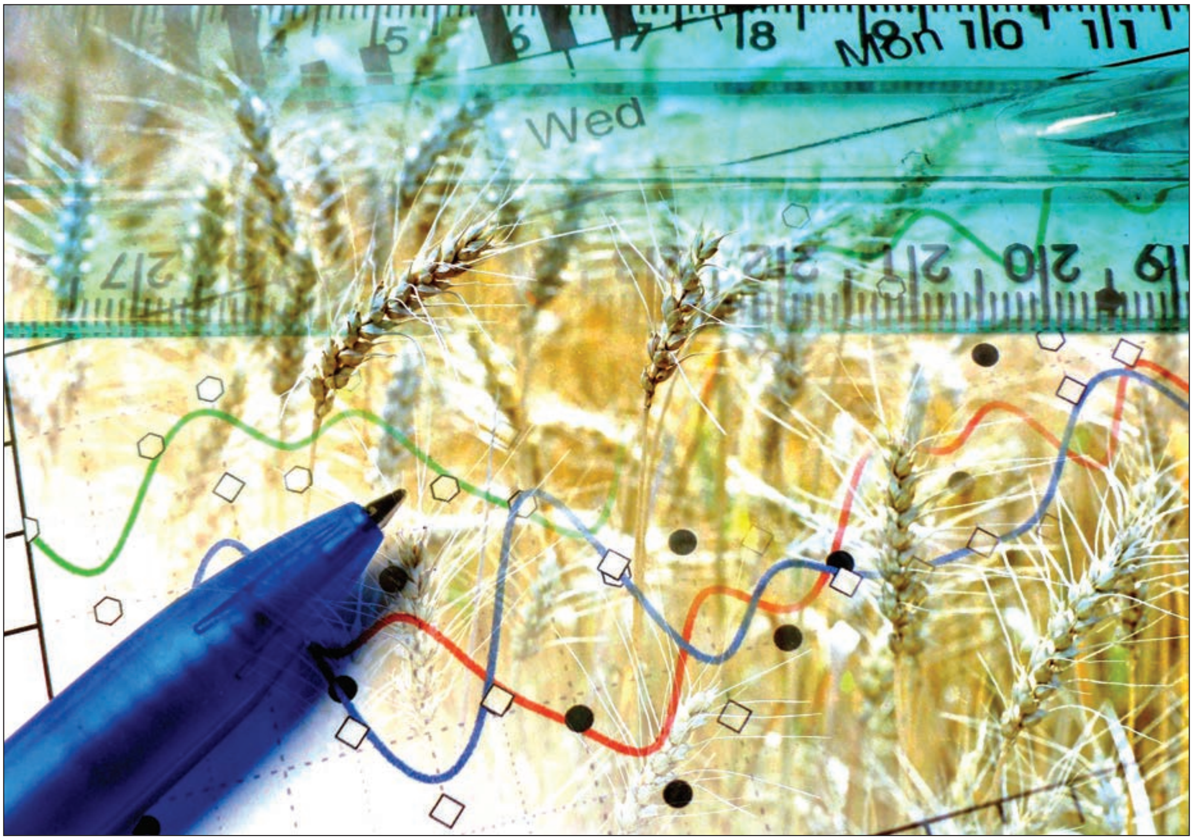

Trends in Agricultural Economics

ISSN 1994-7933

science alert

ANSInet
an open access publisher
http://ansinet.com

Trends in Agricultural Economics 3 (2): 79-93, 2010
ISSN 1994-7933

An Economic Analysis of *Talinum triangulare* (Jacq.) Production/Farming in Southern Nigeria

[1]E.J. Nya, [2]N.U. Okorie and [3]M.J. Eka
[1]School of life Sciences, John Muir Building, Heriot-Watt University, Riccarton, Edinburgh, EH14 4AS, UK
[2]Department of Agricultural Economics, Michael Okpara University of Agriculture, Umudike, Umuahia, Nigeria
[3]Department of Agronomy, College of Crop and Soil Sciences, Michael Okpara University of Agriculture, Umudike, Umuahia, Nigeria

Abstract: This study takes a curious looks into the production systems, cost structure and profitability of *Talinum triangulare* production and farming in South-Eastern Agro ecological zone of Southern Nigeria. In this study area, about 70% of the entire population are peasant farmers cultivating arable crops and vegetables, few deals on Cash crops like oil palm and cocoa. Among the vegetables cultivated by these peasant farmers is *Talinum triangulare*. *Talinum* farming practice is done in extensive mode, casually cultivated in scattered areas and only a few farmers (20%) cultivate semi intensively in fadama areas. The costs and returns of extensive and semi-intensive farming systems are compared. Based on the Cobb-Douglas production function model, return to scale indicates that there is scope to increase production and income from *Talinum* farming in extensive and semi-intensive systems. By applying more inputs like improve cuttings, water irrigation, good cultivation tools and fertilizers in the study area, all farmers would made profit. Considerable variations in production costs and profitability were observed depending on the farming seasons, cycle and practice.

