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IDENTIFICATION OF RESOURCES FOR IRRIGATED TOMATO PRODUCTION IN LAU, TARABA STATE, NIGERIA

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ABSTRACT

This study tries to identify the resources available for irrigated tomato production in Lau Local Government Area, Nigeria. A multistage sampling techniques was employed for the selection of respondents for the study. Data analysis was done using descriptive statistics, gross margin analysis, and stochastic frontier production and inefficiency model. The results of the descriptive statistics showed that the irrigated tomato production in the study area was practiced under small and medium-scale pr0duction system. The result of the gross margin shows that irrigated tomato producers are doing relatively well in terms of both yield and profit. The average rate of return shows that approximately 24 kobo of every of every one naira invested was gained. Results from Maximum Likelihood Estimation shows that all estimated coefficients among various farm operation indicates positive sign which implies that increase in quantities of these inputs would results in increased output of irrigated tomato. The presence of technical inefficiency effect in the irrigated tomato production as indicated by the log-likely ratio test (7.044)was not significant. The insignificant presence of inefficiency in the farmer's production was confirmed by the gamma coefficient (0.003) which indicated that only 0.3% of the deviation of output from the production frontier was attributed to technical inefficiency. The average technical inefficiency of the farmers was 92% leaving a gap of 8% for improvement. while the return to scale(RTS) analysis indicated that, irrigated tomato production in the study area was in the stage II of the production, where resources and production were believing to be efficient. The study recommended that, government, non- governmental organizations and financial institutions should provide adequate needed capital for the farmers. Adequate irrigation facilities (e.g. dams) should be provided (existing ones rehabilitated and new ones constructed) for the expansion of the irrigated tomato production.

KEY WORDS: *Available resources, Irrigated tomato farming, farmers,*

INTRODUCTION

1.1 Background of the Study

Irrigation has ensured significant increase in global food supply and raised millions out of poverty (Faurès *et al.,* 2007). Studies have shown that an increase in irrigation productivity which results in improved farm income creates an increase in demand for local non-tradable goods and services, which offer labour opportunities to the poorest segments of the rural population, promotes local agro-enterprises and stimulates the agricultural sector as a whole (Lipton *et al.*, 2003; Smith, 2004; Hussain and Hanijra, 2004).

Irrigated agriculture is one of the most critical human activities sustaining civilization. The current world population of 6.8 billion people is sustained in a large part by irrigated agriculture. Irrigation has been described as a condition necessary for insufficient rainfall and/or poor distribution of rainfall in agriculture producing area (Punial & Pande 1997).Similarly, Daniel (1990) observed a dry condition due to evaporative demand of the atmosphere which continuously create stress for plants and therefore require water supplements for the period. Irrigation projects are designed to help reduce the dependence of crops growth on precipitation, which to a large extent is uncontrollable by man. Adoption of irrigation in such areas had ensured improved harvest and encouraged crops diversification.

USDA (2010) statistics showed that 17% of cultivated crops land in the United State is irrigated. Yet this acreage produces nearly 50% of total US crop revenues. According to Food and Agricultural Organization (FAO 2008), the approximate 1,260 million ha under rain fed agriculture, corresponding to 80% of the world's total cultivated land, supply 60% of the world's food: while the 277 million ha under irrigation, the remaining 20% of land under cultivation, contribute the other 40% of the food supplies. On average, irrigated crops yields are 2.3 times higher than those from rain fed ground. These numbers demonstrate that irrigated agriculture will continue to play an important role as a significant contributor to the world's food supply.

According to Food and Agricultural Organization (FAO 2008), irrigation has put smiles in the face of many people in semi- arid and arid regions where crops productivity without irrigation is inevitable. Irrigation system is aimed at increasing and improving agricultural yield, particularly in semi-arid and arid environment. Worlf (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 tropics, apart from bigger and reliable yield as against yearly cultivation, which is often at the mercy of the seasonal rainfall (S. R. R. B. D. A. 1984).

Tomato is an important vegetable crop in Nigeria where it is use an important kitchen items cooked as vegetables, used as condiments and salad. The consumption of tomato has high income elasticity of demand (Fateh, 2009). Tomato production requires a high level of management, large labor and capital inputs, it is subjected to the variations that occur in weather, which may result in severe crop damage and losses. Labor requirements for production, harvesting, grading, packaging and transporting are very intense. Tomato production is labour intensive and bulk production is from the dry season cropping system grown yearly under irrigation in Nigeria and Taraba States in particular.

