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Profitability and Technical Efficiency Analysis of Rice Production in Quan' Pan Local Government Area of Plateau State, Nigeria

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ABSTRACT

This study investigated how profitable and technically effective rice farming was in Quan' Pan Local Government Area of Plateau State, Nigeria. Using a multistage sample method, 120 respondents were drawn. The study's findings proved that the farmers were 40 years old on average. The men were higher in numbers constituting 81.0% of the study population. 83% of the people were married and a greater number (81%) of them had at least some form of formal education with a typical household size of 9 persons. Findings from the study also showed that the farmers owned an average of 2.0 hectares of farmland and had acquired an average farming experience of 12 years. For the most of them (78.0%), farming was their primary occupation. The result also demonstrated that 78.0% never accessed credit or bank loans for farming as majority (63%) of the respondents acquired their farmlands through inheritance. The entire cost (total cost) of farming operation/ha incurred by the farmers was 139733 while the average output obtained per hectare was 699kg at a prevailing market/selling price of 285/kg. The total revenue (TR) measured in naira value of 199, 215 was realized. Gross margin (GM) and net farm income (NFI) stood at 70932 and 59482 respectively. The return on investment (ROI) was 0.42 meaning that for every naira spent on rice production, a profit of 0.42 is made. Age, educational level, farm size, farming experience and extension contact all had positive direct relationship with net income from rice production at 1%. The rice growers' mean technical efficiency score was 0.659. Major constraints to rice production were high fertilizer prices (72%), inadequate capital (53%), lack of improved seeds (47%). The research suggests that government should subsidize farming inputs like recommended fertilizer and herbicides so as to reduce the over bearing cost burden of these inputs on farmers. Financial institutions should make credit facilities available and affordable to the farmers.

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Introduction

The diversity of agro-ecological production systems allows Nigeria's food sub-sector to display a wide variety of staple crops. Rice has grown to a position of prominence among the key food crops such as maize, sorghum, millet, tubers, legumes and others (Vihi et al., 2020). These food items significantly affect household income, expenses, and food security. In West Africa, rice has developed into a highly cherished food commodity and is the main source of energy food (Seck et al., 2010). In 1960 when the country gained independence, rice was merely a festive delicacy enjoyed primarily in wealthier houses during religious holidays like Christmas. However, due to accelerated population upsurge and growth in per capita consumption occasioned by shifting consumer tastes, rice consumption in Nigeria has significantly increased since the mid-1970s. One among the few food commodities that transcend cultural, religious, ethnic, or geographic boundaries in Nigeria is rice (Isa et al.., 2013). Owing to the substantial demand rise especially in urban areas, rice among all staple crops has the fastest growing consumption rate for several decades. Consumers are moving more and more toward rice and away from traditional staples like cassava, maize, and yams. It is a vital cereal that can feed a population with the requisite 2,400 calories per person per day that is needed for national food security (Bamidele et al.., 2010). Since the middle of the 1970s, the quest for rice has been growing in Nigeria far more quickly than domestic production and more than in any other African

nation due to its growing proportion to the per capita calorie consumption (Bamidele et al.., 2010). The nation is import-dependent because it cannot produce sufficient rice to satisfy domestic demand. Relying on costly food imported from international markets damages Nigerian farmers, displaces local production, and contributes to increased unemployment in addition to stimulating domestic inflation (FMARD, 2012). Nigeria is ecologically equipped to produce enough paddy rice on its own, with a potential land area of between 4.6 million and 4.9 million ha (FMARD, 2012). However, just 1.8 million ha of Nigeria's total land area that can be used to grow rice is now cultivated, despite the country's enormous untapped potential for rice production (CARD, 2009).

