Economic Analysis of Maize Production Among Irrigation Farmers in Orire Local Government Area, Oyo State, Nigeria

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Abstract

This study analyzed economic value of maize production among irrigation farmers in Orire Local Government, Oyo State, Nigeria. The objectives of this study are to: identify the most important resources used by the farmers in maize production; estimate the production function in order to determine the economic efficiency of different resource used in maize production. The data were obtained through a survey of 80 farmers, comparing farmers using pump and those using shadoof methods of irrigation for maize cultivation. Simple descriptive statistics and Cobb-Douglas production function used revealed that fertilizer was underutilized. The marginal productivity of labour was positive but lower than the average acquisition cost for both techniques of irrigation. Both primary and secondary data were used for the study. Well structured questionnaire and interview schedule were used as approaches to collect data from respondents. The results showed that irrigation users were small-scale farmers, cultivating small hectare of land using simple farm tools, practicing pump irrigation or calabash system. Regression analysis revealed that land, labour purchase inputs had a positive relationship with the output of the enterprises, the linear programming analysis revealed that opportunities existed for increasing profit through resources re-organization, budgetary analysis was used to show that irrigation was profitable.

Keywords

Economic, analysis, irrigation, maize, production

Maize (*Zea mays*), is one of the oldest and widely cultivated cereals in the world. It provides food for man and livestock. Maize production in Nigeria, however, has been experiencing a declining trend. One of these factors is climatic factors hence; this study investigated the effects of climate variables on maize production and also assessed the degree of vulnerability and cropping strategies adopted by the farmers. Empirical models are defined as models directly describing observational data, Ambara Region Agricultural Research Institute and SWHISA Project (2006) opined that one form of empirical model is prediction equation resulted from regression analysis.

Regression analysis of FAO (Food and Agriculture Organization) (1986) is technique utilized to fit a line through a set of observation. As a result, a prediction equation is developed and used to predict the performance of those dependent variables, when values of these independent variables vary. Crop yields and demand for irrigation were estimated using

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DSSAT (Decision Support System for Agrotechnology Transfer) models (Thorp et al. 2008).

Irrigation agriculture is crucial to the economy, it is too important to be marginalized as it is vital for world food security. However, irrigated agriculture often radically changes land use and is a major consumer of freshwater. Recognizing that the full potentials of Nigeria agriculture could not be realized without the development of her water resources for irrigation, governments in Nigeria have adopted various development policies to implement irrigation (Palmer and Philip 1990).

Agriculture has an important impact on the environment. Pollutant sources from land use and poorly managed agriculture are causing widespread deterioration of ground water and surface water, while over irrigation results in water logging and the consequent accumulation of salts, which will lead to salinization of top soils and groundwater if not provided with proper drainage. Intensification of agriculture may lead to an increase in degradation of water quality and irrigated land because of an increasing intensity of inputs in agriculture (Aremun and Ogunwale 1994).

The study revealed that water is scarce in Orire LGA (Local Government Area) during dry season; there will be an increase in use of brackish water and sewage effluents for irrigation. Recycling of water although may improve efficiency of use of water, it could also reduce both surface and groundwater quality. However, increased water withdrawals will lead to salt intrusion in estuaries and over-draught coastal aquifers. Maximum management of water quality is required to prevent these conditions and there is a need for proper monitoring of inflows and effluent water, in the same manner, recycling and reuse systems should take into account its cumulative effect overtime and its impact on the soil and water environment (Edwards et al. 1993).

The protection of water is not only based on the prevention of pollution alone, but also on the recovery,

conservation, and the development of their self-purifying power. At this level, the restoration of rivers and lakes is an important task to be accomplished.

PROBLEM STATEMENT

A critical investigation of the performance of irrigation farming in Nigeria reveals that sub-sector is deficient in technical, financial institution and human resources which subject farmers to being persistent in the vicious cycles poverty, due to low income from low productivity and investment. This study examined the constraints encountered by the irrigation users and provided solution to increase resource utilization. Therefore, these questions are fundamental to this study:

What extents have the farmers thrived in irrigation farming using small-scale irrigation technologies?

How can urban, rural, and irrigation interest work together on how to meet future water needs of irrigation farmers in the study area?

How can irrigation equipments be made available for the benefits of farmers use?

