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RESOURCE USE EFFICIENCY IN RAIN-FED PADDY RICEPRODUCTION: A CASE STUDY OF DONGA LOCAL GOVERNMENT AREA OF TARABA STATE, NIGERIA

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ABSTRACT
The study examined resource use efficiency in rain-fed paddy rice production in Donga Local Government Area of Taraba State. A total of 106 rice farmers were randomly selected for the study. Data was collected through the use of a questionnaire. Data was analyzed using descriptive statistics and multiple regression analysis. The result showed a mean age of 38 years for rice farmers. About 73.8% of the respondents were males and, 71.7% were married with a mean household size of 12 persons per household. Majority (73.8%) had at least primary education and 96.2% had no contact with extension agent. An R^2 of 0.76 implied that 76% variations in yield were accounted for by the explanatory variables included in the regression model. Farm size was not significant at $P \leq 0.01$, while seed quantity, fertilizer and labour were significant at $P \leq 0.01$. Rate of technical substitution (RTS) of 0.70 was obtained, indicating that rice production was at stage II. Seed quantity (0.67) and labour (0.15) were over utilized with each having a less than one resource use efficiency ratio. High cost of fertilizers, high cost of hired labour and inadequate extension contact ranked 1st, 2nd and 3rd, respectively, among the constraints to paddy rice production. Therefore, it was concluded that rice farmers had favourable socioeconomic characteristics, but were not efficient in the use of resources. It was recommended that necessary inputs (at affordable prices) and extension services should be made available and adequate to rice farmers in order to optimize rice production.

Keywords: Donga, Efficiency, Paddy rice, Rain-fed, Resource use.

INTRODUCTION
The multiplicity of the activities involved in agriculture account for the report that about 70% of Nigerians gain their source of livelihood from the sector (Odoemenem and Inakwu, 2011). The importance of the sector to the existence and development of any country cannot be overemphasized. Rice is among the three leading food crops of the world, with maize (corn) and wheat being the other two (Udemezue, 2018). Nigeria is not left out from the nations that produce and consume rice in reasonable quantities. Rice which was not known to be produced and consumed in large quantities in Nigeria up to 1980's has suddenly become a major staple in the diet of every Nigerian household. It is one of the fastest-growing food commodities in Nigeria with a likelihood of continued growth; its increase in demand is associated with rapid population growth, urbanization and consumer's preference for rice as convenience food (Obianefo et al., 2019). Cadoni and Angelucci (2013), reported that of the total arable land mass in Nigeria (about 70 million hectares), rice is cultivated on approximately 3.7 million hectares, which covers about 10.6% of the land under cultivation. Nigeria which had a population of less a hundred million people in the 80's has grown to have a total population of about 206 million people as at 2020, ranking 7th in the list of countries by population. This shows that the population has more than doubled in the period under review. Although there

have been reports of noticeable increase and improvement in the production of rice in Nigeria, it has not resulted in self-sufficiency as it is meant to be. The Statistics of rice production in Nigeria clearly shows that the country needs 7 million metric tons of its demand. As of today, Nigeria is capable of supplying only 49% of domestic demand. Rice production in Nigeria keeps growing, but it will not be enough to supply the domestic demand of the whole country in the next several years (Udemezue, 2018). Although these trends show improvement in the average annual production of rice, the inadequacy of the rice produced to match the demand for rice of the ever-increasing population in Nigeria can be measured in terms of the need for and the quantity of rice imported into Nigeria. The question is why has Nigeria not attain a level of self-sufficiency in rice production in spite of the effort being made in that direction and the fantastic statistics being released every year of achieved growth in rice production? The issue of low productivity of the Nigerian farmer readily comes to mind as this is becoming a source of concern in recent times particularly with respect to rice production and other cereals that have become major staples in the Nigerian household diet. This may not be unconnected to the poor use of resources available to the rice farmers.

