ogun and Ekiti States to be 0.69.

It was found that the level of education, farm size, frequency of extension contact and yield rating/performance were the significant factors influencing both the decision of farmers to adopt the NERICA technology and intensity of its cultivation (MNRDP – ISR, 2011).

Table 5: NERICA rice adoption intensity of the participants

Adoption Intensity	Frequency	Percentage
0.21 – 0.40	7	7
0.41 – 0.6	28	28
0.61 – 0.8	45	45
0.81 – 1.0	20	20
Total	**100**	**100**
Mean = 0.66		
Max. = 1.00		
Min. = 0.25		
SE = 1.20		

Source: Field Survey Data.

Impact of NERICA Rice Adoption on the Productivity of Rice Farmers

Table 6 presents the results of the Double Difference estimation for rice productivity. The mean rice productivity of the participants before the intervention was 2404.52kg/ha and after the intervention it was 2509.11kg/ha. The difference between the after and before values was 104.59kg/ha. This was the *first single difference.* The mean rice productivity of the non-participants before the intervention was 2411.46kg/ha and after the intervention was 2001.11kg/ha.

The difference between the after and before values was -410.35kg/ha. This was the *second single difference*. The *double difference,* which is, the difference between the two productivity differences [(104.59 – (-410.35)] is 514.94kg/ha. The double difference of 514.94kg/ha shows that there is a positive impact but it was not found to be statistically significant (p = 0.123, Table 5). According to Olayide and Heady (1982) the reason for the insignificant value of the double difference might be due to the fact that generally the achievement of the objective of increasing agricultural productivity by Nigerian farmers has been relatively low.

The impact of adoption of improved rice varieties on productivity can lead to the desired result only if farmers comply with the recommendations and requirements of the technologies, in terms of input use and timing of operations. Any significant deviation from the recommended amount of a particular input can result in lower productivity (Ogundele and Okoruwa, 2006). As the productivity (2509.11kg/ha) of the participants after the technology was little above 50% of the expected yield (5000kg/ha), it implies that the NERICA rice farmers had half way complied with the recommendations and requirements of the variety, in terms of input use and timing of operations.

Moreover, Manza (2014) found that soybean, maize and houses renovated or built in the PROSAB project to have a positive DDE and were statistically significant at 5% level of significance. This was unlike cattle and land owned which had negative mean incomes.

Table 6: Double Difference Estimates for rice productivity.

Impact	Productivity Before NERICA (kg/ha)	Productivity After NERICA (kg/ha)	Difference (kg/ha)	% Difference	P - Value
Participants (T)	2404.52	2509.11	104.60	4.4	0.56
Non– Participants (C)	2411.46	2001.11	-410.38	-17	0.134
Difference (kg/ha)	-6.94	508.00	514.98	21.4	0.123
% Difference	-0.28	25.39	25.67		

Source: Field Survey Data.

Hypothesis for difference in productivity

The average rice productivity of both the participants and non-participants after the NERICA rice intervention was statistically tested using one sided Z – test at 5% level of significance. The data sets used were the end-line data for both the participants and non-participants.

The Z - calculated (1.64) was lower than the Z - tabulated (1.65) implying that the null hypothesis which states that there is no significant difference in the rice productivity between participants and non-participants is accepted and the alternative hypothesis which states that there is a significant difference in rice productivity between participants and non-participants is rejected (Table 7). The results of the Double Difference Estimate and that of the hypothesis test have both revealed that the marginal difference in rice productivity between participants and non – participants was not significant.

Table 7: Result of hypothesis testing of productivity

Participants		Non- participants			
Mean Yield (kg/ha)	**Std. Dev.**	**Mean Yield (kg/ha)**	**Std. Dev.**	**Z-cal.**	**Critical Z.**
2509.11	156.55	2001.09	153.97	1.64	1.65

Conclusion and Recommendations

Conclusion

The mean adoption intensity implies that a reasonable percentage of the participants adopted the NERICA technology transferred by the project. The results of the Double Difference Estimate and that of the hypothesis test have both revealed that the marginal difference in the rice productivity between participants and non – participants was not significant. However, this notwithstanding, the NERICA project had a positive impact on the productivity of rice farmers in the study area.

Recommendations

The following recommendations are hereby made based on the findings from the study:

(i) There is an urgent need to re – organize the NERICA seed multiplication arrangement in the study area. Contract growers might be the solution. If the small farms can be supported by adequate finance and technical guidance, large quantities of NERICA seeds could be produced provided they are given adequate incentives. Arrangement for agro – service centres to buy the seeds from the farmers at pre-determine prices and the seeds to be distributed to co-operatives and others along with other inputs should be encouraged.

(ii) The participants need to organize themselves to form co-operatives. This will help them to obtain soft loans for the procurement of farm inputs and rice processing facilities.

(iii) To address the problem of high cost of land, the Kaduna State Government should engage in massive land clearing exercise from the total arable land of 2.02 million hectares so that additional farms could be made available and rented out to the farmers at an affordable rate.

(iv) Since the government does not have and will probably not have for a long time enough staff and resources for the current extension system to meet the recommended number of visits of 48 times per season for NERICA rice production, alternative extension strategies – like group extension system, which economizes on staff and resources should be encouraged to complement or may be even replace the existing system. Also, because of this resource limitation, the execution of a realistic State extension system would require a geographical decentralization of its planning and programming. While the extension system must be operated within the context of set goals, the principal components of the system must originate at the smallest administrative units in the villages.

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