
Impact of Adoption of the New Rice for Africa 1 on Farmers' Yield of in Gombe State, Nigeria

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Abstract

The study assessed the impact of NERICA 1 rice adoption on farmers' yield in Gombe State, Nigeria. Multi-stage sampling procedure was used to select two local governments areas, from which 328 farmers were randomly selected as sample size for the study. Data were collected through structured questionnaire and analyzed with percentages and mean. The result revealed that the average farm size was 1.5 for NERICA 1 and 2.1 non-NERICA 1 farmers. The finding showed that only (3%) of the respondents adopted NERICA 1 rice technology. The result showed a difference of 503.3 Kg/ha between the yield of respondents after the comparison and it shows significant impact at 1% probability level. The adoption of NERICA 1 rice has an impact on the yield of respondents. Farmers should be linked with seed companies and research institutes through extension agents to access certified seeds at an affordable price.

Key words: Impact, rice, adoption, yield

Introduction

Rice is staple food for billions of people in Asia, Africa and Latin America and it provides 27% of the calories in low and middle-income countries (International Rice Research Institute [IRRI], 2016). To meet the high demand for rice amidst the increasing population, it was estimated that the world's annual rice production in year 2014 must increase from 479 Million Tons (MT) milled rice to 536-551 MT by 2030 (IRRI, 2016). According to Olushola (2018), the area under rice production in Nigeria expanded from about 2.4 million harvested hectares (ha) in 2010 to 3.2 million harvested ha in 2017). Since growth in rice production is based on existing agricultural land area, improvement on rice yield is necessary (IRRI, 2016). In developing countries especially in Nigeria, rice is regarded as a cash crop (Ojo,

Dimelu and Okeke, 2018). The ban on importation of rice by the Federal Government led to introduction of NERICA 1 to smallholder farmers to make for their self-sufficient in meeting local demands of the crop.

In order to increase and improve rice production in Africa, New Rice for Africa (NERICA) technologies were disseminated to the rice growers through the implementation of Multinational NERICA Rice Dissemination Project in some countries across sub-Saharan Africa (SSA) including Nigeria (Ojo *et al.*, 2018). NERICA is a hybrid from successful crossing of the common African rice (*Oryza glaberrima*) and Asian rice (*Oryza sativa*) cultivated rice species. The NERICA progeny (known as inter-specifics) has high yield potentials which is three times as high as conventional African rice with small amount of fertilizer, it is suitable for African soil, resistant to insects and weeds (Ken, 2017). The crop is locally known as *Mai zabuwa* in all the northern states except for Kebbi, Sokoto, and Zamfara where it is called *ba'ingila*.

Impact study can provide information for improving the effectiveness of programmes/interventions, agricultural research, agricultural extension services, and venture in new technologies. Thus, impact study is essential for drawing implications for government intervention thereby reducing the cost of non-adoption and facilitating a speedy technological change (Bala, 2020). Various studies on the impact of NERICA have been conducted in Nigeria. Obayelu, Donstop and Adeioti (2016) studied impact evaluation differentials of adoption of Nerica on area cultivated, yield and income of rice producers and determinant in Nigeria. Apata, Awoyemi and Babayemi (2016) studied the impact of NERICA in South-West Nigeria. Impact study concerning the yield of NERICA 1 was not documented; hence, leaving a knowledge gap to be filled. This study assessed the impact of New Rice for Africa (NERICA) 1 adoption on farmers yield in Gombe State, Nigeria. Specifically, the study examined level of adoption of NERICA 1 and determined the impact of NERICA 1 on the farmers yield. The null hypothesis states that the adoption of NERICA 1 had no significant impact on the farmers' yield.

Methodology

This study was carried out in Gombe State, one of the 36 States in Nigeria. It is made up of 11 local government areas and lies on Latitude 100° 15' 100° 25' E; and Longitude 110° 10' 100° 14' N (Egbutah, Askira and Bala, 2016). The State has a population of about 3,216,539 million people disaggregated into 1,692,232 male and 1,524,304 female. About 60% of the population in Gombe State are engaged in agriculture and the State covers a landmass of about 20, 266 square Kilometers (Km²) (Gombe State, 2017).

