Niger Agric. J. 32 (2001): 140-151

TECHNICAL EFFICIENCY IN FOOD CROP PRODUCTION IN GOMBE STATE NIGERIA

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(Accepted, August, 2001)

ABSTRACT

This paper is on the technical efficiency in food crop production in Gombe State of Nigeria Primary data from a sample of 123 food crop farmers were chosen by a multi-stade random sampling procedure. A stochastic frontier production using the maximum likelihood estimation (MLE) was used as analytical tool. The results reveal that family labour, hired labour and material input are the major factors that affected the output of food crops. A range of technical efficiency is observed across the sample farms where the spread is large. The best farm has a technical efficiency of 0.89 (89%), while the worst farm has a technical efficiency of 0.13 (13%) . The mean technical efficiency is 0.69 (69%). The implication of the study is that the mean technical efficiency index of 0.69 could be increase by 31 percent through better use of available resource.

INTRODUCTION

In Nigeria, food consumption accounts for a substantial proportion of total household's expenditure. It accounted for approximately 50% of total household's expenditure in 1994, but the proportion increased to 72 percent in 1995. (Central Bank of Nigeria, 1995) A rapidly growing population, especially urban population exerts pressure on the increased demand for food. Therefore, farmers in Nigeria need to improve the efficiency in food crop production so that that output could be raised to meet the growing demand.

The Federal Ministry of Agriculture 91993) estimated that the annual food supply would have to increase at an average annual rate of 5.9 percent to meet food demand and reduce food importation significantly .Most studies show that aggregate food production in Nigeria has been growing at about 2.5 percent per annum in recent years. But the annual rate of population growth has been as high as 2.9 percent (Olaymi, 1998) the reality is that Nigeria has not been able to attain self-sufficiency in food production, despite increasing land area put into food production annually. The constraint to the rapid growth of food production seems to mainly be that of low crop yield and resource productivity.

An in crease in efficiency in food crop production could lead to an improvement in the welfare of farmers, and consequently a reduction in their poverty level and food insecurity. This paper investigates the farmer's technical efficiency in food crop production in Gombe State, Nigeria

Theoretical Framework

In economic analysis, much is concerned with the technical and economic efficiencies or resource transformation and allocation (Seitz, 1970). Production efficiency is concerned with the relative performance of the process used in transforming inputs into output. The analysis of efficiency is generally associated with the possibility of farms producing a certain optimal level of output from a given bundle of resources of certain level of output r least-cost.

Farrel (1957) distinguishes between three types of efficiency: (a) technical efficiency

(TE), (b) allocative or price efficiency (AE) and (c) economic efficiency (EE). Technical efficiency in production is the physical ratio of product output to the factor input; the greater the ratio, the greater the magnitude of technical efficiency. This definition to technical efficiency implies that difference in technical efficiency between farms may exist. The production function presupposes technical efficiency from which the maximum output from input combinations could be derived. Therefore, it is a factor- product ration. An important assumption of efficiency is that firms operate on the outer bound production function, that is, technically most superior production function available to them. When firms fail to operate on the outer bound production function (i.e. the frontier) they are said to be technically inefficient. For such firms, an improvement of technical efficiency maybe achieved through three methods (Heady, 1961). First, TE can be improved through betterment of the production technique. This implies a change in factor proportions through factors substitution under a given technology. Hence, it represents a change along the given production function. Secondly, TE can also be improved through improvement of the production technology. This represents a change in the production function itself such that the same amounts of resources produce more output. Alternatively, the same amount of output is derived from fewer resources. Thirdly, TE can be improved through the improvement of both the production technique and technology as discussed above.

Allocative efficiency (AE) is concerned with choosing optimal sets of inputs in this regard. A firm is allocatively efficiency when production occurs at a point where the marginal value product is equal to the marginal factor cost.

Economic efficiency (EE) is a situation where there are both technical efficiency and allocative efficiency. Therefore, the achievement of either of technical efficiency or economic efficiency is a necessary but not a sufficient condition to ensure economic efficiency (Ellis, 1988). The simultaneous achievement of both efficient condition according to Heady, (1952), occurs when price relationships are employed to denote maximum profits for the firm or when choice indicators are employed to denote the maximization of other economic objectives. Thus, economic efficiency refers to the choice of the best combination objectives. Thus, economic efficiency refers to the choice of the best combination for a particular level of output which is determined by both input and output prices.

Farrel's measure of efficiency depends on the existence of the efficient production function with which observed performance of a firm can be compared. A production function based on the "best" practical results would have to be used as a reference for measuring individual performance. However, due to the problem of complication, Farrel considered it better to compare performance with the 'best' obtained than to set up some unrealizable ideal. He then obtained from a scatter of diagrams of several firms an isoquant showing the least exacting standard of efficiency assumption of convexity to the origin and non-positive slope at any point.

