Conventional Neoclassical Test Of Economic And Technical Efficiencies In Pearl Millet Production In Niger State, Nigeria

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This study determines the resource use efficiency in pearl millet production in Niger State, Nigeria. Multistage sampling technique was employed to elicit information from 160 millet framers throughadministration of pre-tested questionnaire. Data collection was for 2014 cropping season. Productionfunction analyses which incorporate the conventional neoclassical test of economic and technicalefficiencies were used as the analytical technique. Findings revealed that the farmers were inefficient in theuse of all the resources. Generally, inputs such as farm size, family labour, hired labour, seeds andfertilizers were under-utilized, while herbicides were over-utilized. The results indicate that there is need tomake inputs such as fertilizer, improved seeds and herbicides affordable and accessible to the farmers so asto improve efficiency.

Keywords: Resources, Allocative efficiency, pearl millet, Niger state, Nigeria

INTRODUCTION

Pearl millet (*Pennisetum glaucum L. R. Br.)* known as '*bajra*' in Hindu; *'gero'* in Hausa language, and '*mayee*' in *Nupe* language of northern Nigeria is the most important and probably having the greatest potential among the millet varieties (ICRISAT, 2014). Pearl millet originated from central tropical Africa and the sixth most important cereal crop in the world, cultivated annually as rainfed crop with wide distribution across the drier or semiarid tropics of Africa and Asia (Lonewood Trust, 2013). The plant was domesticated as a food crop some 4 000 to 5 000 years ago along the southern margins of the central highlands of the Sahara (Lu *et al*., 2009; Wikipedia, 2014a). Primarily a tropical plant, pearl millet is often referred to as the "Camel", because of its exceptional ability to tolerate drought, it can be grown where other cereals such as maize or wheat would not survive (ICRISAT, 2014a).

Today, it is grown in over 40 countries predominantly in Africa and Asia as a staple food grain and source of feed and fodder, fuel and construction material (FAOSTATA, 2014). Pearl millet is planted on 20.8 million ha in Africa and 10.6 million ha in Asia. Worldwide, there are nine species of millets with Global production of grain exceeding 27 million tons a year, to which Africa contributes 15.2 million tons, more than half 55%; Asian 12.2 million tons (43.5%) and the remain by other sub-continental countries all from six species (USDA, 2014). Approximately one-third of the world's millet is grown in Africa and Asia, about 70% of it in West Africa. Major producing countries in Africa include Nigeria, Niger, Burkina Faso, Chad, Mali, Mauritius and Senegal in the west, and Sudan and Uganda in the east. Six countries (China, Ethiopia, India, the Niger, Nigeria and the former Soviet Union) are estimated to account for about 80% of global millet utilization (ICRISAT, 2014b). Out of the 30 million tons of millet produced in the world, about 90% is utilised in developing countries, and only a tiny volume is used in the developed countries. At least, 500 million people depend on pearl millet for their lives (Factfish, 2014). The exact statistical data are unavailable for most countries, but it is estimated that a total of 20 million tons are consumed as food, the rest being equally divided between feed and other uses such as seed, the preparation of alcoholic beverages and waste.

World consumption of millet as food has only grown marginally during the recent past in contrast to the significant increase in consumption of other cereals, with at least, 500 million people depending on pearl millet for their lives (FAO, 2014). Pearl millet production is hampered by numerous problems and as such there is a need to find ways of improving its productivity. Nigeria uses millions of tones of pearl millet as staple food in many homes, especially among the poor predominantly in Northern Nigeria (ICRISAT, 2014c).

Future trends need increasing productivity and trade (regionally and internationally) and adding value to products by improving/increasing processing and utilization in industry. More research-for-development and networking are required to achieve these (IRDR, 2014). Pearl millet improvement programme in Nigeria is concerned with higher yield for human food and this will likely play a major role in easing the world food shortage as population skyrockets. FMARD (2014) reported that the purpose for expanding pearl millet production in Nigeria was actually deliberate to meet the growing demand for food which incidentally depends on the success of research in pearl millet cultivation and hybrid improvement programmes. Empirical studies that have made use of classical model in determining resource use efficiency in crop production in Nigeria cannot be over emphasised, but with relatively fewer studies on millet production in the country. In addition, no studies have been documented for millet production in Niger state. Therefore, the objective of this research was to provide empirical information on farm level resource use efficiency in small-scale millet production in Niger state using t he traditional response approach with a view to derive policy implications for proper policy recommendations.

