

COMPARATIVE PROFITABILITY OF SMALL SCALE RICE PROCESSORS WITH AND WITHOUT ACCESS TO IMPROVED TECHNOLOGY IN NORTH CENTRAL NIGERIA

¹Lawal, A. F, ²Gudugi, A.S.I., ³Paiko, M.A., ¹Bwala, M.A., ¹Sule, B.M., ²Bello, A. M., A. ¹Ubandoma, A. and ²Garba, Y.

¹Department of Agricultural Economics and Extension Services, Ibrahim Badamasi Babangida University, Lapai, Nigeria

²Department of Crop Production, Ibrahim Badamasi Babangida University, Lapai, Nigeria

³Department of Biochemistry, Ibrahim Badamasi Babangida University, Lapai, Nigeria

Corresponding Author's Email Address: lafolorunso@ibbu.edu.ng

Received 15th November, 2022 Accepted 18th December, 2022

ABSTRACT

This study evaluated comparative profitability and profit efficiency of small scale rice processors with and without access to improved technology in North Central Nigeria. A multi-stage sampling technique was adopted for this study. Data were collected through the use of a structured questionnaire from 800 each sampled small scale rice processors with and without access to improved technology making a total of 1600 rice processors in the study area. Data were analyzed using descriptive statistics, budgetary technique, stochastic profit frontier model and F-Chow test statistics. The results indicated that rice processing was profitable for both processors with and without access to improved technology. The significant factors influencing profit efficiency for processors with access to technology were: cost of paddy ($P < 0.01$), quantity of paddy milled ($P < 0.01$), cost of labour ($P < 0.01$), cost of transportation ($P < 0.01$), cost of destoning ($P < 0.01$), cost of polishing ($P < 0.01$), and cost of milling ($P < 0.01$). The significant factors influencing profit efficiency for processors without access to improved technology were: quantity of paddy milled ($P < 0.10$), cost of labour ($P < 0.01$), cost of transportation ($P < 0.01$), and cost milling ($P < 0.05$). The major challenges faced by small scale rice processors with access to technology were: poor credit facilities, inadequate technical know-how, and high cost of labour. The F-Chow test shows that there is significant impact on profit efficiency and profitability of rice processors with access to improved technology. Therefore, the study recommends that training and capital should be made available to small scale processors to improve profitability and profit efficiency.

Keywords: Profitability, Profit Efficiency, Rice Processors, Technology

INTRODUCTION

Rice (*Oryza sativa*) processing is an important part of Nigeria's agricultural sector and has the potential to bring significant value to the country (Obianefo *et al.*, 2023). Rice (*Oryza sativa*) is an important food crop in Nigeria; it is among the major staples and one of the major strategic commodities to Nigeria's economy. Nigeria's demand for rice is about 7.9 million Metric tonnes per year out of which an average of about 2 million metric tonnes are imported; the country spends between \$500 million and \$1 Billion on rice importation per annum since 2002 (RMM, 2017). Therefore, achieving the rice self-sufficiency goal of the government requires changes in the level of production, processing and marketing of rice that meets the quality demand of local consumers. The majority of Nigerians, regardless of ethnic group, rely on rice for their

daily diet (Raheem *et al.*, 2021). Rice processing or milling is a combination of operations that turn paddy into high-quality white rice and is highly dependent on processors' management capabilities (Ibitoye *et al.*, 2014). Small-scale rice processors play a significant role in adding value to the rice supply chain by converting paddy rice into processed rice for consumption. However, the adoption of improved production technology can greatly impact the profitability and efficiency of these processors (FAO, 2019).

Profitability level is a crucial indicator of the financial viability of any business enterprise, including small-scale rice processing units. It is influenced by various factors, including input costs, productivity, market conditions, and the adoption of modern technology. Profit efficiency, on the other hand, measures how effectively a business utilizes its

resources to generate profits. Access to improved production technology can revolutionize small-scale rice processing by enhancing productivity, reducing post-harvest losses, improving quality, and reducing processing time (Afolabi, *et al.*, 2020). These technologies include mechanized threshing, enhanced washing of paddy and soaking of paddy, milling equipment, false bottom parboiling units, milling equipment and efficient drying techniques. By adopting these advancements, processors can streamline operations, increase output, and produce higher-quality rice, which can lead to improved profitability (Onu *et al.*, 2018). Reiteratively, the demand for milled rice has increased significantly in recent years and is expected to increase further in the future. Danbaba *et al.* (2023) reported a milled rice demand of 8 million MT in 2022, compared to the 7 million MT demanded in the previous year. This has confirmed the reports that rice demand in Nigeria increased by 7.8% per annum, while the supply increased by 2.3% (Obianefo *et al.*, 2020). The current level of demand and supply situation of milled rice in Nigeria is very alarming; given the current trends in the rice sector, it is clear that the demand for milled rice will continue to grow, which will also continue to drive prices of rice up, making it increasingly difficult for lower-income families and households to afford basic staples (Obianefo *et al.*, 2023). However, there is a gap in empirical research in examining the comparative profitability and profit efficiency of these processor with and without access to improved technology. This research seeks to provide solutions to this gap by exploring the following objectives of the study:

- (i) identify the socio-economic characteristics of the small-scale rice processors with and without access to improved technology,
- (ii) determine the comparative costs, returns and profitability of small-scale rice processors with and without access to improved technology,
- (iii) analyze the comparative profit efficiency of small-scale rice processors with and without access to improved technology,
- (iv) evaluate the factors influencing profit efficiency of small-scale processors with and without access to improved technology, and

- (v) assess the challenges faced by small-scale rice processors with and without access to improved technology in the study area

METHODOLOGY

Area of Study

The study was conducted in North Central Nigeria which comprises of six states namely, Kwara, Kogi, Niger, Nasarawa, Plateau and Benue states. Niger State, and Nasarawa State were selected for the study. Niger State lies between Latitudes 3° 20' and 7° 40' North of the equator and Longitudes 8° 11' and 11° 2' East of the Greenwich Meridian (Niger State Ministry of Information and communication, 2008). The State shares boundaries in the North with Zamfara, Kebbi States and Federal Capital Territory, Abuja. It also shares common boundary with Republic of Benin at Babana in Borgu Local Government Area in Niger State.

Method of Data Collection

Data used for this study were obtained from primary sources. The relevant primary data was obtained from rice processors in two selected states in the study area. The main instrument for data collection was pre-tested structured interview schedule administered on respondents by trained enumerators under the supervision of the researchers.

Sampling Techniques and Sample Size

The target populations for this study were rice processors in North Central Nigeria. Multi stage simple random sampling technique was used for the study. Two States randomly selected were Niger and Nasarawa State. A cross sectional data was used for the study comprising of 800 rice processors that were exposed to improved rice processors. The processors were grouped into clusters of 40 processors, 10 processing groups were trained in each of the selected states. Furthermore, another set of 800 that were not expose to the improved technologies were selected as well. Therefore, a total of 1600 rice processors were used for the study

Method of Data Analysis

Descriptive Statistics

Descriptive statistics such as frequency distribution, mean, and standard variation were used to capture the socio-economics characteristics of the respondents.

Budgetary Technique

Farm Budgetary Analysis were used to capture costs, returns and profitability ratios of

rice processors. The Budgetary Analysis involved the estimation of net farm income and return on Naira (ROI) invested which was used to determine the profitability of rice processing of respondents with and without access to improved technology. Following Olukosi and Erhabor (1988), the net income was estimated on per week basis as follows: -

$$GM = TR - TVC \dots \dots (1)$$

$$GM = \sum_{i=1}^n P_i Q_i - \sum_{j=1}^n P_j X_j \dots \dots (2)$$

$$NFI = GM - TFC \dots \dots (3)$$

Where,

NFI= Net Profit Income; GM = Gross Margin (₦/unit); TR= Total Revenue Py. Y (₦); P_i = Price Rice in (₦), Q_i = Total quantity of rice (Kg); P_j = Price of Input (₦/Kg); X_j = Quantity of Input Used (Kg/unit), Py = Price per unit output (₦); Y = Total quantity of output (Kg)/unit

TFC = Total Fixed cost per hectare (₦) (Average annual depreciation cost for all input was used)

Financial Analysis: According to Alabi et al. (2020), gross margin ratio is defined as follows:

$$\text{Gross Margin Ratio} = \frac{\text{Gross Margin}}{\text{Total Revenue}} \dots \dots (4)$$

According to Olukosi and Erhabor (1989), operating ratio (OR) is defined as follows:

$$\text{Operating Ratio} = \frac{TVC}{GI} \dots \dots (5)$$

Following Lawal (2008) return on Naira invested (ROI) was obtained as follows:

$$RORI = \frac{NI}{TC} \dots \dots (6)$$

Where,

RORI= Rate of Return per Naira Invested (Units);

NI= Net income (Naira);

TC= Total Cost (Naira).

Decision rule: ROI value should be greater than one for an enterprise to be profitable.

Stochastic Profit Frontier Model

Stochastic profit frontier model was used to estimate profit efficiency values and identify factors determining inefficiency. Productivity of resource use estimate would be calculated from the coefficients of the stochastic profit frontier model. The explicit model form is presented as:

$$\pi_i = f(P_i, \beta_i) \cdot \exp(\epsilon_i), i = 1, \dots, N \dots \dots (7)$$

Where

π_i is the normalized profit obtained by i^{th} rice processors, which is defined as gross revenue obtained less variable cost, divided by farm-specific output price (P_y); P_i is the vector of variable input prices faced by the i^{th} processors divided by output price P_i , and β is a coefficients or vector of parameters estimated, and $i = 1, \dots, n$, is the number of Processors in the sample

The explicit function is stated thus:

$$\ln \pi_i = \beta_0 + \beta_1 \ln P_1 + \beta_2 \ln P_2 + \beta_3 \ln P_3 + \beta_4 \ln P_4 + \beta_5 \ln P_5 + \beta_6 \ln P_6 + \beta_7 \ln P_7 + V_i - U_i \dots \dots (8)$$

Where,

$\ln \pi_i$ = Profit (₦)

X_1 = Quantity of Rice Milled (Kg)

X_2 = Cost of Paddy (₦)

X_3 = Cost of Labour (₦)

X_4 = Cost of Transportation (₦)

X_5 = Cost of Destoning (₦)

X_6 = Cost of Milling (₦)

X_7 = Cost of Polishing (₦)

