Comparison of Technical Efficiency across Scale of Paddy Processing in Adamawa State, Nigeria

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Abstract:- **This study analyzes technical efficiency across small, medium and large scale paddy processors in Adamawa State, Nigeria. Multi-stage sampling techniques was employed to select one hundred and sixty respondents with the aid of well-structured questionnaire. Data Envelopment Analysis (DEA) was used to analyze the data collected. On average, the large scale was adjudged the most efficient processors, then the medium scale, while the small scale was found to be the least efficient processors. Results further show the presence of both managerial and scale inefficiency in the small scale paddy processing, while the medium and large scale paddy processing both harbor only scale inefficiency with no evidence of managerial inefficiency. In terms of scale efficiency, on average, the small scale processors are more efficient, followed by the large scale processors, while the medium scale processors are the least efficient. The return to scale assumption indicates that 100% of the processors in both medium and large scale operate at increasing returns to scale, while in the small scale, 91% and 9% of the processors operates at increasing and decreasing returns to scale respectively. Up-scaling and down-scaling of paddy processing are recommended to curb the menace of scale inefficiency. On the other hand, good management practices such as choice of kernel size, ensuring maturity of kernels and imbibing modern parboiling skills among others will help curb the menace of managerial inefficiency. These remedial measures will together enhance frontier paddy processing in Adamawa State.**

Keywords: **Paddy, Processing, Parboiling, Milling, Efficiency**

I. INTRODUCTION

Rice has become the most essential staple food and the most common cereal food crop in Nigeria (Akpokodje *et al.*, 2001) widely consumed in most parts of the world, especially in Asia and the West Indies (Alizadeh and Rahmati, 2011**).**In Nigeria, rice is one of the cereal grain whose consumption has no cultural, religious, ethnic or geographical boundary (Isa *et al.*, 2013). The importance of milled rice to the national economy cannot be overemphasized, as it has become fashionable industry for small and large scale paddy processing that has a great contribution to the economy of the country. The enterprise has assumed greater significance in improving the employment opportunities and standard of living in the country. Efficient utilization of processing resources is a critical requirement for attaining self-sufficiency in rice production and processing, particularly in low income countries where resource constraints are extremely necessary. Akaeze (2010) stated that one of the major problems in paddy processing is the appearance and the cleanliness of the rice delivered to the market. While the milling technology has a great influence on the technical performance, it is recognized that these attributes are greatly affected by the attention given to pre-milling and post-milling operations. Most parboiling is performed by small scale paddy processors some become overcooked causing it to burn, discolor and break when milled. Against this backdrop, assessment of the technical performance vis-à-vis resource endowment deserves special attention for any radical transformation in the paddy processing sub-sector of the economy. Accordingly, this study seeks to compare the technical efficiency in small, medium and large scale paddy processing in the study area given various production technologies in use aimed to improving quality of paddy processing in addition to minimize input bundle for optimal output bundle.

II. METHODOLOGY

Area of Study

The study was conducted in Adamawa state; it is one of the 36 states in Nigeria, located at the North-East geopolitical zone of the country with twenty-one (21) local Government Areas. The area has three senatorial zones, namely: Adamawa North, Adamawa Central, and Adamawa South. Adamawa state has a total area of 39,742.12 square kilometers and a population of 3,161,374 people comprising of 1,580,333 males and 1,581,041 females (NPC, 2006). The annual growth rate of Nigeria's population is 3.2%, while, Adamawa state grows at 2.8% annually. Based on the 2.8% growth rate for the state, Adamawa is estimated to have reached 4,489,641 inhabitants in 2019. The State lies between Latitude 8.00^0N and 11.00^0N of the equator and Longitude 11.50^0E and 13.50^0E of the Greenwich meridian. Mean annual rainfall ranges from 700mm to 1000mm and mean monthly temperature ranges from 26.7^0C to 27.8^0C (Adebayo, 1999). The state has many ethnic groups who live in segmented communities speaking different languages and dialects, but English is the official language. Agriculture is the major economic activity in the state. Food crops grown include; rice, maize, sorghum, yam, sweet potato and cassava and some vegetables, while cash crops such as groundnuts, cowpea, cotton and sugar cane are also produced in large quantities. Livestock reared in the area are cattle, sheep, poultry, goats and pigs.

