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Research Article

Determinants of Rice Production of Small-Scale Farmers in Mono-Cropping and Intercropping Systems in Nigeria

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Abstract

The study examined the effects of social and economic factors on peasant rice farmers' output in North Central zone of Nigeria using Benue and Nasarawa States as case studies. Purposive and snowball sampling approach were used to select across LGAs in the states using structured questionnaire for data collection with the aid of computer assisted personal interview (CAPI). A total of 408 rice farmers was drawn from the mentioned state. Descriptive statistics was used to project socioeconomic characteristics of the rice farmers and their farms, while Gross Margin techniques was used to compare profitability of mono cropping and intercropping enterprises; and also enterprises between improved and local practices. Finally, multiple regression model with semi-log function was used to model rice output and identified factors influencing it. The results of semi-log regression function shows that the coefficients of the farm size, quantity of seeds planted, quantity of fertilizer applied, number of hired labour man-days used, adoption of tractor for land preparation were the positive significant factors influencing rice output at 1% alpha level; family man-days used and adoption of improved rice seed variety are positive and significant at 10% while age of the farmer was negatively related to rice output and significant at 10% probability level. The R2 however indicated that the socioeconomic variables used accounted for 33% variation in the rice output. Cropping system (either mono-cropping or intercropping) did not significantly influence rice output; however, under Gross Margin analysis (GM), mono-cropping was a more profitable investment than intercropping. The result shows that all other things being equal, planting of improved rice variety increased rice output by 18% and that enterprises with improved rice seed adoption had the highest profitability (GM) and Benefit: Cost ratio compared to other farming enterprises. In general, yield is small (<2000kg) despite the fact that farmers relatively had and used basic inputs and practices [improved seeds (43%), herbicides (80%), insecticides (85%), fertilizers (70%), mono-cropping (95%), literacy (65%), irrigation (0.5%) tractor (8%)] yet output is low. The study recommends the need to strengthen awareness as awareness on improve seed variety was only 57%, assist farmers to procure land hectare that will encourage commercial farming, promote the use of tractor as regression's result shows that 1 hour usage of tractor on rice field will increase output by 82%, keep encouraging mono-cropping and make irrigation facilities available in the rice production area since only 0.5% practiced irrigation; these will improve rice productivity. There are platforms: agricultural (32%), trading (25%) and credit (8%) associations through which government, non-governmental organization can come in and assist in this regards. In addition, there is need to follow up farmer field's activities as to ensure compliance by farmers to extension training and assistance, thus the need for service providers to attend to farmers' activities.

Keywords: Gross Margin Techniques; Snowball Sampling; Cropping System; Awareness; Rice Output; Service Providers

Introduction

While rice is very much a cash crop for small to medium scale farmers in East and Southern Africa region, it is more of a subsistence crop in West Africa where most of the continent's rice is produced. Nigeria is West Africa's largest producer of rice, producing an average of 3million metric tons of paddy rice for the past 3 decades. In Nigeria, rice is the most important staple food crop, both for food security and cash income. In the producing

areas, it provides employment for more than 80 per cent of the inhabitants as a result of the activities that take place along the distribution chains from cultivation to consumption [1]. It contributes immensely to both internal and sub-regional trade. Rice production is also a profitable enterprise [2]. It is a crop with a great capacity of adaptation to the most varied conditions of climate, soil, topography and moisture and therefore, it is the only crop grown in all agro-ecological zones in Nigeria. In view of its increasing contribution to per capita calorie consumption of Nigerians, the demand for rice has been increasing at a much faster rate than domestic production and more than in any other African countries since mid-1970 [3]. However, despite the huge demand and increase in land cultivated to rice, there has not been a significant improvement in rice supply as rice yield has continued to witness a decline in growth rate. The total domestic rice demand is estimated at about 5 million tons while the annual domestic output of rice still hovers around 3 million tons, leaving the huge gap of about 2million tons annually [4], a situation which has continued to encourage dependence on importation.

Consequently, rice importation in Nigeria rose from 7,000 tons in the 1960s to 657,000 tons in 1990s [5,6] and increased tremendously to 1.3 million tons and 2.5 million metric tons in 2000 and 2003 respectively. The cost of rice importation in 2003 was 29.85 billion [7]. On the average, Nigeria imports about 16.8 million tons of rice annually at a colossal amount of foreign exchange. However, due to serious foreign exchange scarcity, it is becoming increasingly difficult to import the quantities of rice necessary to sustain per capita rice consumption and to also keep the domestic price down. Hence, one of the developmental challenges facing the nation today is how to meet the local demand of rice, and reduce the over-reliance on rice importation.

