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Input – Output Relationship in Cassava Production: Empirical Evidence among Cassava Farmers in Kogi State, Nigeria

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Abstract

This study assessed the input and output relationship in cassava production in Kogi State, Nigeria. A multistage random sampling technique was used to select 120 cassava farmers for the study. The survey instrument was a structured questionnaire. Data were collected on farmers' socioeconomic characteristics, inputs used in cassava production, and other relevant data. The data were analyzed with the use of descriptive statistics and Cobb- Douglas stochastic frontier production function. The result of the socioeconomic characteristics of the respondents showed that most of the farmers were female (64.2%). This study found an average age of 39.8 years among cassava farmers with a mean family size of 8 members and an average farm size of 3.7ha. Inputs identified in cassava production are; herbicide (65%), hired labour (50.8%), pesticide (21.7%), organic manure (38.3%), fertilizer (29.2%) and improved cassava cuttings (22.5%). The parameters of the production function were estimated by the maximum likelihood method using the computer program frontier. Results indicated that farm size (β = 75862.79), cassava cuttings (β = 63.4853), and labour (β = 409.4048) significantly influenced the output of cassava farmers at 5% level of significance. Furthermore, age (β = -.9921587), household size (β = -10.52704) and farming experience (β = 1.634783) significantly influenced inefficiency among cassava farmers in the area. Recommendations made to enhance the input-output relationship in cassava production include; provision of improved cassava cuttings to boost cassava production and there should be adequate farmland for cassava framers.

Keywords:
Cassava, Input, Output, Frontier, Inefficiency

1. Introduction

Cassava is an important stable crop in Sub Sahara Africa (SSA) where it plays crucial role in the food economy. In most countries in SSA, the crop has a comparative advantage compared to other food crops. It is available in all year round and tolerant to extreme weather condition. Hence, Philip (2004) nicknamed the crop as the "famine security crop". Aside its consumption in African countries, cassava products are exported as source of foreign earnings. The crop can serve as; food, flour, animal feed, alcohol, starches for sizing paper and textiles, sweeteners, prepared foods and bio-degradable products. These products are derived from a number of forms, ranging from fresh leaves and roots to modified cassava starch (Agricultural Research Council, ARC, 2019). Furthermore, the leaves are relatively rich in protein and can be consumed. Cassava can also be stored in the ground for several seasons, thereby serving as a reserve food when other crops fail. Cassava is also increasingly used as an animal feed and in the manufacture of different industrial products. It is also used in industrial processes (ARC, 2019). More than 70 percent of cassava produced in the world is concentrated in five countries of Nigeria, Brazil, Thailand, Indonesia and the Congo Democratic Republic (FAO, 2017). Nigeria produced about three times more than the production in Brazil and almost doubled that of Indonesia and Thailand. Nigeria cassava production contributed 19% to the world cassava output, 34% to that of Africa and 46% to the output of West Africa, while West Africa accounts for 75% of Africa's output. In 2016, Nigeria also ranked first in world cassava production, producing 57,134,478 tons of cassava. Thailand ranked second producing 31,161,000tons (FAO, 2016). Cassava is produced in Nigeria largely by small-scale farmers using simple farm implement. The average land holding is less than two hectares and for most farmers, land and family labour remain the essential input. Land is held on communal, inherited or rented basis. Cases of outright purchase of land are rare. According to the United Nations Food and Agriculture Organization (FAO, 2017), cassava ranks fourth as a food crop in the developing countries, after rice, maize and wheat. Cassava is the most widely grown root crop in Kogi State because it plays vital role in the food security of the rural economy. Cassava is easy to cultivate and maintain compared to other tuber crops where a lot of time and resources are expended on its production. There are many improved cassava cultivars under cultivation in Kogi State, notable among them are the TMS varieties developed by the international Institute for tropical agriculture (IITA) and the NR varieties developed by the National Root Crops Research Institute (NRCRI). Some of those TMS varieties are the TMS 30001, TMS 30211 and TMS 30395. Those of NR varieties are NR7721, NR7734 and NR8208. The local names of those varieties among the farmers in the state are: Governor, Omotoso, Oko-iyawo, Agric, New Agric and Enugu respectively. These improved varieties along with the local varieties can be distinguished from each other by their morphological characteristics such as leaf size, colour and shape, branching habit, plant height, colour of stem, shape of tuber, time of maturity, and leaves.

Efficiency study has assumed important dimension in agricultural production because scarce resources are combined to produce outputs. The success of any farm business depends on the ability of the farmer to combine the scarce resources in the right proportion. The agricultural problem in Nigeria relates to the inefficient use of resources (inputs) on the farm (Bamidele et al, 2008). The ability to quantify activities and expenses are completely lacking, making it difficult to clearly define profit or loss. Despite efforts made by the Kogi state government in improving agricultural productivity and efficiency of the rural farmers, there exist a gap in terms of the efficient use of productive resources with implication on food security and farmers' welfare.

