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Comparative Analysis of Cost Efficiency of Sorghum Production in India and Nigeria

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ABSTRACT: *This study analyzed and compared the cost efficiency of sorghum production in India and Nigeria. Data were collected through the administration of 480 copies of questionnaires to selected sorghum farmers (240 from each country on sorghum production) using simple random sampling and purposive sampling technique. The result of the stochastic frontier production function analysis shows that the variance parameters, that is the sigma squared (δ^2) and the gamma (γ) were statistically significant at 1 % level each for both countries of sorghum production. The coefficient of farm size, labour, seed and fertilizer were positive for India and significant while farm size, seed and fertilizer were positive and significant in Nigeria. Profit level can be increased in India by increasing the amount of farm size, labour, fertilizer and seed and decreasing the use of chemicals while Profit level can be increased in Nigeria by increasing the amount of farm size, fertilizer and seed and decreasing the use of labour and chemical. Mean cost efficiency were (0.5445) and (0.5802) for India and Nigeria respectively. Farmers operate at (45%) and (42%,) for India and Nigeria respectively below frontier level due to variation in cost, efficiency respectively. The inefficiency model shows that the coefficient of Age and Literacy Level was negative a priori sign and in consonance with the a priori expectation. It can be concluded that the farmers in the Nigeria state are more efficient than the farmers in India state*

Keywords: *Cost efficiency, Sorghum, India, Nigeria*

INTRODUCTION

Sorghum (*Sorghum bicolor* (L) Moench) locally called jowar, milo or guinea corn is the world's fifth major cereal in terms of production and acreage after wheat, maize, rice and barley (ICRISAT Website). Sorghum is now widely found in drier area of Africa, Asia, America and Australia. The total annual production ranges from 50-55 million tonnes from approximately 50 million ha, the most important producers are United States with annual production of 17 million tonnes grain from 5 million ha, India (11 million tonnes from 12.5 million of ha), Nigeria (6 million tonnes from 5.7 million ha), China (5,5million tonnes from 1.5million ha), Mexico (5.5million tonnes from 1.3 million ha) and Sudan (3 million tonnes from 5 million ha) (*http//www.icrisat.org/text/coolstuff/crop/gcrop*).

Sorghum has a variety of uses including food for human consumption, feed grain for livestock and industrial applications such as ethanol production. The area planted to sorghum worldwide has increased by 66 percent over the past 50 years, while yield has increased by 255 per cent. Around half of the sorghum produced is fed to livestock, and half is consumed by humans and used in other applications. Currently, most human consumption of sorghum occurs in low-income countries, while high-income countries typically use sorghum as a component in livestock feed or to produce ethanol. Sorghum is a versatile plant because it can tolerate drought, soil toxicities, a wide range of temperatures and high altitudes.

In the recent past various studies on technical efficiency of farmers have been carried out across so many communities in Nigeria and majority of their finding indicated that farmers are utilizing their resources below frontier level that is below unity (less than 100%) which agrees with this particular studies. Empirical evidence can be seen from the work of Shehu Tashkalma and Gabdo, (2007a); Shehu Mshelia and Tashkalma (2007b); Yusuf and Adenegan, (2008); Tashkalma (2010); Zalkuwi (2012); Daniel (2013) Zalkuwi (2014) etc.

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Several studies indicated that the existing low levels of cost efficiency hinder efforts to achieve progress in production (Belete *et al*., 1991; Seyoum *et al*., 1997). Despite the significant growth in sorghum production, there is huge inefficiency in the production system of sorghum production. An improvement in the efficiency of production system will have direct positive impact on agricultural growth, nutritional security and rural livelihood in a country like India and Nigeria, where sorghum is one of the major crops.

Under these circumstances it is important to know that whether the producers have the same or different levels of cost efficiency. The study therefore, tries to measure the cost efficiency under different farm in India and Nigeria.

METHODOLOGY

Selection of the State and Local Government

In Nigeria, Adamawa State based on their production level has been selected purposively. The state has twenty-one Local Government Areas which are categorized into four agricultural zones; South West, Central, North West and North East Zone. Twenty percent of Local Government Area have been (i.e four LGA) have been purposively selected from each zone, comprise Viz; Ganye, Demsa, Madagali and Girei.

In India, Maharashtra state was selected purposively being the highest sorghum producing state.

Selection of District

Ten percent of the district from each state was selected purposively on the basis of highest sorghum production.