Local demand on rice and importation kept on increasing despite availability of basic inputs with government support in area of input in kind supply (chemical fertilizer, seeds, etc) and loan provision to farmers. There is a need for a comprehensive research to identify factors influencing rice production in Nigeria, thus the need for this study.

Methodology

Study area

The work was done in Nigeria; there are 36 states in Nigeria, the survey was conducted in two of the states - Nasarawa and Benue states.

Nasarawa state

The state is centrally located in the Middle Belt region of Nigeria. Its capital is Lafia. The state lies between latitude 7° 45' and 9° 25' N of the equator and between longitude 7° and 9° 37' E of the Greenwich meridian. It has a maximum and minimum temperature of 81.7° F and 16.7° F respectively. Rainfall varies from 131cm to 145 cm. The state is really endowed with rich fertile soils, from the loosed soil materials of alluvial deposit in most of the southern part of the state to the well-structured and developed oxisols and ferrisols in the northern part of the state and the undeveloped soils on hill slopes and entrenched river valleys. Agriculture is the main economic activity in Nasarawa State with bulk of crop production undertaken by small scale farmers. Crops grown include grains such as rice, wheat, soybeans, beans, maize and millet and tuber crops such as yam and cassava.

Benue state

It is one of the 36 states of Nigeria located in the North-Central part of Nigeria. The State has 23 Local Government Areas, and its Headquarters is Makurdi. Located between Longitudes 60 35'E and 100 E and between Latitudes 60 30'N and 80 10'N. The State has abundant land estimated to be 5.09 million hectares. This represents 5.4 percent of the national land mass. Arable land in the State is estimated to be 3.8 million hectares. This State is predominantly rural with an estimated 75 percent of the population engaged in rain-fed subsistence agriculture. The state is made up of 413,159 farm families and a population of 4,219,244 people. These farm families are mainly rural. Farming is the major occupation of Benue State indigenes. Popularly known as the "Food Basket" of the Nation, the State has a lot of land resources. For example, cereal crops like rice, sorghum and millet are produced in abundance. Roots and tubers produced include yams, cassava, cocoyam and sweet potato. Oil seed crops include pigeon pea, soybeans and groundnuts, while tree crops include citrus, mango, oil palm, guava, cashew, cocoa and Avengia spp. (Benjamin C., *et al*.2013).

Sampling techniques

These states were purposefully selected based on the fact that they are among rice producing states in the North Central zone of Nigeria. In Nasarawa 172 rice farmers were purposively and snowballing sampled from across 12 local government areas (LGAs) while in Benue, 236 rice farmers from across 20 LGAs were contacted and interviewed between late in the year 2017 and early 2018 on their rice production practices. In the exercise, a total of 408 rice farmers were contacted and interviewed with questionnaire administered through computer assisted Personal

Interview software (CAPI). Extension agents from Benue and Nasarawa states were trained in the use of CAPI before the survey dates; these agents were the enumerators for the field survey. The questionnaire contains questions on farming activities of farmers and specifically to rice production. The focus of the study was to be able to compare respondents' productivity of farming under mono-cropping and intercropping systems using Gross Margin technique; as well as comparing between local and improved farming practices using farmers adopting improved seedlings as a base for improved practice and those who did not plant as the control. There benefit cost ratios were also compared in order to draw conclusion on better cropping practice.

Nasarawa	
LGA	Number of farmers interviewed
Akwanga	6
Doma	21
Karu	19
Keana	5
Keffi	6
Kokona	19
Lafia	22
N/eggon	22
Nassarawa	17
Obi	11
Toto	12
Wamba	12
Total	172
Benue	
Ado	6
Agatu	22
Apa	22
Buruku	11
Gboko	6
Gwer east	11
Gwer west	14
Kastina-ala	8
Konshisha	11
Kwande	12
Makurdi	12
Obi	37
Ogbadibo	1
Oju	7
Okpokwu	1
Tarka	11
Ukum	11
Ushongo	23
Vandeikya	8
Okpokwu	2
Total	236
Overall Total	408

Table 1: Sample list of LGAs with farmers in Nasarawa and Benue states.

Analytical techniques

Data analysis was done using descriptive analysis, multiple regression model and gross margin technique. Two functional forms: linear and semi-log multiple regression functions were fit to the data. The analysis was done using SPSS IBW 20 and STATA package and it was tested at 5% alpha level of significance.

Multiple regression

A Multiple regression model is a generalization of simple linear regression model to the situation where we have more than one predictor. The model is

$Yj = \beta_0 + \beta_1 X_1 j + ... + \beta_p X_{pj} + \varepsilon_j$, where $\varepsilon \sim N(0,\sigma 2In)$.....1

Where Y, dependent/response variable; $\beta_0.\beta_p$

Like the simple linear model, the assumptions for this model are; X_i-X_p

- Normality assumption: The error ε_i has a normal distribution and independent of X.
- Homoscedasticity assumption: $E(\varepsilon_i) = 0$ and $Var(\varepsilon) = \sigma 2In$.
- β_i are constants.