β_0 = Constant Term

$\beta_1 - \beta_6$ = Parameters Estimated

The Inefficiency Component of the Stochastic Profit Frontier Model is stated thus:

$$U_i = \alpha_0 + \alpha_1 Z_1 + \alpha_2 Z_2 + \alpha_3 Z_3 + \alpha_4 Z_4 + \alpha_5 Z_5 + \alpha_6 Z_6 + \alpha_7 Z_7 + \alpha_8 Z_8 \dots \dots (9)$$

Where,

U_i = Profit Inefficiency Component

Z_1 = Age of Farmers (Years)

Z_2 = Sex (1, Male; 0, otherwise)

Z_3 = Education (Years Schooling)

Z_4 = Processing Experience (Years)

Z_5 = Household Size (Number)

Z_6 = Extension Contact (Number)

Z_7 = Cooperative Association (1, Yes; 0, otherwise)

Z_8 = Credit Access (₦)

α_0 = Constant Term

$\alpha_1 - \alpha_8$ = Regression Coefficients

F-Chow Test Statistics

According to Doughery (2007) and Chow (1960) F-Chow test statistics is often used in determining the equality of error variances in two linear regression equations which is the main restriction assumed in Chow test.

The pooled Regression model is specified as;

$$\pi_{ij} = \alpha + \beta X_{1ij} + \phi X_{2ij} + \epsilon_{ij} \dots \dots (10)$$

If we split the data into two groups, then we have,

$$\pi_{ij} = \alpha_{1ij} + \beta_1 X_{1ij} + \phi_{1ij} X_{2ij} + \epsilon_{ij} \dots \dots (11)$$

$$\pi_{ij} = \alpha_{2ij} + \beta_2 X_{2ij} + \varphi_{2ij} X_{2ij} + \epsilon_{ij} \dots \dots \dots (1)$$

Where,

π_{ij} = Profit from Rice processing with and without

Chow test is an application of the F-distribution test, if F-Chow is greater than the F-table, then there is a significant difference between the profit efficiency of rice processors with and without improved technology or otherwise. The model is specified as follows:

$$F^* - \text{Chow Test} = \frac{RSS - (RSS_1 + RSS_2)/K}{RSS_1 + RSS_2 / [N_1 + N_2 - 2K]} \dots \dots \dots (13)$$

Where,

RSS = Sum of Square Residual from Pooled Data,

RSS₁ = Sum of Square from the rice processors with access to improved technology

RSS₂ = Sum of Squares from rice processors without access to improved technology

K = Total Number of Parameter ,

N₁ , N₂ = Number of Observation in Each Group

Study Hypothesis

$H_0: \beta_{1ij} = \beta_{2ij}$: There is no significant differences of profit efficiency between rice processors with access to improved technology and rice processors without access to improved technology. The main hypothesis in the Chow test is that the coefficient (Profit Efficiencies) are equal for both sub-samples.

RESULTS AND DISCUSSION

Socio-Economic Characteristics of the Small-scale Processors with and without Access to Improved Technology

Table 1 shows the results of the socio-economic characteristics of the sampled scale rice processors with and without access to improved technology. Table 1 depicts that about 32.6% and 24.7% of the rice processors were within the age range of 21-30 years respectively with the average age of the sample rice processors with access to improved technology to be 41 years while those without access to improved technology was 47 years. This results signifies that the rice processors with access to technology and those without were still young, energetic and in their active age of productivity but rice processors with access to technology were more younger than processors without access to improved technology, there was a variance of 6 years between the processors with technology and those without technology, the younger the rice processors the more chances of adopting

improved technology and innovation in rice processing that would lead to increase in profit efficiency level profit. This is contrary with the findings of Obisesan & Salmann, (2017) who reported that processors are 60 years in Ekiti and Ebonyi State, Nigeria. This result is also in consonance with Okello *et al.* (2019) who reported an average age of 38 years for rice farmers and contrary to the findings of Aboaba (2020) who reported the mean age of rice farmers to be 54 years. The results also revealed that majority (92.6%) of the sampled rice processors with access to improved technology were female while majority 81.7% of the sampled rice processors without access to improved technology were also female rice processors, this indicates that majority of the rice processors that had access to technology and without technology were female rice processors. This finding is contrary to the findings of Obisesan & Salmann (2017) who reported that rice processing is mostly carried out by male processors in Ekiti and Ebonyi State, Nigeria. The study also revealed that about 90.5% of the sampled rice processors with access to improved technology were married and 81.3% of those without access to improved technology were also married implying that most of the sampled rice processors had labour supply for rice processing in the study area. Furthermore, the results show that most of the sampled rice processors had some level of formal education. The average household size of the sampled rice processors with access to technology and without access to technology was 6 and 8 members per household respectively. On average processor without access to technology had larger household size than those with access to improve technology with a variance of 2 members per each household. The results revealed that the average length years of rice processing by processors with access to technology and those without access to improved technology was 7 and 12 years respectively. Length of years in rice processing could enable processors to gather enough experience and technical know-how about rice processing which could make them to maximize high profit. This is in line with the findings of Alabi *et al.* (2023). Majority 71.4% of the sampled rice processors with access to improved technology were not members of the cooperative association while majority (61.3%) of the sampled rice processors without access to

improved technology were also not members of the cooperative association. Cooperative association could help processors to come together in order to contribute their resources and pull it in a bulky form that could enable them to have access credit facilities. This is in line with Obisesan & Salmann (2017). The study also revealed that about 86.8% of the processors exposed to technology did not have

access to processing training prior to the study while about 96.9% of responds not exposed to technology had no previous training in rice processing. Thus, any significant difference in profitability and profit efficiency can be attributed to the training acquired during the study. This is line with the findings of Dang (2017) who reported similar results.