Key words: *Talinum triangulare* (Jacq.), cost structure, production system, profitability, production function model

INTRODUCTION

Agriculture is rated the most important economic sector in all developing countries. Particularly, in Nigeria 45-60% of the labour force is engaged in agricultural activities and agriculture contributes up to 30-40% of the GNP (The World Bank, 2008). The importance of Vegetables is both as food and as raw materials for industries, which also serves for economic interest.

In the past decade the consumption of vegetables in Nigeria had been on the increase and currently is estimated to about 22-47.58 kg/person/year (Hart *et al*., 2005). *Talinum triangulare* (waterleaf) are among the most profitable vegetables in Southern Nigeria.

In Nigeria, *Talinum triangulare* farming is presently one of the most important works for the majority of the unemployed youths and women of the rural population. During the past two decades, its cultivation has attracted considerable attention because of its general acceptability by all classes of people and its export potential. *Talinum triangulare*

Corresponding Author: E.J. Nya, School of life Sciences, John Muir Building, Heriot-Watt University, Riccarton, Edinburgh, EH14 4AS, UK

(locally known as waterleaf) is a highly valued product in Nigeria food markets, among the market women and housewives (Nya and Eka, 2007). Normally, almost all the fresh vegetables produced locally are shifted to the thickly populated urban centres, particularly to Uyo, Calabar, Port Harcourt, Umuahia, Aba, Owerri, Enugu and Onitsha. The quantity of *Talinum triangulare* produced in a year remains rather obscure because production statistics of this produce are often not kept by the Ministry of Agriculture or the appropriate Governmental authority. Out of the estimated total cultivable land area of 71.2 m ha^{-1} (Opabode and Adebooye, 2005) spread across the country, the total area put under its cultivation nationwide is estimated to be around 30,000 ha, Department of Agronomy, Michael Okpara University of Agriculture, Umuahia, Nigeria (Oral communication-unpublished). This figure is expected to rise with the increasing awareness among the people, for its profitability and production expansion into fadama areas. *Talinum* farming is mostly concentrated in Southeast and South-Western Nigeria, mainly among the resourced poor rural populace. The increase in demand for Vegetables from the nation's food markets and its short production cycles attracted many farmers to switch to *Talinum* cultivation in different parts of the country (Nya and Eka, 2008). As a result, a new farming system has developed in the area in recent years known as fadama or dry season farming. *Talinum* cultivation practice in this area has developed as an indigenous technology, with no planning and little support or assistance from any outside sources, including the government. The Department of Agriculture and Natural resources and other agencies have been slow to respond to the opportunities of this sector, but there have been encouraging indications that some of the Non-Governmental Organizations (NGOs) and international agencies are beginning to show interest. For example, Agro-based Industries and Agricultural Development Project (ADP) have been exploring this area of economy.

The livelihoods of a considerable number of people are associated with farming in this part of the country. More importantly, vegetable farming, like Fruted pumpkin, *Telfairia occidentalis* (Odiaka and Schippers, 2004), Jute mallow *Corchorus olitorius* (Akoroda, 1985; Akinlosotu, 1977), Lagos spinach *Celosia argentea* (Badra, 1993), Bitter leaf *Vernonia amygdalina* (Misari, 1992) are popular among the people owing to the soft texture of their leaves and palatability. Besides these and particularly *Talinum triangulare*, other vegetables frequently used in soup preparations are okro (*Abelmoschus esculentus*), *Amaranthus hybridus*-vegetable of choice, *Pterocarpus* sp., Okazi *Gnetum africanum* also popular among the people and *Piper guineense* leaves (Hart *et al.*, 2005).