Doberman et al (1996) reported that irrigated tomato accounted for 75% (363 million tones) overall rice production in Nigeria in 1990, while Vermilion (2004) reported that 40% of world food and 60% of its grains is produced under irrigation and land under irrigation had increased drastically from 94 million hectares in 1950 to 240 million hectares in 2000. This is expected because of the increase in world population and the need to expand agricultural land under the threat of climate change. Nigeria has 2.5million hectares of irrigation farmland but just about 320-370 hectares were cultivated in 2009 (Abbas, 2010).

Irrigation farming practice has increased tremendously because of increasing demand for tomatoes. This has placed tremendous pressure on tomato production to meet up with the increasing demand, as limited foreign reserves have to be allocated to tomato importation in order to meet consumption requirements. For these reasons, resource use efficiency in irrigated tomato production has remained an important subject of empirical investigation particularly in Lau Local Government where majority of the farmers are resource-poor.

1.2 The Study Area

1.2.1 Location

The study was conducted in Lau Local Government Area of Taraba state. The local government area covers a total land area of 2.03km^2 and lies between latitude 8^o and 11^o 20^{o}N and longitude 4^o 30 and 7′ 40E. Jalingo and Ardo kola local government area in the south, Yorro in the Southeast and Zing local government area in the Northwest.

1.2.2 Climatic and Soil Condition

The area experiences two distinct seasons within a year. These are: the rainy (wet) season which usually starts in late April or early May and last till October. The annual rainfall varies from 1100mm to 1600mm, while the dry season falls between November and March; the dry season commences from November to March with a temperature range of 35^{0}C to 40^{0}C. The evaporation is in the order of 2540 mm/a; and runoff from within the basin averages about 96 mm/a (Wiafe, 1997). The terrain and the climate condition in addition to the fertile soil which allows for the cultivation of a wide range of crops and animal husbandry. The predominant soils are Plinthic ferralsols (groundwater laterites), Eutric nitosols (savannah ochrosols) with their intergrades (Brammer, 1962; Adu, 1995).). The predominant land use is arable agriculture and widespread grazing of large numbers of cattle and other livestock (up to 100cattle/km2; FAO, 1991).The local government lies in upper guinea savannah; the vegetation is woodland with dense shrubs, grass and forest.

1.2.3 Occupation and Population of the People

The people are predominately peasant farmers cultivating mainly cash crops and food crops irrigated include tomatoes, yam, cassava, rice, pepper, onions, cabbage and lettuce, Maize for family consumption and for market. Farming activities are usually carried out using hand tools and other simple implements and it is labour intensive. In addition to the government developed irrigation systems which are mainly the small reservoir and large reservoir irrigation there are other irrigation technologies developed by the farmers and groups of farmers scattered across the basin. These are located in areas of rich alluvial deposits usually found along streams or rivers and in flood plains. However tomato irrigation is the most extensive and it is practiced under all types of irrigation technologies. Irrigation of tomatoeshas been the main contributor to the up scaling of irrigation development in the basin within the past two decades.The population of the local government area is about 96,590 (National Population Commission, 2006) and has a total of 10 wards. Lau Local Government Area was chosen for this study because of its great resource potentials, abundant human resources, favorable climate condition and most important is the irrigation activities which favor the prevalence of irrigated in farmers the area.

METHODOLOGY

2.0 Introduction

This chapter deals with method employed in carrying out this research, it will cover the study area, source of data, kinds of data, data collection / sampling technique and analytical techniques.

2.1 Sources of Data

The study uses primary sources of data. The primary source of data was derived from structured questionnaires. These questions required the respondents to circle or tick their choices amongst the options provided or to give their free answer where necessary.

2.2 Data Need

The kind of data that will be required in the study include; relevant economic characteristics of respondents, information relating to irrigated tomato farming, income earned, the efficiency of tomato production, input-output data of the farmers defined within economies of scale. The output data include yield of tomatoes in kilograms. The input data include cost of labour, cost of fertilizers, and cost of seed which serves as the basis of calculating total cost of production per annum. Data were also collected on the socio economic variables such as age, gender, marital status, years of schooling, source(s) of credit, farm size and the farming experience of the farmers.

2.3 Sampling Technique and size

The study employed the random sampling technique. Samples will be drawn from five wards in Lau Local Government Area. The wards include: Dogo, Jimlari, Donada, Abare A and Abare B council wards. In each ward, twenty (20) questionnaires will be randomly distributed to irrigated tomato farmers. Thus making a total of 100 questionnaires distributed in the study area. However, the questionnaires will be given to educated irrigated tomato farmers to fill while uneducated ones will be interviewed orally.