Sampling Techniques

Multi-stage random sampling technique was employed for the selection of one hundred and sixty (160) respondents and it includes three stages; first stage involved stratified sampling; used to categorize the study area into four strata based on ADP zones (zone 1 to 4). The second stage involved purposive sampling technique; used to select two local government areas each in zone 1, 2, 4 and three LGA in zone 3 based on availability of rice processing activities. Similarly, purposive sampling techniques was used again in stage 3 to select wards within the selected LGA. Lastly, a non-proportionate simple random sampling was used in stage 4 to select 18 processing units in each of the nine LGA selected. Thus, a total 162 respondents (processing firms) were served with questionnaire for this study, but only 160 questionnaires were duly completely, hence used in the analysis of this study.

Analytical Techniques

Data Envelopment Analysis (DEA) is technique for evaluating the performance of a set of peer entities called Decision Making Units (DMUs). DEA allows a lot of flexibility in the definition of DMUs. DEA has gained wide applicability as an analytical tool in research. Both public and private institutions, across industries, adopted DEA for internal and external benchmarking and thus identifying areas of inefficiency as well as potential for improvement (Ottawa *et al.*, 2012). Farrell, (1957)treated the production frontier on the basis of efficiency assessment, Charnes *et al.* (1979) described a mathematical programming formulation for the empirical evaluation of relative efficiency of a DMU on the basis of the observed quantities of inputs and outputs for a group of similar reference DMUs. Banker *et al.* (1984) provided a formal link between DEA and estimation of efficient production frontiers via constructs employed in production economics. Bokusheva and Hockmann (2006) stated that technical efficiency is attained when the best available technology is used. It therefore implies that the output shows a discrepancy with the level of technology utilized by the processing unit. The DEA model is one of the widely applied estimators of technical efficiency in the field of Agriculture both in developed and developing economies of the world. Research such as Batteseand Coelli(1992), Batteseand Coelli (1995), (Brazdik (2006), Javed *et al., (*2008) and Rahman (2011)all revealed significant inefficiency and the prospective measures to improve the agricultural productivity.

Model Specification

Farrell (1957) argued that measuring productive efficiency of every firm is important to both the economic theorists and the economic policy makers. The DEA involves the use of linear programming. The basic DEA analysis requires two choices of formulation: choice of orientation and choice of envelopment surface. The choice of orientation or focus of analysis is possible through the maximization of outputs or minimization of inputs or no orientation. The choice of envelopment surface is possible as constant return to scale CRS (conicalhull) or variable return to scale VRS (convexhull) (Lovell, 1993). In this study Technical Efficiency (TE) is calculated by using the input-orientation DEA model which is a well-known and widely used model. This study aims to know how much inputs can be minimized to produce the same level of output. Following Coelli *et al. (*1998) an input oriented variable return to scale DEA model for technical efficiency can be defined as

$$\text{Max } \Phi, \lambda\ \Phi, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Subject to $-\Phi y i + Y\lambda \geq 0$

$xi - X\lambda \geq 0$

$N'\lambda = 1$

$\lambda \geq 0$

where;

Y represents an output of milled rice for N processing unit,

Φ represents the output technical efficiency score having a value $0 \leq \Phi \leq 1$,

X represents an input matrix for N processing unit,

λ is an Nx 1 vector of weights which defines linear combination of the peers of i^{th} processing unit,

y_i represents the total paddy processed of the i^{th} processing unit,

x_i denotes the input vector of the i^{th} processing unit,.