Considering that rice have become the most popular everyday food, the Nigeria Government has undertaken various attempts to increase rice production in an effort to ensure food security and improve the socioeconomic welfare of small- and large-scale farmers (Salau 2013). This, the government has done by initiating a number of programs and policies to make sure Nigerian rice production continues. They includes the establishment of National Cereals Research Institute (NCRI), Agricultural Development Program (ADPs) across the states, the Federal Rice Research Station (FRRS), financial/credit institutions for rural and agricultural development like the Bank of Agriculture, enactment of the National Accelerated Food Production Program (NAFPP), the Presidential Rice Initiative etc. (Longtau, 2013; Udumeze, 2018). Rice yield or output in Nigeria grew annually from 5.5 million tons in 2015 to about7.5 million tons in 2016 courtesy of these particular initiatives even though a sizable shortfall of about 3.8 million metric tons still exist (Udumeze, 2018). This appears to point to a critical gap in reaching increased rice output. According to estimates, smallholder farmers who are resource-poor and poorly organized produce almost 90% of the country's rice (USAID 2009). These smallholder farmers practice low-input agriculture, which has low yield and little input requirements. They are faced with numerous obstacles including low productivity, a lack of opportunities for value addition, limited access to resources and inputs, inadequate support services (extension and research), poor market and rural infrastructure, post-harvest losses, and an unfavorable enabling environment (IFAD, 2012). Information on expenses and profits is crucial in rice production just as it is in any other farming enterprise. Particularly when farming economics are at stake, the question of farm costs is crucial. Even in small-scale farming, farm costs account for a significant amount of the economy, especially when efforts to modernize farming in response to the expansion and development of the economy are taken into account. If rice farmers are not interested in tracking their costs and profits, they will not be able to establish whether they are making a profit or running at a loss. However, the issue is that most farmers have only hazy concepts of the industry's potentials and as a result are slow to commit investment capital to rice growing. Additionally, in order to increase farmers' productivity, resources must be used more effectively with a focus on meeting production goals without wasting any (Ume and Nwaobiala, 2012). Efficiency can be attained by either increasing production from available resources or reducing the resources needed to produce a given output (Varian, 2014). Production efficiency is crucial for increasing output. It entails optimization of already available resources to provide the highest production possible under the current technological limits. Technical efficiency is the capacity of a corporation to create as much turn-out with a given amount of inputs given the available technology. Efficiency is a critical component of productivity growth, particularly in our emerging agricultural sector where resources are scarce and opportunities to create and implement improved technologies are currently on the decline (Onyenweaku and Effiong, 2005). Therefore, enhancing the farmers' production efficiency will result in increased output and profitability as well as improved food security for the nation. Efficiency is that missing link which has remained an important subject of empirical investigation particularly in developing economies where majority of farmers are resource poor. Farmers' resistance to using the proper combination of inputs is a very tough nut to crack. When the rate of savings in agricultural technology increases, there is usually a corresponding increase in the rate of returns with high production efficiency.

Quan'Pan Local Government Area is among key regions for rice production in Plateau State. Different production methods are frequently adopted by the rice cultivators in the area. However, there is a lack of knowledge on the profit margins of the various rice production systems' and farmers limitations to increasing investments in rice production. Investigations revealed that majority of the cultivators in the local government are small scale operators adopting traditional production methods and grappling with poor returns to scale. As asserted by Shehu et al.. (2009), a hand full of producers in the state are unable to accurately predict the profitability of their businesses and have limited knowledge of the demands and intricacies of rice farming. Due to farmers' uncertainty about receiving the best returns from the resources invested in the business, total output has been drastically reduced as a result. Information on cost and returns as well as input combination is vital in every enterprise if the aim is for profit maximization. Without a thorough understanding of the income and cost structure of the business, nobody can really speak of profit. Furthermore, there is little/absence of thorough and up-to-date information regarding the level of farmers' effectiveness in using resources as the few studies that are now accessible have mostly concentrated on the profitability of the farm without going in-depth on farmer efficiency. To address this gap, this study was designed to assess how profitable rice enterprise in the area is and how technically efficient the producers in the Local Government Area are. Specifically, the study intends to address the following objectives:

- describe the socio-economic demographics of rice farmers' in the study area,
- estimate the cost vis-à-vis the returns of growing rice in the study area,
- determine the effect of socio-economic and institutional factors on net production income of the rice cultivators,

- estimate the technical efficiency levels of the rice farmers;
- determine the factors influencing technical efficiency of rice farmers and
- identify the problems or constraints militating against rice production in the study area.

Materials and Methods

The study was conducted out in Qua'an Pan Local Government Area of Plateau State, Nigeria. The Local Government is located in the southern part of the State with its headquarters in Ba'ap. It has coordinates 8°48'N 9°09'E, an area of 2,478 km2 and a population of 196,929 (Plateau State Information and Communication Development Agency, 2016). Its boundaries are shared with those of Shendam, Pankshin, Bokkos, and Lafia Local Government Area in the state of Nasarawa. Deomak, Bwall, Kwalla, Kwa, Kwang, Kwande, Namu, and Dokan-Tofa are the 8 districts that make up the local government. The prominent ethno-cultural groups in the local government area are Pan and Geomai. The economy of the local government area is mostly centered on agriculture where important cash crops including yam, rice, maize, millet, and cassava are cultivated while livestock like cattle, sheep, goats, pigs, and poultry are reared. Fruit crops like mangoes, guavas, cashews, and citrus are also produced in significant and commercial quantities.