Table 1: Socio-Economic Characteristics of the Sampled Small-scale Rice Processors in the Study area

Variables	Rice Farmers with Technology n=800		Rice Farmers without Technology n=800	
	Frequency	Percentage	Frequency	Percentage
Age (Years)				
21 – 30	261	32.6	198	24.7
31 – 40	307	38.4	266	33.3
41 – 50	206	25.8	240	30.0
> 50	26	3.2	96	12.0
Mean	40.6		47.68	
Sex				
Male	59	7.4	146	18.3
Female	741	92.6	654	81.7
Marital Status				
Single	34	4.2	42	5.3
Married	724	90.5	650	81.3
Widow	42	5.2	106	13.3
Education Level				
Quaranic	227	28.4	51	6.4
Primary	190	23.7	143	17.9
Secondary	151	18.9	266	33.3
Tertiary	4	0.47	257	32.1
Adult Education	59	7.4	51	6.4
No Formal Education	169	21.1	30	3.8
Household Size (Number)				
1-5	329	41.1	287	35.9
6-10	404	50.5	257	32.1
11-15	67	8.4	256	32.0
Mean	6		8	
Length of Rice Processing				
1-5	240	30.0	215	26.9
6-10	387	48.4	266	33.3
11-15	114	14.2	42	10.3
>15	59	7.4	236	29.5
Mean	7		12	
Member Cooperative				
Members	285	28.5	310	38.7
Not Member		71.5	490	61.3
Training on Paddy Processing				
With access	106	13.2	25	3.1.9
No access	694	86.813.2	775	96.9
Source of Paddy				
Own Farm	76	9.5	543	67.9
Family Farm	50	6.3	20	2.5
Market		65.8	10	1.3
1 & 3	147	18.4	231	28.9
Total	800	100	808	100

Source: Field Survey Data (2022)

Costs, Returns and Profitability of Small-Scale Rice Processors with and Without Access to Improved Production Technology

Table 2 shows the costs, returns and profitability of rice processors with and without access to improved technology. The results revealed that the total cost of purchasing paddy rice incurred by the processors with access to technology was ₦53,827.61 and those without access to technology was ₦50,920.99. The average total variable cost incurred by the processors with access to improved technology was ₦70,563.26 for those without access to improved technology was ₦60,169.10. The total cost of processing rice incurred by the processors with access to technology was ₦83,901.03 while for those processors without access to technology was ₦68,415.78. The estimated total revenue from the sales of milled rice was for processors with access to improved technology was 200,000 while for processors without access to technology was ₦140,000. The study show that the estimated gross margin obtained by the processors with access to technology was ₦116,098.97 for those without access to improved technology was ₦71,584.22.

The net profit obtained by the processors with access to technology access to improved technology was ₦102,761.94 while those processors without access to improved technology obtained ₦62,486.67. The financial analysis revealed that the estimated gross margin ratio for processors with access to technology was 0.4 while those processors without access to technology was 0.51, the operating ratio estimated was 0.35 and 0.51 respectively with the estimated rate of return on investment for processors with access to improved technology and those without was 1.22 and 0.91 respectively. The value of rate of return on investment 1.22 and 0.91 implies that every 1 naira invested in rice processing by processors with access to technology and without access to improved technology yields 1.22 kobo and 0.91 kobo respectively. This concur with findings of Inuwa *et al.* (2011) who reported rice processing as a profitable enterprise in Kano, Nigeria. The study is also in line with the findings of Dang (2017) who also reported significant level of profit in rice processing in Vietnam.

Table 2 Average Costs, Returns and Profitability of Rice Processors with and without Access to Improved Technology

Variables	Rice farmers with Technology			Rice farmers without Technology		
	Average Value (₦)/bag	Financial Ratios	Proportion (%)	Average Value (₦)/bag	Financial Ratios	Proportion (%)
Variable Cost						
Cost of paddy	53,827.61		0.64	50,920.99		0.74
Cost of Tarpaulin	4,764.48		0.06	3,456.65		0.05
Cost of Labour						
Cost of Parboiling	1,115.29		0.01	1,215.58		0.02
Cost of soaking	1,195.66		0.01	1,095.21		0.02
Cost of drying	1,587.28		0.01	1,287.59		0.02
Cost of bagging	691.76		0.01	591.54		0.08
Total	4,590.23		0.05			
Cost of Transportation	901.83		0.01	750.67		0.01
Milling operation cost	1,127.69		0.01	850.87		0.01
Cost of Destoning	349.48		0.004	****		****
Cost of Polishing	411.95		0.004	****		****
Total Variable Cost	70,563.26		0.84	60,169.10		0.88
Fixed Cost						
Depreciation on Equipment	9,837.77		0.12	6,440.32		0.09
Interest on capital	3,500.00		0.04	2,657.23		0.04
Total Fixed Cost	13,337.77		0.16	9,097.55		0.13
Total Cost	83,901.03			68,415.78		
Total Revenue	200,000.00			140,000		
Gross Margin	116,098.97			71,584.22		
Net Profit	102,761.94			62,486.67		
Gross Margin Ratio		0.47			0.51	
Operating Ratio		0.35			0.51	
RORI		1.22			0.91	