All rice farmers constituted the population for the study. Multi-stage sampling procedure was used in the selection of sample for the study. At the first stage, Balanga and Yamaltu-Deba LGAs were purposively selected because of the presence of Dakin-Kowa and Balanga dams which encouraged farmers to cultivate NERICA 1 in the area. In the second stage, Balanga and Yamaltu-Deba have ten (10) and eleven (11) rice producing communities respectively. Out of twenty one (21) communities, five (5) communities from each LGA were randomly selected through

balloting giving a total of ten (10) communities. Gombe State Agricultural Development Project documented 281 NERICA 1 farmers and 282 non-NERICA 1 farmers in the ten (10) selected communities in Balanga and Yamaltu-Deba LGAs. The third stage involved using a Slovia formula (adopted by Bala, Yusuf, Ajala, Lawan and Mumini, 2019) for calculating sample size based on the assumption of 5% expected margins of error, 95% confidence interval and applying the finite population correction factor. The formula was expressed as follows:

$$n = \frac{N}{1 + N(e^2)}$$

Lastly, 58.7% of NERICA 1 and non-NERICA 1 farmers were randomly selected from each community, giving a total of 164 each. A structured questionnaire was used to collect data from the respondents by the help of enumerators. Data collected from the respondents were analysed using descriptive statistics such as histogram, frequency, percentage, mean score and adoption index.

Propensity score matching (PSM)

PSM was used to achieve objective i and test the hypothesis. Propensity score matching was used to determine the impact of the adoption of NERICA 1 among farmers in Gombe State. The impact (Average Treatment Effect [ATT]) on the yield of NERICA 1 respondents was estimated using four matching algorithms; these are nearness neighbour, radius, kernel and stratification matching. In the whole matching algorithm used, both the result of ATT was reported with bootstrap and without bootstrap. The model is specified below

$$Y_i = \ln\left(\frac{P_{ij}}{1 - P_{ij}}\right)$$

Where: P_{ij} = probability of falling into treatment or control group

Given by: $P_{ij} = a_0 + a_1x_1 + a_2x_2 + a_3x_3 + a_4x_4 + a_5x_5 + \dots .. a_nx_n + e$

$$Y_i = \begin{cases} -x, & x < 0 = \text{below threshold} = \text{non - NERICA 1 farmers} \\ x, & x \geq 0 = \text{above threshold} = \text{NERICA 1 farmers} \end{cases}$$

Average treatment effect (ATT)

$$ATT = \frac{1}{N_t} [\sum_{i \in T} Y_j^t - \sum_{j \in T} w_{ij} Y_j^c]$$

Where

ATT = Impact of NERICA 1 rice adoption

N_t = Number of NERICA 1 rice farmers

Y_j^t = yield of NERICA 1 rice farmers

Y_j^c = yield of non-NERICA 1 rice farmers

W_{ij} = weight

j = farm household identifier

Result and Discussions

Characteristics of Respondents

The results indicate that a majority (81.1%) of NERICA 1 respondents were members of cooperative societies. Likewise, the results also revealed that the majority (70.7%) of non-NERICA 1 respondents were not members of cooperative

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societies (Figure 1). This result implies that most of the NERICA 1 respondents were members of the cooperative; hence they have a great chance of acquiring credit, inputs and useful information related to NERICA 1 rice. The finding of this study is related to Chekene and Chancellor (2015) found that the majority (65%) of the respondents in Borno State were members of the association.

