Resource use Efficiency of Ginger (*Zingiber officinale*) Farmers in Jaba Local Government Area of Kaduna State, Nigeria: Evidence from Cobb-Douglas Production Function

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ABSTRACT

The study examined the efficiency of resources used by ginger farmers in Jaba Local Government Area of Kaduna State. Multistage sampling technique was used to select 160 registered ginger farmers. Data were collected using structured questionnaire and analyzed using descriptive statistics, multiple regression analysis with the Cobb-Douglas functional form as the lead equation, and efficiency measures model. The study revealed that the average age of ginger farmers was 41 years. The result also showed that 72.50% of the ginger farmers were married with an average household size of 13 persons. The averages farming experience and farm size were 18 years and 1.75 hectares respectively. The coefficient of multiple determination (R^2) was 0.944 implying that, 94.4% of the variation in the output of ginger in the study area was accounted for by the factors included in the model, while the remaining proportion was by other external factors (error term). The coefficients of farm size, hercides and fertilizers were all significant at 5% level ($p<0.05$). In terms of resource use efficiency, the input factors of farm size, seeds and fertilizer were all under-utilized while labour factor was over-utilized. This implied that labour was overstretched and must be reduced while more units of the other factors of farm size, seeds and fertilizers needed to be used to obtain optimum output. Government and non-state actors concerned should provide credits and subsidized farm inputs to ginger farmers. Ginger farmers should be encouraged to form cooperatives for easy to access to credit facilities, farm inputs and extension information.

Keywords: Resource use efficiency, Ginger farmers, Cobb-Douglas, Production functions

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INTRODUCTION

Nigeria is ranked first in terms of the percentage of total hectares of ginger under cultivation; however, contribution to total world output is too low compared to other countries. This can be attributed to the fact that most of the production is undertaken by small land holders and traditional farmers with rudimentary production techniques, which lead to low yields. (Nmadu and Marcus, 2013). Ginger production in Nigeria today is laborious. Practically all operations are done manually with local tools like hoes and cutlasses. This has several implications and it limits the hectares that each farmer can cultivate; production of the crop is unattractive and tedious; and production costs are relatively high due to the relative high cost of labour. Many smallholder farmers are constrained by many problems as well and they do not see it as a business enterprise. Therefore, they are not adequately focused on profit maximizing motive (Alkali, 2025). According to Unguwanrimi *et al.* (2023) Nigeria has the potential to expand production in a medium to long-term investment strategy that can develop into a self-sufficient industry. The increase experienced over several decades of consistent efforts is too low to make a meaningful change in the income and standard of living of the farmers (Alkali, 2025). It is therefore important to study the use of resources in ginger production in Nigeria to proffer solutions on how it these available resources could be improved through efficient utilization. It is in view of this that the study was designed to evaluate the efficiency of resources used in ginger production in Jaba Local Government Area of Kaduna State.The main objective of this study is to evaluate the efficiency of resources used in ginger production in Jaba Local Government Area of Kaduna State, Nigeria. Specifically, however, the study seeks to:

(i) Describe the socioeconomic characteristics of ginger farmers in the study area
(ii) Determine the factors influencing ginger production
(iii) Evaluate the efficiency of the resources used in ginger production.