Source: Field Survey Data (2022)

Distribution of Profit Efficiency Score among Small-scale Rice Processors with and without Access to Improved Technology

The summary distribution of the profit efficiency score of the sampled rice processors with and without access to improved technology is presented in Table 3. The results depict that profit efficiency varies between the sampled rice processors with and without

access to improved technology. The average profit efficiency for processors with and without technology were 85.3% and 63.7% respectively. This study is in line with the findings of Dang (2017), Ahmed and Melesse (2018) who reported profit efficiency of 75.6% and asserted that rice processors profit efficiency falls below 100% with some inefficiencies that needs to be filled up with technology and innovation

Table 3 Distribution of Profit Efficiency Scores Among Rice Processors with and without Technology

Profit Efficiency Score	Profit with Technology		Profit without Technology	
	Frequency	Percentage	Frequency	Percentage
0.21-0.4	316	21.1	134	8.9
0.41-0.6	385	25.7	1000	66.7
0.61-0.8	168	11.2	173	11.5
0.81-1.00	631	42.1	193	12.9
Minimum	0.111		0.021	
Maximum	1.00		0.9320	
Mean TE	0.8534		0.6361	

Source: Field Survey Data (2022)

Estimates of the Factors Influencing Profit Efficiency among Small-scale Rice Processors with and without Access to Improved Technology

Table 4 presents the results of the maximum Likelihood estimates of the factors influencing profit efficiency of the small-scale rice processors with and without access to technology, the first stage of the stochastic profit frontier function show that the statistically significant factors influencing profit of rice processing for small-scale rice processors with technology were: normalized cost of paddy, quantity of rice milled, normalized cost of labour, normalized cost of transportation, normalized cost of milling, normalized cost of polishing, and normalized cost of destoning. The coefficient of normalized cost of paddy rice for both processors with access to improved technology and without show that processors with technology (0.098625) and was statistically significant at ($P < 0.10$) probability level, it was not statistically significant for processors without access to technology. Quantity of paddy rice processed determines the level of profit that processors will make. This agrees with findings of Obianefo (2023) and Obisesan *et al.* (2023).

Normalized cost of labour influence profit level positively for both processors with access and without access to improved technology and it was statistically significant at

($P < 0.01$) and ($P < 0.10$) respectively. The coefficient of the normalized cost of labour was 0.015692 and 0.02263 for processors with access and without access to improved technology respectively. This implies that percentage change in the cost of labour for processors with access improved technology will result in increase in profit level by 1.5% while percentage increase in the labour supply for processors without technology will result in the increase in profit by 2.3%. Labor supplied by household could reduce the cost of hiring labour thereby increasing profit efficiency. This is in line with the findings of Obisesan *et al.* (2017) who reported that labour supply has a significant effect on influencing profit efficiency in Ekiti and Ebonyi States, Nigeria. Normalized cost of transportation has a negative influence on the profit level of the processors with access to improve technology and positive influence for the processors without access to technology and it was statistically significant for both processors with access and without access to improved technology. The coefficient of transportation was -0.13354 and 0.1396 respectively implying that as transport cost increases by one percent it will result in the decrease in the profit inefficiency level of the rice processors by 1.3% and increase in the profit inefficiency of the rice processors without access to technology by 1.4%. This agrees with the

findings of Obisesan *et al.* (2017) who reported increase in profit efficiency of rice processing due to increase in transportation. This is so because as transport fee increases the processors would also increase the price of milled rice thereby increasing the level of profit efficiency in rice processing. The normalized cost of milling was also statistically significant at ($P<0.01$) and ($P<0.05$) and it influence the profit level of the process positively for both processors with access and without access to improved technology. The magnitude of the coefficient of cost of milling was 0.3420 and -0.1288 respectively implying that a percentage change in the cost of milling rice will result in the increase in the profit level of the processors with access to technology by 34.2% and decrease in the profit level for processors by 12.9%. The normalized cost of destoning influence profit level for processors with access to technology, the coefficient of normalize cost of destoning was 0.141898. This implies that percentage change in the cost of destoning will result in the increase in profit of rice processors with access to technology by 14.2% and it was statistically significant at ($P<0.05$) probability level.

Normalized cost of polishing influence profit level of rice processors positively and it was statistically significant at ($P<0.01$) probability level. The coefficient of normalize cost of polishing for processors with access to technology was 0.28019 which signifies that percentage change in the cost of polishing will result in the increase in the profit level of rice processors by 28%.

The profit inefficiency component revealed that the factors influencing profit inefficiency were Age of the processors the estimated coefficient of age was statistically significant for rice processors with access to improved technology at ($P<0.01$). The coefficient of age was -0.1673 implying that a unit change in the age of processors with access to improved technology will result in the decrease in profit inefficiency (increase in profit efficiency) of processing by 16.7% for processors with access to improved technology. Age has a significant effect on rice processing as age increases experience in rice processing also increases which was accumulated over the years and it could lead to increase in profit efficiency in rice processing enterprise. The estimated coefficient of sex influence profit inefficiency positively for both processors with