METHODOLOGY

Sources of Date

The study used mainly primary data. The relevant primary data were obtained through a farm Management survey of 124 farm-families. The main instruments for data collection were well-structured questionnaires administered on farm-families by trained enumerators under the supervision of the researcher. Multistage random sampling techniques were employed in the selection of a sample of 123 food crop farmers in Gomber State, Nigeria.

The range of data collected covered those on household's farm activities . These include materials input (input purchase cost), family and hired labour use, sources of credit, tenurial arrangement , farm size, farm outputs and their prices. In addition, data were collected variables, such as age , level of education, household size, and so on.

The primary data collected were supplemented with secondary data obtained from Gombe Agriculture Development Project. The Secondary Data covered information on the prices of inputs and outputs, labour wage rates and interest on agricultural loans.

Method of Data Analysis

The Stochastic efficiency frontier models independently proposed by Aigne, Lovell and Schmidt (1997) and Meeusen and den Broeck (1997), and extended by Jondrow (1982) was used in the analysis of data. The approach has the advantage that it accounts for the presence of measurement error in the specification and estimation of the frontier production function in that the former consists of tow error terms. The first error term accounts for the existence of technical efficiency and the second accounts for factors such as measurement error in the output variable, weather and the combined effects of unobserved inputs on production.

The frontier production model begins by considering a stochastic production function with a multiplicative disturbance term of the form:

$Y = f(x_a; ß) e^{\epsilon}$

Where"

Yis the quantity of agricultural output;

$X_a$is a vector of input quantities

ßis a vector of parameters and

eis error term

Where $^{\epsilon}$ is a stochastic disturbance term consisting of two independent elements and v, that is:-

$\epsilon = v+v$

(2)

The symmetric component, v, accounts for random variation in output due to factors outside the farmer's control, such as weather and diseases It is assumed to be independently and identically distributed as N-(0,o2v). A one sided component v 0 reflects technical inefficiency relative to the stochastic frontier, f (XalB) e^{ϵ} Thus, v =0 for a farm output which lies on the frontier and v< 0 for one whose output is below the frontier as (N-(0, o2u) 1, i.2 the distribution of v is half-normal

The stochastic production frontier model can be used to analyse cross sectional data. The frontier of the farm is given by combining (1) and (2). y =f (Xa; β)e (u+v) (3)

Measure of technical efficiency for which be calculated as:

TE =exp . (E {u/$^{\epsilon}$})

The parameters of the stochastic frontier function model are estimated by the method of maximum likelihood, using the computer program **FRONTIER** version 4.1 (Coelli, 1994)

Empirical stochastic frontier production function

The frontier production function began by specifying a Cobb-Douglas function including all the explanatory variables. The regression coefficients are direct elesticities of the dependent variable with respect to the independent variables with which the coefficient is associated. The empirical models is specified as:-

$InYij=\beta o+\beta_1 ln X1ij\ \beta_2 ij + \beta_3 In X_3 ij+ \beta 4 In X_4 ij + \beta_5 In X_5 oj + \beta_6 D+\beta_7 In X_6 ij + Vij - Vij$

Where: subscript ij refer to the Jh observation of the ith. farmer

In denotes logarithm to base e;

Y represents the output of food crops in grain equivalent (in kilograms)

X1is the total farm area under cultivation (in hectares).

X2 is family labour used in production (in man-days)

X3 is hired labour used in production (valued in Naira)

X4 represents expenses on animal traction used in farming operations (valued in Naira).

X5 is expenses on material input of seeds and agro-chemicals (values in Naira).

D is a dummy variable scored one if organic fertilizer was applied in the production if food crops, Zero otherwise;

X6 is the quantity of chemical fertilizer used (in kilogram) and

Vij normal random errors which are assumed to be independently and identically distributed, having N (0,o2)

Uij are non-negative random variables, called technical efficiency associated with the technical efficiency of the farmers involved.

The estimated coefficient for farm size is positive, which conform to a priori expectations. The elasticity of output with respect family labour is negative at –2.20 and statisti-

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Table 1: maximum likelihood Estimates off the Parameters

Variable	Parameter	Coefficient	Standard error
Production	β		
Constant	βo	5.248	1.056****
Farm size	β1	0.082	0.176
Family Labour (X2)	β2	-0.202	0.096**
Hired Labour (x3)	β3	0.092	0.057*
Animal Trac-	β4	0.031	0.069
Materials in-	β5	0.376	0.139***
Organic Fer-	β6	0.166	0.157
Chemical fer-	β7	0.132	0.014
Diagnostic			
Likelihood			
Sigma	O2	1.581	0.964*
Gamma	Y	0.840	0.112 ***
mu	u	-2.304	2.549