Gross Margin analysis

A gross margin for an enterprise is its financial output minus its variable costs or the total income derived from an enterprise less the variable costs incurred in the enterprise. This can only be used to assist in calculating gross margins for a specific case, with costs, prices and management assumptions being changed accordingly. (Faris., *et al*. 2010).

GM = GR – TVC

where:

GR =Gross return from rice produce

TVC = Total variable cost for rice production

Empirical model

Multiple Linear Regression model (MLR)

The empirical model employed for the determinants of rice production in the study area is MLR, and it is stated below in its implicit form:

Y= F(X1,X2,X3,X4,X5,X6,X7,X8,X9,X10,X11,X12,X13,X14,X15,X16,X17,X18,X19,X20,X21, ε). ----------2

Detail description of the acronyms is stated in Table 2 below.

The dependent or endogenous variable is the rice output (To-produce). The explanatory variables included farmer, farm and institutional factors postulated to influence rice output; the variables are shown and describe in Table 2. The rationale for inclusion of these factors was based on previous agricultural production literature and the analysis of these systems.

Variable	Variable symbol	Description	Unit	Apriori	Mean (SD)	%Yes
Toproduce	Y	Rice output (Dependent variable)	Kg		1550.50(2773)	
Toseed	X1	Rice seed	Kg	+	68.6(124)	
Specific Area Rice	X2	Area planted with rice	Kg	+	2.1(4.2)	
Tfertilizer	X3	Fertilizer applied	Kg	+	120(399)	-
Hired labour	X4	Hired labour	Mandays	+	22.2(46)	-
Family labour	X5	Family labour	Mandays	+	16.5(27)	-
Qty herb	X6	Quantity of herbicide used	Litters	+	8.2(26)	-
Qty_insect	X7	Quantity of insecticide used	Litters	+	1.3(4.2)	-
Hhsize	X9	Family size	Number	±	10.3(3.2)	-
AGEM	X10	Age of household head	Years	±	45.2(14.3)	-
EduYrs	X11	Years of eduction of farmers	Years	+	8.0(5.5)	-
TractorU	X8	Use tractor=1, otherwise=0	Dummy	+		10.5
Variety	X12	Plant improved variety=1, Otherwise=0	Dummy	+		43
Intercrop	X13	Practice intercropping=1, Otherwise=0	Dummy	-		5
OwnLivestock	X14	Own livesttock=1, Otherwise=0	Dummy	+		65
Business	X15	Getting income informally=0, Otherwise=0	Dummy	+		46
Salary	X16	Getting paid salary=0, Otherwise=0	Dummy	+		16
Creditgp	X17	Belong to credit association=1, Otherwise=0	Dummy	+		7.6
Agriculturalgp	X18	Belong to agric association=1, Otherwise=0	Dummy	+		31.9
Tradegp	X19	Belong to trade association=1, Otherwise=0	Dummy	+		24.5

Table 2: Descriptions of endogenous and exogenous variables.

Gross margin analysis

For the purpose of evaluating the profitability of rice farm production activities, budgetary analysis (GM) was done involving the computation of gross margin (GM) and benefit cost ration (B:C). This was carried out and compared for farming households engaging in mono-cropping and intercropping rice production as well as those engaged with planting improved and local rice seeds. As defined above

GM = GR – TVC,

GR =QP

Quantity of rice output/ha

P= Price per unit of output

$TVC= Z_iN_i$

Z_i = quantity of each 'I' input (e.g., fertilizer, seed, herbicide, insecticide, hired labour, etc)

N_i=is the price per unit of each input (e.g. prices of fertilizer, seed, herbicide, insecticide, hired labour, etc)

Results and Discussions

Socioeconomic description of farmers

Data on 408 farmers from Benue and Nasarawa states are analyzed. Considering the socioeconomic features of the farmer respondents, the result in Table 3 shows that 94% of the farmers were male-headed farmers and that 93% of them were married with responsibilities that will make them sit up to their farming responsibilities., thus 86% of them were full time farmers. More than 50% of the farmers were educated; education is hypothesized to influence farmer's production positively because as farmers acquire more education, their ability to obtain, process, and use new information improves and enhance their production ability and efficiency. In several studies, positive relationships have been found between education and improved agricultural productivity [8]. The average household size was 10; family size is defined