The food situation and income generation by farmers in Kogi State has become critical as domestic food production cannot meet the food need of the rapidly growing population. FAO (2017) opined that alleviating food insecurity entails both physical and economic access to food particularly staple food to the farmers. Cassava is one of the staple food crops that play an important role in the State's food security and income generation. It is grown by virtually all farmers in Kogi State. The quest to ascertain the resultant effect of various inputs on cassava production to meet food demand and improve farmers' standard of living informed the research.

The specific objectives of this study are to: describe the socio-economic characteristics of cassava farmers in the study area; identify the inputs used in cassava production; and determine the input-output relationship in cassava production.

2. Materials and methods

The study was carried out in Kogi State, Nigeria. The State is located in the middle-belt of Nigeria. It has twenty-one Local Government Areas (LGAs) presently and made up of different ethnic groups majorly; Igala, Ebira, Yoruba and Nupe. The State extends from latitude 6'330N to 8'440N and longitude 5'400E to 7'490E. It has the population of about 4473490 (FAO, 2017). Kogi State has a tropical climate; the climate is divided into two major seasons; dry and wet seasons. The wet season begins towards the ending of March and the dry season toward the ending of October or April and November respectively for very dry year. The harmattan wind commences from December to January. The average annual rainfall rages from 850mm to 2000mm. During raining season the daily mean temperature is about 28oC and 35oC for hot season (KADP, 2011). The vegetation consists of rainforest in the southern part of the state and the woody derived savannah and Guinea savannah in the northern extreme. Generally the land mass is flat or gently undulating and lies at 50m to 700m above sea level. Kogi State is also known as the confluence state, due to the fact that the two largest rivers in Nigeria "Rivers Niger and Benue" flowing through the state, met at a confluence in Lokoja, the state Headquarter. Farming is a major occupation among the people.

Multistage random sampling technique was employed in selecting respondents. First, two (2) agricultural Zones were randomly selected from the four agricultural zones in Kogi State. Secondly, two (2) extension blocks were randomly selected from each agricultural zone to give four extension blocks. Thirdly, three (3) extension cells were randomly selected from each block to give twelve (12) extension cells. Finally, ten (10) cassava framers were randomly selected from each extension cell making a total of one hundred and twenty (120) respondents.

Primary data was used for the study. The primary source of data involved the use of a structured questionnaire to collect information on cassava framers' socio-economic characteristics, inputs used in cassava production, output produced and other relevant variables of interest.

Objectives 1 and 2 were achieved using descriptive statistics such as mean, frequency distribution, percentage and mode, while objective 3 was achieved using a production function model.

Model Specification – Production Function Analysis

According to Adegeye and Dittoh (2015), the primary objective of production function analysis is to determine the various factors which cause variations in the dependent variable. It is concerned with the study of the relationship between one variable called the explained or dependent variable and one or more other variables called independent or explanatory variable(s). Stochastic frontier Cob Douglas form of Production function and the technical inefficiency model were used to analyze objective iii- input-output relationship in cassava production in Kogi State. The stochastic frontier Cobb-Douglas production function in it simplest form is specified as follows:

$$Ln Y = Ln\beta 0 + \beta 1LnX1 + \beta 2LnX2 + \beta 3LnX3 + \beta 4LnX4 + \beta 5LnX5 + \beta 6LnX6 + \beta 7LnX7 + Vi + Ui$$

where:

Y = Output (kg) of the cassava produced

β0 = constant

β1 – β7 = estimated regression coefficients

X1 = farm size (ha). , X2= labour (man-days).

X3= seed/stem cuttings (kg).

X4 = herbicide (Li).

X5= pesticides (Li)

X6=fertilizer (kg)

X7=organic manure (kg)

Vi= stochastic error term

Ui = randomness (technical inefficiency) due to farmers' socioeconomic characteristics such as: age, farm size, farming experience among others. The technical inefficiency model is specified as follows:

$$Ui = \delta 0 + \delta 1Z1 + \delta 2 Z2 + \delta 3 Z3 + \delta 4 Z4$$

Where:

Ui = randomness (technical inefficiency) due to farmers' socioeconomic characteristics

Z1 = age (years), Z2 = level of education (years)

Z3 = household size (number of persons in the households), Z4= farming experience (years)

