

ECONOMIC MELT DOWN AND DECLINE IN PINEAPPLE PRODUCTION: DETERMINANT OF PRODUCTION INEFFICIENCY OF PINEAPPLE-BASED ALLEY CROPPING PRACTICES IN CROSS RIVER STATE, NIGERIA

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ABSTRACT

This study was carried out to determine production inefficiency of pineapple –based alley cropping practices in Cross River State, Nigeria. A total of 120 pineapple-based alley croppers (farmers) were randomly selected from Cross River Agricultural Zones, using a multi-stage stratified random sampling technique. Multiple regression analysis model was the main tool of data analysis where different functions were used. The results indicated that Cobb-Douglas production function had the best fit in explaining the relationship between output of pineapple and inputs used, the co-efficient of multiple determinant ($R^2 = 0.58$) indicated that fifty-eight per cent of variability in output of pineapple is explained by the independent variables. The F-value of 17.26 indicates that the overall significance of the model at 1per cent level, indicating that there is a significant linear relationship between the independent variables taken together and yield of pineapple produced in Cross River State. The results also indicates that farmers' education level positively influence their level of production efficiency in pineapple production in the study area. There existed production inefficiency. Extension agents should train pineapple farmers to improve on production technique. There is need to urge Government for the effective implement of action –research type of programme so as to integrate institutional-technical and socio –economic aspects of pineapple base-alley cropping systems as well as post harvest and marketing aspects either through cooperatives or export processing zones.

Key words: Economic melt down, Production inefficiency, Alley cropping, Cobb-Douglas, Pineapple, Soil fertility management

INTRODUCTION

Population growth and poverty, which pervade Sub-Saharan Africa, continues to emphasize the need to increase food production (Adinya *et al*, 2008a). A major economic problem in Nigeria is the provision of food. This is as a result of population growth, poverty and predominant use of the traditional bush fallow system with shortened periods, is leading to declining agricultural production (Adinya, 2001). The transformation of agriculture from low productivity traditional inputs to high productivity modern inputs is a major problem facing agricultural development in Sub-Saharan African countries (Ibrahim *et al*, 2006). There is need to increase crop production using resources efficiently and alley cropping system of land management that allows sustainable levels of food production while maintaining soil fertility, providing reasonable supplies of firewood, fodder for animals, traditional medicine, and ornamentals and protecting the soil and water catchments area (Owa *et al*, 2006).

United Nations Development Program(UNDP) (1999) revealed that the development of agriculture in Nigeria is not meeting the demand of its teeming-population, despite the country's endowment with abundant and diversified range of natural, human and capital resources and oil revenue, has remained one of the poorest countries in Africa.

Successive government had embarked on agricultural programmes aimed at boosting crop production in Nigeria. These programmes include River Basin Development Authority, Land Use Decree, World Bank Assisted Agricultural Development Programme, National Fadama Development Project, Root and Tuber Expansion Programme and the Special Programme on Food Security (Panwal *et al*, 2006). However, none of these programmes has been able to adequately solve the food problems. Since the desire objectives have not been achieved and productivity of food crops have remain low. The low output realized by smallholder farmers is an indication that resources needed in the production of crops are not at optimal levels (Nweze, 2002; Panwal *et al*, 2006; Adinya *et al*, 2008b).Therefore the need to use

resources efficiently in the production of pineapple in Cross River State, Nigeria.

Pineapple (*Ananas comosus*) is a native of Southern Brazil and Paraguay where wild relatives occur. The crop was spread by the Indians up through South and Central America to the West Indies. Spanish introduced it into the Philippines and may have taken it to England in 1660. By 1720, the crop was grown in green houses in England, from where it came to West Africa in the early 18th century (Sampson, 1986; Ubi *et al.*, 2006; Ubi *et al.*, 2008). According to Ubi *et al.* (2005) the crop is drought tolerant and well adapted to the tropical acid sand with p^H ranging from 4.5 to 6.5 and the crop is propagated by new vegetative growth. Pineapple have oval to cylindrical shaped fruit, develops from many small fruits fused together. Pineapple fruit may be dark green, yellow, orange yellow or reddish when the fruit is ripe for harvest. The fruit is both juicy and fleshy with the stem serving as the fibrous core (Sampson, 1986). Pineapple is used mainly as food in the form of snacks and fruit-juice, while in most parts of the world the fermented juice is used to make vinegar and alcoholic spirit. Pineapple leaves are used to make cloth and rope, while the whole plant is used as a source of energy (Sampson, 1986).