However, their production is being threatened by a lot of production constraints including pests and diseases, as they are highly susceptible to both migratory and sedentary insect species (Schippers, 2000). This is in contrast to *Talinum triangulare*, which is considered a cheap crop and can easily be collected from the wild as vegetable (Opabode and Adebayo, 2005). They are not agronomically demanding and are suitable to many soil types. Their farming first started, when in 1983 dry-spell hits the country and there was dire scarcity of vegetables in the food markets. Adebooye *et al.* (2003) reported that most of the Nigeria's indigenous vegetables are not easily available as farmers now gather them with great drudgery and difficulty from the few stands that are left in the wild. When a few local farmers first converted their lands and/or plots into waterleaf farms during the dry season, they discovered that with few man days for irrigations, application of some manures and sometimes fertilizers, they were better of having enough for food and family income. Subsequently, it spread throughout other parts of states. By 2000, some farmer were doing so well enough to convince other farmers that they should convert to *Talinum* farming and the rate of conversions increased rapidly (Schippers, 2000). This gave rise to the evolution of Fadama farming system. Now, *Talinum* farming has been expanding rapidly in recent years, at an average of 10% of Nigeria's cultivable arable land area of about 71.2 m ha^{-1} Opabode and Adebayo (2005). This land area accommodates several species of Indigenous Leaf Vegetables (ILVs).

The primary reason for converting land and/or plots into *Talinum* farms was for food and later for higher economic returns. Generally, *Talinum triangulare* is cultivated for food and has become a major leaf vegetable in view of its many uses and nutritional contributions to human diets. It is a major source of vitamins and minerals needed for growth (Nya and Eka, 2008). Most farmers consider its cultivation more profitable than other vegetables, as it serves for both as food and raw materials for industries, with attendant economic interest.

MATERIALS AND METHODS

Study Area and Data Collections

The Data were obtained from a standardised questionnaires administered to 40 randomly selected vegetables producers in a survey from five states (Abia, Akwa-Ibom, Cross-river, Ebonyi and Rivers). Supplementary data were obtained through key personal interviews (n = 20) and field observations.

This area of study was selected base on the resources and as centre of diversity for the vegetable, couple with prevalent favourable climatic conditions for vegetable farming. Our previous study had identify the existent of genetically diverse *Talinum* species in these areas (Nya and Eka, 2007). More so, it is an important area for *Talinum* farming because of the availability of low-lying agricultural land, fertile soil, cheap and abundant labour.

Planting Season and Methods

In the study area, the peak season of *Talinum* farming is from October the beginning of the inception of dry season to April, when the conventional farming season starts. As a short cycle crop, the vegetable become available immediately few weeks or one month after planting and are harvested primarily from November to April every year. The planting period is not limited to one crop annually, but its can be two or three cycle cropping depending on the demand and frequency of harvest. However, two cropping cycles are common in many states of the country such as Akwaibom, Cross river, Lagos, Enugu and Rivers (Nya and Eka, 2007).

Although, the predominant *Talinum* farming practice is still extensive in the study area, a few farmers (20%) now practice the improved method where plant cuttings are cultivated semi-intensively. Extensive production typically use slightly modified versions of traditional methods and are called low-density system (11,000-18,000 cuttings ha^{-1}) and low-input two cycle system. The system relies mainly on natural productivity of the soil but organic and inorganic fertilizers are occasionally used to promote the growth of natural foods (Ogban and Babalola, 2002). In the context of the study, extensive farming practices generally use organic manure consisting of a mixture of locally available waste products or materials such as rice bran, kitchen remains and farm wastes. In the extensive system, most farm labours are provided from the household of the owner. The extensive farming system is peculiar to developing world, usually where there is abundant supply of inexpensive labour and large areas of suitable land and water are available at low cost, but where capital is relatively scarce (Table 1).

Table 1: Land area (ha) put under cultivation of *Talinum triangulare*

	Extensive farming system		Semi-intensive farming system	
Farming area	Total area	Cultivated area	Total area	Cultivated area
Umuahia	12	9	2	2
Ikono/Ini	15	12	5	5
Calabar	14	13	4	4
Ishaogu	13	6	3	3
Isiokpo	10	10	4	4

Semi-intensive operations practices intermediate levels of farming in reference to inputs utilization. Inputs can be classified as material inputs (seed, cuttings, feed and fertilizer), management inputs and labour input-field labourers.

Economic Analysis of *Talinum triangulare* Farming

With farm-sourced cuttings and commercially manufactured fertilizers, farm labour recruited from members of the family or hired day labourers, farmers in semi intensive and extensive production system maximize the profit potential of *Talinum* production. The owner often plays an active management role in both semi intensive and extensive production system. The extensive production system is characterized by relatively vast planting hecterage and low inputs such as commercially manufactured fertilizers and chemicals, which normally increase the nutrients and organic matter load of the soil. The extensive farming system is mainly limited by available resources and cost and the farmer's management ability. However, most farmers were found to practice the extensive farming system in the study area because of poor resources, lack of technical knowledge and inadequate technical support.