access to improved technology and it was statistically significant and it was statistically significant at ($P<0.01$) probability level. the magnitude of the coefficient sex implies that a unit change in sex meaning a processor being a male will result in the increase in the profit inefficiency by 4.5% and 5.3% respectively. Education level of the sampled rice processors influence profit inefficiency negatively for processors with access to technology and positively for rice processors without access to technology. The coefficient of education was -0.04548 and 0.0448 respectively implying that a unit change in the level of education will result in the decrease in profit inefficiency level for processors by 4.5% and increase in the profit inefficiency for processors without access to technology. Experience in rice processing influence profit inefficiency negatively for processors with access technology and was statistically significant at $P<0.01$ probability level. The coefficient of processing experience -0.08273 implies that a unit change in the level of experience in rice processing will result in the decrease in profit inefficiency or increase in profit efficiency by 8.3%. Experience helps processors to be equipped by technical know-how due to accumulated experience over the years. This is in contrary with the finding of Dang (2017) who reported positive influence on processing experience with rice profit efficiency in Vietnam. Household size estimates has positive influence on the profit inefficiency for processors with access to improved technology. The estimated coefficients of household size for both processors were 0.2219 and -0.0991 respectively implying that a unit change in the number of persons per households will result in the increase in inefficiency for processors with access to technology and decrease in profit inefficiency by 9.9% for rice processor without access to technology in the study area. The implication of this could be that for processors with access to technology the household members may not be available for rice processing may be most of the members are school children or below the age of productivity. This is in line with the finding of Obianefo (2023) who reported that household size has a positive influence on rice processing in Anambra State, Nigeria.

Extension contact had negative influence on the profit inefficiency of the rice processors with access to improved technology

and was statistically significant at ($P < 0.10$) probability level. The coefficient of extension contact was -0.084223 signifying that a unit change in the access to extension services by the rice processors with access to technology will result in the decrease in profit inefficiency by 8.4%. Access to extension services could enable processors to be trained on modern system of rice processing using machines and other implement that could ease human labour in rice processing. Cooperative association was only significant for processors without access to technology at ($P < 0.01$). The coefficient of the cooperative association was -0.04847 implying that a unit change in chance of the rice processors without technology will result in the increase in the profit efficiency (decrease in inefficiency) of rice processing by 4.8% in the study area. Cooperative association enables the processors to have access to resources that could make them more efficient

in rice processing. This is contrary to the findings of Asrat, (2019) who found positive association with inefficiency. Access to credit facilities influence profit inefficiency for both processors with access to technology negatively and was statistically significant at ($P < 0.01$). The coefficient of access to credit was -0.064454 and -0.0122487 respectively. This implies that a unit change in the access to credit will result in the decrease in the profit inefficiency (increase in efficiency) by 6.4% and 1.2% for both processors with access to improved technology and without respectively. Access to credit plays a vital role in any business enterprise by enabling them to be able to purchase the needed equipment and the paddy that is used in the processing business. This is in line Yusuf (2022) who reported significant relationship between profit efficiency and access to credit in rice production in Kwara State.

Table 4: Maximum Likelihood Estimates of the Stochastic Profit Frontier of Small-scale Rice Processors with and without Technology

Variable	Processor with Technology			Processors without Technology		
	Coefficients	Std Error	Z-Score	Coefficients	Std Error	Z-Score
Cost of paddy	0.09862*	0.022055	4.44	-0.04644	0.069131	-0.67
Quantity of paddy milled	0.02637*	0.001899	13.89	0.073654***	0.044293	1.66
Cost of labour	-0.01569*	0.002599	-6.04	0.022637*	0.005904	3.83
Cost of transportation	-0.01335*	0.001153	-11.15	0.043587*	0.013968	3.12
Cost of destoning	0.141894*	0.066519	-2.17	*****	*****	*****
Cost of polishing	0.280190*	0.088231	3.18	*****	*****	*****
Cost of milling	0.342041*	0.021321	16.04	-0.12886**	.0642346	-2.01
Constant	-2.22459	0.6757967	-3.29	1.34523***	0.00345	1.97
Inefficiency Model						
Age	-0.16731*	0.05251	-3.18	0.05014	0.04482	1.12
Sex	0.045476*	0.00736	3.43	0.05330***	0.03142	1.70
Education	-0.04547*	0.00736	-3.43	0.04486***	0.02699	1.66
Experience	-0.08273*	0.00934	-8.85	0.13177	0.22376	0.59
Household Size	0.221942**	0.92956	2.38	-0.09907*	0.01346	-7.36
Extension Contact	-0.084223***	0.04495	-1.87	-0.00020	0.00021	-0.97
Cooperatives association	-0.003174	0.03453	-0.92	-0.04847*	0.00661	-7.33
Credit Access	-0.064454*	0.00736	-8.75	-0.01224*	0.002513	-4.85
Diagnostic Statistics						
Log likelihood	16.892077			-61.7366		
Sigma square	0.0035067			0.1037081		
Gama	0.0153923			0.0101026		

Source: Field Survey Data (2022)

*Significant at the 1%, ** Significant at the 5%, *** Significant at the 10% Probability Levels

Constraints Faced by Small-scale Rice Processors with Access to Improved Product Technology

The constraints faced by small scale processors is presented in Table 5 for rice processors with access to improved

technology. The results show that majority 95.8% of the smallscale rice processors with access to improved technology were faced with poor access to credit facilities as the main challenge in rice processing and it was ranked as 1st. About 95.3% of the processor that has access to improve technology encountered inadequate technical know-how as a problem

and was ranked as second 2nd most severe constraint while 91.6% of the rice process encountered attitude towards technology adoption. The results also revealed that about 83.9% of the sampled rice processors with access to improved technology were faced with inadequate market infrastructure as a challenge and it was ranked 4th in the order of

severity by the rice processors. This result is in consonance with the findings of Obianefo *et al.* (2023) and Akinniran *et al.* (2020) who reported poor market information, poor storage facilities high cost of processing equipment and inadequate market infrastructure as a major challenge in rice processing in Nigeria.