According to Akalusi and Chomini (2006) pineapple and other crops and livestock farming as currently practiced still give cause for concern. These practices have led to decline in soil productivity, deforestation, desertification, climate change, overgrazing, soil compaction, loss of biodiversity etc. Smaling (1993) shows that there has been a net nutrient loss in soils in the last 30 years mainly due to pineapple and other crops harvests this has led to leaching, denitrification, erosion and lack of soil nutrient replenishment. This is more pronounced in farms belonging to resource poor smallholder farmers. There is a need for shift away from these unsustainable practices and their resultant negative effects on the environment to more sustainable practices (Akalusi and Chomini, 2006).

Sustainable agriculture involves farming systems that are capable of maintaining their productivity and commercial competitiveness without jeopardizing the need for conservation of natural resources and environmental soundness thereby maintaining its usefulness to society (Bisong, 2001). The farming system that is capable of maintaining their productivity without jeopardizing the need for conservation of natural resources and environmental soundness is alley cropping system. Alley cropping is a land use system that combines the growth of trees (*Leuceana leucocephala*) and pineapple in rows, sufficiently spaced to accommodate 4-6 rows of pineapple suckers, has gained prominence as a viable means of practicing sustainable pineapple production in era of economic melt down (Evans, 1992; Brasil, 1992; Akalusi and Chomini, 2006). Owa *et al.* (2006) defined alley crop as the growing of leguminous trees in rows,

while growing crops between the tree rows, high values, short duration crops can be grown in the alleys. *Leuceana leucocephala* (is exclusively leguminous nitrogen-fixing tree) that is periodically pruned to prevent shading of pineapples. Spencer (2002) revealed that resources –poor farmers must be assisted to rise beyond subsistence to increase their incomes through more efficient use of resources. They must be guided on what level of inputs combination that would ensure optimum production. However, higher level of production that leads to increased productivity and income from pineapple production among small and large scale pineapple farmers in Cross River State triggered their fast adoption of improved pineapple base-alley cropping system of farming with numerous advantages that out weighs traditional bush fallow system of farming. The Nigerian National Forestry Policy recognized the role of alley cropping practices in the consolidation of the nation's forest resources and its management for sustained yield (Anon, 1988; Akalusi and Chomini, 2006). Alley cropping was developed in Nigeria in the 1980's (Kang, 1993); since then it has been successfully introduced in other parts of Africa and Asian countries like the Philippines, Indonesia and Sri Lanka (Akalusi and Chomini, 2006). The contributions of alley cropping practices to pineapple and other crops production are as follows:

- Alley cropping is a stable alternative to shifting cultivation
- It is use for erosion control.
- It is use for soil fertility management

Soil fertility management: The basis for soil fertility management is the ability of hedgerow trees (*Leuceana leucocephala*) to recycle nutrients, particularly from deeper soil layers which cannot be reached by the roots of pineapple (*Ananas comosus*). Sampet, (1994) reported that *Leuceana leucocephala* as a good source of nitrogen for wheat and maize and other crops (pineapple, tomato, okro). He further stated that *Leuceana leucocephala* has been widely used in alley cropping system because it has high dry matter production, supplies the soil with high amounts of dry matter and nutrients especially nitrogen, phosphorous and calcium (Sampet, 1994; Van Lauwe *et al.*, 1998; Akalusi and Chomini, 2006). Mulongoy *et al.*, (1992) reported that yields of crop could be maintained for many years at reasonable levels with use of *Leuceana leucocephala* without application of inorganic fertilizers Van Lauwe *et al.*, (1998) reported that *Leuceana leucocephala* has a good residue nitrogen recovery in the top soil (5 cm of the top soil); the residue quality has a major impact on the dynamics of applied residues nitrogen in alley cropping system. Attah-Krah, (1990) reported that within six months *Leuceana leucocephala* fixed 250 kilogram of nitrogen per hectare. Also Kang and Mulongoy, (1992) reported a range of 150-160 kilogram of nitrogen per

hectare that was fixed by *Leuceana leucocephala*. According to Kang *et al.*, (1990) and Attah-Krah and Okali (1986) they observed that soils under *Leuceana leucocephala* had a higher soil organic matter, total soil nitrogen, low soil temperature fluctuation, high soil moisture and soil moisture retention than soil without