here as all the number of people living under the same roof and eating from the same pot and it, has been identified to have either a positive or a negative influence on farm productivity [9]. Larger family size is generally associated with a larger labor force available for the timely operation of farm activities. However, the negative relationship of this variable with in relation to productivity has been linked to the increased consumption pressure associable with a large family. Therefore, it was difficult to predict the impact of this variable a priori in this study. Average age of the farmers was 45 years and was within economic active working life. The effect of age (AGE) on the farm productivity could be negative or positive irrespective of intensification gradients and manners of redistribution, thus for many past studies, there is no agreement on the sign of this variable as the direction of the effect is location- or technology-specific [10]. Previous studies show that the age of individuals affect their mental attitude to new ideas and influences adoption and production in several ways [10]; Younger farmers have been found to be more knowledgeable about new practices and may be more willing to bear risk and adopt innovation because of their longer planning horizons. The older the farmers, the less likely they are to adopt new practices as he gains confidence in his old ways and methods. On the other hand, older farmers may have more experience, resources, or authority that may give them more possibilities for trying a new technology that will lead to improved productivity.

Variables	Score
Household head %	
Maleheaded households	93.86
Femaleheaded households	6.14
Marital status %	
Single	1.97
Married	93.35
Widowed	4.68
Literacy %	
Yes	65.36
No	34.64
Farming as main occupation %	
Yes	86.03
No	13.97
Age(year) Average	45.2
Education(year) Average	8.0
Family size (Number)Average	10.3
Area of rice cultivated (Ha) Average	2.1

Table 3: Socioeconomic characteristics of farmers (N=408).

Average farm size of farmers was 2.1 ha; farmers with larger farm size resource can easily adopt new technologies that will improve his farm productivity; such farmers need not to manage land as such can practice mono-cropping system instead of managing land with mixed cropping system.

Farm specific characteristics

Table 4a reveals some characteristics of the farms under survey. Land tenure ownership was mainly owned by inheritance and purchase (83%), thus most of the farmers were free to use land without any restriction. Farm land wasis mainly loam type (70%) and fertile (62%) and flat (87%). The watering system for the season was rain fed (100%). Mainland preparation method was manual, only few farmers could afford the use of tractors for land cultivation.

Tenure system	% Yes
Owned (Inherited/purchased)	83.09
Others	16.92
Soil_Type	
Loamy soil	70.22
Others	29.72
Soil_quality	
Fertile	61.69
Others(medium/poor)	38.31
Plot_slope	
Flat	86.78
Slopy	11.48
Hilly	1.75
Mainwatering system	
Rain fed	100
Main land preparation method	
Manual	91.89
Tractor/oxen	10.50
Others	0.25
Variety	
Improved	42.96
Local	57.04

Table 4a: Farm specific characteristics.

Table 4b shows that 57% of the farmers were aware of improved rice seeds while 43% of them adopted it. Over 50% of the farmers had needed inputs such as family and hired labour, fertilizer, herbicides and insecticides/pesticides. The rice farmers

in the study areas preferred mono-cropping to intercropping as only 4.9% of them intercropped their rice with other crops. Most of the farmers were involved in livestock production (65%). There are many association platforms including credit, farmers and trading associations that farmers joined to derive one benefit or the other. AgroMall, a service provider, can take advantage of these association to link up with farmers in area of service provision in term of giving loan and inputs in kinds.

Awareness of improved seeds	% Yes
Yes	57.3
Use hired labour	
Yes	81.19
Use family labour	
Yes	89.89
Use communal labour	
Yes	26.8
Use pesticides/insecticides	
Yes	84.86
Use herbicides	
Yes	80.1
Apply fertilizer	
Yes	70.05
Practice irrigation	
Yes	0.5
Livestock production	
Yes	65.11
Belong to credit association	
Yes	7.6
Belong to farmer association	
Yes	31.86
Belong to trading association	
Yes	24.51
Rice intercrop with other crop(s)	
Yes	4.94
incurred losses after harvest	
Yes	13.39

Table 4b: Farm specific characteristics.

Farmers' self-assessment features

Figures 1 to 5 represent the expression of farmers in regard to their farming activates. Figure 1 shows that 68% of the farmers declared that their seed source was from self, and recycled over time; it can be local or improved only 0.25% obtained their seeds from reliable source like research institution and university; this might likely have negative implication on the quality of seeds and produce. Purpose of planting rice is shown in Figure 2; only 0.25% planted rice with the aim to sell the produce only, majority planted to consume and sell the surplus if any (93%), with this scenario, Nigeria will not be able to guarantee production to meet domestic and foreign demand for foreign exchange. AgroMall can help in this regards to re-orientate farmers and assisted them to boost production.