Table 5: Constraint Faced by Rice Processors with Access to Improved Technology in the Study Area

Constraints Faced by Processors With Technology	Frequency	Percentage	Rank
Poor Credit Facilities	766	95.8	1 st
Inadequate technical-knowhow	762	95.3	2 nd
Processor attitude towards adoption	732	91.6	3 rd
Inadequate market infrastructure	671	83.9	4 th
High Cost of Labour	631	78.9	5 th
High cost of processing equipment	526	65.8	6 th
Poor Storage facility	533	66.7	7 th
Inadequate market price information	500	62.6	8 th
Access to market and bad road	446	55.8	9 th
Extension contact	252	31.6	10 th
Total	800	100	

Source: Field Survey (2022)

Constraints Faced by Small Scale Rice Processor without Access to Improved Technology

Table 6 shows the constraints faced by small scale rice processors without access to improved technology in the processing activities, the results revealed that majority (99%) of the sampled rice processors reported poor access to credit as the major constraint encountered in the course of rice processing and

was ranked 1st. More so about 97.4% of the processors reported Inadequate market price information as the challenge faced in rice processing while 96.0% of the respondents encountered inadequate fund as the most important constraints to rice processing as reported by the processors in the order of severity. This result is in conformity with the findings of Ampadu-Ameyaw *et al.* (2017) and Sennuga *et al.* (2021).

Table 6: Constraint Faced by Rice Producers Without Access to Technology in the Study Area

Constraints Faced by Farmers	Frequency	Percentage	Rank
Poor Credit Facilities	792	99.0	1 st
Inadequate market price information	779	97.4	2 nd
Inadequate fund	775	96.9	3 rd
High Cost of Labour	756	94.5	4 th
Lack of Extension Services	621	77.7	5 th
Access to market and bad road	548	68.5	7 th
Farmers attitude towards adoption	616	77.0	8 th
Total	800	100	

Source: Field Survey Data (2022)

Chow Test Result to Determine the Difference between Rice Producers with and without Access to Improved Production Technology in the Study Area.

The results of Chow-test are presented on Table 7. The residual sum of square for pooled sample was 4213.754, while the residual sum of square for processors with access to technology was 6925.306 and that of processors without access to improved technology was 3357.988 with calculate F* Value of 23.44 and the Table F-Value of 3.365. In the Chow test, if

there is no significant statistical difference between two sub-samples (i.e., if $\sigma_i^2 = \sigma_R^2$), then the regression test statistic in Equation (13) follows an F(K, T-2K) distribution. However, if the test statistic (F*) is greater than the respective F-statistic at 5% level of significance (as shown in this study), the null hypothesis should be rejected. Consequently, the relevant conclusion is that the sub-samples are significantly different. This was the statistical evidence which justifies the decision to estimate separate models for the sub-samples.

The coefficients of the rice processors with access to technology were more significant than those without access to technology.

Table 7: F-Chow Test Outcome

RSSP	RSS1	RSS2	F*	F(K, T-K) at 5% significance level	Decision
4213.754	6925.306	3357.988	23.44	3.365	There is Significant Impact on Profit Efficiency and Profitability of Rice Processors with Access to Improved Technology in the Study Area

Source: Field Survey Data (2022)

SUMMARY, CONCLUSION AND RECOMMENDATIONS

The study concludes that rice processors with access to improved technology has higher profit, and profit efficiency level. Processors with access to improved technology obtained significant return on investment than those without access to improved technology. The mean profit efficiency obtained by processors with access to improved technology was 85.3% while processors without access to improved technology obtained 63.6% which implies that processors with access to improved technology were more efficient than those without improved technology. The statically significant factors influencing profit efficiency for processors with access to improved technology were cost of paddy, quantity of paddy, cost of labour, and cost of destoning while the factors influencing the profit efficiency for processors without access to improved technology were quantity milled, cost of labour, cost of transportation and cost of milling. Therefore, the study recommends the following policy implications: Certain measures should be taken in order to reduce the technological gap such as access to training about technology and capital utilization, milling machine and destoning should be provided to processors with access to improved technologies, extension services should also be provided to small scale rice processors on the improved rice processing, processors should be encouraged to join cooperative organizations for them to have access to credit facilities in order to have the ability to adopt rice processing technologies which will in turn increase their processing capacity that might lead into increase in profit and efficiency that could improve their household livelihood and welfare in the study area.

ACKNOWLEDGMENTS

The study was conducted with funding from Tertiary Education Trust Fund of Nigeria (TETFund) through the National Research Fund Grant. The authors appreciate TETFund for this support. We also thanked the management of Ibrahim Badamasi Babangida University (IBBU) Lapai, Nigeria that provides the enabling environment that supports the completion of the project.