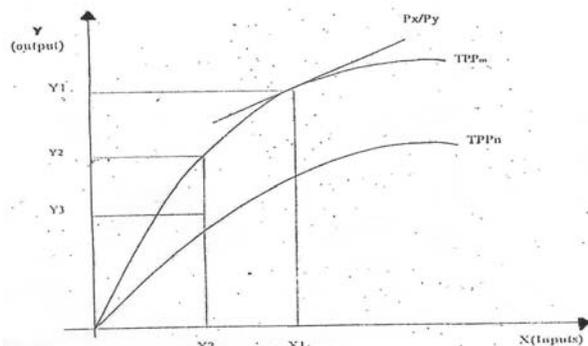


Figure 1: Graphical representation of technical and allocative efficiencies

Leuceana leucocephala. Arowolo (2007) observed that erosion in plots with *Leuceana leucocephala* was reduced by 83 % when compared to the control treatment. Imogie *et al.* (2008) reported that *Leuceana leucocephala* had a highly significant ($P \leq 0.1$) effect on soil physico-chemical properties than the control. They further stated that mean fresh fruit bunch yield, over a three year period, was significantly higher ($P \leq 0.05$), with fresh fruit bunch yield of 10.93 tons/ha in plots with *Leuceana leucocephala* as against 6.8 tons/ha in the control plots.

Cross River State is endowed with natural and human resources being presently exploited. The state has the potential to be world largest producer of pineapple because of the presence of suitable ecological zone for its production but low capacity utilization of resources or inefficient allocation of resources by pineapple farmers in the state has led to decline in pineapple production. In the world market, there is gap between supply and demand of pineapple; the gap is still wide in favour of demand. The major reasons for low productivity in pineapple production are small-scale of operation (small farm size), low capacity utilization of resources or inefficient allocation of resources, decline in soil fertility, low capital, high cost of agricultural inputs and population pressure, etc (Nweze, 2002; Panwal *et al.*, 2006; Adinya *et al.*, 2008). When population grows rapidly, it demands more and more from nature; more food, more water, more energy (Green, 1992). The rapid increase in population has led to increasing demand for food. Nigeria's population growth rate is put at 2.8% per annum, whereas food production declines to below 2.5% per annum (Nsikak-Abasi *et al.*, 2005; Goni *et al.*, 2007). Nigeria has a population of 140 million (Population Census, 2006) and it is projected that by 2050, the

country's population will be 303.6 million. Population does not only increase food demand but influences resources use and indirectly decrease food supply (Sundharam and Vaish, 1973; United Nations Development Programme UNDP, 1996). In Cross River State, pineapple production has been inadequate to bridge the demand – supply gap in both local and urban markets because of non-optimal use of resources, some pineapple farmers still use traditional bush fallow system with shortened fallow periods and enormous losses in post – harvest of pineapple. To reverse this trend, the resource poor farmers must learn to use alley cropping system, resources use efficiently and improved farm management technique is the most effective ways in increasing productivity of pineapple in short and long terms. Resource use efficiency is the ratio of useful output to the inputs that gives a maximum value of output from any given inputs (Shepherd, 1985). Helfaned (2003) observed that the analysis of efficiency is generally associated with the possibility of farms producing certain optimal level of output from a given least cost. Productive efficiency is the attainment of production goals without waste.

Efficiency of production is a very important factor for productivity growth especially in areas where resources are meager as in Nigeria. Efficiency of production is achieved through optimal resource allocation such that more output is achieved with same resource level or the same level of output is achieved using fewer resources. Technical and allocative efficiencies are often investigated using production function models (Kipkoech *et al.*, 2005). The basic model used to measure technical and allocative efficiencies in case of one variable (X_1) and one output (Y) is illustrated in figure 1 below

Farmers maximize their profit at point Y_1 , which is technically and allocatively efficient. Technical efficiency is defined as the ratio of farmers' actual output to the technically maximum possible output at the given level of resource use (Y_1/Y_3) and computed as $1 - Y_2/Y_3$ (Kipkoech *et al.*, 2005). Technical efficiency is the measure of the farms success in producing maximum output from a given set of resources (inputs) i.e. ability to operate on the production frontier (Farrel, 1957).