Selection of Villages

A list of all villages in the districts was prepared on the basis of sorghum production, 10 percent of the villages having the highest sorghum production in each district were selected, and then 10 percent of the farmers were selected randomly to give a total of 240 farmers

Collection of Data

Primary data was used collected from 240 sorghum farmers from Adamawa state, Nigeria and 240 sorghum farmers in Maharashtra state, India. The main instrument that was used for collecting the data was structured schedule. Simple random sampling and purposive sampling techniques were used at various stages as the selection procedures in the selection of 480 respondents.

ANALYTICAL TOOL

The stochastic frontier production model was used to determine the efficiency of the sorghum farmers;

The Empirical Stochastic Cost Frontier Model

The empirical model used in determining cost efficiency of food crop farmers in the State is given by :

$$\ln C_{ij} = \beta_0 + \beta_1 \ln P_{1ij} + \beta_2 \ln P_{2ij} + \beta_3 \ln P_{3ij} + \beta_4 \ln P_{4ij} + \beta_5 \ln P_{5ij} + \beta_6 \ln P_{6ij} + V_{ij} - U_{ij} \quad (1)$$

Where:

Subscript ij refers to the j^{th} observation of the i^{th} farmer.

Ln = Logarithm to base e

C_{ij} = Total production cost (₦/ha) of the i^{th} farmer

P_1 = Expenses on land (₦)

P_2 = Cost of Family labour (₦/ha)

P_3 = Cost of seeds (₦/ha)

P_4 = Cost of inorganic fertilizer (₦/ha)

P_5 = Cost of agrochemicals (₦/ha)

The parameters of the empirical cost function were measured as:

(i) **Total production cost:** This measures the total cost of production per hectare in the last cropping season by the farmers. Since fixed cost of production is negligible in the short-run, the study only used variable cost of production per hectare as a proxy for total production cost.

(ii) **Expenses on land:** This is measured as the amount of money or its equivalent paid as rent for the use of land during the last cropping season. Where produce are given, the study used the value of 10% of the total output as proxy for expenses on land.

(iii) **Cost of family labour:** This is measured as the amount of money which would have been paid for labour if it is hired during farm operations. It is measured in naira per hectare.

(iv) **Cost of hired labour:** This is the amount of money paid for the hire of labour during farm operations. It is measured in naira per hectare.

(v) **Cost of agrochemicals:** This is the total expenses on herbicides and pesticides incurred by the farmer during the last

cropping season. It is measured in naira per hectare.

(vi) **Cost of inorganic fertilizers:** This is the total expenses on inorganic fertilizers such as NPK, Urea incurred by the farmer during the last cropping season. It is measured in naira per hectare.

(vii) **Cost of seed:** This is the total expenses on seed incurred by the farmer during the last cropping season. It is measured in naira per hectare.

It is assumed that the cost inefficiency effects are independently distributed and U_i arises by truncation (at zero) of the normal distribution with mean, m_{ij} and variance d^2, where m_{ij} is defined by:

$$\mu_{ij} = \delta_0 + \delta_1 Z_{1ij} + \delta_2 Z_{2ij} + \delta_3 Z_{3ij} + \delta_4 Z_{4ij} + \delta_5 Z_{5ij} + \delta_6 Z_{6ij} + \delta_7 Z_{7ij} \quad (2)$$

Where:

m_{ij} = Cost inefficiency of the i^{th} farmer

Z_1 = Denotes years of farming experience

Z_2 = Represent years of formal education

Z_3 = Extension contact (number of meetings)

Z_4 = Household size (number)

Z_5 = Primary occupation (dummy, where one indicated farming and zero otherwise)

Z_6 = Crop diversification (dummy, where one indicated mixed cropping and zero Sole cropping)

Z_7 = Credit availability (dummy, where one indicated those that accessed credit and zero otherwise)

RESULT AND DISCUSSION

Table 1
Maximum Likelihood Estimate of the Parameters of the Stochastic Cost Function

Variable	*India* *Parameter*	*Coefficient*	*t-ratio*	*Nigeria* *Coefficient*	*t-ratio*
Cost factors					
Constant	β_0	-0.1531	-0.1624	4.5348***	25.0180
Cost of land (P1)	β_1	0.1585***	7.4996	0.1554***	4.3465
Cost of labour (P2)	β_2	0.2202***	3.5386	0.0092	0.8391
Cost of seed (P3)	β_3	0.4744***	3.8908	0.1105***	2.6001
Cost of fertilizer (P4)	β_4	0.2518**	2.0730	0.2780**	2.522
Cost of chemical (P5)	β_5	0.0287	0.0616	0.0269	1.6628
Diagnostic statistics					
Sigma squared (W^2)		0.3559***	3.6827	0.7123***	6.4063
Gamma (δ)		0.5205***	4.0125	0.8314***	3.842

