Comparative economic analysis of rice parboiling systems in Niger State, Nigeria

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Abstract: The study examined the comparative economic analysis of rice parboiling systems in Niger State, Nigeria. Stratified random sampling method was used to select 60 and 10 rice processors from traditional and improved systems respectively. The study was also to identify major inputs used for rice parboiling systems, determine and estimate cost and returns in the rice parboiling systems, identifying factor hindering the adoption of improved systems in the study area. The data were collected from primary source with the aid of standard questionnaire. The data collected were analysed using descriptive statistical tools, gross margin and Cob-Douglas production model. The result of the analysis indicated that parboiling is done mostly by women, who parboiled between one- three bags per day. In the improved systems, firewood and labour were found to be significant at 1% and 5% and gross margin of ₦ 4,633.50 per batch and traditional systems, firewood was significant at 10% and has ₦ 839.73 gross margin per batch of parboiled rice. The improved systems had capacity of 250kg-1000kg per batch while the traditional had capacity of 75kg-100kg per batch. The study concluded that rice processing with improved technologies is profitable in the study area.

Keywords: Comparative; Economic; Analysis; Parboiling; Systems

1. Introduction

Rice production occurs in all agro-ecological zones in Nigeria with the middle belt enjoying a comparative advantage in production over the other parts of the country. Production is primarily by small-scale producers, with average farm size of one –two hectares. Yield per hectare is low due to production systems, aging, farming population and low competitiveness with imported rice (Daramola, 2005). In Nigeria, rice supplies 6% of total per capita calorie consumption (IRRI, 1994), and its production occupies about one point seventy-seven million hectares of Nigeria's arable land, ranking sixth after sorghum (four million ha), millet (three point five million ha), cowpea (two million ha), cassava (two million ha) and yam (two million ha), Central Bank of Nigeria (CBN, 2003). Rice quality issues have become very important among Nigeria consumers who clearly show stronger preference for imported rice, because of high quality in terms of cleanliness, (WARDA, 2003). This has often been viewed as reflecting the competitiveness of imported rice when compared to locally produced rice. Existing low quality of local rice, reflecting low levels of improved parboiling technology, can hinder efforts to achieve progress in raising output to meet consumers' demands. With the difficulties encountered by farmers and processors in Nigeria for developing and adopting improved technologies due to resource inefficiency, poverty has become a very significant factor in increasing productivity, (Ali and Chaudry, 1990). The major challenge of rice production and marketing in Nigeria, therefore, lies in the development of appropriate technology for rice post harvest handling especially rice parboiling systems or operations. If complete parboiling systems cost and returns of locally produced rice is known, it will be easy to identify the source of quality problems in locally produced rice. Rice production, processing and marketing in the country contribute to food security, job creation, poverty reduction and national productivity. For instance, the economic impacts of rice production and processing in terms of income and employment are at five main levels: production, processing, marketing, food vending and external (import) trade levels. Rice cultivation is increasingly generating employment for new farmers, while established farmers are diversifying into rice cultivation instead of traditional crops and tree crops, such as cocoa and rubber, for which prices have been largely unpredictable for several years. Income and employment in rice processing have also been substantial (Akpokodje et al.,2001).

The specific objectives were to: identify major inputs used for rice parboiling systems in the study area, determine the cost and returns in the traditional and improved rice parboiling systems, and identify the factor militating against adoption and expansion of improved rice parboiling system.

2. Methods

2.1 Study area

Niger State, is located between latitudes 8°11' and 11° 20' N and longitudes 4° 30' and 7° 15' E of equator. It covers an estimated area of 4,240km^2 square. The mean rainfall ranges between 800 and 1000mm. The average annual number of rainy days ranges between 187 to 220 days. The rains start late April and end in October with the peak being in July. The dry season lasts for about six months of the year from November to April making it favourable for agro-processing. The average minimum temperature is about 26 °C while the average maximum temperature is about 36 °C. The mean relative humidity ranges between 60% (January to February) and 80% June to September). The state falls within the guinea savannah vegetation belt. This vegetation supports the cultivation of root crops and grains. The predominant crops are rice, sorghum, millet, yam, groundnut and cotton, National Cereals Research Institute (NCRI, 1997). This justifies the election of the study area.