Allocative efficiency is expressed as the ratio of technically maximum possible output at the farmers' level of resources (Y_3/Y_1), which can also be expressed as $1 - Y_3/Y_1$. Allocative efficiency is the ability of the farmer to use the inputs in optimal proportions given their respective prices and the production technology. Economic efficiency is the product of the technical efficiency and allocative efficiency. Micro-economic theory holds that for profit maximization, firms should produce at the point where the marginal value product of a resource equals its price (Udo and Akintola, 2001a; Udo and Akintola, 2001b; Awoke, 2001; which states that a production input is efficiently utilized if the

ratio of the VMP/ input price equates to unity, a ratio less than unity indicates over- utilization of production inputs while a ratio greater than unity shows that resources are under- utilized.

Pineapple farmers in Cross River State fail to exploit fully the potential of resources and make production errors which results to decline in pineapple production. Ultimately, it is hoped that this study will help to bridge the gap between resources availability and efficient utilization in pineapple production in Cross River State. This study seeks to examine the production inefficiency in pineapple farms in Cross River State, therefore this paper tried to provide some useful information in policies towards increasing pineapple production in the state to bridge the gap between demand and supply of pineapple in both local and world markets. Hence, this study had the following objectives:

- (i) To determine production inefficiency in pineapple production in the study area.
- (ii) To analyze profit from pineapple-base alley farming in the study area.
- (iii) To determine the relationship between inputs and output in pineapple production in the study area.

METHODOLOGY

Study area: The research study was conducted in Cross River State. The state occupies an area of about 22,342.176 Square Kilometers (Quarterly News Letter of the Ministry of Local Government Affairs, C.R.S 2006). It is located on Latitude 5° 25'N and longitude 25° 00'E. The soils of Cross River State are ultisol and alfisol but predominantly ultisol suitable for pineapple production (FAO/UNESCO, 1974). There are eighteen Local Government Areas and one hundred and ninety-three communities in the state(five local government areas in Northern Senatorial Zone (Bekwarra, Yala, Ogoja, Obudu and Obanliku Local Government Areas), six local government areas in Central Senatorial Zone (Boki, Etung, Ikom, Obubra, Yakurr and Abi Local Government Areas) and seven local government areas in Southern Senatorial Zone (Calabar South, Calabar Municipal, Bakassi, Akpabuyo, Odukpani, Akampka and Baise Local Government Areas) (Quarterly News Letter of the Ministry of Local Government Affairs, Cross River State, 2006). Cross River State is bounded on the North by Benue State, South by Bight of Bonny, and in the East by Ebonyi and Abia States, while in the West by Republic of Cameroun(Menakaya and Floyd,1978). About 2,888,966 people inhabit the area, of which the Efiks, Ejaghams and Bekwarras are the major ethnic groups (Population Census, 2006 In: Agbor, 2007 In: MOFINEWS, 2007).

Cross River State has the largest rainforest covering about 7,290 square kilometers. It is described as one of Africa's largest remaining virgin forest harbouring as many as five million species of animals, insects and

plants (MOFINEWS, 2004). The state is located within the evergreen rainforest zone. There are two distinct climate seasons in the area, rainy season from March to October and dry season from November to February. The annual rainfall varies from 2,942mm to 3,424mm Cross River Agricultural Development Project (CRADP) (1992). The average temperature is about 28°C (CRADP, 1992). Cross River State is characterized by presence of numerous ecological and zoo-geographically important high gradient streams, rapids and waterfalls. Fishing and subsistence agriculture are the main occupations of the people. Crops grown in the locality include rice, maize, yam, cassava, pineapple, plantain and banana. Population depends largely on natural water sources for all their water-related activities, as pipe-borne water supply is limited and grossly inadequate. Health services in the area require a lot of improvement. Level of hygiene in the communities is generally poor (Arene *et al.*, 1999).