Data Collection Methods

As earlier mentioned, the primary data were gathered by field survey. This survey involved visit of the study area to administer questionnaires in terms of *Talinum* cultivation and production, cost structure and profitability. It was very difficult to obtain reliable financial data (i.e., costs and returns) because most farmers did not keep any financial records. Even where farmers provided financial data, it was based on their ''guesswork,'' which might not be accurate. Extra attention was therefore, paid and great care had to be taken in compiling financial information using different data collection methods. A combination of participatory, qualitative and quantitative methods were used for data collection. Data were collected for 8 months from October 2003 to June 2004, during the peak season of waterleaf production or farming. Participatory Rural Appraisal method was resorted to in most cases. This was made possible during the Fort Night Training (FNT) program of the various states Agricultural Development Projects (ADP). Participatory Rural Appraisal (PRA) is group methods used to collecting information in a participatory mode from rural communities (Chambers, 1992). The advantage of PRA over other methods is that it allows wider participation of the community; therefore, the information collected is likely to be more accurate (Chambers, 1994). For this study, the PRA methodology Focus on Group Discussion

DISCUSSION

Farmer's Group Discussion (FGD) was conducted with and for Vegetable farmers. FGD is a group meeting where people from the target communities discuss selected topics.

The participation of a range of people from the community provides an opportunity for crosschecking individual opinions as well as allowing the community to discuss the issues that they feel are important, rather than responding to a questionnaire (Theis and Grady, 1991). The FGD was used to get an overview of particular issues such as existing vegetable farming systems, production costs, outputs and returns and profitability. A total of 5 FGD sessions conducted were visited in each state where each group consisted of 5-20 farmers (total 100 farmers) and the duration of each session was approximately 3 h. FGD sessions were held in village/town halls, village squares under shed trees, in contact farmers' houses and in school premises.

Questionnaire Interviews

Questionnaire interviews usually involve preparation of well understandable questionnaire and administering the same to targeted respondents or enumerators. Use of statistical procedures to determine the appropriate sample size and sampling method. The targeted population in this case was *Talinum* farmers. The respondents were 100 farmers in numbers and were chosen from the population of *Talinum* farmers through random sampling technique. Data collection include among other things, bio-data, background information, level of *Talinum* production, production cost, constraints, method/system of cultivations /production, processing, utilization, marketing and profitability.

The pre-survey activities included reconnaissance for the pilot survey and revision of survey instruments and preparation of sampling frame. For the preparation of the questionnaire, visits of *Talinum* farmers and primary interviews with some of the farmers were conducted.

Attention was paid to include any new information that had not been asked in the draft schedule. The draft schedule was then modified and improved upon. Based on experience gained from the pilot survey, Talinum farmers were selected through stratified random sampling. For this sampling method, a database of vegetable farmers was collected from Agricultural Extension office and Zonal ADP offices in the area. A stratified sample is one obtained by dividing the targeting population into strata, i.e., without overlapping and then selecting a sample from each stratum (Scheaffer *et al*., 1990). The most common reason for stratification is to reduce the sample size needed to achieve a desired level of precision and reliability (Arens and Loebbecke, 1981).

Cross-Checking Interviews with Key Informants

A key informant is someone with special knowledge on a particular topic. Key informants are expected to be able to answer questions about the knowledge and behaviour of others and about the operations of the broader systems (Theis and Grady, 1991). For this study, cross-check interviews were conducted with schoolteachers, contact farmers local leaders, Agricultural extension Agents, Agricultural Officers and staff of Agriculture Development Project (ADP). The interviews of respondents were conducted in their offices and/or houses. Where information was found to be contradictory, further assessment was carried out.

Data Processing and Analysis

Data from questionnaire and interviews were coded and entered into a database system using Microsoft Excel software. A statistical method Statistical Package for Social Science (SPSS Version 14.0; SPSS Inc., Chicago, IL, USA) for Window was used for the analysis. Economic analysis was conducted to determine production costs and returns (Shang, 1990).

The analysis was based on farm-gate prices of harvested vegetable and current local market prices obtained from food markets in the respective areas and latter converted to US dollars. The study works within the minimum sample size of 50. Smith (1982) recommended a threshold sample size of 30 as often needed to established and maintain adequate degrees of freedom.