2.4 Techniques of Data Collection

The study used two sources of data collection, comprising primary and secondary data collection. The primary data are those collected from the field with the help of interview and administration of questionnaires. Interview involves face to face conversation with the farmers through planned and unplanned questions with the aim of obtaining information about the respondents. While administration of questionnaires is also refers to as structured questionnaire. Structured questionnaire is employed to obtained information in a predetermined manner. That is respondents are subjected to freedom of response relevant to the subject matter.

2.5 Method of Data Analysis

The research employed tables and the simple percentages to analyze the data collected, the raw data were sorted out, re-arranged and tabulated manually into frequency and percentages for quick and easy interpretation.

2.6 Techniques of Analysis

Three methods were used to analyze the data collected. These are: firstly, descriptive statistics consisting of tables, graphs, bar charts, per charts, simple percentages and proportion will be used to examine the socio-economic characteristics of the farmers. The simple percentages will be used, because it is the easiest statistical measure that can be used for descriptive purpose. It is computed using the following method:

$$\text{Simple percentage (\%)} = \frac{NR}{TNR} \times \frac{100}{1}$$

NR = number of respondents
TNR = total number of respondents

This will satisfy objective one and five. Secondly, Gross Margin Analysis will be to measure the profitability of irrigated tomato farmers. This is done so that comparison can be made between irrigated tomato farmers. It is given as:

$$GM = TR – TVC$$

Where,

GM = gross margin (₦/ha)

TR = total revenue (₦/ha)

TVC = total variable cost (₦/ha) i.e. the cost incurred in the use of variable inputs. The gross margin obtained is used to verify whether there is significant difference between irrigated tomato farmers with respect to the production cost, returns and profitability. This tool is used to satisfy objective two. Thirdly, stochastic frontier production function is used to estimate the resource use efficiency in various scale of rice production. The tool is used to satisfy objectives, three and four. It is given by:

$$\text{In } Y_i = \text{In } \beta_o + \Sigma \beta j \text{ In } Xij + Vi - Ui;$$

Where Yi = farm output from family;

Xi = vector of farm inputs used

X_1 = labour (in man days);

X_2 = farm size;

X_3 = fertilization (dummy: 1 = use fertilizer, 0 = not use fertilizer).

X_4 = planting materials (in kg);

X_5 = pesticide

V = random variability in the production that cannot be influenced by the Farmer;

Ui = deviation from maximum potential output attributable to technical Inefficiency.

β_o = intercept

β = Vector of production function parameters to be estimated;

i = 1, 2, 3, n farmers;

j = 1, 2, 3, m inputs;

The inefficiency model is:

$$\mu_1 = \delta_o + \delta_1 z_1 + \delta_2 z_2 + + \delta_4 z_4$$

Where μ_i = technical inefficiency effect of the i^{th} farm;

Z_1= educational level of farmers in years of formal education completed;

Z_2 = household size;

Z_3 = farm experience.

Z_4 = age of farmer in years;

δ = Parameters to be estimated.

The β and δ coefficient are unknown parameters to be estimated along with the variance parameters δ^2 and γ. The δ^2 and γ coefficients are the diagnostic statistics that indicate the relevance of the use of the stochastic production frontier function and the correctness of the assumptions made on the distribution form of the error term. The δ^2 indicate the goodness of fit and the correctness of the distributional form assumed for the composite error term. The Y indicates that the systematic influences that are unexplained by the production function are the dominant sources of random errors. The statistical significance shows the presence of a one-sided error component v_i, in the model specified. This means that a traditional response function estimated by the ordinary least square cannot adequately represent data; and the use of a stochastic frontier function estimated by the maximum likelihood estimated procedures is therefore appropriate. The parameters of the models will be obtained by the maximum likelihood estimation method using the computer programme, FRONTIER VERSION 4.1 (Coelli, 1994)

The *a priori* expectation is that the estimated coefficients of the inefficiency function provide some explanation for the relative efficiency levels among individual farms. Since the dependent variable of the efficiency function represents the mode of the inefficiency, a positive sign of an estimated parameter implies that the associated variable has a negative effect on efficiency and a negative sign indicate the reverse. Also the estimated coefficient for inputs implies that the associated variable has positive effect on efficiency and a negative sign indicates the reverse.

DATA PRESENTATION, ANALYSIS AND DISCUSSION

3.0 Introduction

This chapter deals with data presentation, analysis and discusses data gathered from the various sources of information. This is followed by the major findings of the analysis.