A multi-stage stratified random sampling technique was used to select the respondents. This procedure recognized the delineation of the study area into zones. The Cross River Agricultural Development Project (CRADP) divided this agricultural zone into three zones namely: Northern Zone (Ogoja Zone), Central Zone (Ikom Zone) and Southern Zone (Calabar Zone) of the state. There are five local government areas in Northern Zone (Bekwarra, Yala, Ogoja, Obudu and Obanliku Local Government Areas), six local government areas in Central Zone (Boki, Etung, Ikom, Obubra, Yakurr and Abi Local Government Areas) and seven local government areas in Southern Zone (Calabar South, Calabar Municipal, Bakassi, Akpabuyo, Odukpani, Akampka and Baise Local Government Areas). In all, there are 18 Local Government Areas in Cross River State. The three agricultural zones consist of 17 blocks, 8 circles and 136 cells with 5200 contact farmers. However, contact and non- contact farmers were use for this study. At the first stage four (4) local government areas were selected from each zone(twelve(12) local government areas were selected from three agricultural zones of the state), then one farming community was randomly chosen from each of local government area (12 farming communities were randomly chosen from twelve(12) local government areas). For better coverage in the study area, one village was randomly chosen from each of the communities (12 villages were taken from 12 farming communities). Ten respondents (five (5) contact farmers and five (5) non-contact farmers) were randomly chosen from each of the selected villages. In all, 120 respondents were selected.

Data analysis: Data obtained for this study was subjected to different types of analyses. In this study, the following tools were employed, namely: descriptive statistics, costs and returns analysis, multiple regression analysis. Multiple regression technique was used to determine the

relationship between pineapple output and the selected variables. The linear, Cobb-Douglas (by applying logarithm on both sides of the equation) and semi-log production functions forms were used to determine which of the forms would best fit the relationship between pineapple output and the explanatory variables.

The implicit form of regression for this analysis was given as:

$Y = f(X_1, X_2, X_3, X_4, X_5, e_1)$ and explicitly form of the regression model for this analysis is given by

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + e$$

Where: Y=total output of pineapple (kilogram)

X_1 =educational level of respondents (measured on a 4 point scale of First School Leaving Certificate=1, Senior Secondary School Certificate=2, Tertiary Institution=3, No education = 4).

X_2 =adoption of improved pineapple base alley cropping system technology (spacing distance) (measured on a 3 point scale of 10 cm between hedge and pineapple sucker row=1, 30 cm between hedge and pineapple sucker row=2, 60 cm between hedge and pineapple sucker row=3) X_3 = labour (man-days) X_4 = farm size (hectare) X_5 = fertilizer (kilogram) $b_0 - b_5$ = Regression coefficients to be estimated. e = error term (error or disturbance term is included to capture the effects of exogenous and endogenous variables not included in the model)

Three linear function forms were applied; these are Linear Production Function, Cobb-Douglas Production Function and Semi-Log Production Function forms. Whichever model that has the highest R^2 and shows many statistical significant variables will be adopted following (Kmenta, 1971, Koutsoyannis, 1977 and Awoke, 2001). The functional forms fitted are specified below: (a) Linear Production Function:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + e \text{ equation (1)}$$

Where Y, X_1, X_2, X_3, X_4, X_5 are defined in the implicit form $b_0 - b_5$ = Regression coefficients of variable inputs X_1, X_2, X_3, X_4, X_5

a = constant term e = error term

(b) Cobb-Douglas Production Function (Double -Log):

$$\text{Log } Y = \text{Log } a + b_1 \text{Log } X_1 + b_2 \text{Log } X_2 + b_3 \text{Log } X_3 + b_4 \text{Log } X_4 + b_5 \text{Log } X_5 + e \dots \text{equation (2)}$$

(c) Semi-Log Production Function:

$$Y = \text{Log } a + b_1 \text{Log } X_1 + b_2 \text{Log } X_2 + b_3 \text{Log } X_3 + b_4 \text{Log } X_4 + b_5 \text{Log } X_5 + e \dots \text{equation (3)}$$

Where Y, X_1, X_2, X_3, X_4, X_5 are defined in the implicit form

$b_0 - b_5$ = Regression coefficients of variable inputs X_1, X_2, X_3, X_4, X_5

a = constant term e = error term

Each resources was measured using the formula: the average physical product (APP) was derived by dividing total output by total inputs

$$\text{APP} = \frac{Y}{X}$$

The marginal physical product (MPP) was derived by dividing total output by total inputs

$$\text{MPP} = \frac{DY}{DX}$$

MPP x price of product= marginal value product (MVP)