δ0 = constant , δ1 – δ4 = estimated parameters

3. Results and discussion

3.1 Socioeconomic Characteristic of Cassava Farmers

The socioeconomic characteristics of respondents considered in this study are: gender, age, family size, level of education, years of experience, access to extension services, membership of any cooperative society, occupation, how land is acquired, farm size and annual income. From Table 1, the involvement of more female in cassava production indicates that cassava production is gender non-exclusive, and can be carried out by both female and male folks. This agrees with the findings of Ebukiba (2010), who found that 60% of the cassava farmers in Akwa Ibom State were females. The mean age f about 40 years is an indication that cassava farmers in the study area were relatively active and productive. This agrees with the findings of Orebiyi et al (2011), who found that mean age of respondents was 49 years. This may have positive effect cassava output in the area in terms of family labour, given that the farmers are more energetic compare to older farmers. This finding agrees with Onogu (2018), who reported age to have cluster between 31- 40 among farmers in Kogi State Nigeria. The average family size of respondents was approximately 8 persons; this is an indication that a large family is still a common practice among farmers as they often depend on family labour. The importance of family labour cannot be overemphasized, because household size is the principal determinant of labour availability in small scale farming given the relatively soaring cost of hired labour. Table 1 further shows that most (65.8%) of the respondents had attained tertiary education. This implies that the farmers are very much likely to adopt innovative ideas that will help increase cassava output. The mean cassava farming experience of 12.8 years is an indication that majority of the farmers have taken into cassava production for a while in the State. This may lead to better decision to improve productivity since experience is the best teacher. Result also show that cassava farmers in the study area mostly (60.8%) acquired their cassava farmland through inheritance, then 12.5%, 12.5%, 7.5% and 6.7% acquired as gift, lease, borrow and purchase respectively. This implies that fragmentation of farmland will be common, leading to small farm size available for cassava farming. Cassava farmers in the State could be categorized as smallholder farmers since the mean farm size is approximately 4 hectares. Todaro (1992) defined small scale farmers as those cultivating not more than 3-5 ha of farm land.

3.2 Inputs Used in Cassava Production

The inputs used in cassava production considered in this study are: variety of cassava, fertilizer, herbicide, pesticide, organic manure, and labour as presented in Table 2. Table 2 shows that most of the respondents cultivated local variety of cassava. This implies that cassava farmers in the study area have partly adopted the use of improved variety of cassava, hence, there is potential for increased yield. Furthermore, 70.8% of the respondents did not use fertilizer in cassava production. This may have implications on high incidence of pest and diseases infestation and associated negative impact on output. This agrees with Evangeline (2013), who found that the use of fertilizer was not wildly practiced by cassava farmers in Anambra State, Nigeria. Furthermore, cassava farmers that adopted fertilizer application mostly used NPK fertilizer on their farm. Table 2 also shows that most (65%) of the cassava farmers used herbicides on their farms. This implies that weed is controlled easily to prevent competition for soil nutrients, thus increasing cassava output. This agrees with Gyanden (2012), who reveals that 75% of the farmers in Benue State applied herbicides on their farms. Of the number that used herbicides, most of the farmers applied glyphosate and gramozone, and primextra. Result in Table 2 also shows that the use of pesticide was not mostly practice among cassava farmers in the study area and such may reduce the cost of cassava production. This may however lead to reduction in cassava output in the face of pest and disease infestation. Also, majority (61.7%) of the farmers did not use organic manure in cassava production and this may have implications on organic farming in cassava production enterprise.

3.3 Input – Output Relationship in Cassava Production

Estimate of the maximum likelihood for parameters of the Cobb-Douglas stochastic production frontiers and technical inefficiency model for cassava farmers in the study area is presented in Table 3. The estimated gamma parameter of the model was 0.59, which is an indication that about 59% of the total variation in cassava output among the farmers could be attributed to differences in their technical efficiencies. The significant ($P<0.01$) wald chi square value confirmed the model to be a good fit.

Table 1. Socioeconomic Characteristic of Cassava Farmers in Kogi State

Socioeconomic characteristics	Frequency	Percent	Mean/Mode
Gender			
Male	43	35.8	
Female	77	64.2	Female
Age			
30 and above	52	43.33	
31-40	30	25.00	39.78 years
41-50	11		1.17
51-60	13	10.83	
61- Max	14	11.67	
Family Size			
1-5	30	25.00	
6-10	11	1.17	8 members
Above 10	13	10.83	
Level of Education			
Tertiary education	79	65.8	Tertiary education
No formal education	10	8.3	
Primary education	16	13.2	
Secondary education	15	12.5	
Years of Experience			
1 -10	74	61.67	
11-20	26	21.67	12.8 years
21- Max	20	16.67	
How Farmers Acquired Cassava Farmland			
Borrowed	9	7.5	
Gift	15	12.5	
Inheritance	73	60.8	Inheritance
Lease	15	12.5	
Purchased	8	6.7	
Farm Size (ha)			
0.1-4	89	74.17	3.7 ha
4.1-8	17	14.17	
Above 8	14	11.67	