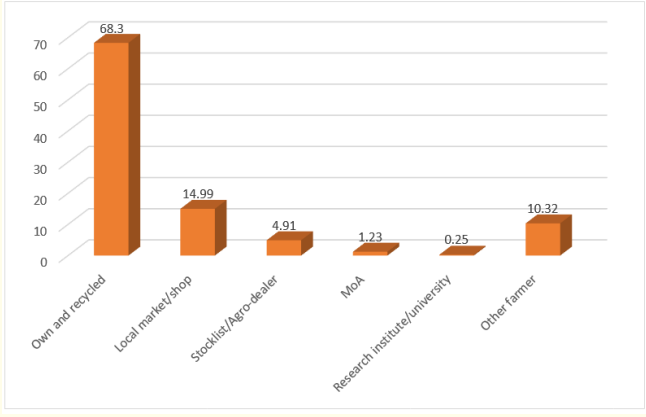

Figure 1: Seed_source.

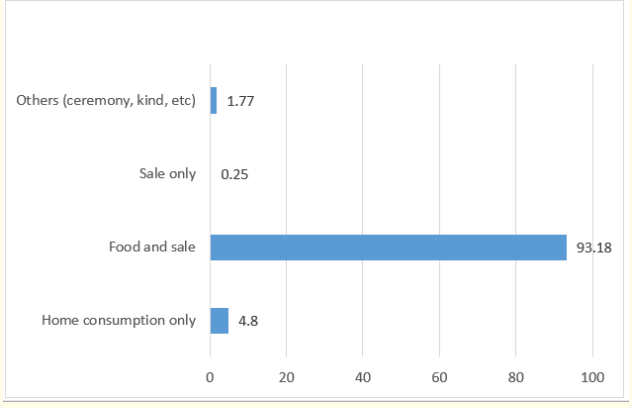

Figure 2: Purpose of cropping rice.

Some of the reasons farmers proffer not selling their rice produce are shown in Figure 3. Rank first among these was the fact that there was no surplus available for sale (40.45%), followed by poor price of produce. Good price might have prompted farmers to sell his produce and out of proceed, buy other cheaper food items to meet his family needs. In general, yield was generally poor despite the fact that more than half of them use fertilizer, and close

to half used improved seeds. AgroMall service provider aims to follow up farmers on the use of these inputs in appropriate way and help farmers manage the farm in the optimal way as to get higher productivity.

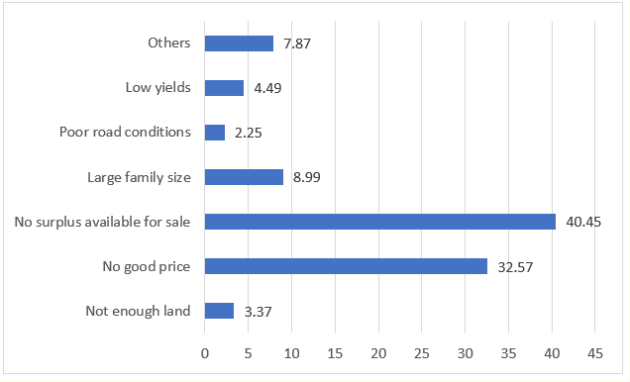

Figure 3: Limitation to sales of rice.

Supposed factors affecting yield are projected in Figure 4; prominent among them are; little rain towards maturity (20.7%), pest and diseases (16.4%), low soil fertility (14.9%) and little rain at planting (13%). There is need to address the issue of irrigation, fertilizer availability and affordability and control of pest and diseases.

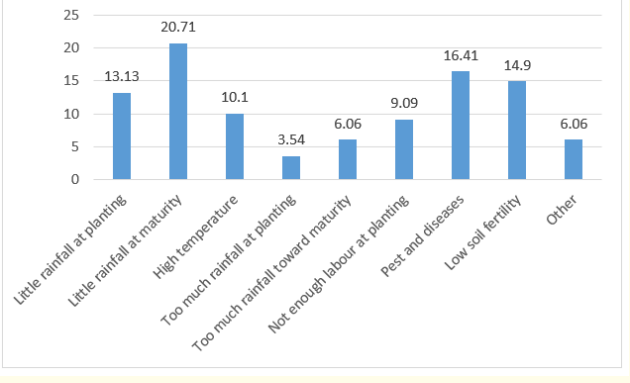

Figure 4: Factors affecting yield.

Type of buyers that buy from farmers are shown in the pie chart in Figure 5; small traders buy most of the produce and only 0.32% were exported. This is not a good trend that can serve as incentive to farmers to be committed to planting rice.