2.0 PRODUCTION FUNCTION IN EFFICIENCY STUDIES

Agricultural productivity can be defined as the index of the ratio of the value of total farm output to the value of the total inputs used in the farm production. Production efficiency means the attainment of production goals without waste. Efficiency is an important factor of productivity growth specifically in developing economies where resources are meager and opportunities for developing and adopting better technologies are limited. Farell (1957) derived the three components of efficiency recognized in the economic literature. They include: (i) Allocative efficiency, and (ii) Economic efficiency. A firm is said to be technically efficient if it produces as much output as possible from a given set of inputs or if it uses the smallest possible amount of inputs for a given level of output and input mix. The allocative efficiency reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices. The product of these two efficiencies is economic efficiency, which could be defined as the ability of the firm to produce a well-specified output at minimum cost.

The modeling and estimation of production efficiency of a farm relative to other farms or the 'best' practice in an industry has become an important area of economic study. Productivity is generally measured in terms of the efficiency with which factor inputs, such as land, labour, fertilizer, herbicides, tools seeds and equipment etc are converted to output within the production process. According to Sadiq and Yakasai (2012), productivity measures are of two types, partial productivity and total factor productivity (TFP). Partial productivity is measured as the ratio of output to one input. Total factor productivity is the ratio of output to all inputs mixed. Generally, two approaches are used in measuring TFP. These referred to growth accounting or index number approach and the econometric or parametric method. The econometric method is based on an econometric estimation of the production function or the underlying cost or profit function. In this study, the production function is used to measure the productivity. From the production function, the conventional neoclassical test of economic efficiency was derived. The rule of this test is that the shape of the production function (MPP) should be equal to the inverse ratio of input price to output price at the profit maximization point. This is given as:

$MPPXi = Pxi/Py$

Where:

Pxi=the price per unit of resource input used

Py= the output price

MPP = the marginal physical product of resource input used

$MPP \times Py = MVP$

$MVP/MFC = r$

Where:

MVP = marginal value product

MFC = marginal factor cost/ unit cost

r = numerical constant

In an attempt to substitute the efficiency hypothesis, focus is centered on the estimated value of r and its closeness to unity (1). Efficiency is attained if: MVP = MFC.

3.0 METHODOLOGY

3.1 Study Area*:* This study was based on the farm level data on small scale maize farmers in Niger State, Nigeria. Niger State is in the North-central part of Nigeria and lies in between longitude $3^0\ 30^1$ and $7^0\ 20^1$ east of the Greenwich Meridian and latitude $8^0\ 20^1$ and $11^0\ 30^1$ north of the equator .The land area is about 80,000 square Kilometre with varying physical features like hills, lowland and rivers (Wikipidea, 2014b). The state enjoys luxuriant vegetation with vast Northern guinea savannah found in the north while the fringe (southern guinea savannah) in the southern part of the state. The people are predominantly peasant farmers cultivating mainly food crops such as yam, cassava, maize and rice for family consumption, and markets (Sadiq, 2014).

3.2 Sampling technique and Data Collection*:* The data for the study was drawn from primary source with the aid of well pre-tested questionnaire. The questionnaires were administered to 160 millet famers selected through multistage sampling procedure. The first stage involved the purposive selection of one Agricultural zone out of the three Agricultural zones in the state, namely, Kontagora for its prominence in millet production. In the second stage, two local government areas, namely Rijau and Nasko were purposively selected due to preponderance of millet producers. The third stage involved random selection of four villages from each selected LGAs. Finally 20 respondents were drawn from each of the villages, thus, given a total sample size of 160 respondents'.

3.3 Method of Data Analysis*:* The analytical procedure employed was production function analysis. This was used to obtain the parameters for the measurement of resource use efficiency of the millet farmers. Four functional forms were tried and the lead equation was selected based on economic, econometric and statistical criteria including signs and magnitudes of the coefficients, the magnitude of R2, T-statistics, F-statistics. The function experimented with were linear, semi log, double log and exponential.

3.3.1 Model specification: The implicit function can be presented by the following equation:

Y= f(X1,X2,X3,X4,X4,X5,X6,X7) ……………………………………………………… …... (1)

Where:

Y = Output of Millet (kg)

X_1 = Farm Size (in hectares)

X_2 = Family labour used (in manday)

X_3 = Hired labour used (in manday)

X_4 = Improved of seeds (kg)

X_5 = Fertilizer (kg)

X_6 = Herbicides (litres)

X_7 = Depreciation on capital inputs (in naira)

The following functional forms were evaluated

(a) Linear function

$Y = b_0 + b_1 X_1 + b_2 X_2$ ....+ $b_n X_n + e_i$ ……………………….(2)

MPP= b

Elasticity = b * X/ Y

(b) Semi–log function

$Y = \log b_0 + b_1 log X_1 + b_2 log X_2$ ....+ $b_n log X_n + e_i$ ………… (3)

MPP = b/ X

Elasticity = b/Y

(c) The Cobb Douglas (double log) function

$Log\ Y = \log b_0 + b_1 log\ X_1 + b_2 log\ X_2$ ....+ $b_n log\ X_n + e_i$ ……… (4)

MPP = b* Y/X

Elasticity = b

(d) Exponential function

$Log\ Y = = b_0 + b_1 X_1 + b_2 X_2$ ....+ $b_n X_n + e_i$ ………………….. (5)

MPP = b*X

Elasticity = b*Y

Note:

b_0 = Intercept

b_1-b_n = Regression co-efficients

Determining technical efficiency of resource use

The elasticity of production which is the percentage change in output as a ratio of a percentage change in input was used to calculate the rate of return to scale which is a measure of a firm's success in producing maximum output from a set of input.