The main objective of this study therefore is to analyze the economic impact of water, irrigation on maize production in the study area.

Specifically, the study:

- (1) Highlight the socio-economic characteristics of irrigation users;
- (2) Identify the type(s) of crop enterprises engaged by the irrigation farmers in the study area;
- (3) Determine how urban, rural, and irrigation interest can work together on how to meet future water needs for the study area;
- (4) Determine how local irrigation equipments and other technologies can be made available for the benefits of farmers use.

JUSTIFICATION OF THE STUDY

The benefits of irrigation have resulted in lower food

prices, provision of employment, more rapid agricultural and economic development. The spread of irrigation has been a key factor behind the near tripling of global grain production; therefore, there is a need for a critical assessment of the performance of irrigation farming in the study area in order to achieve more of benefits of irrigation.

THEORETICAL FRAMEWORK

Farmers using irrigation has been identified as a key source of agricultural growth and development as opposed to previous irrigation development policies according to River Basin Development, where irrigation schemes were designed and managed by government agencies for farmers. Irrigation has been long practiced in northern Nigeria where farmers have traditionally undertaken irrigation through the use of such technologies and methods as shadouf, buckets, and calabash to produce high value agronomic and horticultural crops which are widely grown such as rice, sugar cane, cocoyam, and leafy vegetables among diverse cropping systems. Fruits trees like citrus, mango, cashew, etc. are planted on agricultural lands, this provides cash income as well as food crops to the farmers (Ohikere and Ajogwu 2012).

World (1995) observed that irrigation has made higher and more reliable yield possible as crops can be planted more than once in a year within the topics, apart from bigger and reliable yield as against yearly cultivation, which is often at the mercy of seasonal rainfall.

MATERIALS AND METHODS

The study was conducted in Orire local government area of Oyo state, the population at 2006 census was 45,494 (22,712 males and 22,782 females). The major inhabitants are Yoruba people while some are Igbo and Hausa. They engage in planting of crops such as maize, rice, sugar cane, groundnut, millet, melon, etc.

The climate is characterized by a distinct dry and wet season with annual rainfall varying from 1,200 mm to 1,600 mm. It is located approximately on the intersection of latitude 8° 44' North and longitude 5° 44' East.

SAMPLING PROCEDURE AND DATA COLLECTION

A multi-stage random technique was used to select the respondents. Firstly, the study areas were stratified into eight cells. The second stage involved random selection of four cells out of the eight cells. The third stage involved random selection of two villages from each cell making a total of eight villages. The last stage involved random selection of 10 respondents from each village making a total of 80 respondents. The sample size of the study was 80 irrigation users. The choice of this number was on the basis of the preliminary survey of the study area. The choice of random sampling techniques in the last stage was to give equal opportunity or chances to each farm family of being selected. Data for this study were collected from the selected farmers for the 2014/2015 irrigation season by the researcher and assisted by extension agents using well structured questionnaire and interview schedules. Data were collected between December 2014 and January 2015.

MEASUREMENT OF VARIABLES

There are two major variables in this study: They are the dependent variable and independent variable. The dependent variable is the total farm output, while independent variables include: land, labour, capital, irrigation water, the resource constraints, and socio-economic characteristics such as age, sex, marital status, educational level, households size, etc. The various levels of constraints were determined by what the "representative" farmers in the study area had. The representative farmer in the study area

was taken to be the farmer who used the arithmetic mean of each of the resources. This view was supported by Tsoho (2005) who reported that “A representative farm can be used to depict a typical the farm in the sample”, he further noted that although representative farms are often synthesis in the sense that none of them depict an actual farm, their component can be found on the majority of the farms they represent.

DATA ANALYSIS

Descriptive statistics such as tabulations, frequency distributions, mean (averages) were used to capture the first and second objectives. The third and fourth objectives were achieved by the use of multiple regression, logit model analysis, and linear programming techniques of data analysis.

The Multiple Regression Model

The coefficient of multiple determinations (R^2) was obtained as a measure of goodness of fit. It is the percentage of total variation of the dependent variable (Y) explained by the variation in the independent variable (X_1 - X_n). The equation with the higher R^2 value explained the variation better and was regarded a better fit. The regression coefficients for the various inputs used were tested using chi-square test to determine the inputs to which output was highly responsive, only those variables whose computed t-values were significant at 1%, 5%, and 10% were taken to have significant influence on output.