X_{1i} represents paddy per kg of individual processors on the i^{th}processing unit,

X_{2i}indicates cost of labors used on the i^{th} processing unit,

X_{3i}cost of firewood, fuel, diesel and various spare part the i^{th} processing unit,

X_{4i} cost of water per litter on the i^{th} processing unit

X_{5i}cost of transportation for the i^{th} processing unit

X_{6i}cost of milled rice,

Scale Efficiency (SE)

Based on the results of the TE scores, scale efficiency measure of each processing unit can be calculated simply as follows:

$$SE_i = TE_{i_{CRS}} / TE_{i_{VRS}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where;

SE = 1 implies scale efficiency and

SE < 1 implies scale inefficiency.

However, this scale efficiency measure cannot indicate whether the processors were operating at increasing or decreasing returns to scale. This can be captured by running an additional DEA problem with Non-Increasing Return to Scale (NIRS). Therefore, the return to scale analysis can be one by altering the DEA model in equation (2) by replacing the $N1/\lambda = 1$with $N1/\lambda \leq 1$, to provide;

$$\text{Max } \Phi,\lambda\ \Phi, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

$$\text{Subject to } -\Phi y_i + Y\lambda \geq 0$$

$$x_i - X\lambda \geq 0$$

$$N'\lambda \leq 1$$

$$\lambda \geq 0$$

The scale inefficiencies (increasing or decreasing returns to scale) can be revealed by showing whether the NIRS TE score is equal to the VRS TE score. If the NIRS TE score is equals to 1 or the same with VRS TE score, it indicates an increasing return to scale. However, if the scores are not the same, it is decreasing return to scale. Note that the constraint $N'\lambda \leq 1$ means the ith firms cannot be captured which are larger than1, but it may becompared with firms smaller than it (Yuyu and Hye-Jung, 2015).

III. RESEARCH HYPOTHESES

To achieve the objectives of this research, hypothesis was formulated for the study and stated in null form as below:

(i) **H_0** There is no significant difference in TE of paddy processing in the study area.

This hypothesis is extended to cover various TE assumptions or decompositions. Thus, resulting to 10 different hypotheses as depicted in table 1.

Test of Hypothesis (T-Test) for Mean Differences between Five Assumptions in Paddy Processing

Table: 1 presents t-test results to determine whether statistical significant difference in mean exist between technical efficiency scores. Based on variable return to scale (TE_{VRS}) and constant return to scale (TE_{CRS}) in terms of mean score and standard deviation of the variables, the results revealed that the TE_{VRS} (0.5403 ±0.2099) is higher than TE_{CRS}(0.2002±0.1953). This further shows a mean difference in efficiency score by 0.3401 which falls within its lower limits (0.2955) and upper limits (0.3847) of its 95% confidence interval. It can be seen that the group means are statistically significantly different given a t-value (15.0012) and two- tailed p-value (0.0000) is less than 0.05. Therefore, the null hypothesis of no mean difference is rejected. Thus, there is statistically significant variation in Technical Efficiency scores between constant return scale and variable return to scale assumptions in paddy processing. From table below all the T- test are rejected except TE_{CRS} and TE_{NIRTS} with P > 0.05.

Table 1: Hypothesis (T-Test) for the Statistical Mean Difference between Output-Oriented Technical Efficiency Indexes

	Mean score & STD	Mean dif.Score	T-Value	P- Value	Hypothesis
1	$TE_{VRS} > TE_{CRS}$	0.3401	15.0012	$P<0.05$	Rejected
2	$TE_{VRS} > TE_{NIRTS}$	0.3400	14.0012	$P<0.05$	Rejected
3	$TE_{VRS} > TE_{SE}$	0.1783	7.1862	$P<0.05$	Rejected
4	$TE_{VRS} < TE_{RTS}$	-0.4596	-27.6913	$P<0.05$	Rejected
5	$TE_{CRS} < TE_{NIRTS}$	-0.0001	-0.0023	$P>0.05$	Not rejected
6	$TE_{CRS} < TE_{SE}$	-0.1618	-6.7306	$P<0.05$	Rejected
7	$TE_{CRS} < TE_{RTS}$	-0.7997	-51.7902	$P<0.05$	Rejected
8	$TE_{NIRTS} > TE_{SE}$	-0.1618	-6.7257	$P<0.05$	Rejected
9	$TE_{NIRTS} > TE_{RTS}$	-0.7997	-51.7342	$P<0.05$	Rejected
10	$TE_{SE} < TE_{RTS}$	-0.6379	-34.6081	$P<0.05$	Rejected

