Determinant of Cost Efficiency in Cowpea Production: A Case Study of Adamawa State, Nigeria

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Abstract: ***The study evaluates the allocative efficiency of cowpea production in Adamawa State, Nigeria. Data were collected from 250 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 cowpea production. The coefficient of farm size, labour, seed and chemical were positive and significant at 1%, 5% and 10% levels while fertilizer was not significant. Profit level can be increased by increasing the amount of farm size quantity of seed ,labour and chemical and decreasing the use of fertilizer. Mean efficiency was 0.66; Farmers operate at 34% below frontier level due to variation in Allocative efficiency. The inefficiency model shows that the coefficient of Gender, family size, farming experience and extension have negative a priori sign and in consonance with the a priori expectation.***

Keywords: Allocative efficiency, cowpea and Adamawa State

1. Introduction

Cowpea (*Vigna unguiculata* (L.) Walp.) is of vital importance to the livelihoods of millions of people in the semi-arid regions of West and Central Africa. It is the most important grain legume crop in sub-Saharan Africa. Cowpea is a protein-rich grain that complements staple cereal and starchy tuber crops. It also provides fodder for livestock, improves the soil by fixing nitrogen, and benefits households by bringing in cash and diversifying sources of income. The sale of cowpea stems and leaves for animal feed during the dry season provides vital household income. An estimated 14.5 million hectares of land is planted to cowpea each year worldwide. Global production of dried cowpeas in 2010 was 5.5 million metric tons; Africa was responsible for 94% of this. Nigeria is the largest producer and consumer of cowpea, producing 2.2 million metric tons of dried grain in 2010 (CGIAR). Adamawa state with increasing population over the years, the demand for the crop had gone up but the production has not been increase significantly (Agwu, 2001). This study is therefore to evaluate the allocative efficiency of production of the crop and also identifies the factors affecting the inefficiency in the production process in Adamawa State, Nigeria.

2. Methodology

2.1 Selection of the state and local government:

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 Local Government Area have been(i.e four LGA) have been purposively selected from each zone, comprise Viz; Mayo belwa, Guyuk, Mubi south and Girei.

2.2 Selection of district

Ten percent i.e. one district from each Local government was selected purposively on the basis of highest cowpea production.

2.3 Selection of villages

A list of all villages in the four districts was prepared on the basis of cowpea production, 10 percent of the villages having the highest cowpea production in each district were selected, and then 10 percent of the farmers were selected randomly to give a total of 250 farmers

2.4 Collection of data

Primary data was collected from 250 cowpea farmers from Adamawa state, Nigeria. 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 250 respondents.

2.5 Analytical tools

The inferential statistics (the stochastic frontier production model) was used.

2.6 The Empirical Stochastic Cost Frontier Model

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

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

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:

1) **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.
2) **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.
3) **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.
4) **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.
5) **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.
6) **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.
7) **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, μ_{ij} and variance δ^2, where μ_{ij} is defined by:

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

Where:
μ_{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)

3. Results and discussion

The maximum likelihood estimate of the parameter of the stochastic cost frontier model of the cowpea farmers in India used in estimating allocative efficiency is presented in Table1. All parameters estimated have the expected sign. Most of the parameters estimates are significant except cost of fertilizer meaning that these factors are significantly different from zero and thus are important determinant of cowpea output except for cost of fertilizer not significant. The results implies that the variable (cost of land, cost of labour, cost of seed, and cost of chemical) 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 chemical increases production cost. That is 1% increase in the cost of land will increase total production cost by approximately 0.03%, 1% increase in the cost of labour will increase total production cost by 0.15%, 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 0.16% The maximum likelihood estimates of the parameters of the stochastic cost frontier model used estimating allocative efficiency is presented in Table 1**.** four 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 seed (P_3) and cost of chemical while cost of fertilizer (P_4) is not statistically significant, meaning that these factors (cost of land, labour, seed and chemical are important determinants of total cost associated with cowpea production in the study area. This findings is in harmony with Maurice (2012) and Gwandi(2012)

The inefficiency parameters include gender, age, family size, education, farming experience and extension agent. The inefficiency parameters are specific as those relating to farmers specific socio-economic characteristics and were examined by using the estimated ɗ coefficients. According to Adebayo, (2007), a negative ɗ coefficient indicates that the parameters have a positive effect on efficiency and vice versa.

The coefficient of gender is estimated to be negative and statistically significant at 5% level. This implies that increase in the gender by one unit will increase the efficiency of the farmers, This implies that increase in family size by one unit (Adult male) will increase the efficiency of the farmer.This is in tendem with the findings of Zalkuwi (2012)

The coefficient of age (0.0775) had positive sign and is not in agreement with a priori expectation. It was not statistically significant and different from zero at all levels. This implies that increase in the age of the farmers by one unit (year) will decrease the efficiency of the farmers.