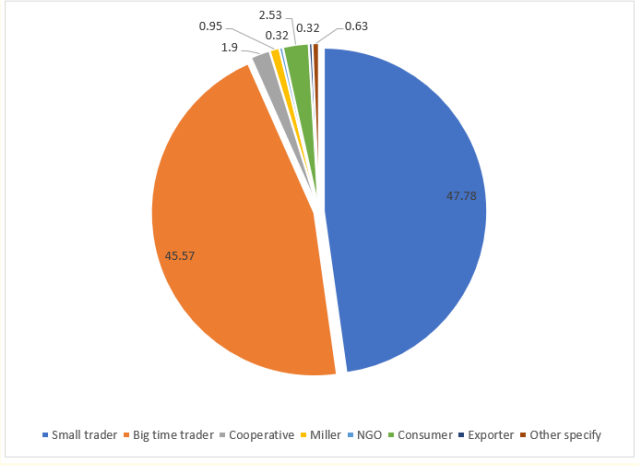

Figure 5: Buyer_type.

Gross margin analysis

Gross margin analysis of rice enterprise are under 2 scenarios: scenario1 is when farmers practicing mono-cropping and intercropping are compared while scenario2 is when farmers cultivating improved rice seedling and local rice seedling are compared; the result is shown in Table 5. Columns in Table 5 are numbered from 1 to 13; column 2 gives the units of variables considered, while columns 4, 6, 8, 10, 12 show the quantity of each variable used by Pooled farmers, and when farmers are disaggregated into mono-cropping, intercropping, improved practice and local practice respectively. Respective price per unit for these variables is in the column 3. When column 3 is multiplied with columns 5, 7, 9, 11 and 13, it gives the cost or return per hectare respectively.

Under scenario 1, the GM for mono-cropping was N29,500/ha and N24,092/ha, while mono-cropping farming enterprise shows better returns per hectare of farm compare to farmers that practice intercropping, it is worth to know that intercropping has a marginal increase in B:C ratio than mono-cropping. A BC ratio is an indicator and is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms. The higher the BC ratio, the better the investment. General rule of thumb is that if the benefit is higher than the cost (i.e. B; C ratio>1) the enterprise is a good investment.

It can be concluded that both enterprises are profitable and should be encouraged, especially intercropping for farmers with limited land size resource. The bottom line for intercropping

should be prudent management. Calculation of a gross margin is the essential first step in farm budgeting and planning. It enables you to directly compare the relative profitability of similar enterprises and consequently provides a starting point to deciding or altering the farms overall enterprise mix http://agriculture.vic.gov.au/agriculture/farm-management/business-management/farm-budgets-and-tools/farm-gross-margins). As in this case, for budget planning, mono cropping will be selected above intercropping especially if the farmer's priority is to produce for markets and not family consumption.

Considering scenario 2, the case of a farmer cropping improved rice seedling compared to a farmer that used the local seedling and may use other technologies like fertilizer, herbicides, etc. The result shows that the GM for improved practice (N72,821) was higher than local practice (-N245). Base on this result, local practice enterprise was not a good investment and should not be encouraged. Using complete technological input package (improved seedling inclusive), give the best returns to production, the implication of B:C ratio of 1.37 for improved practice is that after paying for expenditure cost, the farmers can still smile home with 37% of what he invested in his enterprise.

Examination of the details of Table 5 shows that the enterprises considered are not performing at optimum level, depicting that the farms are not well managed. Considering seed quantity used per hectare of farm; agronomic recommendation stipulates the use of 25-60kg/ha depending on whether it is a low land or upland rice, but here (POOLED) the average seed used is about 69kg/ha with SD of 124kg in Table 2. The average NPK recommended for 1 ha of rice farm is 10 bags (i.e. 500kg), from the POOLED data, the average is 324kg (about 6bags). Based on these and other factors, there is need for a service provider that will make input package available to farmers at right quantity and that will assist farmers with ideal agronomic and farm management practices and follow up the farmers to ensure compliance that will boost their rice productivity. AgroMall, a registered service provider can fill this gap.

VARIABLE	UNIT	PRICE/ UNIT (Naira)	POOLED	COST/ RETURNS	MONO-CROPPING	COST/ RETURNS	INTER-CROPPING	COST/ RETURNS	IMPROVED PRACTICE	COST/ RETURNS	LOCAL PRACTICE	COST/RE-TURNS
1	2	3	4	5	6	7	8	9	10	11	12	13
INPUTS												
Seed	Kg/Ha	202	68.6	13857.2	69.6	14059.2	50.7	10241.4	69.2	13978.4	68.2	13776.4
NPK	Kg/Ha	151.1	324.5	49031.95	332.2	50195.4	156.4	23632.0	418.8	63280.68	228.8	34571.68
Urea	Kg/Ha	193	138.2	26672.6	139.6	26942.8	105.0	20265.0	115	22195	161.8	31227.4
DAP	Kg/Ha	199	70.8	14089.2	70.8	14089.2		0.0	69	13731	73.8	14686.2
Manure	Kg/Ha	12	500	6000	500	6000.0	500.0	6000	450	5400	533.3	6399.6
Hired labour	Person's day/Ha	1200	22.2	26640	22.5	27000.0	30.1	36120	24.8	29760	20.2	24240
Tractor Hour	Hours/ Ha	NA	13.4	24095	13.6	24192.5	4.8	20000	8.8	24769.1	19.9	23158.73
Insecticide applied	Litter/ Ha	1926	3.6	6933.6	3.6	6933.6	3.8	7318.8	3.7	7126.2	3.4	6548.4
Herbicide applied	Litter/ Ha	1976	8.9	17586.4	9.1	17981.6	4.8	9484.8	7.6	15017.6	9.8	19364.8
Total Variable Cost (TVC)				184905.95		187394.3		133062.04		195257.98		173973.21
OUTPUT												
Rice harvest/ Returns	Kg/Ha	138	1550.5	213969	1571.7	216894.6	1138.8	157154.4	1942.6	268078.8	1258.9	173728.2
Gross Margin (GM)				29063.05		29500.3		24092.4		72820.82		-245.01
Benefit Cost Ratio(B:C)				1.16		1.16		1.18		1.37		0.998