Economic Analysis Models

The production function models used to determine the effect of variable inputs were the Cobb-Douglas production function (National Research Council NRC, 1979); the function indicates the log linear form and has many advantages (Smith, 1982; Chong and Lizarondo, 1982). This stipulates that production elasticity which measures the responsiveness of output to increase unit of input are identical to the production coefficients (b_i). Thus, a percentage change in output that is brought about by a given percentage change in used input can be easily estimated. Secondly, the sum of the production coefficients ($\Sigma i\ b^i$) can be shown as a measure of economy of scale. Moreover, input and output data are normally used to estimate the parameters of the model.

Five variables inputs to include farm size, cuttings, fertilizers, watering and labours were hypothesized to calculate income from the vegetable farming. The hypothesis was that using all the input will have effect on the production as well as on the income from the farm. Regression analysis was used to determine the effect of these inputs. The Cobb-Douglas function model of the following form was used for the analysis:

$$\text{Log } Y_i = \log a + b_1 \log x_{1i} + b_2 \log x_{2i} + b_3 \log x_{3i} + b_4 \log x_{4i} + b_5 \log x_{5i} + \log U_i$$

where, Y is production (kg/ha/year); a is constant parameter in the equation, which is mathematically expressed as the intercept; x_1 is farm size in ha; x_2 is plant stands density per ha; x_3 is watering in litre per ha; x_4 is fertilizer in kg ha^{-1}; x_5 is labour in man-days per ha; b_1-b_5 are coefficient of the relevant variables; U_i is random error or regarded as disturbance term; i is index observations (1, 2, 3, 4-----n).

RESULTS AND DISCUSSION

Production Systems

Talinum farming could be divided into sub sector of materials procurement, cultivation and marketing. The procurement sub sector includes market sourcing for planting materials and other inputs such as fertilizers, watering utensils and cultivation tools (hoe and cutlasses). The cultivation sector includes production processes by which *Talinum* are cultivated, grown and harvested for consumption/marketing. Finally, the marketing sub sector involves the various marketing intermediaries by which the cultivated vegetables reached the end users. However, in production, sustainable and profitable operations can be achieved only through better understanding of the relevant elements and their interrelationship in the entire production process. High yield do not depend only on vast area put under cultivation but on yield potentials which may be as a result of use of improved planting materials and good management practices (Sanyang *et al*., 2008). These practices include pest/diseases control, effective use of fertilizers, timely operations of farming activities and soil moisture retention and improvement methods used.

The survey demonstrated that all respondents cultivated improve *Talinum* cultivars in the study area, a range of which are Ntokmfang, Ikpomfang, Afia-mfri and Nteoka cultivated and harvested around the year using irrigation when and where necessary. The average planting density varied from 111,111.11 ha^{-1} in both extensive farming system and semi intensive farming systems (Nya and Eka, 2007). Although, almost all farmers visited produced *Talinum* integrated with other crops or vegetables such as *Manihot* sp., *Capsicum* sp., *Telfairia esculentum*, *Crucifera* and *Amarath* sp., few semi-intensive farmers practices sole or monocropping. Indeed, integrating *Talinum* with other crops is only desirable from environmental point of view and to lesser extent economic reasons. Principally, in Nigeria this type of farming system tends to be more profitable and also favourable than monocropping in view of the fact that it tends to guide against the risk of putting all of ones eggs in one basket. However, this system borrows a leave from the alley cropping system developed by researchers from the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. In which case, crops are grown in alleys along the contours formed by hedgerows planted 3-4 m apart, of leguminous shrubs such as leucaena *Leucaena leucocephala*, which are periodically pruned during cropping season to prevent shading and the prunings are used as mulch and green manure for the associated food crops or vegetables or both (Kang *et al*., 1981). Sometimes, the leaves are used as fodders during the dry season. The leguminous shrubs with their deep rooted systems are also able to recycle soil nutrient, check water runoff and soil erosion (Hauser and Kang, 1993; Juo *et al*., 1994) couple with dual benefit of reducing of soluble and exchangeable Alluminum (AI) complexes in the soil (Wong *et al*., 1995; Hue and Amien, 1989).

However, it could be stated that the nutrient levels in major soil of the tropics are inherently low. In this case, crop production especially vegetables are interestingly dependent on nutrient recycling and biological fixation of atmospheric nitrogen (N_2). Thus, sustainable *Talinum* farming in this area must strongly depend on application of organic input and recycling. Moreover, soil management strategies in this area and indeed in the tropics would highly emphasized environmentally friendly systems based upon the resources available to farmers (Steiner, 1984; Juo and Kang, 1989; Franzluebbers *et al*., 1998; Renard *et al*., 1997).