The plant is now cultivated in different parts of Nigeria, though the major producing areas include Kaduna, Nassarawa, Sokoto, Zamfara, Akwa Ibom, Oyo, Abia, and Lagos States although southern Kaduna remains the largest producer of fresh ginger in Nigeria in Kachia, Jaba, Jema'a and Kagarko Local Government Areas (Katuka *et al.,* 2025). The varieties produced in Nigeria are Taffin Giwa and Yatsun Biri, which are higher in monoterpene and oil, giving a more pungent aroma and pungency. Therefore, it is usually preferred for the production of oils and oleoresins (Baba *et al.,* 2024). The matured roots of ginger are fibrous, and the juice from old ginger roots is extremely potent and often used as spices and a quintessential ingredient of Chinese, Korea, Japanese, and many South Asian cuisines for flavouring dishes (Unguwanrimi, 2023). It is also used largely as recipes such as ginger bread, cookies, crackers, cakes, ginger-ale and ginger beer. Ginger spice was known in Germany and France in the ninth century and had become common in trade as pepper by the thirteenth century. It is used in almost all types of curry and is essential in cooking meat. It is found to be used in various pickles, cake and chatni, and also used in preparing medicine like ayuratic, homeopathic, and also allopathic (Unguwanrimi *et al.,* 2023). The medicinal values of these great ancient spices are widely recognized across the continents to contain a number of unique organic phytochemical ingredients that can take care of some human ailments. Recent studies on health-related effects of ginger which have also stimulated farmers' concern on the growth of the plant have shown the efficacy of the plant in some life-threatening ailments such as enterotoxin induced diarrhea, diabetic nephropathy, nausea, plasma antioxidant, vomiting, high cholesterol, high blood pressure and inflammation (Unguwanrimi *et al.,* 2023). This study therefore, provides valuable information on the profitability of growing gingers to prospective investors, to enable them to consider its production as a viable option for investment to farmers who are already producing the crop, research scientists and scholars.

METHODOLOGY

The study area

The study was conducted in Jaba Local Government Area in Southern Kaduna State, Nigeria located between latitude 9^0 12' to 9^0 38' North and longitude 7^0 54'to 8^0 14'East. The climates of the area are tropical savannah within the Guinea savannah and Sudan savannah with distinct seasonal regimes, oscillating between cool to hot dry and humid to wet (dry and wet seasons) (Figure 1). The rainy season starts from April and ends in October with a mean annual rainfall of 2000mm. August and September are the wettest months and the annual average temperature ranges from 23^0 C to 28°C, an average humidity of 34%, with an average wind speed of 10 km/h.The months of November to March are the dry season (Baba *et al.,* 2024). The primary occupation of over 75 percent of the active population is farming (Shehu *et al.*, 2013). Jaba is a Local Government Area covers an area of 531 km² with a capital in the town of Kwoi and a projected population of 510,500 by 2024. It is inhabited predominantly by Ham people, part of the people likely to have created the Nok culture and they are predominantly Christians.They are known for its unusual agricultural status as one of the world's top producing regions for ginger, with the sale and export of the commodity significantly boosting the local economy (Baba *et al.,*