2.2 Data collection

To achieve the objective of the study, data collected through primary and secondary sources. This was through personal interviews with the selected rice processors using designed structure and unstructured questionnaires. The data was collected based on the batch or capacity of each rice parboiling systems.

2.3 Sampling method

Zone one of Niger State, Nigeria comprises of seven local government areas out of which five were selected, these includes Agaie, Bida, Gbako, Katcha and Lavun LGAs were purposively selected for the study. Two villages each from three Local Government Area (total six villages) were randomly selected for a total of 6 villages for traditional system. These are Badeggi and Egbanti in Katcha LGA, Edozhigi and Gbangba in Gbako LGA, Doko and Chanchaga in Lavun LGA, were selected. In each village, 10 traditional parboilers were randomly selected from the list of the processors in the areas. These give a sample size of 60 processors for traditional systems. While the 10 improved systems chosen for comparisos were from Bida, Doko, Agaie and Badeggi respectively.

2.4 Data analysis

Data collected were analysed using simple descriptive statistics such as tables, percentage and average. Cost and returns of the parboiling systems were also determined.

Cobb-Douglas production function model was used to determine the resources used efficiency in the parboiling systems. The choice of the model was based on the previous studies by Shwetha et al. (2011). The ordinary least square method was used for estimating the parameters associated with different independent variables, the model is specified as follows:

$$Y=a\cdot x_2^{b1}\cdot x_2^{b2}\cdot x_3^{b3}\cdot x_4^{b4}\cdot d^{b5}$$

Where y = output from batch of parboiled rice, a = constant, x_1= cost of paddy rice /batch of parboiling, x_2= cost of firewood /batch of parboiling, x_3= cost of labour/batch of parboiling and x_4=cost of water used/batch of parboiling, d= dummy.

Cobb-Douglas production function was used for both rice parboiling system and gross margin (GM) analysis was used to determine the difference between the total revenue and total variable cost for the parboiling system.:

$$GM=TR-TVC$$

Where GM is gross margin, TR is total revenue and TVC is total variable cost.

Net income (NI) or profit is the difference between the gross margin and total fixed cost of the rice parboiling system:

$$NI=GM-TFC$$

Where NI = net income and TFC = total fixed cost.

$$\pi = TC - TR \text{ the same as}$$

$$\text{Profit=Total cost} - \text{Total revenue}$$

Where π=profit, TC= Total cost and TR=Total Revenue

3 Results

3.1 Major inputs used for rice parboiling

The major inputs used for rice parboiling systems besides the parboiling equipment included paddy rice, drying slab, firewood, water, labour, transportation, wheel barrow. Others included buckets, barrels, rakes and sieves.

Table 1 shows the estimates of regression of the improved rice parboiling systems. The results of the Cobb-Douglas production function were fitted to find out the relationship between the output of paddy and the independent variables, also supported by (Nandhini et al., 2006). Firewood, labour and paddy found to be significant at 1 and 5% respectively. Baba et al. (2009) in their studies also confirmed that Paddy rice cost dominated the processing cost with processors spending more on paddy. However, quantity and quality of paddy may have effects on the cost and income.

The coefficient for the cost of firewood and labour showed that 1% and 5% increase in expenditure from its mean level would have negative effect on output or income. This indicated that increase in the cost of firewood and labour will have negative effect on income. The cost of water may not have effect on the income. Though the quantity and quality of water may affects the quality of the product thereby has effect on the income.

The coefficient of multiple determinations R^2 of the function was 0.579, which indicated that 57.9% of the variation in output was explained by the independent variables included in the model.

Table 1. Estimates of regression of the improved rice parboiling system. * Significant at 5%, ** significant at 1%.

Variables	Notation	Regression Coefficient	Standard Error	T-value
Intercept	A	10.48	28.38	0.369
Qty of paddy	X1	4.2	0.58	7.267
Cost of Firewood	X2	4.6*	0.263	-2.985*
Cost of water	X3	7.8	0.433	-1.592
Cost of labour	X4	8.303**	0.489	2.800**

Table 2. Regression estimates of traditional parboiling system. * Significant at 10%.

