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Resource Use Efficiency In Sorghum Production In Guyuk Local Government Area Of Adamawa State, Nigeria

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Abstract: *The study examined the resource use efficiency of sorghum production in Guyuk Local Government area of Adamawa State, Nigeria. Data were collected from 100 farmers using purposive and simple random sampling with aid of structured schedule.*

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 for tomato production. The coefficient of farm size and seed were positive and significant at 1% level while family and hired labor was negative and not significant at the same level. Profit level can be increased by increasing the amount of farm size and quantity of seed, and decreasing the use of manual labor. Mean efficiency was 0.88; Farmers operate at 11.77% below frontier level due to variation in technical efficiency. . The inefficiency model shows that the coefficient of Age, Gender and family size have negative a priori sign and in consonance with the a priori expectation.

1. Introduction:

Sorghum (*Sorghum bicolor* (L) Moench) locally called 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 40-45 million tonnes from approximately 40 million ha, the most important producers are United States with annual production of 17 million tonnes grain from 4 million ha, India (11 million tonnes from 12.5million of ha), Nigeria (6 million tonnes from 5.7 million ha), China (5,5million tonnes from 1.5million ha), Mexico (4.5million tonnes from 1.3 million ha) and Sudan (3 million tonnes from 5 million ha) (http//www.icrisat.org/text/coolstuff/crop/gcrop). In West and Central Africa, the increase in sorghum area was more than two-fold from 1972 (7.39 to 16.59 million ha), while production increased by almost four times during the same period (4.24 to 16.08 million tons). However, there was 22% reduction in area (12.92million ha) and 28% reduction in production (11.52 million tons/ha) in 2009. Grain yield increased by 17% over 2008 levels. Overall in WCA, an 80% improvement in productivity was seen from the early 1970s (700 kg/ha) to 2009 (1260 kg/ha) (http//www.icrisat.org/text/coolstuff/crop/gcrop). Sorghum is a staple food crop for millions of the poorest and most food-insecure people in the semi-arid and tropics of Africa. It is one of the most important staple foods in Nigeria. The grain is essentially use for human consumption as well as industrial raw material for beer brewing and for the production of syrup, drugs in pharmaceutical industries. The Stover (leafs and stalks) are used as livestock feed while the stalks are use for thatching house and making fences (FAO, 2003). In Adamawa State, sorghum is the most cultivated crop and it is grown on an area of about 70000 hectares (ADADP,1996). Several studies indicated that the existing low levels of technical 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 Nigeria, where sorghum is one of the major crops.

2. Methodology:

2.1. Data and Sampling Design:

Adamawa State being one of the largest sorghum producing state in Nigeria was selected by using purposive sampling. There are twenty-one (21) Local Government Areas (LGAs) in Adamawa state. Out of twenty-one (21) LGA, Guyuk Local Government Area (LGA) was selected for this study. The Local Government Area consists of 10 wards namely; Banjiram, Bobini, Chikila, Guyuk, Kola, Dukul, Bodeno, Rokoro, Purokayo and Dumna. It has an estimated land area of 871.9 km^2 with an estimated population of 177,785 people out of which 90, 422 are males while 87,363 are females based on 2006 census (CBN, 2007).

Guyuk local government area being one of the largest producers of sorghum was selected purposively. Five wards viz. Banjiram, Dumna, Mada, Rokoro and Purakayo out of ten wards having high production proportion were selected purposively. From each selected ward two villages were purposively selected to give ten villages. Finally, ten farmers were randomly selected to give a total sample of one hundred (100) respondents.

Farming is the major occupation of the people of the area with sorghum as the main crops. Other crops cultivated in the area include maize, rice, millet, sweet potatoes, cassava, cowpea and cotton.

Data for the study were obtained from primary source. The data were collected with the use of a structured schedule from 100 farmers.

2.2. Analytical Tools:

The stochastic frontier production model was independently proposed by Aigner *et al.* (1977) and Meeusen and Van den Broeck (1977). It employs a Cobb-Douglas production function to simultaneously estimate the random disturbance term (V_i) which is outside the control of the production unit and the inefficiency effects (U_i) as proposed by Battese *et al.* (1996).