One way the resource poor farmers can achieve greater level of productivity in rice production and ensure sustainability in such production, within the limit of the resources available to them, is to be more efficient in resource use. This can only be achieved when their production is studied with the aim of assessing the level of their resource use efficiency. Should there be any inefficiency as may be inferred from the elasticity of production coefficient, these will serve as focal points to improve productivity and profitability in rice production. Several studies have been carried out on farmers' resource use efficiency in Taraba State. Such studies by Onyekuru *et al.* (2018) assessed 'Structural effects of 2010 – 2015 fertilizer policy on farmers' resource use in Nigeria: Evidence from Taraba State'; Jonathan, and Anthony (2017) examined 'Resource Use Efficiency in Yam Production in Taraba State, Nigeria', and Gwandi *et al.* (2010) assessed 'Resource Use Efficiency in Cotton Production in Gassol local government area of Taraba State, Nigeria. However, little or no research has been carried out on resource use efficiency in rain – fed paddy rice production in Donga local government area, Taraba State. Thus, the need to fill this knowledge gap in literature. It was based on the outlined background that the study was carried out. The specific objectives of the study were to describe the socioeconomic characteristics of rice farmers, determine factors influencing resource use efficiency and determine elasticity and return to scale of the parameters, examine resource use efficiency and identify the constraint to rice production in the study area.

MATERIALS AND METHODS

The Study Area

The study was conducted in Donga local government area of Taraba state which lies between latitude 7°43′00″N of the equator and longitude 10°03′00″E of the meridian. It is situated in southern part of the state, and it is bordered by Kurmi local government area in the East, in the Northwest by Bali local government area, Wukari local government area in the Southwest, and by Takum local government area in the Southeast. There are ten (10) political wards in Donga local government and they are: Fada, GyataAure, Gndindutse, Mararaba, Kadarko, Akate, Suntai, Asibity, Gayama and Nyita wards. Major ethnic groups in the local government area include Chamba, Ichen, Kpanzun, Hausa, Tiv and Fulani. Donga local government area occupies a total land area of 3, 121km^2 (1, 205 sq miles) with a projected population of 205, 235 people, at a growth rate of 2.9% as at 2021(NPC, 2006). The area has two seasons, the dry and the wet or rainy season. The dry season begins from November to March while the wet or rainy season from April to October. The temperature is mostly high

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with mean yearly temperature of 32˚C recorded. Temperature can be as low as 10˚C experienced mostly between December and January, however the mean minimum yearly temperature is 22˚C (Oyatayo *et al.*, 2016). The occupations of most of the inhabitants are farming, hunting, cattle rearing and trading.

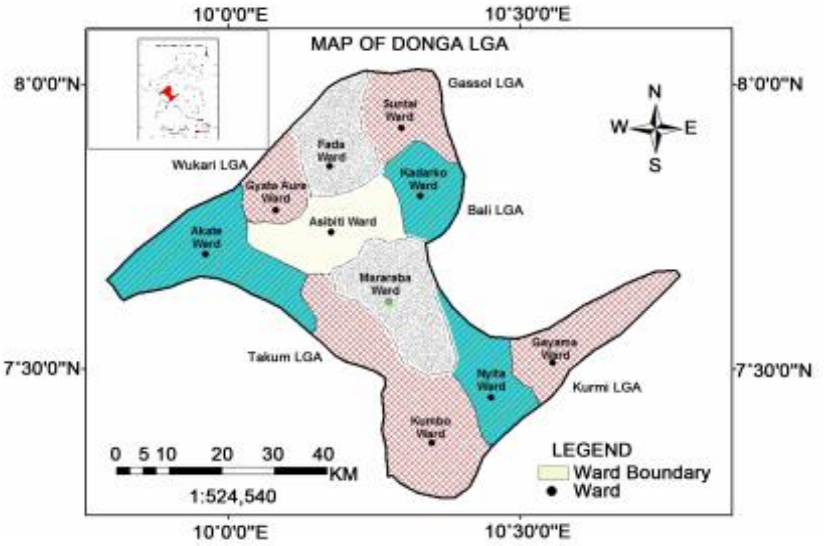

Figure1. *Map of Donga local government area showing study area.*
Source: Ministry of Lands and Survey, Jalingo, Taraba State.