The allocative efficiency (AEL) of resource was determined by ascertaining whether or not the ratio of the marginal value product to the inputs price was equal to one

$$\text{AEL} = \frac{\text{MVP}}{P} = 1$$

Where MVP = marginal value product

P= unit price of input

The marginal products (MP) were derived by multiplying the average production (AP) by the elasticity of production (EP), given that

$$\text{MP} = \text{AP} \times \text{EP}$$

$$\text{EP} = \frac{\text{MP}}{\text{AP}}$$

Profit analysis used for this study is expressed as:

$$\text{GM} = \text{TR} - \text{TVC}$$

$$\text{Profit} = \text{GM} - \text{TFC}$$

Where: GM = Gross Margin

TR = Total Revenue from production of pineapple (naira)

TVC = Total variable cost of production of pineapple (naira)

RESULTS AND DISCUSSION

Analysis of Table 1 revealed that 3.33% of the respondents had Senior Secondary School Certificates (SSSC). However, 23.33% of the respondents revealed that they attended Tertiary Institutions (TI). While 34.17% of the respondents disclosed that they had First School Leaving Certificates (FSLC). Only 39.17% of the respondents had no education. The farmers that had no education (39.17%) revealed that lack of educational training affected their yield and production efficiency because they were unable to read the instruction on fertilizer bags. In addition to that, all extension agents were posted to the state's pineapple farms as a result of this problem no extension agents to guide them on recommended rate of fertilizer application therefore as a result of this illiteracy problem some of them under applied fertilizers per hectare (34.17% of them applied 200 kilogram per hectare of fertilizer (NPK) while others over applied fertilizers in their farms (39.17% of them applied 350 kilogram per hectare of fertilizer (NPK) and above) and . This implies that lack of educational training acquired by pineapple farmers affected their yield and production efficiency and income. Of course, this goes to confirm the earlier deduction by (Adinya, 2001; Idiong *et al*, 2006) that technical and commercial education broaden farmers' intelligence and it also enable farmers to perform the farming activities intelligently, accurately and efficiently this leads to increase yield, productivity and farm income.

Table 1: Distribution of respondents according to socio-economic characteristics of pineapple farmers in Cross River State

Education Attainment	Northern Zone (Ogoja Zone)	Central zone (Ikom Zone)	Southern Zone (Calabar Zone)	Total frequency	Percentage (%)
First School Leaving Certificate	15	14	12	41	34.17
Senior Secondary School Certificate	-	3	1	4	3.33
Tertiary Institution	4	10	14	28	23.33
No education	21	13	13	47	39.17
Total	40	40	40	120	100
Adoption of Improved Alley Cropping system(Spacing distance)					
10cm between <i>Leuceana leucocephala</i> and pineapple sucker rows	1	5	13	19	15.83
30cm between <i>Leuceana leucocephala</i> and pineapple sucker rows	29	16	17	62	51.67
60cm between <i>Leuceana leucocephala</i> and pineapple sucker rows	10	19	10	39	32.50
Total	40	40	40	120	100
Labour(man-days)					
1	8	12	9	29	24.17
2	12	10	10	32	26.67
3	9	5	4	18	15.00
4	4	9	7	20	16.67
5	5	1	6	12	10.00
6 man-days and Above	2	3	4	9	7.50
Total	40	40	40	120	100
Farm size(hectare)					
0.1- 2	34	37	27	98	81.67
3-4	6	3	13	22	18.37
Total	40	40	40	120	100
200 kilogram per hectare of fertilizer (NPK)	15	14	12	41	34.17
250 kilogram per hectare of fertilizer (NPK)	-	3	1	4	3.33
300 kilogram per hectare of fertilizer (NPK)	4	10	14	28	23.33
350 kilogram per hectare of fertilizer (NPK) and above	21	13	13	47	39.17
Total	40	40	40	120	100

Source: Field survey, 2009

Table 2: Average production cost, inputs used and returns, profit margin per hectare of pineapple –based alley cropping practices in Cross River State

Variables	Unit price (₦/Kg)	Northern Zone (Ogoja Zone)	Central zone (Ikom Zone)	Southern Zone (Calabar Zone)	Total quantity	Total Cost(₦)	Total Revenue (TR) (₦)
Pineapple output (PO) kg	90	864	1316	1124	3304	-	297,360.00
Pineapple sucker	25	1.25	2.36	2.11	5.72	143	
<i>Leuceana leucocephala</i>	40	0.31	0.59	0.53	1.43	57.2	
Family labour	62.5	8.00	9.40	1.02	18.42	1,151.25	
Hired labour	62.5	4.20	4.90	5.30	14.40	900.00	
Farm size	1000	89.20	98.80	89.60	277.60	277,600.00	
Fertilizer	100.1	3.01	3.05	3.03	9.09	6,817.50	
Total fixed cost(TFC)	250	250	250	250	-	750.00	
Total variable cost(TVC)							287,418.95
Profit margin							9,191.05