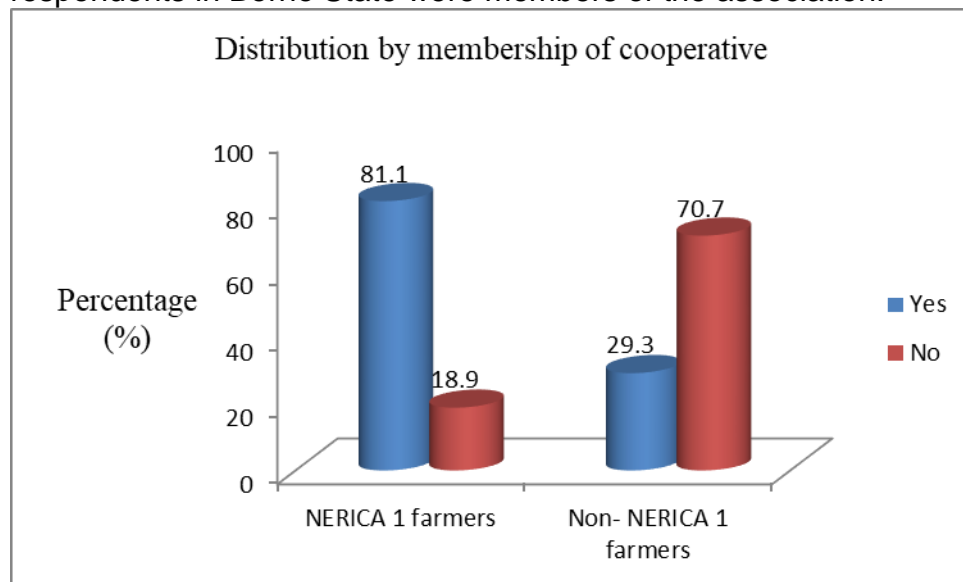


Figure 1: Membership of cooperative
Source: Field survey, 2018

The study indicates that the majority (66%) of NERICA 1 respondents had extension visits quarterly with very few (3%) of them visited by extension agents monthly (Figure 2). This result indicates that the majority of the NERICA 1 respondents received extension visits during the farming season for an on-farm solution to their problems and/or a new method of improving production. Thus, the finding contradicts the result of Ojo *et al.* (2018) revealed that over 70% of the NERICA rice farmers in Ekiti State had contact with ADP officials more than 10 times in a year. Beside, a majority (93.9%) of non-NERICA 1 respondents had no access to extension visit. Only few (3.7%) and (2.4%) had extension visits quarterly and annually respectively. This finding is contrary to Abdulazeez, Musa, Saddiq, Abdulrahman and Oladimeji (2018) revealed that about 17.6% of non-participants in Kogi accelerated rice production programme had access to extension services.

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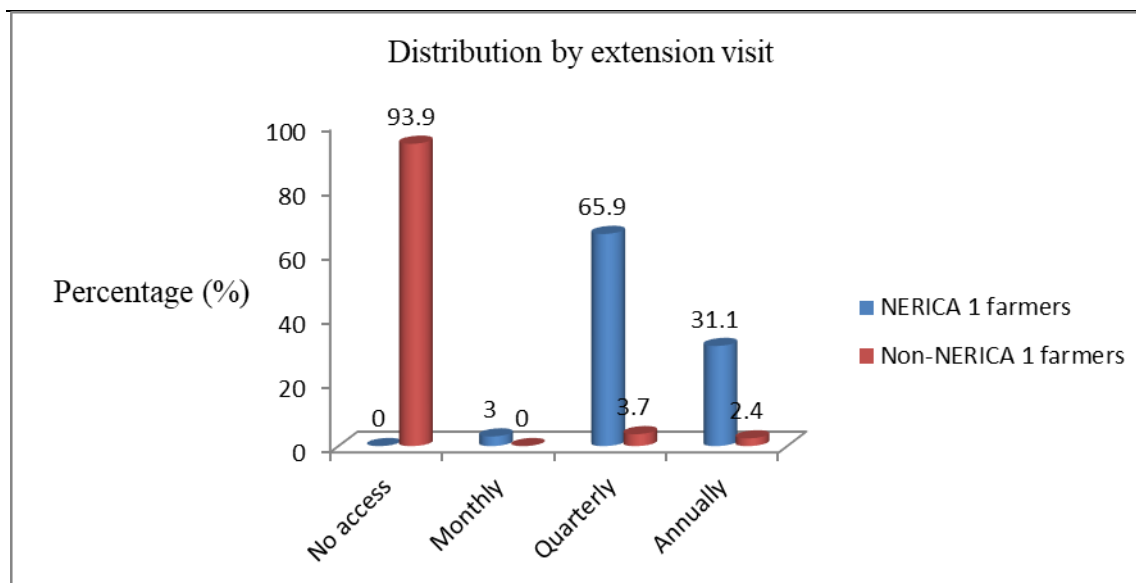


Figure 2: Frequency of extension visit.
 Source: Field survey, 2018

The result of farming experience shows that 42.7% of NERICA 1 respondents had 11-20 years of experience in rice farming while 39.6% have 1-10 years of experience in rice farming. Very few (3.7%) respondents among the NERICA 1 had an experience of 31-40 years in rice farming (Table 1). The average farming experiences was 14.5 years for NERICA 1 respondents. This result shows that the respondents have sufficient experience in farming therefore; they can accept and adopt new technology (NERICA 1 rice) for better yield. This finding is related to that of Abubakar, Garba, Gana and Jacob (2019) most (75%) of adopters of the rice production practices have more than 20 years of farming experience in Niger State. This implies that rice production experience and ability to perceive effectiveness of improved practices over the traditional methods endear farmers to be receptive of innovative ideas. About 50% of the non-NERICA 1 respondents had a rice farming experience of 1-10 years followed by 36.6% with an experience of 11-20 years. The average rice farming experience for non-NERICA 1 respondents was 13.7 years. This means that they were less experience than NERICA 1 farmers, thus it could negatively affects their adoption of new technology like NERICA 1. The finding differs with Ojo *et al.* (2018) majority (49%) of the farmers had their farming experience falling within 11-20years, which puts the average farming experience at 19years. This reveals that most of the farmers have been in rice farming for a long time.