Sampling Procedure/Technique

Rice farmers in Qua'an Pan LGA formed the population from which the study sample was obtained. Multi-stage sampling technique was utilized to draw the samples for the study. In the first stage, 6 districts were purposively selected out of the eighth districts. The selection was based on their massive involvement in rice production. They include; Bwall, Kwalla, Kwa, Kwang, Kwande and Namu. Secondly, two (2) villages were selected on random basis from each district giving a total number of twelve (12) villages. Lastly, a selection of 10 rice farmers randomly in every one of the selected villages was done. This gave a total sample size of one hundred and twenty (120) farmers.

Method of Data Analysis

The collected data were analyzed using descriptive statistics (frequencies, percentages and mean), the budgetary method and multiple regression.

The budgetary method used to estimate the profitability of the enterprise is expressed as:

$GM = TR - TVC$
$NI = GM - TFC$

Where
GM = Gross Margin
TR = Total Revenue
TVC = Total variable Cost
NI = Net Farm Income
TFC = Total Fixed Cost

The variable costs were cost of labour, seed, fertilizer, herbicide, transportation while fixed costs were rent on land and depreciation on fixed assets.

The multiple regression model adopted to establish the effects of socio-economic and institutional factors on net production income of farmers is specified implicitly as:

$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_{9+}U)$

Where:
Y = Net production income (profit) (Naira)
X_1 = Age (years)
X_2 = Gender (Dummy, 1 if male, 0 if female)
X_3 = Marriage status (1 married, 0 = otherwise)
X_4 = Family size (number of persons in same house)
X_5 = Educational level (years of formal education)
X_6 = Farm size (ha)
X_7 = Farming experience (number of years in farming)
X_8 = Access to credit (Dummy, 1= yes, 0= otherwise))
$X_9 = X_7$ = Extension Contact (number of times per production season)
U = error term

In order to assess the technical efficiency levels of rice farmers and identify the determinants of technical efficiency, the stochastic frontier production function was used. In explicit terms, it is defined as:

$$\text{Log}Y_1=\beta 0+\beta_1 logX_{1i}+\beta_2 logX_{2i}+\beta_3 logX_{3i}+\beta_4 logX_{4i}+\beta_5 logX_{5i}+Vi-Ui$$

Where:
Y_i = Total yield/output of ith farmer (kg)
X_1 = Quantity of rice seeds planted (kg);
X_2 = Labour (man-days)
X_3 = Farm size (ha)
X_4 = Fertilizer quantity used (kg)
X_5 = Quantity of herbicides used (Litres);
B = coefficient;
V_i = random error
U_i = technical in-efficiency effects

Inefficiency model

The technical inefficiency model (Ui) is expressed as:

$$U_i=\delta_0+\delta_1 Z_1+\delta_2 Z_2+\delta_3 Z_3+\delta_4 Z_4+\delta_5 Z_5$$

Where:
U_i = Inefficiency effect
Z_1 = Age of the respondent (years)
Z_2 = Farming experience (years)
Z_3 = Years of education (years of formal education)
Z_4 = Household size (Number of persons in the family)
Z_5 = Number of extension contact
δ_o = Constant term
δ_1-δ_5= Coefficient.

Results and Discussion

Socio-economic Characteristics of Rice Farmers.

From the result in Table 1, 51.0% of the rice farming population were within 31-40 years, 25.0% were between 41-50 years, 13.0% were between 21-30 years while only 11% were above 50 years. The farmers were on average 40 years old. This implies that young and active people dominated the farming population. Active age implies