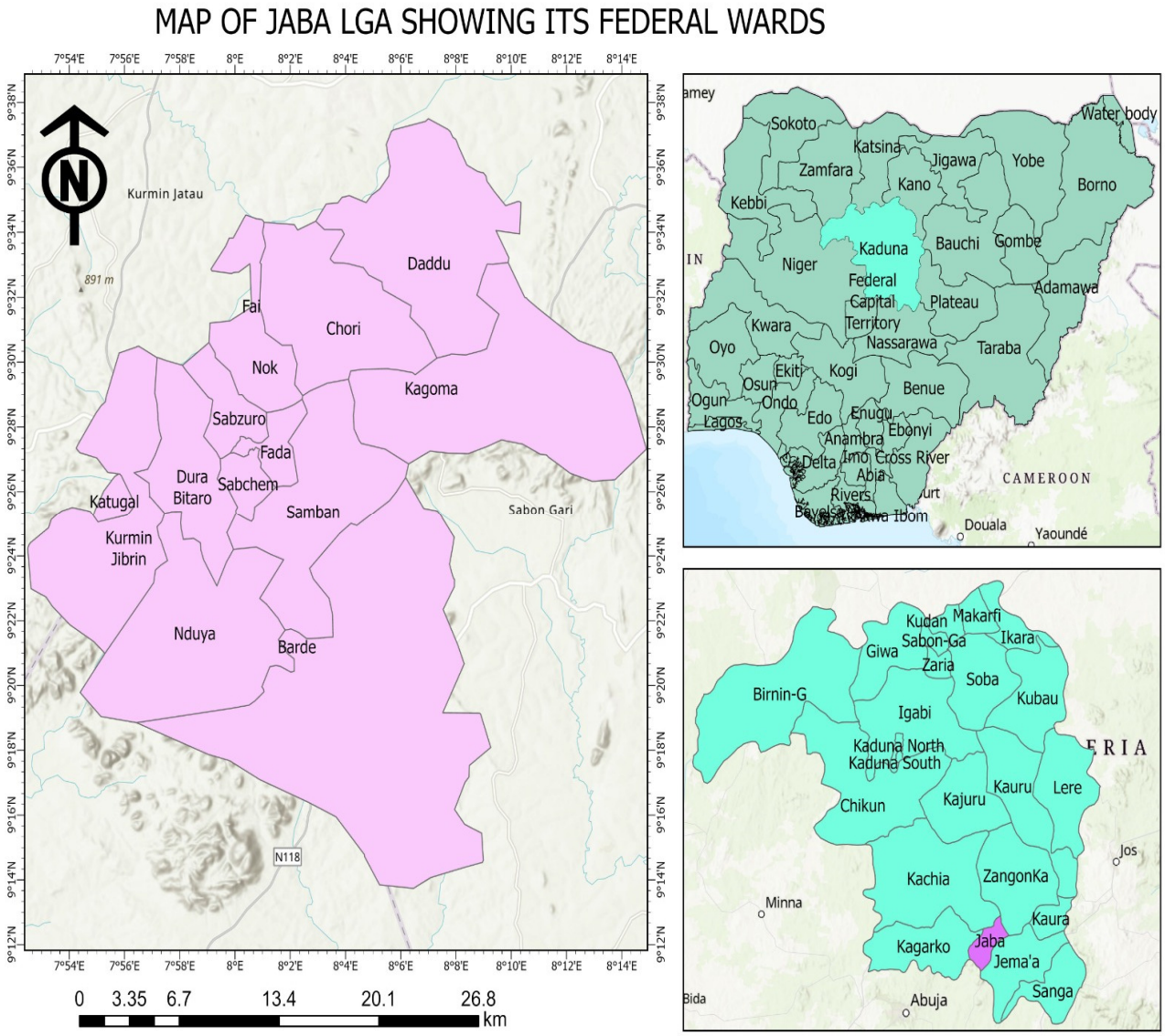

Figure 1: Map of Jaba Local Government Area, Kaduna State, Nigeria**:** Source: Geology Laboratory, University of Jos, Nigeria (2025).

2024). Rams, goats, camels, and donkeys are just a few of the domestic animals that are raised and sold in the area. Hunting and trading are two other significant economic activities carried out by the residents. The Local Government Area shares boundaries with Kachia LGA to the northwest, Kagarko LGA to the southwest, Zangon Kataf LGA to the north, Jema'a LGA to the east; and Karu LGA of Nasarawa State to south, respectively (Katuka *et al.,* 2025)

Ginger is one of the major cash crop where commercial quantities (1,728.930 Metric tonnes) are produced annually with Kachia, Jaba, Kagarko, Jema'a and Zangon Kataf Local Government Areas as the major areas of production (Kaduna State Perspective, 2009).

The major Ethnic groups in the area are Atyap, Chori, Fulani, Gbagyi, Hausa, Ikulu Samban, Jaba (Ham), Kadara (Adara), Kaje (Bajju), and Kuturmi.

Sampling Procedure and Sample Size

Multistage sampling technique was used for the study. In the first stage, Jaba Local Government Area was purposively selected based on prior knowledge that it is a ginger producing area. In the second stage four villages were purposively selected: Antom and Gidan Maga villages in Samban ward and Sabon Sarki and Kurmin Mossa villages in Fada ward, based on the high intensity and concentration of ginger farmers in the areas.

In the third stage a systematic random sampling technique was used to select 40 registered ginger farmers from each village giving a sample of 160 ginger farmers.

Method of Data Collection

The study used structured questionnaires administered to ginger farmers with the help of trained enumerators to collect information from registered ginger farmers in the study area.The questionnaire captured cost and returns in ginger production and constraints associated with ginger production.

Method of Data Analysis

Descriptive Statistics:

Descriptive statistics has been used by Ezra *et al.* (2017); Mailumo *et al.* (2014), Makarau *et al.* (2013) to describe the socioeconomic characteristics of ginger farmers in Kaduna State, Nigeria.
Descriptive statistics such as frequency, percentage, mean were used describe the socioeconomic characteristics of the ginger farmers in the study area.