EP = MPP/APP

Where:

EP = elasticity of production

MPP = marginal physical product

APP = average physical product

If

EP =1: constant return to scale
EP < 1: decreasing return to scale
EP > 1: increasing return to scale

Determining the Economic Efficiency of Resource use

The following ratio was used to estimate the relative efficiency of resource use (r)

r = MVP/MFC

Where:

MFC = unit cost of a particular resource

MVP = value added to millet output due to the use of an additional unit of input, calculated by multiplying the MPP by the price of output. i.e. MPPxi x Py

Decision rule

If r = 1, resource is efficiently utilized,
if r > 1, resource is underutilized, while,
if r < 1, resource is over utilized.

Economic optimum takes place where MVP = MFC. If r is not equal to 1, it suggests that resources are not efficiently utilized. Adjustments could be therefore, be made in the quantity of inputs used and costs in the production process to restore r = 1 and the model is given as follows:

Divergence % = (1-1/ri) x100 or [(ri-1)/ri] x100

RESULTS AND DISCUSSION

4.1 Estimated millet production function

Table 1 shows the multiple regression estimates of the four functional forms that were fitted into the production function models. On the basis of *a priori* expectation, sample coefficient of determination (R^2), population coefficient of determination (F-statistics), statistical significance of the coefficients (t-statistics), test of normality, test of homoscedasticity and multicollinearity test, the semi-logarithms functional form was chosen as the best fit model and lead equation. The regression results indicate that about 78 percent (R^2) of the variation in the output of millet was jointly explained by the explanatory variables included in the model. The remaining 22 percent not explained by the explanatory variables could be attributed to the error or random disturbance in the model. The F-ratio of 35.986 was significant at 1 percent level, implying that the explanatory variables included in the model have strong explanatory power. The F-ratio is a measure of joint significance of all the explanatory variables in the population. The result reveals that all the variables included in the model significantly influenced the output level at various percentage levels, except depreciation on capital items which was not significant, with all the variables exhibiting positive relationship except herbicides.

Furthermore, since the coefficient of the semi-logarithm equation divided by the mean of the output gives the elasticity or the coefficient of the semi-logarithms equation divided by the mean of the respective input is the MPP, the ratio to MPP to APP gives the elasticity, therefore, the following can be inferred: a unit increase in the level of farm size, family labour, hired labour, improved seeds and fertilizer will lead to 0.56, 0.19, 0.15 and 0.07 percent changes in output respectively, while a unit increase in herbicides will leads to -0.05 changes in output level. Variables with positive relationships means a unit increase in respective inputs leads to an increment in the output level, while the variable with negative relationship implies a unit increase in the respective input is accompanied by a decrease in the output level which mean the relationship between the input with respective to output has attained its third stage in the production process. Depreciation on capital items is not significant; as such need no further discussion. The positive relationship of family labour with output is a surprising outcome given that this kind of labour is offered free, cheap and in abundance. Furthermore, previous studies revealed negative relation given the peculiar farming system in Africa which is characterized by subsistence, peasantry, small-holdings which revolve round a vicious cycle continuously. The belief is that farm production and productivity is synonymous to size of the household in a characterized traditional agricultural setting, whereby large household is equivalent to higher output.

Table 1: Multiple Regression Estimates of Pearl Millet Production Function

Variables	Linear	Exponential	Semi-log (+)	Double-log
Constant	-199.44 (-1.10)^{NS}	6.08 (36.78)***	-2007.81 (-2.32)**	4.80 (9.18)***
Farm size	367.37 (5.44)***	0.28 (5.00)***	791.38 (4.78)***	0.58 (5.82)***
Family labour	7.20 (1.24)^{NS}	0.007 (1.5)^{NS}	271.1 (1.83)*	0.19 (2.14)**