increased productivity and enables the farmers engage in other value adding activities like rice processing. Oladimeji and Abdulsalam (2013) stated that workers performance is a function of age because it is believed that age determines the agility and physical strength of the farmers. Sex of the respondents reveals that majority (81.0%) of the rice growers were male while 19.0% were females. It's possible that men predominate in farming of rice because of the labor-intensive nature of rice cultivation which can be incredibly exhausting, chaotic, and time-consuming especially for females who must combine this farming activity with their home responsibilities. This male dominance in rice production could also be explained by the reality that men always have right to land as a productive resource than women. Marital status reveals that greater numbers (83%) of them were married while only 17.0% of them were single. Most married people engage in farming so as to enable them feed their families, which is a common practice. The predominance of married persons has significant implications for family labor as well. This result supports Bamiro and Aloro's (2013) assertion that married people make up the bulk of those employed in the rice industry. Household size shows that 41.0% of the rice cultivators had 6-10 members, 26.0% had family size above 15 persons, 19.0% had household size of 11-15 persons and 14.0% had household size of 1-5 persons. Nine (9) persons make up the mean household size among the rice growers. There is a common belief among many farmers that having more children who would work on the farm would be preferable to employing outside labor. Another explanation for why they have more kids is the polygamous nature of the community, which permits men to marry many wives. The significance of household size in agriculture stems from the belief that it affects the amount of labor available for farm production, the total area cultivated to different crop enterprises, the amount of farm produce retained for domestic consumption, and the marketable surplus (Madu and Aniobi, 2018). Table 1 also shows that 37.0% of the farmers acquired the basic primary education, 23.0% had tertiary education and 21.0% had secondary education while 19.0% of the ice farmers had non-formal education. This result indicates that bulks of the rice cultivators had at least one form of education and are therefore literate. With this level of educational enlightenment, the rice farmers will be more receptive to information from extension agents and other means which will help them in adopting best practices for increased output and rice-harvesting methods that would enhance rice quality. This result discredits the result of Olumba (2014) in Anambra state, where higher numbers of the studied farmers attained only the basic primary education.

Table 1. Rice Farmers' Socio-economic Characteristics (n=120)

	Variable	Frequency	Percentage	Mean
Age	20-30	16	13.0	
	31-40	61	51.0	
	41-50	30	25.0	
	>60	13	11.0	40
Sex	Male	97	81.0	
	Female	23	19.0	
Marital status	Married	100	83.0	
	Single	20	17.0	
Household size	1-5	31	26.0	
	6-10	49	41.0	
	11-15	23	19.0	
	>15	17	14.0	9
Educational level	Primary	44	37.0	
	Secondary	25	21.0	
	Tertiary	28	23.0	
	Non formal	23	19.0	
Farming experience	1-5	12	10.0	
	6-10	47	39.0	
	11-15	31	26.0	
	16-20	23	19.0	
	>20	7	6.0	12
Farm size	0.5-1.0	21	18.0	
	1.1-2.0	60	50.0	
	2.1-3.0	28	23.0	
	>3.0	11	9.0	2.0
Major occupation	Farming	93	78.0	
	Civil servant	12	10.0	
	Business	15	12.0	
Membership of cooperative	Yes	29	24.0	
	No	91	76.0	
Extension contact	Yes	38	32.0	
	No	82	68.0	

Source: Field survey, 2022

On farming experience, a greater number of them said they were into farming for between 6 -10 years representing 39.2% followed by 31.6% having more than 15 years' experience in farming, 19.2% having between 1-5 years while 10.0% had 11 - 15 years farming experience. The respondents had 12 years farming experience on average. This suggests that the farmers had extensive experience in rice farming and might thus be more knowledgeable about how to make maximum use of the little production resources at their disposal in order to ultimately raise their level of output. It is usually expected that farmers' productive capacities and efficiency will increase with their level of agricultural experience. This finding is in agreement with that of Kadiri et al. (2014) who found the mean farming experience of rice farmers to be 17years. About 50% of rice growers had farm sizes of 1.1-2 hectares, 23% had farm sizes between 2.1-3.0 hectares, 18% had farm sizes of 0.5-1.0 while 9% had farm size above 3 hectares.

The rice growers had 2.0 hectares of farmland on average. This suggests that they were small-scale subsistence farmers, the reason they cannot engaging in high levels of production. The mean farm size compares relatively with the finding of Kadiri et al. (2014) who reported a farm size of 2.32 hectares on average amongst rice producers in Nigeria's Niger Delta region. The result also indicates that majority (78.0%) of the farmers' were solely farmers. This means farming was their major means of livelihood. 12.0% were businesses men who also ventured into farming while the remaining 10% of the population of study were civil servants who also practiced farming. This shows clearly that predominantly, the people relied on arable crops farming and rearing of livestock as a means of livelihood and survival. Thus, increasing efficiency and output of rice production would lead to a higher probability of poverty reduction in the area. Majority (76.0%) did not register with any cooperative or farmers' association while the remaining 24.0% were members of farmers association. Through their membership in clubs, associations, or cooperatives, farmers may have access to loans, inputs, and crucial and current information on their farming activities. Also, due to lending institutions' preference for cooperatives over individuals, it is implied that only a small number of farmers will have access to agricultural loan facilities. This result is similar with the findings of Ajah and Ajah (2014) in a research carried out in Abuja, where majority (71.59%) of the farmers did not belong to any cooperative society. About 68% of them did not enjoy any extension visit or contact throughout the last farming season. Only about 32% had an encounter with extension agents. This suggests that many of them might not be aware of recent developments in agriculture and better approaches to boost farm productivity. Access to at least one extension visit is low and can negative effect on the performance of the farmers. Orisakwe and Agomuo (2011) noted that regular interface with extension personnel's motivates and exposes the farmers to innovations.