Table 5: Gross margin analysis for 1 hectare of rice farm.

Multiple regression analysis

Table 6 shows the results of the factors influencing rice farmers' output. Two functional forms - linear and semi-log were tested. The lead equation was semi-log because it has the highest R-square - R^2 compared to linear regression function. The F-ratio (9.45) is significant at 1%, implying goodness of fit of the model. The R^2 (0.33) indicates that 33% in the variation of the dependent variable was due to the independence variables used in the study. The magnitude of R^2 is in line with a priori expectation because there are many factors that can influence rice production; and these factors have been highlighted in the literatures by scholars.

Variable	Coef.	Std. Err.	t	P>|t|
Toseed (Seed quantity)	0.0019	0.0005	3.7800	0.0000
Specific Area Rice (Farm size)	0.0330	0.0130	2.5400	0.0120
Tfertilizer (Fertilizer applied)	0.0004	0.0002	2.7400	0.0070
Hiredl abour (Hired labour)	0.0005	0.0002	2.9200	0.0040
Familylabour (Family labour)	0.0005	0.0003	1.6700	0.0950
Qherb(Quantity of herbicide)	0.0018	0.0020	0.9100	0.3640
Qinsect (Quantity of insecticide)	0.0152	0.0126	1.2100	0.2270
Tractor (Use of tractor)	0.8196	0.1931	4.2500	0.0000
Hhsize (Family size)	0.0006	0.0187	0.0300	0.9750
AGEM (Age of farmer)	-0.0071	0.0040	-1.7800	0.0760
Edu Yrs (Years of education)	0.0111	0.0105	1.0600	0.2900
Variety (Use of improved variety)	0.1832	0.1082	1.6900	0.0910
Intercrop (Intercropping)	-0.3607	0.2440	-1.4800	0.1400
Own livestock (Livestock ownership)	-0.2116	0.1120	-1.8900	0.0590
Business (Income from informal means)	-0.1152	0.1134	-1.0200	0.3110
Salary (Salary earners)	0.0058	0.1514	0.0400	0.9690
Creditgp (Credit group)	-0.0160	0.2010	-0.0800	0.9370
Agricultural pg (Agric association)	-0.0254	0.1183	-0.2100	0.8300
Tradegp (Trade association)	0.1398	0.1329	1.0500	0.2940
Constant	6.5490	0.2941	22.2700	0.0000
Number of observation	408			
F-value	9.45			
Prob>F	0.000			
R^2	0.33			
Adj. R^2	0.29			

Table 6: Determinants of rice production.

Among the independent variables tested, results shows that the coefficients of the farm size, quantity of seeds planted, quantity of fertilizer applied and number of hired and family man-days used, adoption of tractor for land preparation, adoption of improved rice seed variety are positive and significant at different probability levels. The implication is that a unit increase in any of the variable, will lead to increase in rice output. The coefficients of the age of the farmers and livestock ownership by farmer are negative and significant, meaning that increase in any of the variable will lead to decrease in rice output.

The coefficients of quantity of herbicide used, quantity of insecticide, family size of the farmer, years of education of farmers, farmer with informal business, salary earners, membership of

agricultural, credit and trade associations wee not significant: This did not portend that that the listed variables do not have any effect, but rather, the level of significance fell below the level of confidence limit tested.

Explicitly, since the coefficient of farm size is positive and significant at 1%, it therefore means that (all things being equal), output of rice will increase if the rice farmers increase farm size. This agrees with the findings of Basoru and Fasakin [11]. The coefficient of the quantity of rice seed plant is significant at 1% level and positively related to rice output. All thing being equal, the quantity of rice produced increases as quantity of seed planted increases. The coefficient of the quantity of fertilizer applied is significant at 1% and positively related to output of rice. Thus, output of rice increases with increase in fertilizer application. This result agreed with those of Onyenweaku and Effiong [12], Onyenweaku and Nwaru [13] and Okoye., *et al.* [14] who observed that fertilizer shifts the production frontier upwards leading to higher productivity.