*** Estimates are significant at1% level
** Estimates are significant at 5% level.
*Estimates are significant at 10% level

The maximum likelihood estimate of the parameter of the stochastic cost frontier model of the sorghum farmers in India used in estimating cost efficiency is presented in Table 1. All parameters estimated have the expected sign. Most of the parameters estimates are significant except cost of chemical meaning that these factors are significantly different from zero and thus are important determinant of sorghum output except for cost of chemical not significant. The results implies that the variable (cost of land, cost of labour, cost of seed, and cost of fertilizer) used in the analysis have direct relationship with total cost of production. The cost elasticity with respect to all input variables used in the production analysis are positive , implying that an increase in the cost of land , cost of labour, cost of seed, and cost of fertilizer increases production cost. That is 1% increase in the cost of land will increase total production cost by approximately 0.16%, 1% increase in the cost of labour will increase total production cost by 0.22% ,1% increase in the cost of seed will increase total production cost by 0.47% and 1% increase in the cost of fertilizer will increase production cost by 0.25% The maximum likelihood estimates of the parameters of the stochastic cost frontier model used in Nigeria estimating cost efficiency is presented in Table 1**.** Three parameters out of five estimates have the expected sign and are statistically significant, ie cost of land (P_1), cost of labour (P_2), cost of fertilizer (P_4) while cost of seed

(P_3) and cost of chemical (P_5) are not statistically significant, meaning that these factors (cost of land, labour and fertilizer are important determinants of total cost associated with sorghum production in the study area. The cost elasticities with respect to this three input variables used in the production analysis are positive, implying that an increase in the cost of land, cost of labour, cost of fertilizer increases total production cost. That is, 1% increase in the cost of land will increase total production cost by approximately 0.1554%, 1% increase in the cost of seed will increase total production cost by 0.1105%, 1% increase in the and cost of fertilizer will increase total production cost by 0.2780%.This findings are in cosonances with Gwandi (2012), Maurice (2012) and Daniel (2013)

Table 2
Cost Efficiency Rating of the Sorghum Farmers

Efficiency	*India Frequency*	*Percentage*	*Nigeria Frequency*	*Percentage*
<0.40	48	20	24	10.0
0.40 – 0.49	41	17.0	50	20.8
0.50 – 0.59	34	14.0	52	21.7
0.60 – 0.69	46	19.1	54	22.5
0.70 – 0.79	48	20.0	50	20.8
0.80 – 0.89	22	9.1	10	4.2
0.90 – 1.00	2	0.8	0	0
Total	240	100	240	100
Minimum efficiency	0.1144		0.1156	
Maximum efficiency	0.9000		0.8709	
Mean efficiency	0.5445		0.5802	

The distribution of farmers' cost efficiency indices derived from the analysis of the stochastic cost function is presented in Table 2. The cost efficiency of the sampled farmers ranged from 0.1144 to 0.9000. The mean cost efficiency is estimated to be 0.5445, meaning that an average farmer in the study area has the scope for increasing cost efficiency by 45% in the short-run under the existing technology. This would enable the average farmer equate the marginal value product (MVP) of the inputs to the total production while for Nigeria the distribution of farmers' cost efficiency indices derived from the analysis of the stochastic cost function is presented in Table 2. The cost efficiency of the sampled farmers ranged from 0.1156 to 0.8709. The mean cost efficiency is estimated to be 0.5802, meaning that an average farmer in the study area has the scope for increasing cost efficiency by 42% in the short-run under the existing technology. This would enable the average farmer equate the marginal value product (MVP) of the inputs to the total production

Hypothesis 2: There is no significant difference between the cost efficiency of the farmers in the two countries ($X_1 = X_2$).

X_1 = India Sorghum Farmers

X_2 = Nigeria sorghum Farmers

Level of significance $\alpha = 0.05\%$

$\alpha/_2 = 0.025$

Z computed is 1.2471 Z tabulated =1.96 thus at 5% level of significance Z computed is greater than Z tab (1.2471 < 1.96). From the result, the null hypothesis was accepted and the alternative hypothesis was rejected. Meaning that at 5% level of significance there was no significant difference between the cost efficiencies for India sorghum farmers and Nigeria sorghum farmers. It is clear that, Nigeria and India sorghum producers have almost the same cost efficient.

CONCLUSION

Farmers in both study area operate below the frontier level, so Profit on the farms in India can be enhanced by increasing farm size, increasing the human resources, increasing the quantity of seed and the use of fertilizer on the farm while Profit on the farms in Nigeria can be enhanced by increasing farm size, increasing the quantity of seed and the use of fertilizer on the farm.

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