Source: Field survey, 2009

Footnote: Profit analysis used for this study is expressed as:

$$GM = TR - TVC$$

$$\text{Profit} = GM - TFC$$

Where:

TR = Total Revenue from production of pineapple (naira) = ₦297,360.00

TVC = Total variable cost of production of pineapple (naira) = ₦287,418.95

GM = Gross Margin = ₦297,360.00 - ₦287,418.95 = ₦9,941.05

$$\text{Profit} = GM - TFC = ₦9,941.05 - ₦750.00 = ₦9,191.05$$

Table 2 revealed that the total yield of pineapple produced in the study area was 3304kg and the value of pineapple produced was ₦297,360.00. A total of 2051.25 man-days were used in pineapple production. The profit obtained was ₦9,191.05. Further analysis of Table 2 revealed that the benefit of pineapple based-alley cropping technique of farming is attractive to the point at which the cost incurred in its adoption was fully offset by the revenue that accrued from pineapple farming business.

Table 3: Multiple regression equations for pineapple production in Cross River State

Production function forms	Constant	X ₁	X ₂	X ₃	X ₄	X ₅	R ²	Adjusted R ²	F-Value
Linear Production Function	-2.659 (1.498)	0.134 (0.212)	0.281 (0.374)	0.130 (0.117)	1.237 (0.163)	1.295 (0.049)	0.54	0.56	16.42
Semi-log Production Function	-5.754 (5.058)	0.579 (1.008)	0.991 (1.306)	1.053 (0.912)	7.249 (1.182)	4.018 (1.681)	0.55	0.50	13.4
Cobb-Douglas Production Function	-1.313 (0.710)	9.687 (0.142)	0.164 (0.183)	0.252 (0.128)	0.941 (0.166)	0.553 (0.236)	0.58	0.57	17.26

Source: Field survey, 2009 Footnote: values are significant at 1%

Figures in parenthesis are standard errors

Table 3 revealed that Cobb-Douglas production function is the lead equation because it has the highest R² value of 0.58 and met other econometric criteria; therefore Cobb-Douglas production function equation is a good equation compared to linear and semi-log production function equations.

The regression analysis revealed that education has positive influence on output of pineapple produced in Cross River State and is significant at 1 per cent level of significance. Further analysis of Table 3 revealed that labour, farm size, fertilizer and adoption of improved alley cropping system has positive influence on output of pineapple production and it is significant at 1 per cent level of significance. The F-value of 17.26 for the function is significant at 1 per cent indicating that there is a significant linear relationship between the independent variables taken together and the yield of pineapple produced in Cross River State. Kalirajan (1981) and Fujimoto (1988) reported similar results for labour in the aggregate while Akalusi and Chomini, (2006) reported similar result for alley cropping system of leave space as spacing (spacing distance of 60cm between *Leuceana leucocephala* and pineapple sucker rows. They further stated that alley cropping system can improve productivity in a sustainable manner by having outputs that satisfy most of the farmers' income need, at the same time nutrient recycling is enhanced, soil erosion is prevented and soil moisture is conserved. Kang and Mulongoy (1992) reported that yields of crop could be maintained for many years at reasonable levels with use of *Leuceana leucocephala* without application of

inorganic fertilizers Van Lauwe *et al* (1998) reported that *Leuceana leucocephala* has a good residue nitrogen recovery in the top soil (5 cm of the top soil); the residue quality has a major impact on the dynamics of applied residues nitrogen in alley cropping system. Attah-Krah (1990) reported that within six months *Leuceana leucocephala* fixed 250 kilogram of nitrogen per hectare. Also Kang and Mulongoy (1992) reported a range of 150-160 kilogram of nitrogen per hectare that was fixed by *Leuceana leucocephala*. According to Kang *et al* (1990) and Attah-Krah and Okali (1986) they observed that soil soils under *Leuceana leucocephala* had a higher soil organic matter, total soil nitrogen, low soil temperature fluctuation, high soil moisture and soil moisture retention than soil without *Leuceana leucocephala*. Arowolo (2007) observed that erosion in plots with *Leuceana leucocephala* was reduced by 83 % when compared to the control treatment. Imogie *et al* (2008) reported that *Leuceana leucocephala* had a highly significant (P ≤ 0.1) effect on soil physico-chemical properties than the control. They further stated that mean fresh fruit bunch yield, over a three year period, was significantly higher (P ≤ 0.05), with fresh fruit bunch yield of 10.93 tons/ha in plots with *Leuceana leucocephala* as against 6.8 tons/ha in the control plots.