The stochastic frontier production function used in this study was specified as follows:

$$\text{Log}Y_i = B_o + B_1 \log X_1 + B_2 \log X_2 + B_3 \log X_3 + \ldots\ldots\ldots\ldots B_6 \log X_6 + V_i - U_i \ldots..(1)$$

Y = Output of sorghum in kg

X_1 = Farm size in hectares

X_2 = Quantity of fertilizer applied in kg

X_3 = Quantity of sorghum seed planted in kg

X_4 = Quantity of herbicides used in litres

X_5= Amount of family labour used in man-days

X_6 = Amount of hired labour used in man-days

X_7 = Expenses on ploughing (tractor and animal traction)

V_i = Random noise (white noise) which are $N(0,\delta^2, V)$

U_i = Inefficiency effects which are non-negative, half normal distribution $N(0,\delta^2, U)$

The technical efficiency of sorghum production for i^{th} farmers, defined by the ratio of observed product as to the corresponding frontier production associated with no technical inefficiency, is expressed by;

$TE = Exp(-U_i)$ so that $O \leq Te \leq 1$……..……..(2)

Variance parameters are δ^2 =

$\delta^2_V + \delta^2_U$ and $\gamma = \delta^2_U / \delta^2$ .....(3)

So that $O \leq \gamma \leq 1$

The inefficiency model is defined by,

$U_i = \delta_o + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + \delta_6 Z_6 + \delta_7 Z_7$……..(4)

Where,

U_i = inefficiency effect

Z_1 = Age of farmer (in years)

Z_2 = Literacy level (in years)

Z_3 = Farming experience (in years)

Z_4 = Extension contact (1 contacted, 0 otherwise)

Z_5 = Gender of the farmer (1 female and 0 for female)

Z_6 = Family size (total number of person in household)

Z_7 = Access to formal credit (binary)

δ^2, δ_o, γ, βs are unknown parameters that were estimated.

The potential level of output was derived by averaging the yield of ten highest farmers. The maximum likelihood estimate (MLE) for all the parameters of the stochastic frontier production function and the inefficiency model defined above and the technical efficiency was obtained using the Frontier 4.1 computer programme (Coelli, 1994; Ajibefun, 1998).

3. Results And Discussions:

3.1. Stochastic Frontier Production Function And Inefficiency Model Result:

The maximum likelihood estimates of the stochastic frontier production function and inefficiency model results are presented in Table 1 and 2. The estimate for parameters of the stochastic frontier production function indicates that the elasticity of output with farm size was positive and approximately 0.533 and it was statistically significant at 1 % level. This implies that a one percent increase in area under sorghum production will raise output of sorghum by 0.533 % this shows that land is a very important factor in sorghum production. This finding is at tandem with the findings of Eyo and Igben (2002); Maurice *et al.*, (2005); Odoh and Folake (2006), that land has positive sign and statistically significant.

The production elasticity of seed is 0.259 it was statistically significant at 1% level, this also, implies that a one percent increase in seed under sorghum production will raise the output of sorghum production by 0.259 % So seed is also a very important factor of production. The significant and positive sign of seed variable also indicated that a moderate increase in population of sorghum on the field will increase the yield provided that, the farm is not overpopulated beyond the recommended sorghum carrying capacity that will lead to competition for nutrients which will lower the yield. This finding is in consonance with the work of Shehu *et al.* (2007a) and Ogundari (2008), who found that seed is an important factor in production.

The production elasticity of fertilizer was -0.016 it was statistically significant. The production elasticity for herbicide was 0.019 and was not statistically significant, the

coefficient for family labour (-0.010) and hired labour (-0.003) were negative and insignificant, which is contrary to *apriori* expectation signs. The negative effect and the insignificance of family and hired labour may be attributed to the over dependence of respondents on manual labour as well as over use of the variable inputs. This is a common feature of agricultural production in the developing countries like Nigeria. A unit increase in labour tends to increase the cost of sorghum production and consequently reduces the output. This findings therefore is an indication that labour is the most critical variable input in sorghum production in the study area which reduce the output of sorghum farmers.

3.2. Determinants OF Technical Inefficiency:

Table 2 presents the coefficients of inefficiency function which explain levels of technical inefficiency among the respondents. It should be noted that the signs of the coefficient in the inefficiency model are interpreted in the opposite way and such a negative sign means that, the variable increase efficiency and positive sign mean that it decreases efficiency (Adebayo, 2007). The coefficient of age (-2.728) had negative sign and inconsonance with *apriori* expectation. It was statistically significant and different from zero at 10%. This implies that increase in the age of the farmers by one unit (year) will increase the efficiency of the farmers.