Variables	Notation	Regression coefficient	Standard error	T-value
Intercept	A	20.98	40.07	0.523
Qty of paddy kg	X^1	0.0028	0.007	2.173
Cost of Firewood	X^2	-0.260*	0.027	-1.923*
Cost of water	X^3	0.209	0.031	1.484
Cost of labour	X^4	-0.217	0.017	-1.673

Table 2 shows regression estimates of the traditional rice parboiling systems. Firewood used for traditional parboiling system was found to be significant at 10% level, while water and labour used for parboiling were found to be non-significant. The co-efficient indicated that increase in the cost of firewood by 1% would ceterious paribus results in 26% decrease in income without commensurate increase in the quantity of paddy from its mean level. Water and Labour cost was found to be non-significant. This indicates that water and labour did not have much influence on output or income in the sampled processors of rice in the study area. The cost of water is negligible, since majority of the sampled processors had sources of water supply, it is the quality and quantity of water used that affects the quality of the product and income.

The co-efficient of multiple determinations R^2 of the function was 0.500, which indicated that 50.0% of the variation in income or output was explained by three independent variables included in the model.

Gross margins can be used in evaluating various farm situations such as comparing different farms or processing methods, estimating farm profit and loss, calculating costs of production and assisting in making investment decisions (CIMMYT 1998). The gross margin from improved system (₦4633.5) was higher than that of traditional system (₦989.73). This may be due to adoption of improved technologies such as packaging and branding of the product, despite that it add to the cost of production the branded product can be sale at a fixed price The results indicated that the use of improved parboiling systems is more profitable than the traditional rice parboiling systems as confirmed by Aderibigbe(1997).

The result in table 4 indicated that improved system (250 kg) handled more quantity of rice conveniently at a time than the traditional system (75 kg). This is supported by Onu and Edom (2009), Shwetha et al. (2011). The benefits of improved rice processing technology include greater quantity of processed paddy in a single batch, and processing time by half and improved quality of the product. Improved system performed some operations such as cleaning with water before soaking, tempered before milling, de-stoning and grading. This is not practiced in traditional system thus resulting in breakages and grain quality contamination. Improved system soaked for 6 hours, because of hot water used while the traditional system takes 24 hours which causes fermentation giving odour to the milled rice The parboiling time is shorten in the improved systems given a high turnover and quality improvement than the traditional systems. Soaking and steaming in the improved system takes 6 hours and 35 minutes while that of the traditional system takes 24 hours and 60 minutes respectively. Improved systems used hot water at the temperature of 70 °C which accelerate quick and uniform water absorption, but traditional system soaked at the ambient temperature, therefore it takes between 24-36 hours to obtain 30% moisture content required in the grain.

Table 3.Gross margin per batch of improved and traditional rice parboiling systems.

Inputs	Improved Systems(₦)	Traditional systems(₦)
Paddy rice	15,360	5120
Firewood	1005	335
Labour	1506	147.67
Water	450	57.5
Transportation	631.5	100
Packaging	360	-
Total Variable Cost (TVC)	19,366.5	5,760.27
Fixed Cost (FC)	549,975	25,150
Revenue	24,000	6750
Quantity Kg/batch	250 kg	75kg
Output kg/batch	156kg	52kg
Adjusted output kg/batch	150kg	50kg
Selling price/Measure	8000	220
Total Revenue (TR)	24,000	6750
Gross Margin (GM)	4,633.5	989.73

Table 4. Summary data on operations of improved and traditional rice parboiling systems.

Parameters	Improved Systems	Traditional Systems
Optimum Capacity (kg)	250	75
Batches/day	3	3
Cleaning operations (Minutes)	45	-
Soaking (hours)	6	24
Steaming (Minutes)	45	60
Drying (hours)	5	6
Tempering (hours)	10	-
Moisture content before milling (%)	14	14
Milling (minutes)	35	25
De-stoning (minutes)	25	-
Grading (minutes)	27	-
Bagging (minutes)	20	15

However, the following were identified in the study as improved technologies for adoption by processors; acquisition of improved rice parboiler, wet-cleaning of paddy rice before soaking, soak paddy using warm or hot water, steaming at regulated time and observed paddy for optimum steaming, spread on a concrete slab or tarpaulin at 2cm thick and turned at intervals, avoid continuous and rapid drying of parboiled paddy on the sun, temper before milling and maintaining hygienic or sanitary condition during paddy parboiling operations.