3.1 Socio-Economic Characteristics of Irrigated Tomato Farmers

Efforts were made to understand the socio-economic characteristics of irrigated tomato farmers in the study area. This was done with the hope of identifying those characteristics that may explain the farming activities in the area. The characteristics considered were age, gender, marital status, educational attainments, years of farming experience, membership of co-operative societies, contact with extension agents, classification of farmers based on farm size, means of land acquisition, source of income as well as farmers income level.

Irrigated tomato production requires both physical strength and experience. As the farmer advances in age, he/she gains more experience but also his ability to perform farm operation(s) declines. Table 4.1 indicates that 46% of the farmers sampled were youth within the age of 20-39 years, 29% were within the age of 40-49 years, while 18% were within the age of 50 - 59 years and 8% were old farmers within the age of 60 years and above. The mean age of the entire respondents was approximately 44 years which implies that they are active and productive. Contrary to findings of past studies which reported the farming population to be ageing (Sankhayan, 1988) the present study shows a young farming population. This may, be attributed to the location of the study area being a satellite town.

Table 4.1 Age Distribution of Irrigated Tomato Farmers

Age (year)	Mid –Point	Number of Respondents	Percentage
20 – 29	24.5	15	18
30 -39	34.5	38	28
40 – 49	44.5	32	28.8
50 – 59	54.5	10	17.6
60 – 69	64.5	5	7.6
Above			
TOTAL		**100**	**100**

Source: Field Survey Data 2013

Table 4.2 shows that majority of the respondents indicating 79% were males. This is a manifestation of gross inequality in gender distribution and calls for concerted effort in empowering the women to contribute their own quota to production in the study area.

Table 4.2 Gender Status of Irrigated Tomato Farmer

Gender Status	Number of Respondent	Percentage of Respondents
Male	79	79
Female	21	21
TOTAL	**100**	**100**

Field Survey, 2013.

Table 4.3 shows that 79% where married, while 19% where single and 2% where widow(er) and non-indicates divorce in the study area.

Table 4.3 Marital Status of Irrigated Tomato Farmer

Marital Status	Number of Respondent	Percentage
Single	19	19
Married	79	79
Divorced	0	0
Widow(er)	2	2
TOTAL	**100**	**100**

Field survey, 2013.

Educational attainments of farmers are one of the most important variables that influence farmers' decision with regards to production of Tomato. The modal class of educational level of respondents was non-formal education (62%) followed by Primary (27%) and secondary (11%) education as indicated in table 4.4. This is not surprising outcome as the study area falls within educationally disadvantaged states of Nigeria.

Table 4.4 Educational Attainment of Irrigated Tomato Farmer

Level of Education	Number of Respondent	Percentage
No Formal Education	62	62
Secondary	11	11
Primary	27	27
Tertiary	0	0
TOTAL	**100**	**100**

Source: Field Survey Data, 2013.

Table 4.5 also showed that 81% of the irrigated tomato farmers had less than 10 family members while 19% had 11 to 20 members. Generally, in agrarian settlements, a large family size guarantees free and cheap labour.

Table 4.5 Household Size of Irrigated Tomato Farmer

Household Size	Number of Respondent	Percentage
1 - 10	81	81
11 - 20	19	19
TOTAL	**100**	**100**

Source: Field Survey Data, 2013.

The importance of co-operatives societies in the study area cannot be over emphasized. Table 4.6 indicates that only 78% belong to a co-operative society, because farmers cannot satisfy the package of conditionalities and procedures involved in obtaining loans from formal financial institutions. One's membership of co-operative society therefore, could give a farmer the opportunity of getting loan easily, this is because it does not requires collateral security, receiving input at a lower cost, getting information on production practices and even providing distribution channels for farmers' produce. While 22% are not members of any co-operative society. This is because they satisfy the package of conditionalities and procedures involved in obtaining loans from formal financial institutions. This offers the farmers' opportunity of getting adequate loan, input and information on production practices.

Table 4.6 Distribution of Farmers Based on Membership of Co-operative Society or Association.

Membership Co-operative	Number of Respondents	Percentage
Yes	78	78
No	22	22
TOTAL	**100**	**100**

Source: Field Survey Data, 2013.

Contact with extension agents is expected to give the farmer a good opportunity to get information on better managerial practices, new technology and other auxiliary services.Table 4.7 shows that only 46% of the farmers had contact with extension agents while 54% of the farmers did not have contact with the extension workers.

Table 4.7 Distribution of Farmers Based on Contact with Extension Agents

Contact with Extension Agents	Number of Respondent	Percentage
Yes	46	46
No	54	54
TOTAL	**100**	**100**

Source: Field Survey Data, 2013.