Farm Size

Farm size plays an important role in farming profitability as it reflect the availability of capital and management skills of the farmers which has to do with his/her potential to operate and use resources efficiently. Regardless of the farming systems, the average farm size i.e. total land area put under cultivation of *Talinum* was found to be between 4-10 ha in all the surveyed farming areas in question. The single largest *Talinum* farm size was 0.40 ha and the smallest was 0.06 ha in all the study area.

Fertilization

The essence of using fertilizers in *Talinum* farming is to argument and creates soil condition that would help increase the productivity and quality of produce. In general, *Talinum* farmers use mainly two types of inorganic fertilizer namely Urea and NPK, off course, the only available types. The organic fertilizer used ranges from green manuring to animal dungs. Their uses helps increases the growth of *Talinum* for harvest at three weekly intervals throughout the production cycle. In all production areas, most respondent about 20% uses inorganic fertilizers. This is low as compare to 80% respondents using organic fertilizers at varying frequencies. This discrepancy may be due to cost, availability of the product, lack of technical knowledge and capital (Mcintire, 1986; Bumb and Baanate, 1996).

Productivity

According to our investigation, the average annual yield of *Talinum* was estimated to be 600 kg/ha/crop cycle in 2002, varying from 833 kg ha^{-1} in an extensive farming systems to about 1453 kg ha^{-1} in the semi-intensive farming in 2003, with a clear significant difference ($p<0.05$) between the two production/farming systems. There are three cropping cycles of *Talinum* per annum. It was revealed that some inter-dependent factors affected growth and productivity of *Talinum* vegetable, among which are plants density, fertilization, management factors including labour inputs, watering schedules and environmental factors. Moreover, farm size holding, production cycles which has to do with the time interval at which the crops are harvested also influences the total yield. It is hope that with technical support and adequate extension services, the average productivity of *Talinum* in these study areas will be higher than before. Higher production can be realized by further improving the existing farming systems and practices, removing bottlenecks in supporting services or a combination of both alternatives.

Cost Structure

The cost of production in any farming ventures consist of and is a function of cost and level of inputs, cultivation systems and institutional supports such as cost of credit and marketing strategies (Shang and Tisdell, 1997). In the present study, data on yield, costs and returns of *Talinum* farming were collected to evaluate the production cost and assessed the profitability there of. A comparison of the breakdown components of production costs provides a better understanding of the cost structure and relative production efficiency. We compare the production cost of the two farming systems. This indicated that productivity varies between the farming systems arising from the differences in resource allocation. However, production costs are grouped into: fixed cost and variable costs. The later i.e., variable costs are directly related to the scale of farm operation at any given time. In this present study, variable cost are cost of improved planting materials (cuttings/seeds), fertilizers/ organic manure, water for irrigations and labours hired for farming operations, harvesting and marketing. The average annual variable cost in extensive farming systems were estimated to be USD 643.93 ha^{-1} compared to USD 900.39 ha^{-1} in semi-intensive farming system (Table 2). Human labours and fertilizers are the two major cost items in *Talinum* production. The average cost of fertilizer was estimated to be USD 464.29 ha^{-1} varying from USD 235.00 in extensive farming system to USD 522.86 in semi intensive farming system. Whereas labours being the important and widely used input in the production process of *Talinum* farming normally compose of family labour, which is always free, no payment is

Table 2: Production cost of *Talinum triangulare* farming in 2003

Items	Extensive farming system	Semi-intensive system
Variable cost (VC)		
Planting materials- cuttings/seeds Fertilization (kg ha^{-1})	960	3520.00 (25.14)
Cow/poultry dungs	890	1950.00 (13.93)
Urea/NPK	65,000.00 (464.29)	73,200.00 (522.86)
Irrigation	1348.00 (9.63)	2416.00 (17.26)
Labour (105 man days $annum^{-1}$)	21,000.00 (150.00)	42,000.00 (300.00)
Miscellaneous (pesticides)	952	1484
Total	90,150.00 (643.93)	126,054.00 (900.39)
Fixed Costs (FC)		
Depreciation	4000.00 (28.57)	7000.00 (50.00)
Tools	12,200.00 (87.14)	20,200.00 (144.29)
Land use	10,000.00 (71.43)	10,000.00 (71.43)
Interest on loan	6,000.00 (42.86)	13,200.00 (94.29)
Total	32,200.00 (230.00)	50,400.00 (360.00)
Total costs = VC+FC	122,350.00 (873.93)	176,450.00 (1260.36)