The estimated coefficient for years of farming experience was (-0.583), it was statistically significant at 10% level. The sorghum production has a negative coefficient, implying that, respondents' with high years of farming experience, are more efficient than those with lower years of farming experience. This is an indication that years of farming experience was not a critical factor of inefficiency among respondents who cultivated sorghum in the study area.

The estimated coefficient for extension contact is -0.442 for respondents involved in sorghum production; it had a positive sign and was statistically insignificant. Its significant may be attributed to the poor extension services experienced by respondents since the withdrawal of funding by the World Bank to the Agricultural Development Programme (ADP) in Adamawa as it is in other states of the federation.

The coefficient of gender and family size are (0.007) and (0.395) both the coefficient for gender and household size had positive sign and was statistically insignificant. This implies that increase in family size by one unit (Adult) will increase the efficiency of the farmer.

The estimated sigma square (δ^2) in Table 1 was large (0.552) and significantly different from zero. This indicates a good fit and the correctness of the specified distributional assumption of the composite error term. The variance ratio of gamma (γ) which was associated with the variance of technical inefficiency effect in the stochastic frontier was estimated to be 0.70 production system. This indicates that 70 of the total variation in sorghum output for the farmers were due to differences in technical efficiency (TE). This also implies that the ordinary least squares estimates may not be adequate enough to explain the inefficiency variation among the respondents hence the use of stochastic frontier production function.

3.3. Technical Efficiency Of Sorghum Farmer In The Study Area:

The technical efficiency in Table 2 was derived from MLE result of the stochastic production function. The result shows that the TE of the respondents was less than 1 (100 %) hence the variation in TE exits among respondents. It means that, all the respondents produced below maximum efficiency. The minimum efficiency of sorghum producers was 0.5545, while their maximum efficiency was 0.9761; and the mean efficiency was 0.8823.

The distribution of the farm efficiency in sorghum production shows that, majority (88 %) of them operated above 79 % of their maximum efficiency and only 12 % operated between 50-79 %.

Variable	**Parameter**	**Coefficient**	**t-value**
Constant	β_0	2.872	22.836***
Farm size (X_1)	β_1	0.533	5.347***
Fertilizer (X_2)	β_2	-0.016	-1.893*
Seed (X_3)	β_3	0.259	3.109***
Herbicide (X_4)	β_4	0.019	1.624
Family labour (X_5)	β_5	-0.010	-0.879
Hired labour (X_6)	β_6	-0.003	-0.377
Inefficiency model			
Constant	δ_0	3.080	2.782***

Age	δ_1	-2.728	-1.916*
Literacy level	δ_2	-0.095	-1.823*
Farming experience	δ_3	-0.583	-1.820*
Extension contact	δ_4	-0.442	-0.794
Gender	δ_5	0.007	0.148
Family size	δ_6	0.395	1.562
Variance parameters			
Sigma squared	δ^2	0.589	4.595***
Gamma	Γ	0.999	7180.188***

Source: computed from stochastic Frontier Result
***=Significant at 1%
**= Significant at 5%
*= Significant at 10%

Table 1: Maximum Likelihood Estimate of the Cobb-Douglas Stochastic frontier production function and inefficiency model for sorghum farmers

Efficiency	Frequency	Percentage
<0.40	-	-
0.40 – 0.49	-	-
0.50 – 0.59	4	4
0.60 – 0.69	3	3
0.70 – 0.79	5	5
0.80 – 0.89	27	27
0.90 – 1.00	61	61
Total	100	100
Minimum efficiency		0.5545
Maximum efficiency		0.9761
Mean efficiency		0.8823

Source: Computed from Stochastic Frontier Result

Table 2: Frequency Distribution of Technical efficiency rating of the sorghum farmers

4. Conclusion:

It may be concluded from the study that under the given socio-economic and farm conditions (including technology), the production of sorghum can be increased by more than 11 percent. Profit on the far can also be enhanced by reducing the human resources, which are over employed on the farm. It is suggested that the Government of Nigeria should strengthen the technology dissemination work in order to increase the efficiency of farmers. A policy should also be framed to transfer the surplus human resource from agricultural sector to another sector, which will increase the profitability of farms and improve the labor efficiency.

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