Apart from irrigated tomato farming, some of the irrigated tomato producers in the study area engaged in one kind of economic activity or the other in order to augment their farming income during farming season or earn a living during off-season. Table 4.8 shows that, 45% of the respondents engaged in irrigated tomato farming alone throughout the year however, the table also points out that, 30% of the respondents combined irrigated tomato farming with buying and selling of goods as their source of income, 8% of the respondents were civil servants as well as rice farmers, and 10% of the respondents engaged irrigated tomato farming and driving e.g. Okada "Kabu Kabu" motor driving, while 7% of the respondents combined Tomato farming with other activities like butchering, milling, tailoring.

Table 4.8 Source of Income

Occupation	Number of Respondents	Percentage
Tomato Farming only	45	45
Tomato Farming &Trading	30	30
Civil Servant & Tomato Farming	8	8
Tomato farming & Commercial Driving	10	10
Others	7	7
Total	**100**	**100**

Source: field survey, 2013

Some studies have shown that high and middle – income households constitute a significant and growing proportion of irrigated tomato producers, who often engage in this activity for commercial purposes. The results from table 4.9, to some extent support this position. About 50% of the respondents of irrigated tomato farming are of the high – income bracket (more than ₦23000) arrived at, based on the mean income of twenty three thousand naira (23,000) in the study area. While 58% belong to the low-income group (less than ₦23000) and 12% are of the middle income group (of ₦23000). This shows that the irrigated tomato farming population straddles both the high as well as low-income households. This implies that irrigated tomato farming in the study area may be driven by other factors more than subsistence needs.

Table 4.9 Farmers Income Level

Income Level of Respondents	Number of Respondents	Percentage
Low income (less than ₦23000)	38	38
Middle income (₦23,000)	12	12
High income (more than ₦23000)	50	50
Total	**100**	**100**

Source: Field Survey, 2013

Table 4.10 indicates that, the total hectares of land cultivated by farmers in the study area were 44.22, 237.06 and 435.6 hectares and their averages are 1.1, 3 and 5.9 ha for small, medium and large scale respectively. This indicates that, the size of land owned and cultivated by a farmer in the study area determines to a large extent the farmers' level of output (ceteris paribus).

Table 4.10 Farm size Distribution of Irrigated Tomato Farmers in Lau Local Government Area.

Farm size	No of Farmers	Total Hecters of land	Range in Hecters	Av. farm size
Small scale	40	88.22	0.4 – 1.8	1.1
Medium scale	40	237.06	2.00 – 4.0	3.0
Large scale	20	435.6	5 - 7.2	5.9
Total	**100**	**760.3**	**7.4 – 13.6**	**100**

Source: Field Survey, 2013

From Table 4.11 indicates that 70% of the respondents has more years of farming experience from 20-30 years and 20% of the respondent has years of faming experience from 0 to less than 10 years and 10% of the farmers has years of experience from 31 years above. The implication is that farmers with more years of farming experience tend to be more efficient: in irrigated tomato production. This conforms to the findings of Tacoli (2004) who reported that older farmers are relatively more efficient. It is possible that such farmers gained more years of farming experience through "learning by doing", and thereby becoming more efficient.

Table 4.11: Distribution of farmers based on years of farming experience

Years of Experience	Number of Respondents	Percentage
0 -10	20	20
11 – 20	30	30
21 – 30	40	40
31 above	10	10
Total	**100**	**100**

Source: Field Survey, 2013.

3.2 Gross Margin Analysis

The gross margin associated with irrigated tomato production was estimated based on the following assumptions.

i. Open market price was used for fertilizer instead of the subsidized rate because subsidized price does not actually reflect the true cost (price) of the output.
ii. Since family labour is a substitute for hired labour in the study area, family labour was valued alongside hired labour at the prevailing market price of N31.35 per man-hour.

Thus for this study, only variable costs such as cost of seeds, fertilizer, pesticides, bags and labour were used. Other costs such as marketing and fixed costs were not considered. On the other hand, returns were calculated based on average price that farmers received per kg of tomato. The average cost of producing one hectare of tomato was calculated as represented in Table 4.12.

The Average Total Variable Cost of irrigated tomato farmers was ₦56, 566.51 per hectare (Table 4.12) labour cost accounted for N40, 915.66 representing 72% of the total variable cost. This simply shows that of irrigated tomato farmer in the study area used labour intensive mode of production. Out of this amount, contribution of family labour was estimated as N23,091 (56%) while hired labour was responsible for only N17828 (44%) from this, one can conclude that small scale Tomato producers used more of family labour than hired labour as shown in Table 4.8. The table equally shows that yields varies from one farmer to the other, on the average, it was estimated to be 2,433kg of tomato per hectare. Therefore, the gross margin obtained was ₦13, 382.6.