Values within parenthesis are amount in USD dollars, exchange rate $1.00 = 140.00 Naira made. Hired labours attract payment of cash, sometimes, food; beverages given to hired labours are costed and taken into considerations to determine the actual cost of labour. However, to determine the cost of free family labour, opportunity cost principle was adopted. Opportunity cost principles refer to the alternative cost associated with forgone engagements. This gives an insight into an implicit price relationship between competing alternatives. According to Hulse *et al.* (1982) opportunity cost of human labour is its values in its best alternatives uses or the return forgone by not participating in the best alternative job. For the purpose of this study, a man day was considered at 8 h of work engagement. The average wages rate then was estimated at USD 1.50 day^{-1} varying from USD1.00 day^{-1} to 1.70 day^{-1}.

The average annual cost of labour were estimated at USD150.00 ha^{-1} for extensive farming system and USD300.00 ha^{-1} for semi-intensive system. The total labour requirement for 1 ha of farms covering all the production processes amounted to 105 man days, including family labour. However, it was revealed that most respondents about 40% do not harvest the crop themselves because of lack of necessary equipment and the strenuous mode of the work. Therefore, harvesting is usually hired out to local labours, sometimes, harvested products (vegetables) are used to settle the hired labours and its money equivalents estimated for records purpose. According to our survey, a breakdown of the labour cost showed that the average cost of harvesting and marketing of *Talinum* varied between USD24.70 ha^{-1} in extensive farming system and USD40.00 ha^{-1} in semi-intensive systems. Pests such as *Zonocerus variegatus*, *aphids* and *crickets* are common problems of this vegetable in the study areas, unlike disease which are rare. This necessitates the use of pesticides which attract additional cost. Thus, other variables costs or miscellaneous costs were calculated to about USD6.80 ha^{-1} on the average in extensive farming system, compared to USD10.60 ha^{-1} in the semi-intensive farming system (Table 2).

Fixed Costs

Fixed costs involved in *Talinum* production or farming consist of depreciation of equipment and tools i.e. water pump, water-can, head-pan/basin and wheel barrow; land used cost and interest on operating capital or loan calculated at 15% annum^{-1}. Land use costs were estimated using the concept of valuation of land at its rental price. According to our survey, the average annual fixed cost for *Talinum* farming varied from USD230.00 ha^{-1} in extensive farming system to USD360.00 ha^{-1} in semi-intensive farming system (Table 2).

Total Costs

The results in Table 2 showed that the total costs of *Talinum* farming of all sampled farmers in the surveyed areas were on the average of USD873.93 ha^{-1}, varying from USD1070.00 ha^{-1} in extensive farming system to USD1260.36 ha^{-1} in the semi-intensive system, with variable and fixed costs estimated at USD643.93 ha^{-1} and USD230.00 in the extensive system, respectively. The variable cost on the average amounted to 74% of the total cost in extensive farming system and about 71% in the semi-intensive farming system. Among these, the costs of planting materials, fertilizers/manures, labours and other miscellaneous costs considered as variable costs averaged 0.78, 55, 2.30, 17.16 and 0.78% of the total cost, respectively.

Fixed costs average 26.32% of the total cost in extensive farming systems and 26.56% in semi-intensive farming systems. The costs of depreciations, land use and interest on loan valued at 3.27, 8.17 and 4.50% of the total costs, respectively. There was indication that the costs of production in semi-intensive farming systems are higher as compared to extensive farming system. Almost all respondents interviewed reported the cost of production had increased notably in recent years. The overall cost of production in the study areas, showed higher increases in Port Harcourt area than Umuahia, followed by Uyo farming area.

Profitability

The Gross Income (GI) from the farms is affected by the level of production and its market price. The market price of any vegetables mainly depends on quality, bundle size/weight, seasons, demand and supply. The Gross income was seen as the function of the total production and prevailing markets price. The GI was estimated by calculating and multiplying the total amount sold and those consumed by its market price; the realized amount was converted to United State dollar USD kg^{-1} rated at naira N140.00 to USD1.00 exchange rate. The average market price of *Talinum* was estimated at USD1.50 kg^{-1}. Interestingly, increasing farms productivity was one way to increasing GI; this depended on the use of improved planting materials and fertilizers/manures, besides other human and environmental factors.

However, the annual GI of *Talinum* farming of all sampled farmers averaged USD1250.00 in extensive farming systems to USD2180.00 in semi-intensive farming system (Table 3). There was a significant difference ($p<0.05$) in the GI between the two farming systems. Unlike semi-intensive, the extensive farming systems witnesses relatively low level income per unit cost of input, perhaps due to limited input devoted to it.