Sampling Procedure

To determine a representative sample size from the target population, different strategies can be used. Since the actual number of the rice farmers in Donga LGA was unknown, the Cochran's method for sample size determination was used to determine the sample size for this study.

It is expressed mathematically as:

$$n_0 = \frac{z^2pq}{e^2} \quad \ldots(1)$$

where;

n_0 = Sample size,

z = is the selected critical value of desired confidence level,

p = is the estimated proportion of an attribute that is present in the population,

q = 1 - p and

e = desired level of precision.

p = q = 0.5

e = 0.08

z = 1.65

$$n_0 = \frac{1.65^2 \times 0.5 \times 0.5}{0.08^2} = 106.34765625$$

Therefore, the sample size for the study was 106. Four communities were randomly selected from the about 40 communities in the Local Government Area. Samples were then assigned to the selected communities after a simple census of rice farmers in the communities as presented the Table 1. The 106 rice farmers were then randomly selected from the rice population in each of the community according to the proportions.

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Table 1: Sample Frame

Towns	Rice farmers	Samples
Akate	78	22
Donga	113	32
Gindin-Dutse	93	27
Kumbo	88	25
Total	372	106

Source: Field survey, 2022

Analytical Techniques

The analytical tools used for this study were; descriptive statistics and multiple regression analysis. Descriptive statistics involved the use of frequencies, percentages and means and was used to analyze the socioeconomic characteristic of rice farmers which included their age, sex, marital status, household size, level of education, years of farming experience and visit of extension agents and constraints to rice production. Multiple regression analysis was used to determine factors influencing resource use efficiency and determine elasticity and return to scale of the parameters and examine resource use efficiency. This study specifies the production function using the Cobb-Douglass production function. The implicit function is presented as:

$Y = \beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + U$ …(2)

where;

Y_i = Quantity of rice output (kg)
X_1 = Farm size (ha)
X_2 = Quantity of seed planted (kg)
X_3 = Labour, both family and hired labour (man days)
X_4 = Quantity of fertiliser (kg)

U_i = Error term which are non-random variables or technical inefficiency effect
β_0 = Intercept
$\beta_1 – \beta_4$ = Regression coefficients

The independent variables are regressed on the dependent variable (Y) to determine resources that have significant effect on the farmer's output. The coefficients (β_1, β_2, β_3, β_4) of the best fit function were used to compute the Marginal value product (MVP) for some inputs, the marginal factor cost (MFC) for each input were also computed. Note that,

MVP = MPP*Py …(3)
MFC = Pxi …(4)

where;

Pxi = price of the ith variable input
MPP = Marginal physical production that is dy/dxi
Ui = Error term

The ratio of the MVP to MFC were used to determine the efficiency of resources used in rice production. The ratio used thus;

r_i = MVP/MFC …(5)

where;

r_i is the efficiency determinant
And when
$r_i = 1$ (MVP = MFC), resource being efficiently utilized
$r_i < 1$ (MVP < MFC), resource being over used

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$r_i > 1$ (MVP > MFC), resource being under utilized