The return on gross margin, which is a measure of financial success or failure, was 0.24. This implies that on the average, a gross-margin of 24 kobo was made for every one naira invested in irrigated tomato production in the study area. The Table 4.12, equally shows that of irrigated tomato producers are doing relatively well in terms of both yield and profit. This is because their yield was within the expected yield of 1000kg – 5000kg per hectare (N. A. E. R. L. S 1993) and also the average rate of return shows that approximately 24 kobo of every one naira invested was gained. Finally, the average fertilizer used per hectare of land was 222.85kg/ha. This quantity is far below the recommended rate of 400kg/ha (N.A.E.R.L.S. 1993).

Table 4.11 Average Costs and Returns per Hectares of Irrigated Tomato Production.

Variables	Unit/haUnit	Price (N)	Values/ha (N)
A. Returns			
i. Tomato yield (Kg/ha)	21433	28.75	
Gross Return			69,948.75
B. Variable Cost:			
Seeds (kg/ha)	42.36	30.29	1,282.59
Fertilizer (kg/ha)	222.85	39	8691.15
Herbicides (kg/ha)	1.72	950	1,634
Tractor hiring			1,100
Labour Input (Man-Hour)			
Nursery Preparation	40.7		
Field preparation	124.6		
Planting	198.5		
Transplanting	201.9		
Weeding	184		
Fertilizer Application	45.3		
Chemical Spraying	38		
Bird Scaring	93.7		
Harvesting	200.3		
Threshing			
Winnowing, bagging			
And transportation	182.3		
Total labour input	1,309.3	31.25	
Total labour cost			40,915.66
C. Other cost:			
Bags	49.05	60	2,942.75
D. Total Variable Cost (B + C)			56,566.15
Gross Margin (A - D)			13,382.6
Average Return On Gross Margin (E/D)		0.24	

Source: Filed Survey Data, 2013.

4.3 Efficiency of Irrigated Tomato Production in the Study Area.

4.12 Result of Stochastic Frontier Production Function (MLE) for Irrigated Tomato

Variable	Parameter	Coefficient	t-ratio
Constant	β_0	11.877	18.804
Farm size (X)	$\beta_1$0.392	1.082	
Family labour (X)	β_2	0.141	2.434**
Hired labour (X)	β_3-0.060	-1.522	
Tomato seed (X)	β_4	0.717	2.114**
Fertilizer (X)	$\beta_5$0.111	1.000	
Herbicide (X)	β_6	0.272	3.254***
Irrigation water in ha-cm (X)	β_7	0.303	3.66***
Sigma squared	$\delta_0{}^2$	0.113	5.147***
Gamma	γ	0.003	0.288
Log-likelihood function (H_1)	$L(H_1)$	-16.685	-
Log-likelihood function (H_0)	$L(H_0)$	-20.207	-
Variance of error caused by noise	δ_v^2	0.1127	-
Variance of error accounting for inefficiency	$\delta_u{}^2$	0.0003	-
Log-likelihood ratio test LR		- 7.044	

*** Significant at 1%, ** Significant at 5%,

Table values: Chi-square at 5% = 16.949, $t_{0.05}$ = 2.617, $t_{0.5}$ = 1.980, $t_{0.1}$ = 1.658

Source: Computed from Field data, 2013.

The stochastic frontier production function for irrigated tomato in Lau local government area is presented in Table 4.13, the results showed that with the exception of hired labour, all inputs under consideration (farm size, family labour, tomato seed, fertilizer and herbicide), correlated positively with irrigated tomato output, consistent with a priori expectation. The coefficients of family labour

(0.141), farm size (0.392) tomato seed (0.717), fertilizer (0.111), herbicide (0.272) and irrigated water (0.303) has a significant effects on output. The significant effect of farm size, family labour, tomato seed, fertilizer and herbicide on the output may imply increasing production efficiency by effective use of these inputs. These results compares with a number of findings. Idiong [2010] reported that labour, farm size and seed positively and significantly related to tomato output. Similarly, the results of the Cobb-Douglas maximum likelihood estimate given by Backman et al. [2011] showed that land, labour and seed, among others factors, positively and significantly influenced tomato production. The coefficient of gamma (0.003) which indicated that 0.3% of the variation in the output of the irrigated tomato was attributed to technical inefficiency was not significant. This means that 99.7% of the deviation of output from the production frontier was occasioned by noise. The log-likelihood ratio test confirmed that the presence of inefficiency effect in the irrigated tomato production was not significant, implying that the Ordinary Least Squares (OLS) estimation technique which attributes random effect in production to all factors beyond the control of the farmers can adequately estimate the production function for the irrigated tomato. The sigma squared (0.113) was significant indicating the correctness of the specified assumptions of the composite error term. This finding is, however, at variance with the findings of Okoruwa and Ogundele [2012] and Idiong [2010] who established that tomato production in Nigeria is characterized by significant presence of technical inefficiency effects.