*** Significant at the 0.01 level *** at the 0.05 level' * at the 0.10 level
Source Computed MLE results.

cally significant at the 5-percent level. This implies that family labour is a significant factor that influences changes In the output of food crops. The output of food crops is expected to increase with a decrease in family labour input and vice versa. The negative production elasticity with respect to family labour is unexpected but conforms to similar findings by Battese et al. (1996), Hallam and Machado (1996) and Wilson et al (1998) who variously reported negative elasticity of labour using stochastic frontier production functions. The negative sign on the coefficient of family labour suggests a situation of excessive use of family labour in food crop production. The inefficiency of family labour resources-use could be explained by the influence of population pressure. In countries where there is a rapid population growth, there is natural tendency towards excessive utilization of labour on farm (Meier, 1989). This situation exists when there are no alternative employment opportunities to absorb the excess labour. The surplus supply of labour depresses its price, thus encouraging farmers to excessively use it, with a resulting inefficiency in labour use.

The production elasticity with respect to hired labour is positive as expected and statistically significant at the 10-percent level. The elasticity of hired labour, which is 0.09, suggests that a 1- percent increase in hired labour induce an increase of 0.09 percent in the farm gross margin, and vice versa.

The coefficient of the variable associated with materials (i.e. seeds and agro-chemicals) is positive as expected and statistically significant at the 1-percent level, which conforms to a priori expectation. Expenditure on planting seeds and agro-chemicals, which constitute the materials input variable, is shown by the frontier production function to be strongly positive. Agro-chemical as significant component of material input which is applied to crops to mitigate the effects of crop losses due to infestation from pests which is common in the study area. It is expected that agro-chemicals will have a positive effect on food crop production, through relatively high crop yields.

The estimate of the sigma-squared (Q2) in table 1 is significantly different from zero at the 10-percent level. This indicates a good fit and the correctness of the specified distributional assumptions of the composite error term. In addition, the magnitude of the various ratio is estimated to be high at 9.84, suggesting that systematic influences that are unexplained by the production function are the dominant sources of random errors.

The generalized likelihood ratio is significant at the 1-percent level, suggesting the presence of the one-sided error component. This means technical efficiency is significant and a classical model of pro-

Table 2: Distribution of the farmer's technical efficiency indices Gombe State Nigeria

Efficiency Class Index	Number of Farmers	Percentage of
0.0-0.10	0	0
0.11-0.20	1	0.8
0.21-0.30	0	0
0.31-0.40	2	16
0.4`-0.50	7	5.7
0.51-0.60	18	14.6
0.61-00.70	23	18.7
0.71-0.80	52	42.3
0.81-0.90	20	16.3
0.91-1.00	0	0
Mean=0.69		
Total	123	100.0

Source: Computed from MLE results

duction function based on OLS estimation technique would be an inadequate representation of the data. Thus, the results of the diagnostic statistics confirm the relevance of stochastic frontier production function using maximum likelihood estimator.

Technical Efficiency Estimates of the farmers

A significant characteristic of the stochastic frontier production model is its ability to provide farm-specific The technical efficiency indices are derived from the MLE results of the stochastic production function in equation 4, using computer program Frontier 4.1.

The technical efficiency of the sampled farmers is less than 1 (100 %) indicating that all the farmers are producing below the maximum efficiency frontier. A range of technical efficiency is observed across the sample farms where the spread is large. The best farm has a technical efficiency of 0.888 (89%), while the worst farm has a technical efficiency of 0.127 (13%). The mean technical efficiency is 0.694 (69%). This implies that on the average the respondents are able to obtain a little over 69 percent of potential output from a given mix of production inputs. The distribution of technical efficiency of the farmers reveals that only 1-percent o the farmers has a technical efficiency less than 30 percent, while 47 percent of the farmers have a technical efficiency about 70 percent.

The picture that emerges from this analysis is one of generally average technical efficiency in food crop production in the study area. Maximum technical efficiency is not yet achieved probably because most of the sample farmers carry out food crop production under conditions involving the use of inefficient tools, unimproved seed varieties and so on. The low production technology adopted by the majority of the farmers and their low levels of formal education are the major factors that have influenced the magnitude of their technical efficiency

SUMMARY AND CONCLUSION

The Maximum likelihood estimation results reveal that family labour. Hired labour and material inputs are the major factors that are associated with changes in the output of food crops. The distribution of the technical efficiency dicices reveal that the current state of technology used by the sample farmers is inferior. Therefore, a superior technology is needed which could be applied to current resources endowment to enhance food crop output.

The policy implication of the study is that the mean technical efficiency of 0.69 could be increase by 31 percent through better use of available resources. This could be achieved by the farmers through the use f improved seeds and the application of agro-chemicals in food crop production. The excessive and, hence. Inefficiency use of family labour in food crop production could also be reduced through the creation of alternative employment opportunities in the study area. The creation of alternative employment opportunities will tend to absorb the excess family labour, and therefore enhance the efficiency of food crop production.

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