REFERENCES

- Aboaba K. O. (2020). Economic efficiency of rice farming: a stochastic frontier analysis approach. *J. Agribus. Rural Dev.*, 4(58), 423–435. <http://dx.doi.org/10.17306/J.JARD.2020.01377>
- Afolabi, J., et al. (2020). Analysis of Profitability and Technical Efficiency of Rice Processing among Small-Scale Rice Processors in North Central Nigeria. *International Journal of Agricultural Economics*, 5(1), 22-36.
- Akinniran, T.N., Faleye, G.R. (2020) Economics Analysis of Rice Production and Processing in Nigeria (1981-2019). *Int. J. Agric. Environ Bioresearch*. 5, 113-132.
- Alabi O.O., Safuga, G.F.&Aluwong J.S. (2023). Cost Efficiency and Profitability Analysis of Rice (*Oryza sativa*) Production among Smallholder Farmers in Federal Capital Territory, Nigeria. *Australian Journal of Science and Technology* 7(1):1-9
- Ampadu-Ameyaw, R., Omari, R., Owusu, E.G (2017). Development and Analysis

- of Rice Value Chain for Hohoe and Jasikan Districts of the Volta Region, Ghana. *FARA Res. Result* 1, 1-48
- Ahmed M.H, Melesse KA (2018). Impact of Off-farm Activities on Technical Efficiency:Evidence from Maize Producers of Eastern Ethiopia. *Agric Food Econ* 6(1):3–13
- Asrat, A.A., (2019). Analysis of profit efficiency among smallholder Maize Producers (evidence from DamotPulsa District, Woliata Zone Ethiopia) *International Journal of Economics and Business*.
- Chow, G.C. (1960). Test of Equality Between Sets of Coefficients in Two Linear Regression *Econometrica*, 28 (3):591
- Danbaba, M. Nigeria Can Be Self-Sufficient in Rice in 8 Years. National Accord. 2023. Available online: <https://www.nationalaccordnewspaper.com/nigeria-can-be-self-sufficient-in-rice-in-8-years-if-research/> (accessed on 19 January 2023)
- Dang, N.H. (2017). Profitability and Profit Efficiency of Rice Farming in TRA Vinh Province, Vietnam. *Review of Integrated Business and Economics Research* 6(1):191-201
- Dougherty, C. (2007). *Introduction to Econometrics* Oxford University Press, 2007.
- FAO. (2019). Small-Scale Rice Milling and Processing in Nigeria: Opportunities and Challenges. Food and Agriculture Organization of the United Nations.
- Ibitoye, S.J.; Idoko, D.; Shaibu, U.M. Economic Assessment of Rice Processing in Bassa Local Government Area of Kogi State, Nigeria. *Asian J. Basic Appl. Sci.* 2014, 1, 8–17
- Inuwa, I.M., Kyiogwom, S.U.B Ala, A.L., Maikasuwa, M.A and Ibrahim, N.D (2011). Profitability Analysis of Rice Processing and Marketing in Kano State, Nigeria. *Nigerian Journal of Basic and Applied Sciences*. 19(2): 293-298
- Obianefo, C.A. Ezeano, C.I., Isibor. C, A. &Ahaneku, C.E. (2023). Technolog Gap Efficiency of Small-scale Rice Processors in Anambra State, Nigeria. *Sustainability*, 15, 4840. 1-22
- Obianefo, C.A.; Nwigwe, C.A.; Meludu, T.N.; Anyasie, I.C. Technical efficiency of rice farmers in Anambra State value chain development program. *J. Dev. Agric. Econ.* 2020, 12, 67–74.
- Obisesan, O.O., Salmann, K.K. &Akintayo, (2017). Analysis of Profit Efficiency Among Rice Processors in Ekiti and Ebonyi States, Nigeria. *RJOAS* 3(63): 1-6
- Okello, D.M. Bonabana-Wabbi, J. &Mugonola, B. (2019). Farm Level Allocative Efficiency of Rice Production in Gulu and Amuru Districts Northern Uganda *Agriculture and Food Science* 7(9) :1-19
- Olukosi, J. O and Erahbor, P. O., (1988). *Introduction to Farm Management Economics: Principles and Applications*. Agitab Publishers, Zaria.
- Olukosi, J.O. & P.O. Erhabor (1989). *Introduction to Farm Management Economics: Principles and Applications*, Zaria, Nigeria: Agitab Publishers Limited
- Onu, F. S., et al. (2018). Impact of Parboiling Technology Adoption on Profitability of Small-Scale Rice Processors in North Central Nigeria. *International Journal of Agricultural Management and Development*, 8(3), 347-355.
- Raheem, D.; Dayoub, M.; Birech, R.; Nakiyemba, A. ‘The Contribution of Cereal Grains to Food Security and Sustainability in Africa: Potential Application of UAV in Ghana, Nigeria, Uganda, and Namibia’. *Urban Sci.* 2021, 5, 8

Sennuga, S.O., Adeniran, B.T., Olorunnniyi, A.A. (2021). Assessment of the Constraints Associated with the Proccessing of Paddy Rice: A. Case Study of Smallholder Farmers in Gwagwalada, Abuja. *J. Curr. Trends Agric. Environ. Sustain.* 2, 1

Yusuf, T.M. 2022). Profit Efficiency of Small-scale Rice Farms in Patigi Local Government Area of Kwara State, Nigeria. *International Journal of Innovative Research and Advanced Studies* 9(1): 1-9.