Source: Computed from Field Survey (2018)

Technical Efficiency in Small Scale Paddy Processing

Table 2 presents result of input-oriented technical efficiency index for the sampled small scale paddy processors. On average, the small scale paddy operators process at 84.6% and 87.9% efficiency under CRS and VRS assumptions respectively; this further implies 15.4% and 12.1% inefficiency levels based on CRS and VRS orientation. Inefficiency level signals unease situation which need to be tackled. The implication for this is that, given the present processing technology, the small scale paddy processors can on average withdraw input supply by 15.4% and 12.1% and still process the same level of output (milled rice) under the CRS and VRS orientations respectively. This is in accordance with Luke *et al.* (2012) who estimated mean TE = 85.9% and 80.9% for VRTS and CRTS respectively; with a range between 54% and 100% as minimum and maximum TE scores. The technical efficiency range under CRS and VRS orientation indicates that there is a wide variation in efficiency of processed milled rice by the small scale paddy processors.

This may possibly be attributed to many factors which may include; the variety of paddy, and kernel size. This agrees with Ume *et al.* (2016) in similar study, estimated TE scores range between 0.24% and 0.95% as minimum and maximum respectively; depicting wide variation also.

It is noteworthy that the VRS estimate contains more fully efficient (frontier) processors (21) than the CRS estimate (17), higher mean TE scores (VRS= 87.9%, CRS = 84.6%). TE range (VRS = 59.3% to 100%, CRS = 54.1% to 100%). These higher performances or estimates of VRS over CRS is in tandem with theory; the envelopment surface of the CRS is tighter than that of VRS, thus allowing lower estimates of the CRS relative to VRS. The table further shows 19.4% of the firm operates at optimal scale, while 80.6% operates at sub optimal level.

Table 2: Distribution of Technical Efficiency of Small Scale Paddy Processors

TE Ranges	VRS Freq (%)	CRS Freq (%)	NIRTS Freq (%)	SE Freq (%)	RTS Freq (%)
Very Low 0.0000-0.2500	00 (00)	00 (00)	00 (00)	00 (00)	00 (00)
Low 0.2501-0.5000	00 (00)	00 (00)	00 (00)	00 (00)	00 (00)
High 0.5001-0.7500	7(7.32)	21 (22.58)	21(922.58)	1(1.08)	00 (00)
Very High 0.7501-0.9999	65(69.90)	55(59.14)	55(59.14)	74(79.57)	8(8.60)
Fully Efficient 1.0000	21(22.60)	17(18.28)	17(18.28)	18(19.36)	85(91)
Total	**93**	**93**	**93**	**93**	**93**
Minimum	0.5928	0.5413	0.5413	0.7597	0.9331
Maximum	1.0000	1.0000	1.0000	1.0000	1.0000
Mean	0.8785	0.8462	0.8485	0.9627	0.9975
STD	0.0955	0.1043	0.1056	0.0456	0.0101

Source: Computed from Field Survey (2018)

The table also shows 96.3% mean scale efficiency (SE) with a range between 76% and 100%. The SE level is therefore high. However, comparing the SE scores with VRS scores in line with Padilla and Nuthall (2012) helps to under the sources of inefficiency in the sector. Thus, on average, the SE estimated here (SE= 96.3%) is higher than the TE_{VRS} (TE_{VRS}= 87.9%). Padilla and Nuthall (2009) asserted that when SE score is higher than VRS score, managerial problem exists, otherwise problem in scale of production; hence, managerial problem exists. Furthermore, problem of scale also exist since the mean SE is less than 100%. Thus, from the foregoing, it can be seen that the small scale paddy processing in the study has both managerial and scale problems. Similarly, 91% of the processors process at Increasing Returns to Scale (IRS), while 9% process at Decreasing Returns to Scale (DRS). Thus, the DRS processors need to scale down processing activities where applicable and ensure good management practices such as employing proper modern parboiling skills and machine, consideration for kernel size and its maturity and examination of output (milled rice) in the milling centers to enhance frontier processing.