Hired labour	8.45 (1.28)^{NS}	0.008 (1.33)^{NS}	207.31 (1.29)^{NS}	0.12 (1.12)^{NS}
Improved seeds	54.66 (1.73)*	0.018 (1.06)^{NS}	338.46 (1.69)*	0.19 (1.47)^{NS}
Fertilizer	2.82 (2.28)**	0.002 (1.77)*	100.08 (1.7)*	0.12 (1.77)*
Herbicides	-22.72 (-1.38)^{NS}	-0.022 (-1.58)^{NS}	-72.16 (2.24)**	-0.07 (1.70)*
Depreciation on capital items	0.028 (1.05)^{NS}	2.58E-3 (1.5)^{NS}	85.87 (1.16)^{NS}	0.05 (1.18)^{NS}
R^2 value	**0.85**	**0.77**	**0.78**	**0.82**
R^2 Adjusted	**0.83**	**0.74**	**0.76**	**0.81**
F-statistics	**55.176*** **	**33.177**	**35.986*** **	**47.29*** **

Source: Field survey 2014 *** ** * : significant at 1, 5 and 10 percent level of probability respectively. NS: Not significant; ( ): t – ratio computed; +: lead equation

4.2 Elasticity of Productive Resource and Return to Scale.

The sum of elasticities of 1.22 was obtained; this value being greater then unity, means that the farmers are operating at the region of increasing- returns to scale (Table 2). Increasing returns refers to a situation whereby an additional unit of input results in a larger increase in product than the preceding unit. This suggests that millet famers in the study area can increase their output by increasing the use of some of these key resources, except depreciation on capital item, thus, the need for re-allocation of existing resources optimally to maximize returns.

Table 2: Estimated Elasticitiesof Production Resource and Returns to scale

Variables	**Elasticity coefficients**
Farm size	0.56
Family labour	0.19
Hired labour	0.15
Improved seeds	0.24
Fertilizer	0.07
Herbicides	-0.05
Depreciation on capital items	0.06
Returns to scale	**1.22**

Source: Field survey, 2014

4.3 Estimates of resources use efficiency

Table 3 reveals measure of technical efficiency of resource use such as Average Physical Product (APP), Marginal Physical Product (MPP), and Marginal Value Product (MVP) and Marginal Factor Cost (MFC) were derived. The values of the MPP show that the farmers were more efficient in the use of land than other resources. This suggests that if additional hectares were available, it would lead to an increase in millet yield by 375.85 kg among the farmers. This means that the farmers were more technically efficient in the use of land. Of all the resources used, fertilizer had the least MPP (1.02 kg). This shows inefficiency in the use of available fertilizer. Given the level of technology and prices of both inputs and outputs, efficiency of resource use was further ascertained by equating the MVP to MFC of the productive resources. A resource is said to be optimally allocated if there is no significant difference between the MVP and MFC i.e. if the ratio of MVP to MFC =1 (unit). Furthermore, the result reveals that the ratios of the MVP to the MFC for all resources were greater than unity (1) except herbicides. This implies that farm size, family labour, hired labour, improved seed and fertilizer were under-utilized, while herbicides were over utilized. This implies that millet output was likely to increase and hence revenue if more of these inputs (farm size, family labour, hired labour, improved seed and fertilizer) had been utilized. The adjustment in the MVPs for optimal resource use indicates that for optimum allocation of resources more than 64.66% increase in farm size was required, while approximately 19.35% increase in family labour was needed. Similarly, over 21% increase of hired labour was needed, while more than 87% increase in improved seeds was required. Furthermore, fertilizer requires more than 9% resource allocation adjustment to attain optimum level. Herbicides were over utilized and required more than 3% reduction for optimal use in millet production.

Table 3: Estimates of Allocative Efficiency for Resource-use

Variables	MPP	APP	MVP	MFC	MVP/MFC	Divergence%
Land	376.85	675.91	22611	8000	2.83	64.66
Family labour	12.42	65.02	745.2	600	1.24	19.35
Hired labour	12.79	87.60	767.4	600	1.28	21.88
Improved seeds	60.44	253.46	3626.40	450	8.06	87.59
Fertilizer	1.02	14.45	61.2	55	1.11	9.91
Herbicides	-16.40	322.5p	984	950	-1.04	-3.85

Source: Field survey, 2014

5.0 Conclusion and Recommendations

Findings from this study revealed that millet farmers were allocatively inefficient in the use of farm resources. The inefficiency of the farmers may be directly or indirectly linked to the high cost of improved seeds, fertilizers cost, herbicides and rent cost. The implication of the study is that allocative efficiency in millet production in the study area could be increased through better use of improved seeds, fertilizer, herbicides land and subsidies on the aforementioned inputs. The improvement in the efficiency among the farmers is the responsibility of the individual farmers, government and research institutions. There should be improvement in extension services delivery, adequate provision of improved rural infrastructures and enabling policies (such as making available all agricultural inputs required at the right time and affordable prices) among others, are also required in order to enhance efficiency.

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