Journal of Agriculture and Rural Research
(ISSN 2523-1189)

PROFITABILITY DIFFERENTIALS AMONG NEW RICE FOR AFRICA (NERICA): CASE OF OGUN STATE, NIGERIA

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Received: 26th October, 2017
Accepted: 2nd November, 2017
Published: 9th November, 2017

ABSTRACT

This study examines the comparative analysis of profitability differentials and problems confronting New Rice for Africa (NERICA) rice farmers with a view to improving NERICA production among rice farmers in the study area. A multi-stage sampling technique was used to select 200 NERICA rice farmers for the study. Primary data collected were analyzed using descriptive statistics and technology adoption index. Results showed that there were two main levels of NERICA technology adoption among the farmers based on the mean adoption index 0.9547. These were partial adopters with an index of <0.9547 and full adopters with an index of >0.9547.
The costs and returns analysis show that labour and fertilizers inputs accounted for greater parts of the total variable costs incurred by both the partial and full adopters of NERICA rice varieties and were represented by 48.99% (partial adopters) and 44.53% for labour cost while fertilizer accounted for 10.37% for partial adopters and 17.73% for full adopters respectively. The gross margin analysis shows that from one hectare of land cultivated, the total cost of production for partial and full adopters of NERICA technology were N83,896.83 and 120,440.15 and net revenue of N45,892.41and N73,374.95 respectively. Most of NERICA farmers were faced with the problem of bird's invasion and many lost their rice crop to pest invasion. Pests and diseases are important natural factors limiting the production of rice and in severe cases, they account for 100% of crop loses. This paper recommends that full adoption of NERICA technology will generate more returns to farmers than partially adopting the technology

Keywords: NERICA, Levels of Adoption, Profitability differentials

1. INTRODUCTION

Rice is a staple food for about 2.6 billion people in the world (Adedeji *et al*., 2013). The global output shows that the Asian continent account for about 92 percent, while American and Caribbean account for 5 percent and 3 percent for Africa (Adegbola *et al*., 2006). Nigeria is one of the major rice producing countries in West Africa ranking side by side with Sierra Leone and Ivory Cost (Kudi *et al*., 2011). This is because rice is no longer an occasional food eaten during festive periods but has become an everyday food consumed by most of the inhabitants of Nigeria (Moses and Adebayo, 2007).
Nigeria consumes about five million metric tonnes (mts) of rice annually (Awotide *et al*., 2013). In 2011-2012, Nigeria imported a record of 3.4 million tons, making the country the world's largest rice importer that year. Rice production in Nigeria is expected to rise from 2.37 (mts) in 2012-2013 to 3.1 million mts in 2013-2014 (Adedeji *et al*., 2013). The local production, however, has not kept pace over the years. The difference between what was consumed and what was produced was provided for through importation of about 2.1 million mts at a huge annual import expense of about ₦ 356 billion (990,267,400 USD) which is clearly inappropriate and devastating to the Nigerian economy (Raufun, 2014). In response to the prevailing rice supply deficit situation in the country, successive Nigerian governments have intervened in the rice sub-sector, by increasing tariff on rice importation so that local production could be encouraged. This was expected to widen the home market for the nation's local