Technical Efficiency in Medium Scale Paddy Processing

Table 3 presents result of input-oriented technical efficiency index of the sample medium scale paddy processors. It shows on the average, the paddy processors are 23.1% and 91.6% efficient under CRS and VRS assumptions respectively; further implies 76.9% and 8.4% inefficiency status. The implication for this is that, given the present processing technology, the medium scale paddy processors can on an average get rid of input supply by 76.9% and 8.4% and still process the same level of milled rice under the CRS and VRS assumption respectively. All attention should be centered on the levels of inefficiency in the medium scale paddy processing. The TE range under CRS and VRS assumption are from 45.9% to 100% and 59.7% to 100% respectively. Under both assumption, the TE range is observed to have wide variations among the processors. This wide variation in TE may be attributed to many factors such as: variety of paddy, chalkiness, immature kernel and size of the kernel.

Terry *et al.* (2009) reported that the broken rice produced during milling are generally as a result of immature, chalky, or fissured kernels, all of which are weak and typically break during milling due to the substantial forces impacted on kernels in order to remove bran and drastically reduced milling yield (output). They further opined that any factor that causes a reduction in the strength of kernels, and the resultant ability of kernels to withstand the forces exerted during hulling and milling, will impact milling quality and quantity. These factors include those incurred during production, such as fungal diseases and insects, and as recently documented, high nighttime air temperatures during kernel filling. The VRS estimate contains more efficient processors (10) than the CRS estimated (1) with a higher mean TE scores (VRS= 91.6%, CRS = 23.1%) and a narrower; TE range (VRS = 59.7% to 100% CRS = 4.6% to 100%. These higher performances or estimates of VRS over CRS is in tandem with theory which states that, the envelopment surface of the CRS is higher than the VRS, thus allowing lower estimates of the CRS relative to VRS.

The table also shows that 2.3% of the firm operating at optimal scale with 95.5% operates at sub optimal level. The table also show a mean scale efficiency (SE) = 24.8% with a range between 4.7% and 100%. The SE level is therefore not high, but comparing the SE scores with VRS scores in line with Padilla and Nuthall (2012) it helps to under the sources of inefficiency in the sector. Thus, on an average, the SE estimated here (SE= 24.8%) is not higher than the TE_{VRS} (TE_{VRS}= 91.6%). Padilla and Nuthall (2009) asserted that when SE score is higher than VRS score, managerial problem exists otherwise problems of scale in production. Based on the foregoing, the medium scale paddy processing in the study has serious scale problem. Note also that all (100%) the medium scale processors process under increasing return to scale. There is need to increase processing activities and ensure high-quality skillful practices; like modern parboiling system, skillful labor and machine, kernel size, maturity and proper examination of output milled rice in the milling centers for processing to be improved.

Table 3: Distribution of Technical Efficiency of Medium Scale Paddy Processors

TE Ranges	**VRS** **Freq (%)**	**CRS** **Freq (%)**	**NIRTS** **Freq (%)**	**SE** **Freq (%)**	**RTS** **Freq (%)**
Very Low 0.0000-0.2500	00 (00)	00 (00)	00 (00)	00 (00)	00 (00)
Low 0.2501-0.5000	00 (00)	00 (00)	00 (00)	00 (00)	00 (00)
High 0.5001- 0.7500	3(6.82)	2(4.55)	2(4.55)	1(2.27)	00 (00)
Very High 0.7501- 0.9999	31(70.46)	41(93.20)	41(93.20)	42(95.50)	00 (00)
Fully Efficient 1.0000	10(22.73)	1(2.27)	1(2.27)	1(2.27)	44 (100)
Total	**44**	**44**	**44**	**44**	**44**
Minimum	0.5972	0.0459	0.0456	0.0466	1.0000
Maximum	1.0000	1.0000	1.0000	1.0000	1.0000
Mean	0.9158	0.23110	0.2311	0.2480	1.0000
STD	0.0993	0.2209	0.2209	0.2173	0.0000