Hired labour is significantly related to output at 1%; a unit increase (manday) in hired labour will increase rice output by 0.05%, same is applicable to family labour, but at 10% probability level, meaning that hired labour is strongly related to rice output than family labour. The use of tractor for land preparation and for farming activities is significant at 1%, a unit increase (hour) in the use of tractor on the farm will increase output by 82%. The gross margin analysis compared use of improved seed variety and that of local one, and concluded that usage of improved seed is a more profitable enterprise compared to local seed. Under this regression, the use of improved seed (Variety) has positive and significant relationship with rice output; when a farmer shifted to the use of improved variety (dummy=1), the rice output will increase by 18.3%. On the other hand, intercropping (intercrop dummy=1) with rice does not has significant relationship with rice production, all other thing been equal, planting other crops with rice does not affect its productivity statistically.

Age of farmer (AGEM) has a negative and significant relationship with rice output. A unit(year) increase in the age of farmer will reduce rice output by 0.07%; it therefore means that a younger farmer is needed on the rice field to get the needed increase rice output. Finally, it is surprising to note that livestock production has negative and significant relationship with rice farming (mixed farming); this can be a research gap for further study in the future.

Conclusion

The paper examined determinants of rice production of small-scale farmers in mono-cropping and intercropping systems in Nigeria. Data from rice farmers from Benue and Nasarawa States totaling 408 were used for the analysis. Descriptive statistics was used to project socioeconomic characteristics of the rice farmers and their farms, while Gross Margin techniques was used to compare profitability of mono cropping and intercropping enterprises; and also enterprises between improved and local practices. Finally, multiple regression model with semi-log function was used to model rice output and identified factors influencing it.

The results shows that 86% of the farmers were full time farmers, thus no distraction to their farming activities, above 50% educated, thus can understand information that will help them adopt new technologies successfully; have average family size of 10, which can be a source of family labour. On farm specific characteristics, the farmers have average farm size of 2.1 ha, which are owned by farmers as the study claimed that 83% of the farmers have land by inheritance and purchased. The small farm size is a characteristics of peasant farmers, and the small size will prevent attainment of commercialization in rice production. The cropping system used for rice production was mainly mono cropping (95%), while intercropping is just 5%; mono cropping encourages the use of mechanization in rice production. The cropping system was mainly 100% rainfed with only 0.5 engaging in irrigation. 43% of the farmers planted improved rice seeds, while only 11% used tractor in their farms; 70% of the farmers used inorganic fertilizers, 80% used herbicides and 85% used pesticide/insecticides; with all these input packaged used by farmers, the productivity was below 2tons/ha. The question is why was it so? There are association platforms though which various interventions from NGOs and government can come in. The associations are - agricultural (farmer) – 32%, trader-25% and Credit (8%) associations.

Gross margin analysis shows that both mono-cropping and intercropping were profitable enterprises depending on farmer's objective of producing for sales or consumption; however, farmers that practiced mono-cropping had higher yield/ha(1572kg) and higher gross margin figure (N216,895) compared to intercropping. Planting improved rice seed (Improved practice) was better than local seeds (Local practices), as improved practices had higher yield 1943kg and profit (GM) of N268, 079. In general, all enterprises break even, as each of the enterprise has GM>1 except Local practice.

Semi-log multiple regression results show that the coefficients of the farm size, quantity of seeds planted, quantity of fertilizer applied and number of hired and family man-days used, adoption of tractor for land preparation, adoption of improved rice seed variety were positive and significant at different probability levels. The implication is that a unit increase in any of the variable, will lead to increase in rice output. The coefficients of the age of the farmers and livestock ownership by farmer are negative and significant, meaning that a unit increase in any of the variable will lead to decrease in rice output. Younger farmers will be more productive than older ones, as 1 year increase in age will reduce rice output by 0.71%; use of tractor will increase output by 82% and improve seed variety will increase rice output by 18%. Although, mono-cropping in terms of profitability is more profitable than intercropping, nevertheless, Intercropping does not affect rice output negatively statistically.

In general, yield is small (<2000kg) despite the fact that farmers relatively had basic inputs (improved seeds, herbicides, insecticides, fertilizers, etc). There is need to follow up farmer field's activities as to ensure good management of farms and compliance by farmers to extension training, thus the need for service providers to attend to farmers' activities. Association platform on ground in the study communities can be used by service providers or government for inputs and credit procurement to farmers. AgroMall, as a service provider can fit in in this regards.

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