The results reveal that 56.1% of NERICA 1 respondents had less than 1.5 ha of cultivated land, 40.2% had 1.6 - 3.2 ha of cultivated land. A larger proportion (45.7) of non-NERICA 1 respondents had 1.6-3.2 ha of cultivated farmland while about 18.9 cultivated greater that 3.3 ha of land (Table 1). The average farm size for NERICA 1 and non-NERICA 1 respondents were 1.5 and 2.1 ha respectively. This result implies that the majority of the NERICA 1 farmers in the study were smallholder farmers. This may hinder farmers' access to credit from financial institutions (such as commercial banks) that may require collateral before releasing funds. The findings of this study vary with Adenuga, Omotesho, Ojehomon, Diagne, Ayinde and Arouna (2016)

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average farm size for the adopters of improved rice varieties was 2.82 ha while that of non-adopters was 4 ha in Nigeria. The large land holding of the non-adopters could be attributed to the existence of large family land on which they grow a particular variety the family may be known for.

Data in Table 1 reveal that 53.7% of NERICA 1 respondents have no access to credit facilities; about 46.3% of the respondents had access to credit. This result indicates that majority of the respondents had no access to credit for NERICA 1 rice production. This could be attributed to the smallholder farming system of the respondents. The result agrees with Diran (2015) that majority of Nerica rice farmers in Nigeria had no access to credit facilities. The result further shows the various categories of the amount of credit accessed by the respondents. From the result of Table 1, about 29.3% of NERICA 1 respondents' access credit that ranges between ₦ 30, 000 - ₦60, 000 and the lowest (1.8%) of the respondents had access credit of more than ₦120, 000. The average amount of credit accessed of about ₦ 42, 868.4 received by NERICA 1 respondents. On the other side, on the other side, more than two-third (79.3%) of non-NERICA 1 respondents had no access to credit with a few (20.7%) accessed credit. This could be associated with their poor participation in farmers' cooperative groups which give members soft loan in form of credit to finance farming operations. About 11% and 0.6% of non-NERICA 1 respondents received a credit of ₦ 30, 000 - ₦60, 000 and ₦90, 001 - ₦ 120, 000 respectively. The overall mean amount of credit accessed by non-NERICA 1 respondents was ₦ 37, 470.6. This result is similar to Bala *et al.* (2019) average of amount of credit received by Nerica farmers was ₦42, 868.4. This result indicates that majority of the respondents' access credit for their NERICA 1 rice production based on the farm size and nature of farming intended.

Table 1: Characteristics of respondents

	NERICA 1		non-NERICA 1	
	%	Mean	%	Mean
Farm size				
<1.5	56.1		35.4	
1.6 -3.2	40.2	1.5	45.7	2.1
>3.3	3.7		18.9	
Amount of credit (₦)				
No access	53.7		79.3	
<30,000	12.2		7.9	
30,000 - 60,000	29.3	42868.4	11	37470.6
60,001 - 90,000	0.6		1.2	
90,001 - 120,000	2.4		0.6	
>120,000	1.8		0.0	
Yield (Kg/ha)				
≤ 1000	15.9		25.0	
1001 – 2000	45.1		37.8	
2001 – 3000	19.5	2189.8	13.4	2039.8
3001 – 4000	10.4		14.0	
≥ 4000	9.1		9.8	

Source: Field survey, 2018

The result shows that 45.1% and 37.8% of the NERICA 1 and non-NERICA 1 respondents respectively obtained yield ranges from 1001-2000 Kg/ha. This implies

that many of the NERICA 1 respondents did not attain the potential yield of 5 tons which could be attributed to the low level of adoption of NERICA 1. Likewise, very few (9.1%) and 9.8 of the NERICA 1 and non-NERICA 1 respondents respectively had yield greater than or equal to 4000 Kg/ha. This result could be related to the few farmers that adopted the NERICA 1 among the adopters. The average yield of NERICA 1 respondents was 2189.8 Kg/ha and 2039.8 Kg/ha for non-NERICA 1 respondents. The variation in the average yield of the farmers could be associated with the high yielding quality of NERICA 1 rice over the local variety. The result is in line with Adisa, Ahmed, Ebenehi and Oyibo (2019) the majority (98.6%) of the respondents had increase in their rice output as a result of their contact with extension agents and their involvement in extension activities and adoption of the technologies disseminated.