Multiple Regression Analysis

Multiple regression analysis has been used by Mailumo *et al.* (2014), Makarau *et al.* (2013) and Ugbajah and Uzuegbuna (2012) to determine the extent of resources used and their effects on outputs of ginger in Kaduna and Enugu States in Nigeria. Multiple regression analysis was employed to determine the extent of farm resources use. The functional forms fitted to the ginger output level and cost of inputs were linear, Cobb Douglas and Semi–log. The explicit models were specified as;

(i) Linear function:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + e \quad (1)$$

(ii) Semi-log function:

$$Y = b_0 + b_1\ln X_1 + b_2\ln X_2 + b_3\ln X_3 + b_4\ln X_4 + b_5\ln X_5 + b_6\ln X_6 + b_7\ln X_7 + b_8\ln X_8 + e \quad (2)$$

(iii) Double log (Cobb-Douglas):

$$\ln Y = b_0 + b_1\ln X_1 + b_2\ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + b_8\ln X_8 + e \quad (3)$$

Where:
Y = Ginger output (kg)
X_1 = Farm size (ha)

X_2 = Cost of Agro-chemicals (Herbicides, Insecticides) (₦/litter)
X_3 = Cost of Seeds (₦/kg)
X_4 = Cost of fertilizer (₦/bag)
X_5 = Cost of Labour (₦)
X_6 = Farming experience (Years)
X_7 = Education (years)
X_8 = Farmer's age (years)
b_o = Constant
b_{1-8}= Parameters to be estimated
e = a residual term (error term)
The Cobb-Douglas functional form was the most fitted and taken as the lead equation and used for this work analysis and discussions.

Resource use efficiency Model

Resource use efficiency coeffiecient (*RUE or r*) has been used by Mailumo *et al.* (2014) and Adewumi and Okunmadewa (2011) to evaluate the efficiencies of resources used in ginger and other crops production in Kaduna and Kwara States in Nigeria.
Resource use efficiency model [the ratios of the marginal value product (MVP) to the marginal factor cost (MFC)] were used to determine resource use efficiency of ginger production in the study area.
The model is specified as:

$$r = \frac{MVP}{MFC} \quad \ldots(4)$$

$$MVP = \frac{\Delta TVP}{\Delta X_1} = \frac{\Delta y \,.\, P_y}{\Delta X_1} = MPP \,.\, P_y \quad \ldots(5)$$

$$MFC = \frac{\Delta TC}{\Delta X_1} = \frac{\Delta X \,.\, P_x}{\Delta x} = Px_1 \quad \ldots(6)$$

Where;
MVP = Marginal value product of the resource input
MFC = Marginal factor cost of the resource input
MPP = Marginal physical product of the resources
ΔTVP = Change in total value product
ΔTC = Change in total factor cost
ΔX1= Unit change in the variable input quantity
PX= Price per unit of input
Py = Price per unit of output
r = efficiency ratio
Decision rule;
If r =1, resource is efficiently utilized;
If r >1, resource is underutilized;
If r <1, resource is over utilized.
Olukosi and Erhabor (2008).

According to Binswager *et al.* (2012) perfect resource allocation efficiency exists, *ceterisparibus*, if the marginal value product (MVP) of resource input is at equilibrium, parity or unit with their corresponding marginal factor cost (MFC). In this regard, maximum profit is realized, if the ratio of MVP to its MFC is one. A ratio of less than unity shows over utilization of the resource and profit would be

increased by decreasing the rate of use of the input. In the like manner, a ratio greater than unity shows underutilization of resources and a further usage of the factors would increase profit level.

RESULTS AND DISCUSSION

The socioeconomic parameters included were age, marital status, household size, educational level, and years of experience in ginger production. Others are; land acquisition, land size, and sources of finance for production.

Age of the ginger farmers

The result in (Table 1) showed that the average age of ginger farmers was 41 years, 36.87% of were in the age bracket of 41 – 50 years, 25% and 17.5% were within the ages of 31-40 years and 51-60 years respectively. This implies that the farmers were within their economically active age, which is important because they may be willing to assume greater risk in anticipation of profit than the older that are often more risk aversive. This result agrees with the findings of (Alabi *et al.*, 2006) and (shehu *et al.*, 2013) who reported that farmer's age may influence his resource allocation, reasoning and management ability and as well, more likely for him to try new technologies.