rice (Bamidele *et al*., 2010). However, despite the numerous government policies and programmes on rice and rise in domestic production, the demand/consumption exceeds the local production resulting in rice importation.
Singh *et al*., (2011) and FAO (2006) reported that Nigeria is the largest producer of rice in West Africa producing over 46% of the regions total production. The inability of Nigeria's rice sub-sector to meet the domestic demand could be attributed to low productivity, inefficiency in the use of resources, disincentives from the macro-economic environment, and production by small -scale farmers, who use traditional technologies (FMARD, 2012). Also maximum yield is not realized due to limited access to and inefficient use of complementary technologies such as fertilizer, land cultivation techniques, weeding, and water control. Part of the problem has been the high cost of inputs such as fertilizer, chemicals (herbicides and insecticides), and mechanized implements (tractors and tillers). The use of tractors has been limited to large-scale irrigated areas and, mostly on a fee for service basis, areas where the land has been parceled out among many small-scale farmers. For the majority of farmers, owning a tractor is next to impossible given its high up-front capital cost and high operating and maintenance costs. In developing countries such as Nigeria, low productivity of rice possesses a major concern not only for smallholder farmers but also for researchers, crop scientists, development agents, and policy makers. Low productivity of rice is further aggravated by the persistent differences in the productivity estimates across the various regions of the country; with some regions reporting far below the national average of 2.6Mt/ha (MOFA, 2011). These yields gap present sufficient scope to increase the productivity of rice through productivity enhancing technologies. One such technologies that have been promoted in sub-Saharan African countries is the New Rice for Africa (NERICA). The introduction of NERICA has been seen as a major policy directive for boosting the economic incentives - productivity and profitability of rice farmers.
Following its introduction in 1996, NERICA has spread quickly in Nigeria, Cote D'Ivoire, Ethiopia, Mali, The Gambia, and Ghana. Available evidence from Ethiopia, Mali, and The Gambia, for example, suggests that NERICA achieves high yields between 3000 and 6000 kg ha^{-1} in rain-fed dependent production system (Zenna *et al*., 2008) with prospects for additional yield gains between 140 kg ha^{-1} and 1000 kg ha^{-1} (Adegbola *et al*., 2006 and Dibba, 2010). NERICA's yield gains are reportedly higher than the very low yields of between 700 and 1500 kg ha^{-1} of traditional rice varieties under the same production system (Africa Development Fund, 2001). It is also expected that adoption of appropriate technologies and improved management practices would lead to substantial yield increase in rice production. However, the disparity in the use of yield improving technologies such as fertilizers, pesticides, use of machinery, insecticides and improved seed varieties result in different levels of technology adoption such as Non – adoption, Partial adoption and Full adoption. Non-adoption implies that farmers do not use a particular technology, partial adoption suggests that a farmer do not comply with the component of a technology while full adoption signifies the use of all component of a particular technology. The disparity in the levels of technology adoption has been identified as a major setback in rice-based production systems in most developing economies especially in Nigeria which in turn has led to the production efficiency differentials among rice farmers (Ologbon *et al*., 2012). The following research questions however have to be addressed. What are the levels of adoption of technology among NERICA farmers? What are the socio-characteristics among adopters of NERICA technology? What are the costs and returns to production among the levels of NERICA adopters? What are the constraints faced among NERICA farmers?

2. MATERIALS AND METHODOLOGY

2.1 Study Area

The study was carried out in Ogun State in the south-western part of Nigeria. Ogun State was created out of the Old Western State of Nigeria on February 3, 1976. It shares boundaries with Lagos State in the south, Republic of Benin in the west, Ondo State in the East and Oyo State in the North. The State lies within latitudes 6^0 30' and $7^0$5' N and longitudes 2^0 80' and 4^0 60' E of the Greenwich meridian. Ogun State has twenty Local Government Areas (LGAs) divided into 4 socio-political zones, namely: Egba, Yewa, Ijebu and Remo zones. A multistage sampling technique was employed to select respondents for the study and NERICA growing farmers are the target population. Out of the twenty LGAs in the state, ten are rice producing areas (Akinbile *et al*., 2007). In the first stage, four rice producing LGAs (namely Obafemi-Owode, Ewekoro, Ifo and Yewa North) were purposively selected based on the predominance of NERICA rice farmers. In the second stage, five communities/ villages for NERICA rice production were randomly selected from the list of rice growing communities/villages in each of the four LGAs. In the third stage, ten NERICA farming households were randomly selected from each of the communities to make a total sample of 200 respondents for the study.

2.2. Analytical tools

2.2.1. Adoption index

Adoption index was used to determine levels of technology adoption among individual farmers using the following formula as adopted from (Tiamiyu, 2010).

$$\text{AIi} = \Sigma\{(\frac{ATi}{RTi} \times ISi)\} \quad \ldots\ldots(1)$$

Where;
AIi is adoption index of ith farmer,
ATi is the level or quantity of input the farmer actually applied,
RTi is the recommended level or quantity of an input he ought to apply,
ISi is the proportion of score attributable to a particular input (as given by percentage for each innovation).
Farmer's group is dictated by his/her position with respect to grand mean adoption score. A farmer whose score is higher than the grand mean is said to be a "Full Adopter of technology", otherwise he is categorized as "Partial Adopter of technology". These constitute the two levels of technology adoption used in this study.

2.2.2. Cost and Return analysis of NERICA production

Net returns are calculated from the profitability of the firm enterprise. Gross margin is calculated as difference between farm total revenue and total variable cost.
The budgetary technique used is specified as:

$TR_1 = P_1 \times Q_1$ (₦) ..... (2)
$GM_1 = TR_1 - TVC_1$ (₦)..... (3)
Profit (π_1) = $TR_1 - TC_1$ (₦)..... (4)
$NI_1 = GM_1 - TFC_1$ (₦) ..... (5)
While,
$TR_2 = P_2 \times Q_2$ (₦)..... (6)
$GM_2 = TR_2 - TVC_2$ (₦)..... (7)
Profit (π_2) = $TR_2 - TC_2$ (₦) ..... (8)
$NI_2 = GM_2 - TFC_2$ (₦)..... (9)
$TR = TR_1 + TR_2$ (₦)..... (10)
$TC = TC_1 + TC_2$ (₦)..... (11)
GM= TR-TVC (₦)..... (12)
NI= GM– TFC (₦)..... (13)