Source: Computed from Field Survey (2018)

Technical Efficiency of Large Scale Processors

The result of input-oriented technical efficiency index of sampled large scale paddy processors is displayed in Table 4. The pure technical efficiency (TE_{VRS}) and the mean overall technical efficiency (TE_{CRS}) is 94.5% and 86.8% respectively. This means that the large scale paddy processors are 5.5% and 13.2% inefficient based on VRS and CRS assumption respectively. The implication for this is that, given the present processing technology, the large scale paddy processors can on an average remove input supply by 5.5% and 13.2% and still process the same level of milled rice under the VRS and CRS orientation respectively. Inefficiency levels are undeniably the most important aspects to be considered in paddy processing. The TE range, under VRS and CRS is 37.5% to 100% and 12.0% to 100% respectively under both assumption, The TE range are wide, indicating wide variations in the processed milled rice by the large scale paddy processors. This somewhat wide variation in milled rice may be attributed to many factors which may include among others; modern processing facilities, inadequate capital, variety of paddy processed and size of the kernel. VRS estimate contains higher TE scores than the CRS (VRS= 94.5%, CRS = 86.8%) and a narrowerTE range (VRS = 37.5% to 100% CRS = 12.0% to 100%. These higher performances or estimates of VRS over CRS is in tandem with theory; the envelopment surface of the VRS is higher than the CRS, thus, allowing lower estimates of the CRS relative to VRS.

The table further shows that 43.4% of the firms operates at an optimal scale while, 66.6% operate at sub optimal level. The table also shows mean scale efficiency (SE) of 90.7% with a range between 20.6% and 100%. The SE level is therefore high, but comparing the SE scores with VRS scores in line with Padilla and Nuthall (2012) helps to understand the sources of inefficiency in the sector. Thus, on average, the SE estimated here (SE= 90.7%) is not higher than the TE VRS (TE_{VRS}= 94.5%).

Table 4: Distribution of Technical Efficiency of Large Scale Paddy Processors

TE Ranges	VRS Freq (%)	CRS Freq (%)	NIRTS Freq (%)	SE Freq (%)	RTS Freq (%)
Very Low 0.0000-0.2500	00 (00)	00 (00)	00 (00)	00 (00)	00 (00)
Low 0.2501- 0.5000	00 (00)	00 (00)	00 (00)	00 (00)	00 (00)
High 0.5001- 0.7500	2(8.70)	2(8.70)	3(13.04)	3(13.04)	00 (00)
Very High 0.7501- 0.9999	20(86.96)	11(47.83)	9(39.13)	10(43.48)	00 (00)
Fully Efficient 1.0000	1(4.35)	10(43.48)	11(47.83)	10(43.48)	23 (100)
Total	**23**	**23**	**23**	**23**	**23**
Minimum	0.3753	0.1203	0.1203	0.2058	0.9003
Maximum	1.0000	1.0000	1.0000	1.0000	1.0000
Mean	0.9451	0.8679	0.8723	0.9066	0.9957
STD	0.1522	0.2544	0.2559	0.2177	0.0208

Source: Computed from Field Survey (2018)

Padilla and Nuthall (2009) asserted that when SE score is higher than VRS score, managerial problems exist otherwise problems of scale in production. Thus, from the foregoing, it can be seen that the large scale paddy processing in the study has mild scale problem; which may be attributed to problem of chalkiness and milling facilities, noted that 100% of the processors process under increasing return to scale level while, none process at decreasing return to scale. This calls for scaling up of processing activities to ensure good management practices like parboiling skills and milling machine, consider kernel size and its maturity and examination of milled rice in the milling centers to enhance frontier processing. The study further presents the technical efficiency in paddy processing based on pooled data (small, medium and large scale). Figure 1, 2, 3,4 and 5 shows the distribution of technical efficiency using pooled data (DMU = 160) for VRS, CRS, NIRTS, SE and RTS assumptions respectively.

