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The Effect of Structural Adjusment Programme (SAP) on Technical Efficiency on Rice Farming in Nigeria

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Abstract

The study analyzed technical efficiency of rice farming in Nigeria using time series data obtained from FAO STAT (FAO Data base) covering a period of 1960 to 2010.

The main feature of the data use includes rice output and input of land, fertilizer, labour, seed, tractor number and land area under irrigation. The major tool of analysis is stochastic frontier and t-test of difference between two independent mean.

Results of the analysis showed that estimated production function for both OLS and MLE models showed that almost all explanatory variables exhibit expected sign and magnitude except for irrigation input in OLS model. Coefficients of the estimated parameters were all statistically significant in the frontier function while in the average function, the coefficient of capital (X_5) and irrigation (X_6) were not significant.

The estimated mean technical efficiencies values of 94.3 percent for all period; 91.7 percent for pre-SAP period and 95.6 percent for post-SAP period confirm the fact that rice farming in Nigeria experience high technical efficiency over the period of study. The result of the hypothesis of the study also revealed that, there is no significant difference in the mean technical efficiency recorded before SAP and post-SAP period.

The study therefore suggested appropriate policy that will encourage proper and effective use of primary inputs such as land, labour, seed, capital and fertilizer for efficiency improvement.

Key Words:- Rice Farming, Technical Efficiency, Structural Adjustment Programme

Background to the study

Rice has become a major staple in Nigeria. It is relatively easy to produce and is grown for both sale and consumption. In some areas, there is a long tradition of growing but for others, its cultivation is relatively recent.The earliest cultivation of improved rice varieties (O. sativa L) started in about 1890 with the introduction of improved varieties to the high forest zone in western Nigeria (Hardcastle. 1959). Consequently, by 1960, O. sativa has take over from O. glaberrima, which is now limited to some deep- flooded plan of the sokoto – rima river basin and other isolated pockets of cultivated deep swamps all over the country (Atanda 1978).

There are many varieties of rice grown some of which are considered as "traditional" varieties, while other have been introduced within the last twenty years from research institutes, or are imports from Asia. Rice is grown in paddles or on upland fields depending on the requirement of the particular variety; there is also limited mangrove cultivation.With expansion of the land area of rice there has been a steady increase in rice production and consumption in Nigeria. The production increase has however not been enough to meet the consortium of the rapidly growing urban population, who has a great preference for parboiled rice (Singh and Jain, 1997).

Nigeria has experienced rapid grown in per capita rice consumption during the last three decades from5kg in 1960s to 25kg in the late 1990s. The successive programmes launched to increase rice production have not been able to reduce the resulting rice deficit. The imposition of ban on rice importation from 1985 to 1995 and the ensuing increase in the relative price against other major staples, boosted rice production mainly through area increases. Yields reached plateau in the 1990s and there are now some evidences that they are actually declining. In spite of the relative increase in the price of rice, per capita consumption has maintained its upward trend, showing that rice has become a structural components of Nigerian diet with a low elasticity of demand. Rice is now an "ordinary good" (West Africa Rice Development Association, 2003).

Rice is important in so many ways: Rice may be grinded into flour, which can be used by people allergic to wheat flour. (Potter and Hotchikiss 1996) Rice is a food source for starch.

Nigeria has thus become a major rice importer, second only to Idonesia over the period 1998 – 2002. Beyond the large volume involved, the Nigeria rice market is even more attractive than other West African markets because Nigeria imports high – value (parboiled) rice rather than rice of lower quality typically imported into the other countries of the sub-region. One of the key components of the strategy is increasing efficiency at producer level. This includes increasing productivity of the various rice production in Nigeria farm.In 1984 international institute of tropical Agriculture (IITA) yearly reports shown that rice is a preferred food in the urban centers of many countries.

Based on the problem discussed above, rice production in Nigeria is replete with a plethora of problems. Specifically, the problem confronting rice cultivation and/ or production in some area. Local rice has not kept up with the domestic consumption demand of the Nigeria populace and consequently rice is still imported (Singh and Jain 1997). Nigeria government both past and present recognized the importance of rice in the diet of populate and hence, various policy have been introduce to improve productivity and efficiency of rice farming in Nigeria. This study will provide answer to the following research questions.