Level of Adoption of NERICA 1 Technology

Entries in Table 2 show that a greater proportion (41%) of the respondents were conservative and not ease adopters of innovations. This implies that they could be suspicious of innovations and the change agents. This attitude could lead to low productivity, income and poor standard of living. The finding agrees with Bala and Mumini (2020) about 39% of the farmers in Balanga were laggards. The result shows that 3% of the respondents adopted NERICA 1 rice technology. This implies that despite the potential high yield of NERICA 1, its adoption is low among farmers. The low level of adoption could be attributed to the inability of farmers to access the credit needed to purchase ample farm inputs and finance the farming activities. This category is known as technology enthusiast because they understand the technology and bear the high degree of uncertainty associated with it. The result is similar to Bala and Mumini (2020) finding that 3.9% of the farmers accepted the Improved Upland Rice Production Practices (IURPPs) in Balanga Local Government Area in Gombe State. About 36% of the respondents were categorized as early adopters. This indicated that the farmers accepted and adopted the rice technology after careful observation from their fellow farmers. On the other hand, 10% of the respondents were categorized as the early and late majority.

Table 2: Level of adoption of NERICA 1

Adoption index	%
0.01 - 0.39	41
0.04 - 0.49	36
0.05 - 0.59	10
0.06 - 0.69	10
0.07 - 1.00	3

Source: Field survey, 2018

Impact of Adoption of NERICA 1 on Farmers Yield

The result in Table 3 indicates that nearness neighbour shows a difference of 410.1 Kg/ha among respondents after comparison. The result of this matching shows that there was a significant impact at a 1% level of probability. This implies that the adoption of NERICA 1 had positively and significantly impacted on the yield of farmers. This varies with the result of Mohammad (2017) on average; yield of the wet season improved rice technology adopters was 24.2% - 55.4% higher than non-

adopters. The result of the radius matching shows a difference of 503.3 Kg/ha between respondents. This result means that the adoption of NERICA 1 has a significant impact on the yield of farmers. This result coincides with Mabe *et al.* (2018) that adoption of improved varieties proved to have a significant influence on rice output with the coefficient value of 555.36 is statistically significant at 5% and therefore, it is in favour of the adopters, implying a farmer who adopts improved rice varieties has 555.36Kg (5.55bags) of rice more than his counterpart who uses unimproved varieties.

Kernel matching result reveals a difference of 455.3 Kg/ha between respondents after the comparison and it shows significant impact at 1% probability level. This implies that the adoption of NERICA 1 has a positive and significant impact on the yield of NERICA 1. This agrees with the findings of Adisa *et al.* (2019) that the majority (98.6%) of the respondents had increase in their rice output as a result of their contact with extension agents and their involvement in extension activities and adoption of the technologies disseminated. Stratification result revealed 474.2 Kg/ha difference among respondents which denotes significant impact. This result indicated that adoption of NERICA 1 rice had a significant impact on the yield of NERICA 1 respondents. This result is concurrent with Apata *et al.* (2016) productivity of Nerica farmers is greater than the non-Nerica farmers.

The null hypothesis was rejected and the alternative hypothesis accepted hence, adoption of NERICA 1 rice has a positive and significant impact on farmers yield.

Table 3: Impact of adoption of Nerica 1 rice on farmers yield

Variable	NERICA 1 farmers	Non-NERICA farmers	Impact (ATT)	Standard Before Bootstrap	Standard After Bootstrap	Bias	t-value
Nearness Neighbour Radius	164	58	410.1	198.2	131.7	20.0	3.12***
Kernel	164	148	503.3	101.2	95.3	-10.6	5.28***
Stratification	164	148	455.3	110.3	120.5	-10.2	3.78***
	164	148	474.2	125.2	130.8	1.20	3.63***

Source: Field survey, 2018. *** P≤0.01

Conclusion and Recommendation

Adoption of NERICA 1 rice have a significant impact on yield. Farmers should be linked with seeds companies and research institutes through extension agents to access certified seeds at affordable price. The certified seeds will help to increase farmers' yield when technological practices are fully adopted. It is recommended that land and credit facilities should be provided to farmers at an affordable price to encourage large scale rice production.

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