Where;
TR is the total revenue arising from income from sales. It comprises TR_1 (total revenue from sales by partial adopters of NERICA technology) and TR_2 (total revenue from sales by full adopters of NERICA technology). TC is the total cost arising from expenses. These are the total obligations incurred by a farmer per unit of time for all the variable input used. It comprises TC_1 (total cost incurred by partial adopters of NERICA technology) and TC_2 (total cost incurred by full adopters of NERICA technology).
TVC is the total variable cost of production. It is defined as expenses (direct and imputed) on seeds, hired labour, fertilizer, herbicide and transportation but excluding unpaid family labour. It comprises TVC_1 (total variable cost incurred by partial adopters of NERICA technology) and TVC_2 (total variable cost incurred by full adopters of NERICA technology).
TFC is the total fixed cost of production. These are the total obligations incurred by a farmer per unit of time for all fixed cost, for example, land. It comprises TFC_1 (total fixed cost by partial adopters of NERICA technology) and TFC_2 (total fixed cost by full adopters of NERICA technology).
GM is the gross margin. It comprises GM_1 (gross margin by partial adopters of NERICA technology and GM_2 (gross margin by full adopters of NERICA technology).
NI is the net income arising from difference between Gross margin and Total fixed cost. It comprises NI_1 (net income by partial adopters of NERICA technology) and NI_2 (net income by full adopters of NERICA technology).
Profit Margin = (Net Income/Total Revenue) *100
Operating Cash Expenses Ratio = Total Variable Cost/Total Revenue
Benefit Cost Ratio = Total Revenue /Total Cost and Net Farm Income Ratio = Net Income/Gross Margin.

3. RESULT AND DISCUSSION

The adoption index of NERICA technology varied between a minimum of 0.47 and maximum 2.01, with a mean of 0.9547. Based on the mean figure, the adoption level was categorized into two: partial with indices < 0.9547 and full adopters with indices >0.9547. There was a significant difference between the mean adoption index of partial adopters (0.7453) and full adopters (1.1667) at ($t = 17.787$, $p < 0.01$). Hence we reject the null hypothesis, that there were no significant differences between the different levels of technology adoption.
Partial adopters of NERICA technology accounted for 50.5% of the farmers while full adopters constituted 49.5%. This means that the adoption of NERICA technology had not made an appreciable headway in the study area suggesting that most farmers using the NERICA technology still make use of traditional methods of rice cultivation.

TABLE 1: Adoption index among NERICA rice farmers in Ogun State

Adoption index	All Respondents (n=200)		Partial Adopters (n=101)		Full Adopters (n=99)			
	Frequency	%	Frequency	%	Frequency	%	Cumulative percentage	T-test
<0.5	5.0	2.5	5.0	5.0	-	-		
0.5 - 1.0	11.1	55.5	96.0	95.0	15.0	15.2	50.5	
1.01–1.50	78.0	39.5	-	-	78.0	78.7		
1.51-2.00	5.0	2.5	-	-	5.0	5.1	49.5	
≥2.01	1.0	0.5	-	-	1.0	1.0		
Minimum	0.47		0.47		0.96			
Maximum	2.01		0.95		2.01			
Mean	0.95		0.74		1.17			17.78***
Std. deviation	0.16		0.14		0.19			

Source: Field survey, 2015

***** Significant at 1%**

Out of the entire 200 respondents, 77% were male, comprising 36.1% male partial adopters of NERICA technology and 40.9% full adopters. Also, of the 23% respondents that were female, partial adopters accounted for 13.9% while 9.1% were full adopters. When separately considered, partial adopters were made up of 72.3% male and 27.7% female while full adopters comprised 81.8% male and 18.2% female. These results show that NERICA production is dominated by men in the study area.

The mean level of education (8.44 years) for all respondents; partial adopters (7.96 years) and full adopters (8.92 years). The test difference (1.74) exists between mean level of education of partial and full adopters. This suggests that a larger proportion (about 94%) of the respondents had formal education. The respondents' age that fell between the range of 41 and 60 years are in the majority with about 70%, while 74.2% and 67.7% of the partial adopters and full adopters of NERICA belong to this category, respectively. The results show a range of experience from a minimum of 2.00 and a maximum of 10 years. More than 70% of the respondents had over 3 years of experience in NERICA farming. The mean household size for all respondents was 9.31, partial adopters (9.07) of NERICA rice and 9.55 for full adopters. The majority of the respondents (77.5%) had a household size of between 6 and 10 members and the distribution for the partial adopters (83.2%) and full adopters (71.7%) of NERICA rice farmers follow the same trend. The result shows that the modal class was between 0.51 and 1 hectare for both the partial and full adopters of NERICA. For both partial adopters and full adopters of NERICA, the mean of farm size cultivated was 0.91 and 1.5, respectively.