Rice Production Resources

Information on rice farmers' sources and access to production resources are presented in Table 2. The result showed that majority (78.0%) of the respondent never benefitted from agricultural credit or loan facilities. Only 22.0% of them had access to credit for rice farming. This suggests that most of the farmers source their capital by themselves or from family and friends. Their inability to access financial institutions can contribute to low output because they may not be able to afford inputs that will help them improve on their production capacity. On land tenure, majority (63%) of the respondents acquired their farmlands through inheritance, 28% of the respondents acquired their farmlands through rent, while the remaining 9% acquired their land through purchase. Secured land ownership on permanent basis allows people to adopt desired farming techniques. In addition to being used as collateral, land ownership determines the amount of money that banking institutions will lend. The drawback of most people using inherited land is that it would lead to splitting of farmland due to sharing among siblings thereby lowering the possibility of mechanized agriculture operations. The result went ahead to show that 76% of the farmers' sourced labour from the family members, 13% of farmers depended on hired labour, 6% employed both family and paid labour while 5% sourced their labour through cooperative society means. This implies that family members constituted the predominant labour force. Idrisa et al. (2012) also reported in their study that family labor constituted a significant source of labor for small-scale farmers.

Table 2. Respondents Distribution According to Rice Production Demographics

Variable		Frequency	Percentage	Mean
Access to credit	Yes	26	22.0	
	No	94	78.0	
Land tenure	Inheritance	76	63.0	
	Hired	33	28.0	
	Purchased	11	9.0	
	Communal	-	-	
Source of seeds	Previous harvest	89	74.0	
	Open market	26	22.0	
	Fellow farmers	5	4.0	
	Extension agents	-	-	
Source of labour	Hired labour	16	13.0	
	Family labour	91	76.0	
	Cooperative	6	5.0	
	Hired/family labour	7	6.0	
Type of seeds	Improved seeds	32	27.0	
	Local seeds	88	73.0	

Source: Field survey, 2022

Table 3. Cost and Return analysis Distribution of Rice Production (₦/ha)

Items		Cost/ha (₦)	Percentage
(A) Variable cost	Land preparation	10, 225	7.0
	Sowing	4,17	3.0
	Weeding	7, 367	5.0
	Harvesting	7,162	5.0
	Seed	11,171	8.0
	Fertilizer	67, 925	49.0
	Herbicides	8,792	6.0
	Transportation	11,471	8.0
	TVC	128, 283	
(B) Fixed cost	Land rent	10500	8.5
	Depreciation on farm tools	950	0.6
	TFC	11450	
	Total Cost=TVC+TFC	139733	
(C) Returns	Average yield	699 kg	
	Price/kg	285	
	Total Revenue	199215	
	Gross Margin=TR-TVC	70932	
	Net Farm Income (NFI)=GM-TFC	59482	
	Return on Naira invested (RNI) = NFI/TC	0.42	

Source: Field survey, 2022

Table 2 further shows that 74% of the rice cultivators sourced their seeds from recycled seeds saved from previous cropping season, 22% of the farmers sourced their seeds from the open market while 4% of the farmers source their seed from other farmers. Research indicates that informal sources account for most of the supply of seeds. Certified seeds normally obtained through formal sources of seed supply comprising agricultural extension agents (AEAs), research institutes or direct purchase from agro-input dealers was not reported by the farmers. This raised questions about the caliber of seeds that farmers planted. Table 2 also shows that 73% of the rice farmers' planted local seed varieties while 27% planted improved seed varieties.

This may be because of ignorance, limited or no awareness coupled with the unavailability of the improved rice varieties within the reach of the farmers. With the low level of cultivation of improved varieties, output may be low especially with declining soil fertility and other adverse environmental conditions. This calls for more awareness and sensitization of the farmers on the existence and benefits of improved technologies in rice production. Intervention programmes where inputs are given to farmers at subsidized rate should be extended to the study area thus encouraging most of the farmers to plant improved varieties. This result conforms to the findings of Osanyinlusi and Adenegan (2016) done in Ekiti State in which 30% planted improved variety, 33.1% planted local variety and about 40% planted both improved and local rice varieties.