Sex of the ginger farmers

The result in (Table 1) showed that majority 91.9% of the ginger farmers were male while 8.1% of ginger farmers were female in the study area. This suggested that most of the ginger farm work were undertaken by men in the study area, as ginger production is labour demanding more so that most of the operations are manually done at this level. This agrees with the claims of Ojo and Jibowo (2008) in their study, that leadership role visa- vise decision making are dominated by the men folk.

Marital status of ginger farmers

The result in (Table 1) also showed that majority (72.50%) of ginger producers were married while 27.50% were single. The low participation of the unmarried may be attributed to the fact that they were mostly young and still dependent on their parents for livelihood. The result agrees with Ojo and Jibowo (2008) who reported that married people being responsible, their views are likely to be respected within rural communities as they take decision on the use of agricultural inputs.

Household size of ginger farmers

The result in (Table 1) also showed that 40% of ginger farmers had a household size of 11-15 persons while 26.25% and 17.50% of the ginger farmers had 6-10 persons and 1-5 persons respectively. Also the result further indicated that 8.74% and 7.51% of ginger farmers had household sizes of 16-20 persons and above 20 persons respectively, with an average household size of 13 persons. This means the total number of people in the house which includes the wives, children and dependents that resided within the same house. Since food requirements increases with the number of person in the household and also because land and finance to purchase agricultural inputs are limited. Increasing family size, according to Mailumo *et al.,* (2004), tends to exert more pressure on consumption than the labour it contributes to production. The larger the family size the more favourably disposed will be the members to food insecurity. The result is also in line with the findings of Orojobi and Damisa (2007) that household size is crucial to traditional agriculture where the main source of labour is the family particularly in Nigeria.

Farming experience of ginger farmers

The result in (Table 1) also showed that about 36% of ginger farmers in the area had farming experience of 11–20 years, with an average of 18 years. Only 16.88% of them had experience of 31–40 years. The implication is that, years of farming experience enables farmers to analyse production situations, manage risk and uncertainties in production activities in an attempt to produce more output. This finding is in tandem with the findings of Adewumi and Okunmadewa, (2011), that, the more experienced a farmer, the more efficient the farmer might be in the use of productive resources.

Educational level of the ginger farmers

The result in (Table 1) revealed that 37.50% of the ginger farmers had non-formal education also 27.50% of the ginger farmers had adult education, 11.25% of the ginger farmers had secondary education, while those with primary and Tertiary education constituted 16.25% and 7.50% of the respondents respectively. This implies that majority of ginger farmers in the area had obtained one form of formal education or the other. Thus producers who acquired formal education might have greater chance for adoption of new technologies (innovations) participation (Shehu *et al.*, 2013).

Ogundele *et al.* (2009) posited that education was likely enhance the adoption of modern farm technologies by youth and thereby sustaining a virile farming population. The more educated farmers are, the more likely they adopt technology and also translate into production experience. Level of education is measured by number of years spent in formal schooling.

Land ownership of ginger farmers

Table 1 showed that, majority 66.88% of ginger farmers in the study area acquired their land through inheritance,

Table 1: Socioeconomic characteristics of ginger farmers in the study area n=160.

Variables	Frequency	Percent	Mean
Age (years)			
21 – 30	33	20.63	
31 – 40	40	25.00	41.0
41 – 50	59	36.87	
51 – 60	28	17.50	
Sex			
Male	147	91.9	
Female	13	8.1	
Marital Status			
Married	116	72.50	
Single	44	27.50	
Household Size			
1 – 5	28	17.50	
6 – 10	42	26.25	
11 – 15	64	40.00	13.0
16 – 20	14	8.74	
>20	12	7.51	
Farming Experience (years)			
1 – 10	31	19.37	
11 – 20	58	36.25	
21 – 30	44	27.50	18.0
31 – 40	27	16.88	
Educational background			
Primary	26	16.25	
Secondary	18	11.25	
Tertiary	12	7.50	
Adult education	44	27.50	
Non formal	60	37.50	
Total	160	100	
Land Acquisition			
Hired	36	22.50	
Inheritance	107	66.88	
Purchase	9	5.62	
Inheritance/Hired	06	3.75	
Inheritance/Purchase	02	1.25	
Farm Size (ha)			
1 – 2	94	58.75	
3 – 4	43	26.88	1.75
5 – 6	12	7.50	
>6	11	6.87	
Sources of capital			
Personal Saving	86	53.75	
Friends/Relatives	54	33.75	
Commercial Banks	16	10.00	
Cooperatives	04	2.50	