The multiple regression equation and explanation of variables:

$$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \beta_n X_n + \varepsilon$$

Where, Y = (total farm output) dependent variable

X_1 = Age of respondents

X_2 = Sex (male or female)

X_3 = Marital status

X_4 = Educational level

X_5 = Household size

X_6 = Land (resource constraints in the study area)

X_7 = Labour (resource constraints in the study area)

X_8 = Capital (the monetary value of machinery and tractors)

X_9 = Irrigation (method of supply water into dry land)

X_{10} = Water (water within wetlands, rivers, groundwater, and ditches)

ε = Error term

Age of Farmer

This is the age of the farmer measured in years. Evidence from previous studies shows that the age of an individual affects his mental attitude to new ideas and this may influence adoption in one of several ways. Younger farmers have been found to be more knowledgeable about irrigation practices and may be more willing to bear risk and adopt a technology because of their longer planning horizons. The older the farmer, the less likely he adopts new ideas of irrigation practices as he gains more confidence in his old ways and methods. On the other hand, older farmers may have more experience, resources, or authority that may give them more possibilities for trying a new method of irrigation practices. Generally, there is no agreement on the sign of this variable in the adoption literature as the direction of the effect is location or technology specific.

Gender of Farmer

Women farmers are generally perceived to face more constraints on their farms and this will negatively affect their adoption of new irrigation ideas. This variable is expected to have a negative sign on the dependent variable. Male farmers are scored one, while female farmers are scored zero.

Level of Literacy

Education is a measure of the ability to assess new

technology, it is posited that education and experience are two common measures of human capital (the ability to acquire and process information about a new technology) which may be used as proxies for risk. It is therefore expected to have a positive impact on the decision to adopt irrigation practices. Uncertainty and risk aversion have been shown to decrease the propensity for individual to adopt technologies. However, while measuring an individual's risk perceptions and risk aversion is difficult, economic theory posits that their perceptions are influenced by information and human capital. Thus, following earlier empirical findings, the maintained hypothesis is that level of literacy is positively related to adoption behavior. It is measured as number of years spent in school.

Household Size

This comprises all the people living under the same roof and who eat from the same pot with the farmer. Some previous studies show this variable to be positively related to adoption behavior as it provides a larger supply of family labour while other studies view that this variable has a negative relationship with adoption since increased household size increases consumption pressure.

The Linear Programming Model

Linear programming is often helpful in decisions requiring a choice among a large number of alternatives. It has been employed in several studies to determine the optimal organization of peasant farming system in Nigeria (Ogunfowora 1980).

The linear programming model employed for the study area was estimated as:

$$\begin{aligned} \text{Max} Z &= \sum (p_j q_i - c_i) \\ &= \sum A_i X_{ji} - b \\ &= X_i (j = 1 - M) \end{aligned}$$

Where:

Z = Return of owners labour and management (N/ha.)

p_j = Price of j^{th} crop per unit in naira (N)

q_j = Quantity of j^{th} crop in kilogram

c_j = Total variable cost of labour and purchased inputs

A_j = Per unit requirement of j^{th} activity carried out

M = The number of activities and it ranges from 1-4

i^{th} = Resource, ranges from 1-4h

b_i = The level of j^{th} resources

b_1 = Average farm size (ha.)

b_2 = Average labour available per farm in man-day/ha.

b_3 = Average capital employed per farmer in man-day/ha.

b_4 = Average water input in cm/ha.

RESULTS AND DISCUSSIONS

Socio-Economic Characteristics

Table 1 showed that over 82% of the respondents were males with females accounting for only 17.5%. This confirms the popular belief in the area that farming is a primary occupation for the male folks while the female folks are only to prepare food and maintain home for the males while working on their farms. It also confirms the religious belief that women in pedal are not to leave their homes for any outside activities.

Table 1 also shows the age distribution of respondents. Age is the length of past life or existence of a person. It is an important factor to be considered in determining the quality of labour employed and the enterprise. Age is particularly important considering the tedious nature of manual farming. In labour force prevalent in any given the study area, more than half of the respondents (80%) were within the age groups of 25-60 years. Because of the tedious nature of

Table 1. Socio-Economic Characteristics of the Respondents

Characteristics		
Gender distribution of respondents		
Characteristics	Frequency	Percentage (%)
Male	66	82.5
Female	14	17.5
Total	80	100.0
Age distribution of respondents		
Characteristics	Frequency	Percentage (%)
Age (group)		
25-40 years	11	13.8
41-50 years	32	40.0
51-60 years	33	41.2
60 above	4	5.0
Total	80	100.0

Notes: Source: Field survey, 2015; middle age group = 40-50 years; mean age group = 40 years.