Decision rule:

EP = 1 is unitary elasticity production

EP > 1 elastic production

EP < 1 in-elastic production

Table 4 revealed that marginal value product of alley cropping system of leave space as spacing (spacing between *Leuceana leucocephala* and pineapple sucker

rows), labour, farm size and fertilizers were ₦ 0.48, ₦ 17.09, ₦ 2,313.33 and ₦ 1.19 respectively, while allocative in-efficiency for alley cropping system of spacing (spacing between *Leuceana leucocephala* and pineapple sucker rows), labour and fertilizers were 0.012

over utilized, 0.27 over utilized, 0.048 over utilized while farm size was 2.31 under utilized, there existed production in-efficiency, this implies that there is potential for pineapple farmers to improve on production technique.

Table 4: Estimated elasticities of production function (EP), Average production (AP), Marginal production (AP), Marginal value product (MVP) and Allocative efficiency of pineapple-based alley cropping in Cross River State

Variables	EP	AP	MVP	MPP	P	AEL	Inference
Adoption of alley cropping system of spacing distance of 60cm between <i>Leuceana leucocephala</i> and pineapple sucker rows	1	0.012	0.48	0.012	40	0.012	Over utilized
Labour	1.01	0.27	17.09	0.273	62.50	0.273	Over utilized
Farm size	1	2.31	2313.33	2.31	1000	2.31	Under utilized
Fertilizer	1	0.048	1.19	0.048	25	0.048	Over utilized

Source: Field survey, 2009. Footnote:

Conclusion: The result of this study showed that improved pineapple alley-base cropping system of production by small-scale farmer was profitable (profit obtained was ₦ 9,191.05) but respondents were inefficient in production of pineapple; they over-utilized or under-utilized resources (allocative in-efficiency for alley cropping system of spacing (spacing between *Leuceana leucocephala* and pineapple sucker rows), labour and fertilizers were 0.012 over utilized, 0.27 over utilized, 0.048 over utilized while farm size was 2.31 under utilized). However, expectation of huge profits had cause most of respondents in study area to shift from traditional bush fallow system of farming to improved pineapple alley-base cropping system but the return from the farming business was below their expectation due to lack of technical training by extension agents. However, the extension agents gave more attention to the state's pineapple farms and had little or no time to train pineapple farmers in the study area as a result of this lack of training it affected yield, productivity and income of stake holders. Some farmers with higher educational attainment use recommended dosage of fertilizer application more often than farmers with no educational attainment.

Finally, estimating a production function calls for accurately measured data on output and inputs. The five explanatory variables in the model were statistically significant. The cost of farm land was a powerful explanatory variable with unitary elasticity of production.

Some key recommendations have been derived. They are address to governments, industry, farmers, research and development organizations and development agencies. The recommendations are as follows:

* Urge relevant government agencies to implement capacity building programmes on train the trainers (extension agents) and farmers on production technique and farm management of available resources as efficient

as possible to achieve optimum production because inefficient use of resource can jeopardize pineapple availability and pineapple security.

The provision of loans with low interest rate to both small and large-scales pineapple farmers not politicians, motor park boys or civil servant. Furthermore, extension agents should monitor beneficiaries of such loans to ensure that farmers do not divert funds to buy motor-cycles, cars or marry more wives and also they should ensure that regular repayment of loans by such beneficiaries.

There is need to urge Government for the effective implement of action –research type of programme so as to integrate institutional-technical and socio –economic aspects of pineapple base-alley cropping systems as well as post harvest and marketing aspects either through cooperatives or export processing zones.

*Non- economics variables (such as soil type, soil P^H, rainfall and quality of pineapple suckers) should be explicitly considered in future econometric studies.

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