1. What is the level of technical efficiency in rice production in Nigeria?
2. Is there any difference in Technical efficiency level of rice production before and after SAP?

Hypothesis of the study

There is no significant difference in technical efficiency of rice production in pre and post structural adjustment programme (SAP).

METHODOLOGY

3.1 The study area

The study area is Nigeria. Nigeria is situated on the Gulf of Guinea in West Africa. It is located between the equator and the tropic of cancer and this makes it hot. Nigeria is one third larger than Texas and the most populous country in African. Its Neighbors are Benin, Niger, Cameroon and Chad. The lower course of the Niger river flows south through the western part of the country in to the Gulf of Guinea. Swamps and mangrove forest border the southern coast, wood and hardwood forest. The two main temperatures are the tropical region and savanna region in north with temperature between 60^0F and 100^0F.

Nigeria comprises of thirty – six States in which the federal capital is situated in Abuja. It occupies a land area of about 923, 764 square kilometers with a population of about 140million (2006 census) making it the largest county in West Africa. There are two main seasons that occurs in Nigeria and they are:

i. Dry season: It is called dry season because we do not get as much rain compared to the rain season and it lasts the remainder of the year.
ii. Rainy season: It is called raining season because we get a lot of rain during this season which last from around may to September in the north and march to November in the south.

3.2 Method of data collection

Data used for this study is secondary data obtained from FAO STAT. The commodity that was studied **is** rice. The data used will cover the period between 1960 to 2010. The feature of data includes:

- Output of rice (in thousand tones)
- Land area planted to rice (in thousand hectares)
- Quantity of fertilizer used in rice production(in thousand tones)
- Labour (Rural population)
- Rice land area under irrigation (in thousand Hectares)
- Quantity of rice seed planted (in thousand kg)
- Disaggregate number of tractors available for rice farms

3.3 Method of data analysis

Descriptive statistics like frequency counts, percentage, means, median, mode and standard deviation. Stochastic frontier analysis using computer program frontier version
4.1 were used

T – test was also used to test hypothesis of the study

3.4 The stochastic frontier production and cost functions

Stochastic production frontier model proposed by Battese and Coelli (1995) was used to achieve the general objective of the study, where the parameters of the production functions was estimated simultaneously with the technical inefficiency effects.

The stochastic production frontier function model is specified in the implicit form as follows:

Yi = f(Xi, β) + (Vi-Ui)
Yi = the output of the 1^{st} farm
Xi = a Kxi vector of input quantities of the i^{t} farm
β = a vector of unknown parameters to be estimated
Vi = random variables which are assumed to be normally distributed. N (O, σ^2 V)
and independent of the Vi. It is assumed $/_0$ account for measurement error and other factors not under the control of the farmer.

U = Non-negative random variables, called technical inefficiency effects, which are assumed to account technical inefficiency in production and are often assumed to be half normally distributed N ((O, σ^2 V) (Algner et al., 1977). A Cobb-Douglas functional form was be employ in this study because, according to Kopp and Smith (1980) functional form has a limited effect on empirical efficiency measurement. Moreover the Cobb-Douglas form has been used in many empirical studies, particularly those relating to developing country agriculture. The frontier production function model is estimated using maximum likelihood procedures. This is because it is considered to be asymptotically more efficient than the corrected ordinary least square estimators (Coelli, 1995).

The model in its explicit form is as follows,

$Y = \beta_0 + \beta_1X_1 + \beta_3X_3 + \beta_4X_4 + \beta_5 + \beta_5 + \beta_6X_6 + V_1\text{-}U_1$ ……………….(iv)

According to Coelli (1995), to estimate a Cobb-Douglas production function, input and output data must be logged before analysis. The equation thus become.