Source: Field Survey 2018 n = 120

Table 2. Input Used in Cassava Production

Input variables	Frequency	Percent
Variety of cassava cultivated		
Improved variety	27	22.5
Local variety	61	50.8
Both varieties	32	26.7
Use of Fertilizer in Cassava Production		
No	85	70.8
Yes	35	29.2
Type of Fertilizer Applied		
NPK	24	68.8
SSP	4	11.2
Urea	7	20
Use of herbicides in Cassava Production		
No	42	35
Yes	78	65
Type of herbicide Applied		
Force-off	12	15.38
Glyphosate	28	35.9
Gramozone	25	32.05
Primextra	13	16.67
Use of pesticide in Cassava Production		
No	94	78.3
Yes	26	21.7
Use of Organic Manure in Cassava Production		
No	74	61.7
Yes	46	38.3
Labour used for cassava production		
Family labour	27	22.5
Hired labour	61	50.8
Both	32	26.7

Source: Field Survey 2018 n = 120

Table 3. Maximum Likelihood Estimate of the Stochastic Frontier Cobb-Douglas Production Function.

Input variables	Coefficient	Standard error	t-ratios
Constant	78859.53	98420.35	0.80
Farm size (ha)	75862.79	9864.312	7.69****
Labour (man/day)	409.4048	169.3879	2.42**
Cassava cuttings (kg)	63.4853	25.97377	2.44**
Herbicide (li)	-6260.517	13742.57	- 0.46
Pesticide (li)	-27192.4	18031.27	- 1.51
Fertilizer (kg)	-139.9409	456.549	- 0.31
Organic manure (kg)	43.21361	168.8019	0.26
Gamma	0.59		
Log likelihood	1686.6344		
Wald chi^2	139.43 ***		
Age	-.9921587	.0004692	- 2114.52***
Level of education	-10.52704	3158.72	- 0.00
Household size	7.026837	.0015655	4488.61***
Farming experience	1.634783	.000494	3309.24***

Source: Field Survey Data 2018. *** = 1% sig, ** = 5% sig

The approach of simultaneously estimating stochastic frontiers and models for the technical inefficiency effects is expected to lead to more efficient inference with respect to the parameters involved. Three of the seven input variables were statistically significant in the Cobb-Douglas function. The result shows that farm size has a positive coefficient (β = 75862.79) and significant at 1%. This implies that an increase in farm size will lead to a corresponding increase in cassava output in the study area all things been equal. This agrees with Okoh (2016), who found farm size to be positive and significant at 5% in Benue State at the time of her study. Cassava cuttings had a positive coefficient (β = 63.4854) and 5% level of significance on cassava output. This implies that an increase in the kg of cassava cutting would increase the level of output of cassava in the study area. The coefficient obtained for labour (β = 409.4048) was found to be positive and significant at 5% level of significance. This implies that labour is a very essential input in cassava production in Kogi State as change in the unit of labour will lead to a change in cassava output.

In the technical inefficiency effect model; age, household size, and farming experience significantly influenced inefficiency among cassava farmers in the study area. Age had negative and significant ($P< 0.01$) effect on the inefficiency of cassava farmers. The result showed that older cassava farmers had smaller inefficiency than that of younger farmers. Put differently, it can be said that the older farmers were technically more efficient than the younger cassava farmers. This finding agrees with Rahman et al (2012), who reported similar finding among rice farmers in Bangladesh. The result however disagrees with Idiong (2005) and Audu et al (2013) who in their inefficiency model, reported positive and significant effect of age among farmers in Cross River and Kogi States respectively. Household size and farming experience had positive and significant ($P < 0.01$) impact on the inefficiency model. By implication, inefficiency increased with increase in household size and years spent farming. The finding on farming experience is similar with the report of Audu et al (2013) among farmers in Kogi State, Nigeria.

4. Conclusion and Recommendations

This study assessed the input-output relationship in cassava production in Kogi State, Nigeria. Three inputs (cassava cuttings, farm size, and labour) were statistically significant and had positive effect on cassava output. Age, household size, and farming experience significantly influenced inefficiency among cassava farmers in the area. Conclusively, for improved cassava production, inputs such as stem cuttings, farm size, and labour are key policy variables decision. Recommendations made to enhance input- output relationship in cassava production includes; providing improved cassava cuttings to boost cassava production and there should be adequate farm land for cassava framers since farm size positively affect cassava output in the area.

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