Analysis of the Cost and Returns of Rice Production

Table 3 shows the analysis of costs and returns of rice production using gross margin analysis on a per hectare basis. The costs (variable and fixed) include all the expenses encountered in the rice production process. These include cost of variable inputs namely, labour (i.e. land preparation, sowing, weeding and harvesting), seeds, herbicides, fertilizer, transportation as well as land rent and depreciation on farm tools which constitute the fixed costs. The Gross margin analysis as presented in Table 3 indicates that the total cost (TC) of farming operation/ha stood at 139733. Out of this, total variable cost (TVC/ha) was estimated at 128, 283 representing 91.3% of the total farming cost, while the estimated total fixed costs (TFC/ha) stood at 11,450 representing 8.7% of the overall cost of production. The average output obtained per hectare was 699kg at a prevailing market/selling price of 285/kg. Thus, the total revenue (TR) measured in naira value of 199, 215 was realized. Gross margin (GM) and net farm income (NFI) stood at 70932 and 59482 respectively. Farmers had a return on investment (ROI) of 0.42, inferring that for each one naira invested, they made 0.42 in profit. This implies that rice farming is viable in the place .It was clear that around 49% of the total amount of money utilized were accounted for by fertilizer's component of the total variable cost. The excessive price put on fertilizer could be reduced through subsidizing of the input by Government to reduce the high cost incurred by farmers. Despite the profit gained, it could be seen that the returns is low which might possibly be due to high cost of inputs especially fertilizer.

Factors Affecting Net Production Income of Rice Farmers

The regression findings of the determinants of rice farmers' net production income are shown in Table 4. To determine the variables influencing net rice production income in the study area, the Ordinary Least Squares (OLS) regression analysis was conducted. The four functional forms investigated were linear, semi-logarithmic, exponential, and double logarithmic. The linear model was adopted because it offered the best fit taking into account the fact that it conformed to *apriori* assumption and had the highest coefficient of multiple determination (R^2) value and highest number of significant variables. The sample data fit the model, and the independent variables are significant explanatory factors of the variation in the predictor (dependent) variable based on

the statistical significance of the F-ratio at 1%. The R^2 was 0.982, signifying that the independent variables accounted for nearly 98% of the overall variation in the reliant (dependent) variable. The findings showed that six of the seven variables, including age, farmers' educational status, farmland size, years of experience in farming, labor, and fertilizer, all had significant influence on rice production at 1% level suggesting a clear relationship between these factors and rice production.

Age (X_1): At 5% level of probability, the age coefficient was negative and statistically significant, indicating a decline in rice production that resulted in a low net production income. In other words, compared to older farmers, younger farmers were more likely to produce more and earn more money from their net production. This could stem from the reality that, as farmers' grows older, their physical capacity to perform farm tasks declines, which lowers productivity and lowers net production revenue. This results conflicts with that of Ohen & Ajah (2020), who reported a positive and significant association between age and rice yield.

Educational status (X_5): The coefficient of educational attainment of the farmer was significant at 1% level and positive. This may be explained to mean that there is higher tendency of adopting better agricultural methods if the farmers acquire higher levels of education, which would increase output and consequently higher income. This result shares semblance with that of Uhuegbulem et al.. (2020), who also found a strong connection between level of education and yield/output. Education equips the farmers with more knowledge in managing farms and the adoption and use of technology and inputs that increase output.

Size of farm (X_6): Size of the farm had a positive coefficient and is significant at 1% level. The significance of this finding is that, an increase in hectares of land will inevitably result in a rise in output and net production revenue. Nwike & Ugwumba (2015) and Ohaka et al.. (2013) also established a positive link between size of farmland and net farm output/revenue.

Farming experience (X_7): At a 1% level of likelihood, the coefficient of farming experience had a positive and statistically significant impact on net production output. Farmers' net income would rise due to increased production output. This is consistent with *apriori* assumptions that more skilled farmers should produce more than those with less or no experience. This result follows the same path with Uhuegbulem et al. (2020), who found that farming experience had a substantial impact on the output of rice crop in the Nigerian state of Ebonyi. However, this finding goes against Osanyinlusi and Adenegan's (2016) who reported that production was inversely correlated with farming experience.

Extension contact (X_9): Coefficient of extension contact had a positive relationship with rice output and income at 1% level of significance indicating that an increase of 1% in extension agent contact will result in an increase of 2.193% in rice output and net production income.