Source; Field Survey, 2018

22.50% hired, 5.62% purchased, 3.75% both hired and inherited and 1% inherited and purchased. The result conforms to Alkali (2025) that the commonest means through which farmers acquired their lands in Kaduna State was through inheritance. This practice encourages land fragmentation thus discouraging mechanization and promotes the subsistence of agriculture.

Farm size of the ginger farmers

The result in (Table 1) further revealed that 58.75% of the ginger farmers had farm size between 1–2 hectares, with an average of 1.75 hectares. In addition, 26.88% of the ginger farmers had farm size between 3–4 hectares, 7.50% of the ginger farmers had farm size between 5– 6 hectares, 4.37% of the ginger farmers had farm size between 7–8 hectares and only 2.50% of the ginger farmers had farm size between 9–10 hectares as shown on (Table 1). The implication is that majority of ginger producers in the study were small scale farmers. This is in line with the findings of Makarau *et al.,* (2013), who assessed the impacts in terms of changes in farm size and recorded a significant and positive impact on farm income due to increase in farm size and consequently reducing rural poverty.

Sources of capital of the ginger farmers

The result in (Table 1) revealed that, majority (53.7%) of ginger producers in the study sourced their capital through

Table 2: Factors influencing ginger production in the study area.

Predictor	Coefficient	t-value	Probability level
Constant	1.1057	(6.39)	***
Farm size (ha)	0.7852	(5.35)	**
Herbicide (l)	0.2775	(2.01)	**
Seed (kg)	0.07931	(-1.01)	
Fertilizer (kg)	0.0253	(10.19)	**
Labour (μ)	0.02015	(0.21)	**
Age (years)	0.2681	(0.83)	
Education (years)	-0.2095	(-1.59)	
Experience (years)	1.92401	(20.29)	***
R^2			0.944

*** = Significant at P<0.01; ** = Significant at P<0.05
Source; field survey, 2018

personal savings, 33.75% of the farmers acquired credits from friends, relatives, 10% of them from commercial banks, and only 2.50% of them from cooperative societies. The economic implication of this result is that, the scale of the production of ginger in the study area remains small with very slow growth rate due to relatively small personal saving. Similarly, Shehu *et al.* (2013) reported that, many of the farmers, especially the small-scale, may lack suitable collateral which is a pre-condition to obtain loans from the financial institutions. This refers to amount of money received from both formal and informal sources. It was measured as the actual money/credit borrowed. Credit is a very strong important factor that is needed to acquire or develop farm enterprise (Ekong, 2003).

Factors Influencing Ginger Production in the Study Area

Regression provides an overall measure of the extent to which the variation in one variable, determines the variation in the other (Adegboye, 2011). The coefficient of multiple determination (R^2) measures the proportion of or percentage of total variation in dependent (Y) explained by the regression model. Production factors and socioeconomic parameters were regressed to show the relationship between quantity of input and output, to estimate the effects of factors of production and socioeconomic characteristics of the farmers on their output. Three functional forms of the regression models were used, and the lead equation was chosen based on the number of significant variables, mathematical signs of the significant variables and the magnitude of the coefficient of multiple determination (R^2), Olukosi and Erhabor (2008).

The result of the double log (Cobb-Douglas) function as the lead equation presented in (Table 2) revealed that years of farming experience was significant (P<0.01). This concurred with the findings of Mailumo *et al.* (2014) who reported that years of farming experience enable farmers to analyze production situations, manage risk and uncertainties in production activities in an attempt to produce more output. The economic implication of this result is that the more experience a farmer has in the production of ginger, the more he is likely to make more output than the less experienced ones.