RESULTS AND DISCUSSION

Socio-economic Characteristics of Rice Farmers

The result for the socio-economic characteristics of rice farmers in the study area as presented in Table 2 shows that rice farmers had a mean age of 38 years. At this age one is strong, agile and mentally alert to take decisions that will positively impact on rice production. Ataboh *et al.* (2014) had reported a mean age of 43, suggesting that most of the rice farmers studied were young people who were still strong and full of energy to make meaningful impact in agricultural production. Majority 73.8% of the rice farmers were males, 71.7% were married with a mean household size of 7 persons per household. This implies the rice farmers studied had responsibilities for the upkeep of the members of their households that makes engagement in rice production a necessary venture. It is in line with the report of Osanyinlusi and Adenegan (2016) that majority (73.1%) of the rice farmers were males, 88% married, with a mean a household sizes of between 8 to 10 persons per household. This agrees with Bamiro and Aloro (2013) that high levels of men and married couple involvement in rice production may not be unconnected with high demand of labour for bush clearing, weeding, planting and scaring of birds; and the possibility of supply of the required labour at the family level. The result shows that 73.8% of the farmers had some extent of formal education which could be primary, secondary or tertiary education. That was an indication that they were literate enough to understand and adopt new technologies. This supports the findings of Olumba (2014) in research carried out in Anambra State, where majority of the farmers had formal education. The respondents had a mean farming experience of 12 years. This shows enough representation of potentials for improvement in rice production. Contact with extension agents in the course of their rice production activities, however, revealed that only 3.8% of the respondents had contact with extension agents, while 96.2% of them never had contact with any extension agent. The absence of extension agents and by implication lack of extension services will certainly to a large extent affect farmers' productivity.

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Table 2: Socioeconomic Characteristics of Rice Farmers

Variable	Min.	Max.	Mean	Std. Dev.
Age (years)	20	60	38	10
Household size (number)	2	20	7	3
Years of experience in rice production (years)	1	19	12	4
	Frequency		**Percentage**	
Level of education				
Non-formal	22		26.2	
Primary education	17		20.2	
Secondary education	29		34.5	
Tertiary education.	16		19.1	
Sex				
Male	78		73.8	
Female	28		26.2	
Marital status				
Single	7		6.6	
Married	76		71.7	
Divorce	5		4.7	
Widowed	18		17.0	
Extension visits				
Yes	4		3.8	
No	102		96.2	

Source: Field Survey, 2020

Determinants of Resource Use Efficiency in Rice Production

Multiple regression analysis was used to determine the influence of the inputs on the output of paddy rice farming in the study area. Cobb-Douglas production function was estimated with the aid of the ordinary least square, the result is presented in Table 3. From the results, the coefficient of multiple determination (R^2) was 0.7608, which implies that 76.08% of the variations in the yield of paddy rice farming in the study area was explained by the explanatory variables included in the model. The F-statistics with value of 62.80898 and a corresponding p-value of 0.0000 was significant showing that the relationship estimated was fit. Fertilizer (Kg), seed quantity and labour were found to be significant at $P \leq 0.01$ level of significance, which implies that fertilizer, seed quantity and labour were significant inputs determining the production of paddy rice in Donga local government area of Taraba State. While the coefficient for seed quantity and labour were positive that of fertilizer was negative. This implies that addition of one more unit of either seed quantity or labour will result in increase in output, while addition of one more unit of fertilizer will result in decrease in output. This disagrees with the findings of Osanyinlusi and Adenegan (2016) who reported that fertilizer used had positive relationship with productivity among the rice farmers in the area but agrees with their finding that labour had positive relationship with productivity. It however disagrees with the findings of Obasi *et al*. (2013) who observed that quantity of seed sown was inversely related with productivity.

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Table 3: Estimated Production Function for Input and Output Variables

Variable	Coefficient	Std. Error	t-stat	Prob.
Constant	1.640973	0.109916	14.92933	0.0000***
Farm size (ha)	0.093998	0.190877	0.492453	0.6238^{NS}
Seed (kg)	0.738466	0.192609	3.834023	0.003***
Fertiliser (kg)	-0.875315	0.239969	-3.647612	0.005***
Labour (man-days)	0.463239	0.172776	2.681158	0.0089***
R-squired	0.760777			
Adjusted R-squire	0.748665			