$\text{In } Y = \beta_0 + \beta_1 \text{ Inx}_1 + \beta_2 \text{ Inx}_2 + \beta_3 \text{ Inx}_3 + \beta_4 \text{ Inx}_4 + \beta_5 \text{ Inx}_5 + \beta_6 \text{ Inx}_6 + (V_1\text{-}U_1)$……………….(v)

Where:

Y	=	Yield (output of Rice) tones
X1	=	Land (Ha)
X2	=	Seed (Ha)
X3	=	Fertilizer (tones)
X4	=	Labour (Rural population)
X5	=	Capital (Number of tractors available)
X6	=	Land area under irrigation

3.5 Technical Efficiency

The technical efficiency of production of the ith farmer in the appropriate data set, given the levels of his inputs, is defined by:

$$TEi= \frac{\exp(X_1\beta + V_i - U_i}{\exp(X_i\beta + V_i)} = \exp(-v)\text{………………….(vii)}$$

From equation above, the two components V_i and U_i are assumed to be independent of each other, where V_i is the one-sided, normally distributed random error (Vi N(0, σ v^2), and U_i is the one-sided efficiency component with a half normal distribution (Ui /N(O, σ u^2). Yi, ad X_i are as defined earlier. The β's are unknown parameters to be estimated together with the variance parameters.

The variance of the parameters, V_i and U_i are σ_u^2 and σ_u^2 respectively and the overall model variance given as related thus:

$\sigma^2 = \sigma_v^2 + \sigma_u^2$……………………………………..(viii)

The measures of total variation of output from the frontier, which can be attributed to technical efficiency, are lambda (λ) and gamma (γ) (Battese and Cora 1977) while the variability measures derived by joadrow et al (1982) are presented by equations (ix) and (x).

$$\lambda = \frac{\sigma_n}{\sigma_v} \text{……………………………(ix)}$$

and

$$\lambda = \frac{\sigma^2}{\sigma^{2u}} \text{…………………………..(x)}$$

On the assumption that V_i, and U_i, are independent and normally distributed, the parameters β, σ^2, σ_u^2, σ_v^2, λ and γ were estimated by method of Maximum Likelihood Estimated 9MLE), using the computer program FRONTIER Version 4.1 (Coelli, 1996). This computer program also computed estimates of technical and allocative efficiencies.

Following Olowofeso and Ajibefin (1999), a three-step procedure in estimating the MLE estimates of the parameters of the stochastic frontier production was then used.

The steps are:

Step I: The OLS estimates of the production function were obtained.

Step II: A two-phase grid search for the gamma (γ) and men (u) parameters were conducted with the β_0 and σ^2 parameters were suitably adjusted.

Step III: The values selected in the grid search were used as starting values to obtain the maximum likelihood estimates.

The farm specific technical efficiency (TE) of the farmer was estimated using the expectation of Ui conditional on the random variable (εi) as shown by Battese and Coelli (1988). The TE of an individual farmer is defined in terms of the ratio of the observed output to the corresponding frontier output given the available technology, that

TEi = $\frac{Yi}{Yi} \frac{\exp(X_i\beta + V_i - U_i)}{\exp(X_i\beta + V_i}$ = exp (---Ui) ………………………..(xi)

so that O $\leq$ Te $\leq$ 1

The technical efficiency of an individual farm defined in terms of the ratio of the observed output (Yi) to the corresponding frontier output (Yi*), given the available technology, conditional on the level of input used by the farm, hence the technical efficiency of farm I assuming Cobb-Douglas production function is express as;

Technical efficiency = Y_i/Y^*

= $f(X_i, \beta) \exp(V_i, - U_i) / f(X_i, \beta) \exp(V_i)$

This is obtainable from the result of the FRONTIER 4.1 (Coelli, 1995). Based on the individual farm's technical efficiency, the mean technical efficiency for the sample will be obtained (Yao and Liu, 1998).

RESULT AND DISCUSSION

4.1 ESTIMATED PRODUCTION FUNCTION

The ordinary least square (OLS) and the maximum likelihood (ML) estimate of the production function parameters of rice farming in Nigeria are presented in table 1.The OLS function provides estimates of the "average production function while the ML model yield estimates of the stochastic production function. A comparison of the functions shows that the stochastic production function has a higher intercept term than the average production function. Beside the slope parameter was different in both functions. This suggest that the stochastic frontier function represents a non-neutral upward shift of the average production function. This result were consistent with those of Shenggen, Wiles and Young (1997) for rice in Egypt, and contrast from the neutral upward. Shift obtained by Bravo – Ureta and Evenson (1994) in Eastern Paraguay and Bravo – Ureta and Pinheiro (1997) in Dominician Republic.