3.3 Technical Efficiency of Irrigated Tomato Farmers

Table 4.13: Frequency Distribution of Technical Efficiency of Irrigated tomato Farmers in Lau Local Government Area

Technical efficiency (TE)	No. of Respondent Frequency	Percentage (%)
0.601 - 0.700	1	2
0.701 - 0.800	13	5
0.801 - 0.900	24	23
0.901 - 1.000	62	70
Total	**100**	**100**
Minimum TE 0.696		
Maximum TE 0.998		
Mean TE 0.920		

Source: Computed from Field data, 2013.

The technical efficiency (TE) estimates of the irrigated tomato farmers are presented in Table 4.13. Technical efficiency of the farmers ranged from 69.60 to 99.80% with the average of 92%, corroborating the finding of Onoja and Achike [2013] who reported high technical efficiency of 95% for irrigated and rainfed rice production systems. The mean Technical Efficiency (TE) indicates that given the level of technology of the irrigated tomato farmers, little (8%) can be done to increase their technical production capacity. Despite the high level of technical efficiency of the farmers, their observed output as well as the output of the most efficient farmers based on the available technologies employed was lower than the maximum potential yield of the irrigated tomato by 3.37 and 2.89 metric tons respectively. This means that the existing levels of technological practices employed by the irrigated tomato farmers were still low, a pointer to the need for improvement. The low levels of the technologies raises a question of the where about of the numerous improved technologies developed to boost tomato production. It is either there are lapses on the part of agricultural extension services in transferring the improved technologies to the farmers or the farmers could not afford the technologies.

3.4 Sources of Inefficiency in Irrigated Tomato Farming

Table 4.14: Technical Inefficiency Parameters of Irrigated Tomato Farmers

Variable	Parameter	Coefficient	t-ratio
Constant	δ_0	-0.171	-0.681
Age (Z)	δ_1	0.009	- 1.370
Farming experience (Z)	δ_2	- 0.080	- 0.595
Household size (Z	δ_3	-0.027	-1.738*
Education (Z)	δ_4	-0.002	-0.207

t-tabulated: $t_{0.1}$ = 1.658 , *Significant at 10%

Source: Computed from Field data, 2013

The sources of inefficiency are examined by using the estimated δ coefficients in Table 4.14. The contribution of farmers' personal characteristics-level of education, age, years of farming experience and household size to farm inefficiency was also studied. If the dependent variables of the inefficiency model have a negative sign on an estimated parameter, it implies that the associated variable has a positive effect on efficiency, and a positive sign indicate that the reverse is true.

The positive coefficient for age δ_1 (0.009) variable implies that the older farmers are more technically inefficient than the younger ones. Older farmers tend to be more conservative and less receptive to modern and newly introduced agricultural technology. These results are in conformity with previous works by Parikh et al (2007). While the coefficients of farm experience δ_2 (-0.080) is estimated to be negative, that is (-0.080) and statistically significant at the 1 percent level. The implication is that farmers with more years of farming experience tend to be more efficient in Tomato production. This conforms to the findings of Battese and Coelli (1995) who reported negative production elasticity with respect to farming experience for farmers in two villages in India. Thus suggests that farmers gained more years of farming experience through learning by doing, and thereby becoming more efficient. While house hold size δ_3 (-0.027) and education δ_4 (-0.002) have negative sign. This implies that farmers' personal characteristics do not contribute to farm inefficiency. Since these variables were not significant, they do not deserve further discussion. Alongside with the parameters already presented and discussed, the technical efficiency rating of farmers was also estimated.

3.5 The Returns to Scale (RTS)

Table 4. 16: Elasticities and returns to scale of the parameters of stochastic frontier production function

Variables	Elasticity
Farm size	0.149
Family labour	0.181
Tomato seeds	-0.036
Fertilizer	0.237
Agro-chemical	0.078
Irrigation water	0.303
RTS 0.834	

Source: field survey, 2013.