A Processor scored 1 for each of these technologies that he/his adopts, and zero otherwise. A technology adoption index for individual processor was developed as the proportion of improved methods he/she adopted out of the total package recommended. For instance, if a farmer adopted 6 out of the 8 recommended technologies, his/her technology adoption index would be 0.6. Adoption indices of individual processor were regressed against some socioeconomic characteristics using OLS technique. The OLS regression equations is $A = y^0 + y^1 k^1 + y^2 k^2 + y^3 k^3 + \dots + y^n k^n + hi$

Where y = technology adoption index, k^1 = age of processor in years, k^2 = education in number of years spent in schools, k^3 = years of rice processor experience, k^4 = income from the previous year's rice processing activities, k^5 = household size, k^6 = number of contacts with extension agent per cropping season, k^7 = membership of cooperative society (1 for member, 0 otherwise), k^8 = amount of credit used (in naira).

The choice of these variables (k^n) was based on the findings of previous studies on technology adoption (Nkonya et al., 1997; Manyong et al., 1999), which identified these variables as significant factors affecting agricultural technology adoption in developing countries.

Table 5. Major factors militating against adoption of improved parboiling system.

Factors	Frequency	Percentage
Lack of credit facilities	12	17.11
Poor infrastructures	11	16.08
Lack of awareness	12	17.04
High cost of equipments	13	19.06
Lack of technical knowledge	10	14.26
Low capital	12	16.45
TOTAL	70	100

Table 5 indicating some the factors affecting adoption of improved parboiling systems, high cost of the available machineries beyond the reach of the farmers was identified with 19.06%. Lack of credit facilities and collaterals demanded by the financial institutions was a major factor. Other factors identified in the study includes, lack of awareness of the improved technologies by the processors, poor infrastructure facilities was a major factor hindering the adoption of improved systems also, since these improved technologies required them for proper functioning. Low capital among the processors and lack of technical no how was among the factors militating adoption of improved system in the study.

4 Conclusions

The findings of the study revealed that traditional rice parboiling system is commonly practiced in the study area, although there were few improved parboiling systems. Improved rice parboiling system has higher capacity than the traditional system and is more efficient, though under-utilized due to scarcity of raw material (paddy rice) during off-seasons. Many factors such as lack of credit facilities, poor rural infrastructures, lack of awareness and technical know-how, lack of cheap improved processing machines were identified as factors militating against the adoption of improved rice parboiling systems in the study area. However, the problems facing processors are: lack of homogeneity arising from assembling rice stocks from different producers, mixtures of many varieties in batch processing with inclusion of pebbles, stones, sands and other contaminants. Secondly, high cost of parboiling rice representing 65%-75% of total processing costs. Despite all the factors highlighted above rice parboiling business or enterprise still holds bright prospects in the study area.

With the numerous problems identified militating against the adoption of improved rice parboiling system in the study area, it will be very imperative to make appropriate recommendations that could enhance improvement in the adoption and use of improved rice parboiling system. These recommendations are [i] credits should be provided at low interest rate to prospective rice processing individuals or cooperatives through agricultural financing institutions such as Agricultural Bank, commercial banks and micro-finance banks at the right time with simple collateral; [ii] government should intensify efforts in the provision of rural infrastructures in the rural areas for easy accessibility and distribution of farm and processing products; [iii] the use of extension workers in the rice processing cluster should be intensified by government both at state and local government levels to keep the processors abreast with new technologies; they should also be enlightening on the importance of forming cooperative societies since through cooperative it will be easy for them to acquire loan and machineries; [iv] the government should develop a clear policy towards rice processing sector with consistent implementation; [v] provision of tax incentives for rice processing factories; [vi] research and development institutions should be better funded and directed towards research into appropriate, small scale and affordable rice processing machinery; [vii] the government should promote local rice products to enhance demand and prices; and, finally, [viii] capacity of the rice processors should strengthen with skills and entrepreneurial training.

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