The coefficient of the estimated parameters had the desired signs in both functions except for irrigation in OLS model, which had unexpected negative sign. However, they coefficients of the estimated parameters were all statistically significant in the frontier function while in the average function, the coefficients of capital (X_5) and irrigation (X_6) were not significant. The ratio of the standard error of u to that of V and called lamb is estimated as 2.84 in the frontier function and was statically significant Gamma was estimated as 0.9991. This implies that 99.91% of variation in rice output in Nigeria was due to technical inefficiency.

The estimated coefficient for land was statistically significant and positive, this implies that the employment of more land resources would lead to greater output in rice farming. This conform to a priori expectation. Labour is one of the most important resources next to land in traditional agriculture. The coefficient of labour was positive and statistically significant significant in all the estimated models and this conforms to a priori expectation because farm operations in Nigeria had remained labour intensive.Planting materials consisting of seeds and seedlings and fertilizer were also highly significant and positive in both models, this imply that as more and more seeds and fertilizer were used output of rice in Nigeria increases. Capital input (Number of Tractors) and irrigation were significant in MLE model but not significant in OLS model, but were positively sign in ch b in whoth model. It cam therefore be deduced that using more and more of these input will lead to an increase in rice input in Nigeria and this is in contrast with the findings of Nwaru et al, (2006) in which capital was negatively sign.

Table 1: Estimated Production Function for Rice Farming in Nigeria.

Variables	Parameter	Average OLS Function	Frontier MLE Function
Constant term	b_o	3.23	3.71
		$(3.91)^{xxx}$	$(9.85)^{xxx}$
Land (X_1)	b_1	3.43	0.88
		$(3.83)^{xxx}$	$(2.27)^{xx}$
Seed (X_2)	b_2	4.43	4.56
		$(3.22)^{xxx}$	$(4.31)^{xxx}$
Fertilizer (X_2)	b_3	0.13	0.087
		$(3.37)^{xxx}$	$(4.97)^{xxx}$
Labour (X_4)	b_4	1.03	1.03
		$(2.70)^{xxx}$	$(8.27)^{xxx}$
Tractor (X_5)	b_5	2.11	0.10
		(0.28)	$(5.25)^{xxx}$
Irrigation (X_6)	b_6	-2.05	0.042
		(0.23)	$(2.32)^{xxx}$
R2		0.755	
F-ratio		24.11^{xxx}	
Log likelihood function			81.85
Sigma square			78.77
			$(11.97)^{xxx}$
			0.9991
Gamma			2.84
Lambda			$(2.012)^{xx}$

Extracted from computer printout 2010

Figure in parenthesis are t – ratio, (^{xxx}) implies significant at 5% and 1% respectively.

4. Technical efficiency estimate for rice farming Nigeria.

The technical efficiency of rice farming in Nigeria were summarized and in table 2,3 and 4. The range of technical efficiencies varied from 0.776 to 0.999 with a mean of 0.943. it can be seen from the table that over the study period, the mean technical efficiency of Nigeria rice farming was about 94.3 percent. This is also implied that technical efficiency in Nigeria rice farming can still be improved by about 5.7 percent.

In order to compare technical efficiency of rice farming before structural adjustment programme (Pre-SAP) and post structural adjustment Programme (post – SAP) a t – test of difference between Pre SAP (1970-1896) and post SAP (1986-2005) means was carried out. The result in table 5, showed that the mean technical efficiency for pre – SAP period (0.917) was not significantly lower than the mean technical efficiency for post SAP period (0.956). This implies that the SAP polices had not significantly influence on the performance of Nigeria rice farming in terms of technical efficiency.

Table 2:- Frequency distribution of technical efficiency in Nigeria rice production (1960-2005)

			Frequency	Percentage
0.71	-	0.80	1	2
0.81	-	0.90	5	10
0.91	-	1.00	44	88
Total			50	100

Mean Technical Efficiency - 0.943
Minimum Technical Efficiency – 0.776
Maximum Technical Efficiency – 0.999
Source:- Extracted from computer printout 2010.