TABLE 2: Socio-economic Characteristics of NERICA rice farmers in Ogun State

Variables	All Respondents	Levels of Adoption	
		Partial Adopters Coefficient	Full Adopters Coefficient
Sex:			
Male	77	72.3	81.8
Female	23	27.3	18.2
Age (mean)	54.09	54.16	54.02
Household size (mean)	9.02	9.31	9.55
Level of education(mean)	8.44	7.96	8.92
Farming experience(mean)	3.65	3.44	3.55
Nerica Farmland (hectares)	0.96	0.91	1.50

Source: Field survey, 2015.

The results of costs and returns for an average NERICA farm in Ogun State based on the adoption of NERICA technology as shown in Table 3. The results show a significant difference between the total revenue earned by farmers that partially adopt (₦129,789.29) and that of full adopters (₦193,815.10) at 1% level of probability. This implies that full adopters earned higher total income than partial adopters. The difference between the total cost of production incurred by partial adopters (₦83,896.88) and those of full adopters (₦120,440.15) was significant

at 1%. Also, the difference between the total variable cost of production by partial adopters (₦77,763.22) and that of full adopters (₦113,014.90) was significant at 1%, suggesting that there is much difference in the cost of production incurred by the partial and full adopters of NERICA technology.

Labour cost for partial adopters of NERICA accounted for (48.99%) of the total variable costs and full adopters (44.53%) of NERICA technology. This was followed by the cost of fertilizer that accounted for 10.37% for partial adopters and 17.73% for full adopters. This result agrees with Raufun (2014) who concluded that the cost of fertilizer of rice production was significant at 1%. There was a significant difference between the mean net income earned by partial adopters (₦45,892.41) and that of full adopters (₦73,374.95). The same trend was obtained for the difference between the mean gross margin of partial adopters (₦52,026.07) and that of full adopters (₦80,800.20) which was significant at the 1% level of probability. These suggest that full adopters of NERICA technology earned higher net income and gross margin than partial adopters. The operating cash expenses ratio was 0.60 and 0.58 for partial and full adopters respectively while the benefit cost ratio was 1.55 and 1.61 for partial and full adopters of NERICA technology respectively. These indicate that for every ₦1 incurred on NERICA production, 55kobo was gained by partial adopters while 61 kobo were gained by full adopters of NERICA technology. This result is in line with Fabusoro (2000) who concluded that rice is more revenue yielding than other relative crops. The implication of these findings is that full adopters in the study area incurred higher costs and returns than partial adopters, hence we reject the null hypothesis.

TABLE 3: Average costs and returns per farm producing NERICA rice in Ogun State

S/N	Items	All Respondents	Level of Adoption		T-test
			Partial Adopters	Full adopters	
a	**REVENUE**				
b	Quantity of Rice (kg)	764.52	602.97	926.06	10.22***
c	Price per kg (₦)	212.27	215.25	209.29	2.57**
d	**Total Revenue (TR)**	**161,802.20**	**129,789.29**	**193,815.10**	**9.89*** **
e	**Total Variable Cost (TVC)**	95,389.06	77,763.22	113,014.90	10.39***
f	Cost of Planting Materials	8558.56	8452.97	8664.14	0.51
g	Cost of Labour	44209.12	38097.03	50321.21	6.38***
h	cost of Transportation	3773.46	3678.22	3868.69	1.96*
i	Cost of Herbicides	5847.71	4277.23	7418.18	8.57***
j	Cost of Insecticides	4979.54	3451.49	6507.58	9.82***
k	Cost of Pesticides	5684.33	3901.98	7466.67	9.85***
l	Cost of Fertilizer	14047.18	8064.36	20030.0	15.46***
m	Cost of Tractor	2123.74	1000.00	3247.47	2.79***
n	Cost of organic fertilizer	833.34	1666.67	0.00	1.62
o	Cost of irrigation	1261.73	1089.11	1434.34	0.42
p	Cost of threshing	4070.37	4084.16	4056.57	0.07
q	**Gross margin (TR-TVC)**	**66,414.64**	**52,026.07**	**80,800.20**	**8.24*** **
r	**Total Fixed Costs**	**6,779.46**	**6,133.66**	**7,425.25**	**2.08****
s	Cost of Cutlass	4053.85	3543.56	4564.14	4.73***
t	Cost of Hoe	2725.61	2590.10	2861.11	0.99
u	**Total Cost (TC) = (r + e)**	**102,168.52**	**83,896.88**	**120,440.15**	**10.13*** **
v	**Net Income (NI) = (q - r)**	**59,633.68**	**45,892.41**	**73,374.95**	**8.39*** **
	EFFICIENCY AND PROFITABILITY				
W	Profit Margin = v/d *100	36.85	35.36	37.86	
X	Operating Cash Expenses Ratio = e/d	0.59	0.60	0.58	
Y	Benefit Cost Ratio = d/u	1.58	1.55	1.61	
Z	Net Farm Income Ratio = v/q	0.895	0.88	0.91	