Table 2. Educational Status of Respondents

Characteristics	Frequency	Percentage (%)
Level of education		
Primary	25	31.3
Secondary	22	27.5
Tertiary	11	13.7
No formal education	22	27.5
Total	80	100.0

Source: Field survey, 2015.

Table 3. Marital Status of Respondents

Characteristics	Frequency	Percentage (%)
Marital status		
Married	61	76.3
Divorced	8	10.0
Widowed	6	7.5
Single	5	6.2
Total	80	100.0

Source: Field survey, 2015.

Table 4. Family Size of Respondents

Characteristics	Frequency	Percentage (%)
House size		
1-5	28	35.0
6-10	40	50.0
11-15	8	10.0
> 16	4	5.0
Total	80	100.0

Notes: Source: Field survey, 2015; average family size = 8; standard deviation = 4.8.

manual farming which characterized the farming system in the area, only adults of working age (25-50 years) could take into irrigation farming using pump, calabash, and pipe watering irrigation methods. The age group also represents the most economically active age group. The reason for low percentage of youth/young farmers (13.8%) could be due to rural-urban migration and the quest for modern education urban centers. Capital stock is the monetary value of machinery and tractors, including pumping machines, soil preparation equipment/machines, and crop harvesters used in agriculture. Irrigation is captured as irrigation intensity defined as irrigated land per total crop area.

Findings revealed that water resource use conservation measure within the study area on irrigated crop sector of agriculture accounts for 80%-90% of the nation's water use (water is lost to the environment by evaporation, crop transpiration, or incorporation into products). Population growth, environmental flows (i.e. water within wetlands, rivers, and groundwater systems that is needed to maintain natural ecosystems), and energy-sector growth expand the demand for water resources. The independent variables considered were standardized as following: farm output in kilogramme, water in litres, age in years, etc.

Education is a very important factor in development of any country's economy.

The quality of skills of the farmers determines their level of locative abilities and shows well-informed of innovations and technology around him. Roger and Shoemaker (1991) reported that education is not only an important determinant of adoption of innovations but also a tool for successful implementation of innovation. Table 2 shows the educational status of the respondents in the study area, it shows that 27.5% of the respondents had no formal education. This is in accordance with the reports of Tsoho (2005). Agricultural production requires marital status and it becomes an important factor

especially when farm labour is in short supply. It is possible for married couple with large family size to have large supply of labour to work on the farm, and this may increase the size of farm land cultivated. Table 3 also shows that 76.3% of respondents in the study area were married having average family size of eight persons, and hence some satisfied family labours are for use on their farms.

Table 4 shows that 35% of the farmers had 1-5 family size, 50% had 6-10 family size, 10% had 11-15 family size, while only 5% had more than 16 family size. This implies that farmers had more hands from their family to support their farming activities, hence they spent less on labour.

Levels of Resource Use/Impact of Input or Output

Factors that influenced output (Q) of the entire crop enterprises were regressed against the explanatory variables: farm size in ha. (X_1), labour input in mandays (X_2), value of purchased inputs in naira (X_3), and the random error term (μ).

The regression analysis result for each of the four functional forms examined in the production function was linear, semi-log, exponential, and double log of equations.

From the regression estimate, the lead equation selected was double-logarithm (Cob-Douglas). This was based on fitness criteria, for example, apart from the fact that it has a relatively higher R^2 value, it also has two significantly expected signs of regression coefficients both in terms of economic and agricultural logic, and is considered as the appropriate form to the estimated (lead) equation which is presented as follows:

$$\begin{aligned} Q &= -.485 + 4.682X_1 + .572X_2 + .317X_3 \\ &= -.485 + (4.682) + (1.144) + (.951) \\ &= (-.485)(13.815)(3.851)(2.089) \\ R^2 &= .85 \\ F &= 94.433 \end{aligned}$$