Table 4. Determinants of Net Production Income/ Revenue of the Rice Farmers

Variables	Coefficients	Standard error	T-ratios	P-values
Constant	-171.761.009	22.752.837	-7.549	.000***
Age (X1)	-8.353	3.710	-2.251	.026**
Gender (X2)	-21.980	77.427	-284	.777
Marital status (X3)	-4.584	4.573	-1.002	.318
Family size (X4)	-577.328	936.678	-.616	.539
Educational level (X5)	72.774.160	15.332.025	4.747	.000***
Farm size (X6)	153.161.228	22.847.661	6.704	.000***
Farming experience (X7)	606.806	79.562	7.627	.000***
Access to credit (X8)	-1.119.667	1.15.830	-1.102	.273
Contact with EA (X9)	664.925	87.469	7.602	.000***
R Square	=	.982		
Adjusted R square	=	.981		
F statistics	=	767.886		
Observations	=	120		

***, **= Significant at 1% and 5%

Table 5. Distribution of the Rice Farmers' Technical Efficiency Scores

Technical efficiency range (%)	Frequency	Percentage
<5.0	6	10.0
0.51 - 0.60	11	24.0
0.61 - 0.70	43	30.0
0.71 - 0.80	51	26.0
0.81 – 0.90	7	7.5
0.91 – 1.00	2	2.5
Total	120	100
Mean	0.695	

Source: Field survey, 2022

Table 6. Probability estimates of stochastic production function of rice farmers

Yield	Coefficient	Std Error	Z	P-value
Production factors				
Constant	.1691	.0073	22.86	0.000***
Quantity of seeds (X1)	-.0335258	.0761933	-0.44	0.660
Labour (X2)	.0694385	.0205337	3.38	0.001***
Farm size (X3)	1.019.719	.0740252	13.78	0.000***
Quantity of fertilizer (X4)	.1336197	.0167738	7.97	0.000***
Qntity of herbicides (X5)	-.1405191	.0189234	-7.43	0.000***
Inefficiency Model				
Constant	76.778	58.702	1.31	0.191
Age	-.4063	.2795	-1.45	0.146
Farming experience	-.0291868	.012885	-2.27	0.024**
Educational level	.1254	.1040	1.21	0.228
Household size	.2382	.3503	0.68	0.496
Extension contact	-23.554	.8975	-2.62	0.009***
Variance Parameters				
Sigma squared (σ2)	14.41			
Gama (γ)	0.99			
Log likelihood	92.67			

***and ** = Significant at 1% and 5% respectively

Technical Efficiency Levels of the Rice Farmers

Table 5 displays the distribution of technical efficiency scores among rice growers. The findings indicated that 56% of the farmers operated at technical efficiency levels between 60% and 80%. Roughly 34% of rice farms were below 60% of their technical efficiency. The investigation showed that just 10% of the cultivators operated along the frontier with a technical efficiency of more than 80%. With a mean technical efficiency level of 0.695 inferring that they were technically inefficient in their utilization of resources. This suggests that throughout the production period under investigation, farmers only managed to generate 69.5% of the highest yield possible given the input levels. The rice farmers can increase their output by a reasonably large margin of 30.5% by implementing improved techniques and technology. In comparison to the mean technical efficiency of 0.695 from this study, Oladimeji and Abdulsalam (2013) reported a technical efficiency of 0.65 for rice production in Kwara State, Nigeria.

Technical Efficiency Determinants of Rice Farmers

Table 6 presents the maximum likelihood estimates for the parameters of the stochastic frontier production model for factors influencing the technical efficiency of rice farmers. The magnitude of variable ratio gamma (γ) was determined to be 0.99, indicating that the main sources of errors were systematic impacts that the production function was unable to account for.

This indicates that the model adequately accounted for 99% of the changes in the quantity of rice produced by the farmers. The outcome showed that four of the five production factors—labor, farm size, quantities of fertilizer and herbicide used had statistically significant effects on rice production.

Labour (X_2): The labour coefficient was positively significant at 1% probability level. The interpretation of this finding is that, rice output would increase by 0.069% when man-days assigned to rice plots grow by 1% provided every other condition remained constant. Due to the labor-intensive nature of most rice farming activities, from pre-planting to processing, rice output is comparatively more sensitive to labor usage than other inputs. According to Muhammed-lawal et al. (2009) and Usman (2007), this conclusion is consistent (2011).

Farm size (X_3): At 1% likelihood level, farm size demonstrated a substantial positive association with production output. This suggested that a rise in 1% in arable land would lead to an increase of 1.019% in rice production (Citeris Paribus).

Quantity of fertilizer (X4): The fertilizer coefficient was also significant and positive at 1% level. According to this result, a 1% increase in fertilizer applied to rice plots is linked to a boost in rice being produced of about 0.133%, ceteris paribus. This finding is congruent with those of Emmanuel & Isaac, 2013.