Source: Data Analysis, 2015

* Significant at10%; **Significant at 5%; *** Significant at 1%

Constraints to NERICA rice production

There are various problems facing NERICA rice farmers in the study area, namely: lack of credit, insufficient use of NERICA seeds, lack of land preparation equipment, untimely delivery of fertilizer, frequent change in policies and bird's invasion (Table 4).

The result shows that for partial adopters (14%) lacked credit, (7%) experienced insufficient NERICA seeds, (23%) experienced lack of land preparation equipment, (7%) untimely delivery of fertilizer, (8%) frequent change in policies and (41%) bird's invasion. However, for full adopters (10%) lacked credit, (9%) experienced insufficient use of NERICA seeds, (27%) were accosted with lack of land preparation equipment, (11%) untimely delivery of fertilizer, (4%) frequent change in policies and (39%) bird's invasion.

Most of NERICA farmers were faced with the problem of bird's invasion. The outbreak of qualea birds affected most parts of the study area and many NERICA rice farmers lost their rice crop to pest invasion. Pests and diseases are important natural factors limiting the production of rice and, in severe cases, they account for 100 percent of crop losses. Traditional farm operations, including those for rice production, are carried out with hand tools, which make farming tedious and cumbersome.

TABLE 4: Distribution of constraints in NERICA production Levels of Adoption

Constraints	**All Respondents** (n = 200)	**Partial Adopters** (n= 101)	**Full Adopters** (n=99)
Lack of credit	12.0	14.0	10.0
Insufficient Seeds	8.0	7.0	9.0
Lack of Land prep. equipment	25.0	23.0	27.0
Untimely delivery of fertilizer	9.0	7.0	11.0
change in policies	6.0	8.0	4.0
Birds invasion	40.0	41.0	39.0

4. CONCLUSION AND RECOMMENDATIONS

The results showed that there are two main levels of NERICA technology adoption among the farmers based on the mean adoption index 0.9547. These are partial adopters with an index of <0.9547 and full adopters with an index of >0.9547. Partial adopters of the NERICA technology accounted for 50.5% of the farmers while full adopters accounted for 49.5%. Farmers studied by this research were over 40 years of age, married and with average number of farmers having at least primary level of education and cultivating less than 2 hectares of farmland. The estimated production efficiencies for the NERICA growers ranged from a minimum of 0.74 for the least efficient farmer to a maximum of 0.99 for the highest efficient farmer with a mean of 0.93. The partial adopters ranged from 0.74 to 0.93 while that for full adopters ranged from 0.77 to 0.99. There was significant difference between the estimated mean production efficiencies for partial (0.91) and full adopters (0.95) at $p < 0.01$. The levels of adoption of NERICA technology was influenced by three factors: age, farming experience and quantity of fertilizer used by the NERICA farmers while intensity was influenced by three factors: number of labour used, farming experience and quantity of fertilizer used. The estimated total cost of production per hectare of NERICA was ₦102,168.52 with a significant difference between partial adopters (₦83,896.88) and full adopters (₦120,440.15) at ($p< 0.01$).

NERICA rice production in the study area was found by the study to be profitable. Also, NERICA farms that fully adopt the complementary technology appear to be more profitable than partial adopters. Most of the farms that fully adopt NERICA technology were more efficient than farms that adopted partially. Therefore, this study offers the following recommendations toward increasing NERICA production in Ogun State.

Farmers should be encouraged to grow NERICA varieties with its profitability.

There should be increased extension contact in which the farmers will be sensitized on the use of complementary NERICA technology and to increase the number of NERICA growers who are cultivating closer to optimum efficiency in the study area.

In addition, there should be adequate and timely ease of access to farm inputs like fertilizer to all NERICA rice farmers. This will help farmers to improve their productivity.

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