Table 5. Crop Cultivated by the Respondents

Crop cultivated	Frequency	Percentage (%)
Maize	11	13.8
Sorghum	12	15.0
Rice	10	12.5
Cassava	15	18.7
Yam	13	16.3
Vegetable	12	15.0
Others	7	8.7
Total	80	100.0

Impact of irrigation

Crop cultivated	Frequency	Percentage (%)
Decline the crop yield	8	10.0
Increase the crop yield	20	25.0
Stunted crop growth	2	2.5
Food shortage	9	11.3
Food secure	7	8.7
Food price increase	4	5.0
Food price decrease	9	11.3
Others	21	26.2
Total	80	100.0

Impact of drought

Crop cultivated	Frequency	Percentage (%)
Food shortage	13	16.3
Decline in crop yield	16	20.0
Stunted crop growth	14	17.5
Decrease in land area cultivated	15	18.7
Poor quality of crops	12	15.0
Others	10	12.5
Total	80	100.0

Irrigation method

Crop cultivated	Frequency	Percentage (%)
Ditch irrigation	37	46.3
Terraced irrigation	10	12.5
Drip irrigation	16	20.0
Sprinkler irrigation	3	3.7
Rotary irrigation	5	6.2
Center irrigation	9	11.3
Total	80	100.0

Problem encountered

Crop cultivated	Frequency	Percentage (%)
Maintenance problem	20	25.0
Water availability	18	22.5
Insufficient irrigation materials	12	15.0
Others	30	37.5
Total	80	100.0

Table 5. Continued

Result of logit regression analysis	Co-efficient	Standard error	T-ratio
Age	37.86	9.647	3.925***
Sex	-39.65	24.41	-1.626*
Marital status	-1.166	24.41	-1.338
Household size	189.5	82.36	2.302**
Primary occupation (farming)	76.23	126.2	.604
Total land area	14.4	65.42	2.22**

Notes: Source: Field survey data, 2015; log-likelihood = -65.08; dependent variable = irrigation user (rep. by 1), while non irrigation user (rep. by 0); *** significant at 1%; ** significant at 5%; * significant at 10%.

From the equation, land and labour were significant ($p < .05$). Also, land, labour, and inputs have a positive relationship with output. Henceforth, more land, labour, and inputs should be allocated to irrigation users in order to affect the much needed increase in output, to ensure food security in the study area.

From the table, it can be seen that there is significance between the independent variables, this suggests that there is no problem of multicollinearity in the data use, hence the data use is judged free of problem of multicollinearity.

Table 5 shows the optimum results obtained through multiple regression, linear programme, and logit regression model analysis for irrigation users (farmers) in the study area. It can be seen that out of the various crops combinations listed on the table above, cassava and maize entered the optimum. The table shows that 25% of the respondents indicate that irrigation increases their crop yield, while 8.7% claim to have maximum food security as a result of irrigation methods practice in the study area. The difference in the variation of these impacts could be attributed to level of farm soil fertility. It was revealed from the table that 17.5% of the respondents indicated that drought increased the stunted growth of their crop, this impact may be attributed to individual farmer level of understanding. It was revealed that 46.3% of the respondents practiced ditch irrigation, 12.5% used terraced irrigation, and 20% used drip irrigation while 3.7%, 6.2%, and 11.3% used sprinkle irrigation, rotary,

and center irrigation. The variation in the method used by the individual farmer depends on the cost and level of understanding of the irrigation users (farmer) in the study area, as indicated by the farmers are maintenance problem (25%), water availability (22.5%), insufficient irrigation materials (15%) as it was revealed on the table with their percentages.

It was tested to confirm that irrigation and drought have both positive and negative significant effects on agricultural productivity. Also it was revealed on Table 5 that age is statistically significant at 1% with a coefficient value of 37.86% with a positive sign, sex is significant at 10% with a negative sign.

It further shows that household size is statistically significant at 5% with a value of a 189.5 with a positive sign, while total land area is also significant at 5% with a value of 14.4%. Household size has the highest coefficient value which implies that it exists as the most important factor that greatly determines the output of the farmers in the study area.

CONCLUSIONS

The study analyzed economic value of irrigated maize production using pump and shadoof irrigation techniques among farmers in Orire Local Government Area of Oyo State, Nigeria. The optimum irrigation farming computed showed that re-organized, well-planned, and proper irrigation application would yield more income to farmers.

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