Table 3 – frequency distribution of technical efficiency in Nigeria rice farming (Pre SAP = 1960-1986)

			Frequency	Percentage
0.71	-	0.80	1	4
0.81	-	0.90	3	12
0.91	-	1.00	21	84
Total			25	100

Mean Technical Efficiency – 0.917
Minimum Technical Efficiency – 0.776
Maximum Technical Efficiency 0.997
Source:- Extracted from computer print out 2010

Table 4: Frequency distribution of technical efficiency in Nigeria rice faming post SAP (1987-2005) period.

			Frequency	Percentage
0.71	-	0.80	-	-
0.81	-	0.91	2	10
0.91	-	1.00	23	90
Total			**25**	**100**

Mean Technical Efficiency – 0.956
Minimum Technical Efficiency – 0.872
Maximum Technical Efficiency 0.999
Source:- Extracted from computer printout 2010

Table 5: t – test (paired sample test)

Paired samples	Mean	t-value	d.f	p-value
Efficiency Pre – SAP versus Post- SAP period	0.93	1.204	44	0.347

Source:- Extracted from computer printout 2010

CONCLUSION

The result of the study show that although rice farming in Nigeria over the study period recorded high technical efficiency but there is still room for improvement in technical efficiency since 100 percent level of technical efficiency have not been achieved. Further analysis also revealed that policy in structural adjustment programme did not have significant effect on rice technical efficiency performance.

REFERENCES

Atanda; O.A. "International Rice Commission News letter" FAO Corporate document Repository 198 p1.

Battese, G.E and G.S cora (1977); Estimation of production from the Dominican republic: The development economics vol. 35 (1) Pp. 48-57.

Bravo Ureta B.E and R.E Evenson (1994); "Efficiency in Agricultural Production. Thecase of peasant farmers in Eastern Praguay" Agricultural economics. Vol 10 (1), Pp 27-37.

Bravo- Ureta, and A.E Pinhero (1997); "Technical, Economic and efficiency and Agricultural production. The case of peasant farmer in Eastern Paraguay" Agricultural economics. Vol 12 (2), Pp 45-55.

Coelli, T.J and Buttese, G.E (1999); A model for Technical Inefficiency effect in a stochastic frontier production function. "Empirical Economics, 20" 325-332.

Farell M (1957); The measurement of productive efficiency, journal of Royal Stastician Society series A General 120:253-287.

Hardcastle, J.E.Y (1959); The development of Rice production and research in the federal republic of Nigeria Tropical Agriculture (Trinidad) pg 36, 79-95.

Jondreow, J.C., M. and Schmidt (1982); On the Estimation of Technical in efficiency in frontier stochastic production Journal of Econometrics 19:233-238.

Juliano, B.O. (1994); Rice in human nutrition FAO food and nutrition series to determine the role of bioscience/biotechnology in the study of agricultural as perceived by vocational agricultural instructors.

Onyenweaku C.E and J.C. Nwaru (2005); "Application of a stochastic frontier production to the measurement of technical efficiency in food crop production in Imo state Nigeria. Nigeria agricultural journal. Vol. 36 Pp 1-12

Polter N.N and Hotchkiss J.N. (1996); Food science fifth Edition New York.

Schultz A (1994): Production function. Analysis as a guide to policy in low income farm areas Canadian journal of agricultural economics.

Shapiro KH (1983); Efficiency differentials in peasant agriculture and their implications for development policies journal of development studies 19(2): 77-190.

Shenggen, F, E.J Wayss and K.B Young (1997); "Policy reform, and technological change in Egyptian rice production. A frontier production function approach" journal of African economic. Vol. 6 (2) Pp 391-411.

Sighn and Jain (1997); "International Rice Commission News Letter" FAO Corporation Documents Repository 1985 pi.

Taylor, G.T. and Shronkwile, J.S. (1986); Alternative Stochastic specification of the frontier production function in the analysis or agricultural credit program and technical efficiency journal of development economics 24, 149-160.

WARDA (2003); Strategy for rice sector revitalization in Nigeria.

Yao, and Liu Z. (1998); Determinants of Grain production and Technical Efficiency in china, journal of Agricultural Economics 46(2): 171-184.