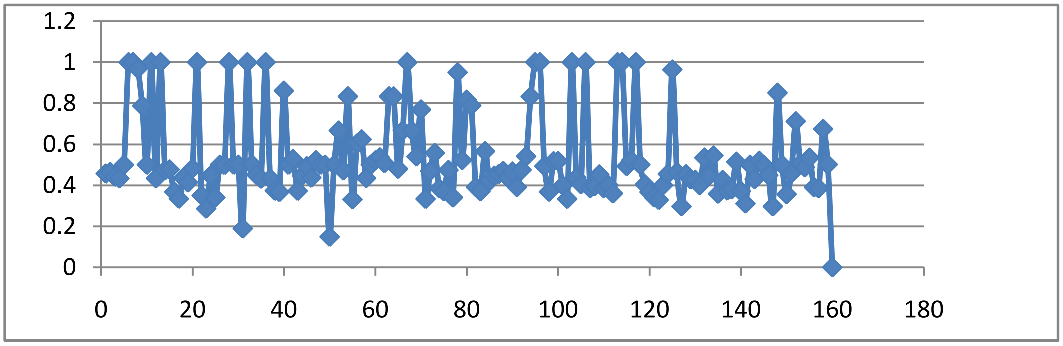

Figure 1: Technical Efficiency scores (VRS) based on pooled data of all paddy processors

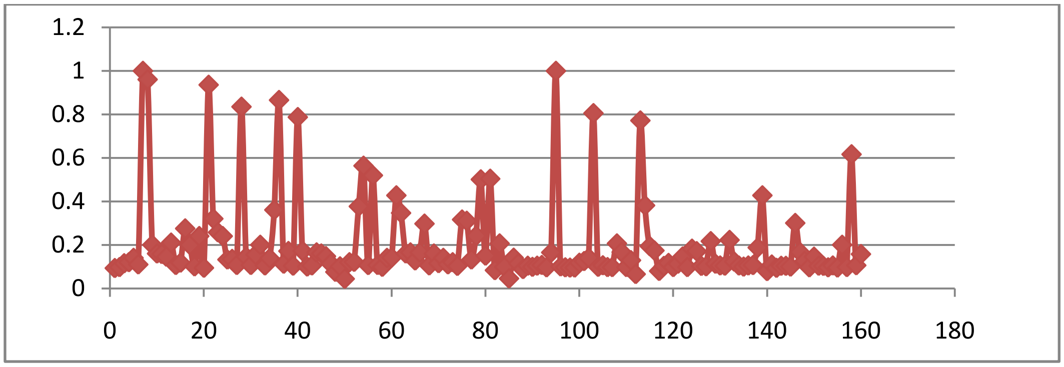

Figure 2: Technical Efficiency scores (CRS) based on pooled data of all paddy processors

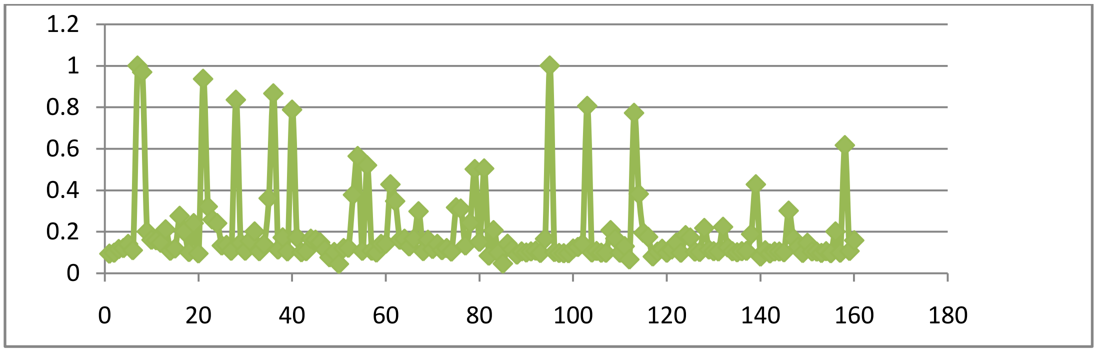

Figure 3: Technical Efficiency scores (NIRTS) based on pooled data of all paddy processors