Note: ***P ≤ 0.01

Source: Field Survey, 2020

Rate of Technical Substitution

The result for rate of technical substitution (RTS) showed that rice output had greater responsiveness to labour (0.75) than seed quantity (0.74). This implies that addition of one more unit of labour and seed quantity will result in an increase in output by 75% and 74%, respectively. Fertilizer which was also a significant factor in determining rice production however had a negative coefficient of -0.88. This implies that any addition of one more unit of fertilizer will result in decrease in rice output by 88%. The rate of technical substitution (RTS) 0.70 was obtained from the summation of the coefficients of the inputs (elasticity) which indicated that rice production in the study area was in stage II of the classical production surface. Stage II is the stage of decreasing positive return-to-scale, where resources used are believed to be efficient. This however disagree with Ataboh *et al.* (2014) who reported that return to scale (RTS) was 1.83, indicating an increasing return to scale and that rice production was in stage I of the production surface.

Table 3: Elasticity and Return to Scale of the Parameters

Variable	Elasticity
Farm Size	0.09
Seed Quantity	0.74
Fertiliser	-0.88
Labour	0.75
RTS	**0.70**

Source: Field Survey, 2020

Resource Use Efficiency Ratio

The result for resource use efficiency as presented in Table 5 shows that seed quantity and labour were over utilized with a less than one (<1) resource efficiency use ratio. This therefore implies that farmers need to decrease the use of seed and labour. This agree with the report of Gidado *et al.* (2013) that hired labour was over – utilized. This cannot be achieved where farmers do not have adequate extension services.

Table 5: Resource Use Efficiency Ratios

Resource	MPP	MVP	MFC	R(MVP/MFC
Seed	0.74	148	220	0.67
Labour	0.75	150	1000	0.15

Source: Field Survey, 2020

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Constraints to Rice Production

Table 6 presents a summary of constraints associated with paddy rice farming in the study area. The constraints were ranked based on the percentage of the responses to the constraints by the respondents, since the options were prone to multiples responses. Among the constraints, high cost of fertilizers, high cost of hired labour and inadequate extension contact ranked 1st, 2nd and 3rd, respectively. This is however dissimilar to the report of Osanyinlusi and Adenegan (2016) that pest (birds and grass cutter) infestations, inadequate funds (in form of credit access), labour availability and cost of labour were ranked as foremost constraints limiting rice production in the study area based on their weighted score. Others were poor soil fertility (4th), problems associated with land tenure system (5th), inadequate traction facility (6th), inadequate improved variety (7th), poor storage facilities (8th) and high cost of transportation (9th). The remaining were lack of processing facilities (10th) and high cost of agrochemicals (11th). From the analysis of the farmers' responses, we observed that in all the cases, the respondents were convinced that those constraints militated against the production of paddy rice in the study area.

Table 6: Constraints to Paddy Rice Production

Constraint	Frequency	Percentage	Ranking
High cost of fertilizer	103	11.07	1st
High cost of hired labour	99	10.64	2nd
Inadequate extension contacts	98	10.54	3rd
Poor soil fertility	91	9.78	4th
Land tenure problem	88	9.46	5th
Inadequate traction facility	81	8.71	6th
Inadequate improved variety	80	8.62	7th
Poor storage facilities	78	8.39	8th
High cost of transportation	76	8.17	9th
Lack of processing facilities	71	7.63	10th
High cost of agrochemicals	65	6.99	11th
Total	930*	100	

*Multiple responses recorded
Source: Field survey, 2020

CONCLUSION AND RECOMMENDATIONS

Based on the information available it was concluded that rice farmers in the study area possess socioeconomic characteristics that could favour improvement in rice production. Rice farmers were however, not efficient in resource use in all the inputs employed for rice production as studied. This may be attributable to lack of adequate extension services to guide in key areas of management of the production and the presence of so many challenges to rice production as experienced by the farmers. It was therefore recommended that extension services should be made available and adequate so as to provide adequate services to farmers on how best to use the resources available to them in order to optimize rice production. Also, necessary inputs should be made available and affordable to farmers so as to boost resource use efficiency and improve output of rice farmer in the study area.

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