The result further revealed that land, labour, herbicide and fertilizer were significant (P<0.05) variables influencing ginger output. This conformed to *a priori* expectation that unit increase in these factors while holding others constant, will lead to increase in the level of output of ginger in the study area. The coefficient of multiple determination (R^2) was 0.944 implying that, 94.4% of the variation in the output of ginger in the study area was accounted by the factors included in the model, while the remaining proportion was by other external factors (error term).

Efficiency of Resource used in Ginger Production

The marginal value product (MVP), marginal factor costs (MFC) and efficiency ratios (r) were presented in (Table 3). The results revealed that the labour factor has an efficiency ratio (*r)* of 0.41. The labour factor was over-utilized meaning that more units of labour were used above the required optimum. This was because the MFC>MVP, evidently, the efficiency ratio of labour of 0.41 signified over utilization of the resource. The study suggested that, the ginger farmers in the study area should therefore, reduce the level of labour input by 41% while holding other inputs constant so as to attain optimal level in output and profit. However, the efficiency ratios of farm size, seed and fertilizer were 1.21, 1.10, and 1.62 respectively which showed that lesser units of these factors were used in ginger production in the study than the required optimum level. The efficiency ratios were all greater than 1 which showed that these factors were under-utilized. Thus, while holding other factors constant, ginger farmers should increase the level of farm size, seeds and fertilizer to attain optimal levels in output and profit. This result is at variant with Nmadu and Marcus (2013), in his study of resource use efficiency of ginger farmers in Kaduna State, Nigeria, who found that, the labour was greatly under-utilized with efficiency ratio of 9.584. However, the results corroborated with the findings of Shehu *et al*. (2013) who found out that farm size was under-utilized with a ratio 1.24 in their study of resources used in ginger production in Kaduna State, Nigeria. The coefficient of farm size of 0.7852 was highest among all the coefficients of the factors which showed that a 1% increase in the farm size would have resulted in about 8% increase in output and profit; therefore, increase

Table 3: Efficiency of resource used in ginger production.

Variables	Coefficient	Py(₦/100kg)	MVP	MFC	r	Remark
Labour	0.02015	8,136	163.94	400	0.41	Over-utilized
Farm size	0.7852	8,136	6,388.39	5,300	1.21	Over-utilized
Seed	0.07931	8,136	645.27	587.43	1.10	Under-utilized
Fertilizer	0.0253	8,136	205.84	127.03	1.62	Under-utilized

Source field survey, 2018

of this factor should take preeminence. In addition, Ugbajah and Uzuegbuna (2012) further suggested that, all variable inputs having efficiency ratio (r) greater than 1 should be increased to achieve optimum output and profit.

Conclusion

Most of the ginger farmers were male, married with mean age of 41 years. The average household size of 13 persons showed available family labour with farming experience of 18 years. Majority of the farmers had non formal education, owned their lands through inheritance, with average farm size of 1.7 hectares, and financed their farm operations through person savings. The regression coefficient, R^2 of 0.944 showed that 94.4% of ginger output was explained by the variables included in the production function. The study revealed that, of the resources considered in ginger production in the study area, only labour was over-utilized whereas farm size, seeds and fertilizer resources were all under-utilized. If units of the labour resource were reduced while units of farm size, seeds and fertilizer were increased simultaneously, optimum levels of ginger output and profit would be obtained. Despite all these, if labour resources are properly harnessed, with minimal adjustments to other significant production resources, the efficiency of resources used in ginger production with significantly improve in Jaba Local Government Area of Kaduna State, Nigeria.

Recommendations

Based on the findings of the study, the following recommendations were made:

i.Governments and all responsible non state actors are encouraged to provide adequate extension services to ginger farmers in the study area to educate them on efficient combinations of resources.

ii.Government, cooperatives and farmers associations should assist ginger farmers with seeds, fertilizer and credit facilities at affordable prices to help increase utilization of these resources hence enhancing efficiency.

iii.Ginger farmers in the study area strongly advised and encouraged to form cooperative associations to make it easy for them to access to inputs, credits and sharing of information.

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