Quantity of herbicides (X_5): The coefficient of herbicides on the contrary was negatively significant at 1% level indicating that, assuming everything else is equal, a 1% increase in the application of herbicide to rice plots would result in a 0.140% decrease in rice yield. This outcome fell short of expectations. The inability of most farmers to understand the right procedure for herbicide application could be attributed to this finding.

Inefficiency

Regarding the inefficiency variables, farming experience and extension visit coefficients were negatively signed and significant. The negative values of technical inefficiency function's parameters' suggest a positive influence on the production or volume of rice that farmers produce inferring that technical inefficiency decreases as the farmers' level of farming experience and extension contact increases. Long-term rice growers are likely to have a greater understanding of rainfall patterns, pest and disease occurrence, and other agronomic practices than newcomers to the industry. Additionally, extension visits to farmers provide them the opportunity to use advised methods in production to increase their level of efficiency. This finding is actually in line with expectations and collaborates the findings of Oumaruo and Zhou (2016) and Djomo et al. (2016) that technical inefficiency declines as farmer experience and access to extension services increases.

Table 7. Distribution of Respondents Based on Rice Production Restraints

Constraint	Frequency	Percentage	Rank
High cost of fertilizer	108	72.0	1st
Inadequate capital	79	53.0	2nd
High cost of labour	33	22.0	5th
Lack of extension contact	64	43.0	4th
Lack of improved seeds	71	47.0	3rd
Pest and diseases	19	13.0	7th
High cost of herbicides	28	17.0	6th

Multiple Responses

Constraints Militating against Rice Production

The constraints to rice production are presented in Table 7. The results shows that excessive prices charged on fertilizer ranked first with 72% followed by inadequate capital (53%), lack of improved seeds (47%), lack of extension support (43%), high cost of labour (22%), high cost of herbicides (17%) and pest and diseases (13%). Fertilizer was the highest cost item accounting for 49% of total cost of production as shown earlier in Table 3. Fertilizer requires high capital and most farmers could hardly afford the needed capital to procure them in order to have good production output. The second significant problem with rice production was a lack of funding for farm operations. The issue was made worse by the inability to access official lending sources due to a lack of collateral. Because farmers lacked access to better seed distributors and extension organizations, they were forced to rely constantly on low-yielding local varieties, which contributed to the scarcity of improved seeds. Poor extension service support contributes to poor productivity as farmers are not exposed to innovations/information on improved farming practices that will boost their productivity. The rural urban drift by young able bodied men and women in search of white collar job is responsible for prohibitive cost of labour in the areas. Given the expensive fares charged for labour associated to the cultivation of rice, money to pay for labour becomes very essential. Despite these difficulties, the farmers nonetheless turned a sizable profit.

Conclusion

The concluded that rice production in Quan' Pan Local Government Area of Plateau State is profitable. The gross margin (GM) and net farm income (NFI) per hectare stood at 70932 and 59482 respectively. The return on investment (ROI) was 0.42 implying that for each one naira committed to rice production, a farmer will make a profit of 0.42. Rice farming in the study area shows growing returns to scale. The mean technical efficiency level of the farmers was 0.695 which shows that on the average, production has been technically inefficient due to influence of significant socio-economic determinants and serious constraints to production. Age, educational status, farming experience, farm size, and extension contact were significant determinants of net rice production income from the study. Labour, farm size, quantity of fertilizer and quantity of herbicides all had significant effects on rice output at 1% likelihood level. The inefficiency factors namely; farming experience and extension visits were all significant and negatively signed. Major constraints to rice production were high cost of fertilizer, inadequate capital, lack of improved seeds and lack of extension support.

Recommendations

The study suggested the following recommendations;

- Access to improved rice seeds varieties, fertilizers and capital at subsidized rates either from government or non- governmental organizations would make the rice enterprise more profitable, efficient and attractive.
- Financial institutions such as the banks and other agricultural agencies should make credit facilities available and affordable to the farmers.
- Rice stakeholders and other research oriented organizations or institutes in Nigeria such as Institute for Agricultural Research should work more on introducing new varieties that will guarantee higher productivity. There is lack of extension support to rice farmers as evidenced in the low extension contact by extension agents.
- The Plateau State Agricultural Development Projects/Programmes should improve extension visits to the rice farmers to educate them on better and efficient methods of rice cultivation so as to boost productivity
- Tractor hiring services should be introduced and subsidized so that farmers can make use of them to increase productivity.

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