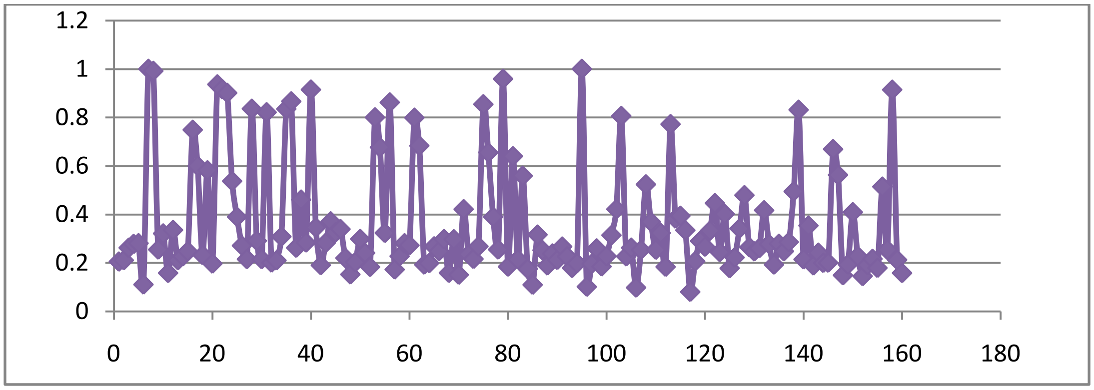

Figure 4: Scale Efficiency scores (SE) based on pooled data of all paddy processors

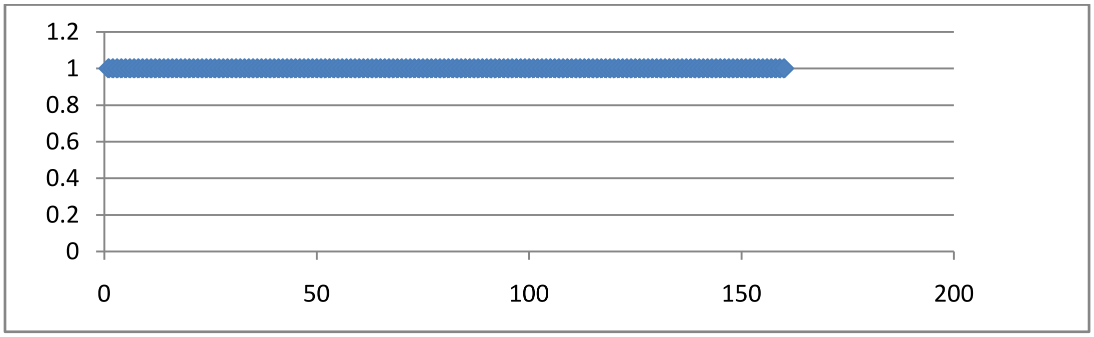

Figure 5**:** Returns to Scale (RTS) based on pooled data of all paddy processors

IV. CONCLUSION

The study reveals very high technical efficiency in the paddy processing in Adamawa State. On average, the small, medium and large scale processors operate at 87.6%, 91.6% and 94.5% efficiency level respectively. This further means the medium scale processors are more efficient than the small scale processors and the large scale processors in turn more efficient than the medium scale processors. Thus, the large scale processors are the most efficient, followed by the medium scale and finally the small scale as the least efficient. The study also unravels the presence of both managerial and scale problems (managerial and scale inefficiency) in the small scale paddy processing, serious scale issue (scale inefficiency) in the medium scale paddy processing and mild scale issue (scale inefficiency) in the large scale paddy processing. The study recommends up-scaling and down-scaling for IRS and DRS processors respectively. On the other hand, good management practices such as choice of kernel size, maturity of the kernel, modern parboiling skills and quality machines will break the influence of managerial inefficiency and aid in enhancing frontier paddy processing.

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