The coefficient of farming experience is negative and significant, meaning that as the farming experience of cowpea farmers in the study area increases, their Allocative inefficiency will decrease. This is in harmony with the study of Adebayo and Lawal (2000), and Ogundari and Ojo (2007) which also show a decrease in the Allocative inefficiency of farmers as their farming experience increases

The coefficient of education variable is estimated to be negative and is not statistically significant. This implies that farmers that are illiterate tend to be more efficient in agricultural production; this is due to their enhanced ability to acquire Allocative knowledge, which enhances their Agricultural productivity. It is plausible that farmers with not education respond easily to the use of improved technology.

The coefficient of the extension variable is estimated to be negative and statistically significant at 1% level. This indicates that increased extension services to farmers tend to increase Allocative efficiency in food crop production. Extension visits affords the farmer the opportunity to learn improved technologies and how to acquire the needed inputs and services. The significance of extension in this study corroborates the findings of Seyoum *et al.* (1998), Amaza *et al.* (2006), Shehu et al (2007a) who reported positive influence of extension contact on efficiency.

The estimated gamma parameter (γ) of 8004 is highly significant at 1% level, indicating that 80% of the variation in the total cost of production among the sampled farmers is due to differences in their cost efficiencies. Sigma squared (σ^2) on the other hand is 0.585 and is statistically significant at 1% level indicating correctness of fit of the model as assumed for the composite error term.

Table 1: Maximum likelihood estimate of the parameters of the stochastic cost function

Variable	*Parameter*	*Coefficient*	*t-ratio*
Cost factors			
Constant	β_0	3.1225***	11.7659
Cost of land (P1)	β_1	0.0294**	2.0958
Cost of labour (P2)	β_2	0.1538*	1.8983
Cost of seed (P3)	β_3	0.4687***	5.7207
Cost of fertilizer (P4)	β_4	0.0650	0.6715
Cost of chemical (P5)	β_5	0.1545**	0.2505
Inefficiency effects			
Gender	d_1	-0.0914**	-2.4417
Age	d_2	0.7753	1.7804
Family size	d_3	-0.4278***	-3.6113
Literacy level	d_4	-0.03089	-1.2013
Farming experience	d_5	-0.2392***	-4.1174
Extension contact	d_6	-0.0569***	-0.0348
Diagnostic statistics			
Sigma squared (d^2)		0.0584***	7.9421
Gamma (ϒ)		0.8003**	0.2433

Source: Computer printout of frontier 4.1
*** Significant at 1% **Significant at 5%*Significant at 10%

Frequency Distribution of Allocative Efficiency Rating of the Cowpea Farmers

Efficiency	*Frequency*	*Percentage*
<0.40	25	10.0
0.40 – 0.49	26	10.4
0.50 – 0.59	29	11.6
0.60 – 0.69	50	20.0
0.70 – 0.79	70	28.0
0.80 – 0.89	50	20.0
0.90 – 1.00	0	0
Total	250	100
Minimum efficiency	0.2239	
Maximum efficiency	0.8995	
Mean efficiency	0.6611	

The distribution of farmers' allocative efficiency indices derived from the analysis of the stochastic cost function is presented in Table 2. The allocative efficiency of the sampled farmers ranged from 0.2239 to 0.8995. The mean allocative efficiency is estimated to be 0.6611, meaning that an average farmer in the study area has the scope for increasing allocative efficiency by 34% 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

4. Problems affecting cowpea Production in the Study Area

From Table 3 the major production constraints confronting the farmers have been examined. Majority of the farmers (13.2%) in indicated that pest and disease are the most serious problems affecting cowpea farmers. Pest and disease can affect the farmer's productivity by reducing the quantity produce. More than 12% of the farmers also reported that high cost of fertilizer is one of their major problems militating against increase production. Lack of fertilizer could decrease the production. Other problems mentioned among the farmers were poor market arrangement (11.2%), inadequate information on innovation (9.9%), inadequate and high cost of herbicide (11.9%) , high cost of transport (9.7%), high cost of labour (2.7%), lack of improved seed (12.6%), poor pricing(5.9%) and limited farm size(2.0%). The cumulative effects of these problems can affect cowpea output negatively. These problems were earlier identified by Adebayo and Onu (1999),Zalkuwi et al (2013).

Table 3: Problems Affecting Cowpea Production

Table	Frequency	Percentage	Ranking
Inadequate credit facilities	68	8.4	1
High cost of labour	22	2.7	9
Lack of improved seed	102	12.6	2
High cost of Herbicide	97	11.9	4
Inadequate and high cost of fertilizer	102	12.6	2
Limited farm size	16	2	10
Inadequate information on innovation	80	9.9	6
Pest and disease	107	13.2	1
High cost of transportation	79	9.7	7
Poor pricing	48	5.9	8
Poor market arrangement	91	11.2	5
Total	812*	100	

5. Conclusion

It may be concluded from the study that under the given socio-economic and farm conditions (including technology), the production of cowpea can be increased by more than 34 percent. Profit on the farm can also be enhanced by increasing farm size, increasing the human resources, increasing the quantity of seed and the use of chemical 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.

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