The return to scale (RTS) analysis, which serves as a measure of total resource productivity, is given in Table 4.15. The maximum likelihood estimates (MLE) of the Cobb-Douglas based stochastic production function parameter of 0.834 is obtained from the summation of the coefficients of the estimated inputs (elasticites). It indicated that, irrigated tomato production in the study area was in the stage II of the production surface. Stage II is the stage of decreasing positive return-to scale, where resources and production were believes to be efficient.

3.6 DISCUSSIONS OF FINDINGS

Irrigated tomato production requires both physical strength and experience. As the farmer advances in age, he/she gains more experience but also his ability to perform farm operation(s) declines. Table 4.1 indicates that 75% of the farmers sampled were youth within the age of 20-49 years. The mean age of the entire respondents was approximately 44 years which implies that they are active and productive. Contrary to findings of past studies which reported the farming population to be ageing (Sankhayan, 1988) the present study shows a young farming population. This may, be attributed to the location of the study area being a satellite town.

The result from table 4.6 indicates that only 78% belong to a co-operative society, because farmers cannot satisfy the package of conditionalities and procedures involved in obtaining loans from formal financial institutions. This is because they satisfy the package of conditionalities and procedures involved in obtaining loans from formal financial institutions. This offers the farmers' opportunity of getting adequate loan, input and information on production practices.

From Table 4.10 the result indicates that 70% of the respondents have more years of farming experience from 20-30 years. The implication is that farmers with more years of farming experience tend to be more efficient: in irrigated tomato production. This conforms to the findings of Tacoli (2004) who reported that older farmers are relatively more efficient. It is possible that such farmers gained more years of farming experience through "learning by doing", and thereby becoming more efficient. While Table 4.11, equally shows that of irrigated tomato producers are doing relatively well in terms of both yield and profit. This is because their yield was within the expected yield of 1000kg – 5000kg per hectare (N. A. E. R. L. S 1993) and also the average rate of return shows that approximately 24 kobo of every one naira invested was gained. Finally, the average fertilizer used per hectare of land was 222.85kg/ha. This figure is far below the recommended rate of 400kg/ha (N.A.E.R.L.S. 1993).

The results of the stochastic frontier production function showed that all inputs under family labour (0.141), farm size (0.392) tomato seed (0.717), fertilizer (0.111), herbicide (0.272) and irrigated water (0.303), correlated positively with irrigated tomato output, this is in consistent with a priori expectation. The coefficients has a significant effects on output. These results compares with a number of findings of Idiong [2010] reported that labour, farm size and seed positively and significantly related to rice output. While the technical efficiency of the farmers ranged from 69.60 to 99.80% with the average of 92%, corroborating the finding of Onoja and Achike [2013] who reported high technical efficiency of 95% for irrigated and rainfed tomato production systems. The positive coefficient for age δ_1 (0.009) variable implies that the older farmers are more technically inefficient than the younger ones. Older farmers tend to be more conservative and less receptive to modern and newly introduced agricultural technology. These results are in conformity with previous works by Parikh et al (2007). While the coefficients of farm experience δ_2 (-0.080) is estimated to be negative, that is (-0.080) and statistically significant at the 1 percent level. The implication is that farmers with more years of farming experience tend to be more efficient in irrigated tomato production. This conforms to the findings of Battese and Coelli (1995) who reported negative production elasticity with respect to farming experience for farmers in two villages in India. While Table 4.15 indicated that, irrigated tomato production in the study area was in the stage II of the production surface. Stage II is the stage of decreasing positive return-to scale, where resources and production were believed to be efficient.

4.1 CONCLUSION

The study has established that irrigated tomatoes production in Lau local Government Area, was practiced under various farm operations. The presence of technical inefficiency effect in the farmers production was found to be insignificant as only an average of about 0.3% of the deviation of output from the production frontier was accounted by technical inefficiency. The average technical efficiency of the farmers was 92% leaving 8% gap for technical improvement. Despite the high level of technical efficiency of the farmers, the average frontier output based on the available production technologies employed was 2.89 metric tones lower than the maximum potential yield of the irrigated tomato, implying that the levels of production technologies employed by the farmers were still low.

4.2 Recommendations

1. Based on these findings, it is recommended that the irrigated tomatoes farmers should intensify effort to expand their farm size to maximize the use of the vast land area for tomato production during the dry season.
2. The government, non-governmental organizations and financial institutions should provide adequate needed capital for the farmers.
3. Also adequate irrigation facilities e.g. Dams should be provided, existing ones rehabilitated and new ones constructed for the expansion of the irrigated tomato production.
4. Furthermore, a detailed study should be conducted to ascertain the levels of production technologies for irrigated tomato in the study area with a view to improving the standard of the technologies or transferring the technology to the farmers

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