Net Returns

The aim of any sustainable farm ventures should be to maximize its net returns in the long run and in a sustainable way. Shang and Tisdell (1997) reported that increased income of any farms depends on increase production and the existence of a potential markets and marketing system. At the farm level, net income is affected by the level of production, farm price and operating costs. However, reduced production cost relative to farm productivity which gives rise to increase farm revenue are major steps to increasing net returns (Shang and Tisdell, 1997). According to our survey and investigation, the annual net return per ha of *Talinum* farms averaged USD376.07 in extensive farming system and USD919.64 in the semi-intensive systems (Table 3). With respects to extensive farming system, the net return is low because of low inputs which attract lower production as compared to the other system. Almost all respondents reported having low returns as cost of inputs had increased over the recent years without corresponding increases in the price of *Talinum* vegetable.

Income above Variable Costs

In most cases, farmer's production decision is based on the expected net returns; sometimes refer to income above variable costs. However, fixed cost or investments are

Table 3: Economic indicators of *Talinum triangulare* farming

Items	Extensive farming system	Semi-intensive farming system
Out put (kg ha^{-1})		
Vegetables	168,000±244.00 (1200.00)	294,000.00±385.69 (2100)
Cuttings	7000±58.4 (50.00)	11200.00±77.98 (80)
Gross income GI	175,000± 785.02 (1250.00)	305,200.00±865.98 (2180)
Variable costs VC	90,150.0±73.2 (643.93)	126,054.00±702.62 (900.39)
Fixed costs FC	32,200±139.82 (230.00)	50,400.00±407.03 (360)
Total costs = VC+FC	122,350±112.54 (873.93)	176,400±504.48 (1260.36)
Income above VC = GI-VC	84850±86.8 (606.07)	179,146±671.02 (1279.61)
Net returns NR = GI- TC	52,650±67.89 (376.07)	128,750±472.16 (919.64)
Rate of income = (NR/GI)×100	30±3	42±4
Benefit cost ratio BCR = GI/TC	1.43±0.08	1.72±0.11

Values within parenthesis are amount in USD dollars considered as sunk costs, which may not be recovered in a very short time of at least one farming season or production cycle. The income above variable costs was calculated to be USD606.07 ha^{-1} in extensive farming systems compared to USD1279.61 ha^{-1} in the semi-intensive system (Table 3). It was indicated that *Talinum* farmers were able to make positive returns to variable costs, showing that both systems are profitable as the returns to variable costs were positive.

Rate of Income

The rate of farm income is referred to and calculated as the net return divided by gross revenue multiplied by 100. This varies from 30% in extensive system to 42% in semi-intensive system (Table 2).

Benefit Costs Ratio BCR

This also referred to as profitability index and is defined as gross revenue divided by total costs of *Talinum* farming. However, in this case, a ratio of 1 is normally an indicator that the venture is at breakeven position. The result in Table 3 showed that the BCR of all sample farmers gives 1.43 in the extensive farming system, showing that the farmers are able to recover same per every USD1.00 invested. Whereas in the semi-intensive system, the value increases to 1.72. However, *Talinum* farmers with BCR greater than 1 have greater benefit than liability to make.

Economic Analysis

The regression results showed that the coefficient of multiple determinants (R^2) for the both farming systems varies from 0.6 to 0.7 indicating that 61-70% of the total production variation could be explained by the 5 independent variables involved in the model. It also indicated that variables excluded from the venture accounted for 30-39% of the total variables. The calculated F-values of all equations are significant showing that all the variables involved are extremely important for explaining the variations inherent in both farming systems. The selected production function has adequate degree of freedom d.f, for testing the probability level of significance. However, farm size is a key factor in determining the extent of care and management of *Talinum* farms, which has to do with the use of farm inputs. The estimated coefficient of farm size is 0.3 in both the extensive and semi-intensive farming systems respectively (Table 4). Taking another example, in the extensive farming system; the estimated coefficient of planting materials (cuttings/seeds) was 0.4. This showed that increasing this input by 1% and keeping other factors constant, would increased

Table 4: Mean values of regression coefficients and related statistics of the cobb-douglas production functions

	Regression coefficient of different farming systems	
Estimated variables	Extensive farming system	Semi-intensive system
Y-intercept	3.2±0.6	2.5±0.6
Farm size (x_1)	0.3±0.2	0.3±0.1
Plant density (x_2)	0.4±0.2	0.3±0.1
Fertilizer (x_3)	0.2±0.1	0.2±0.1
Irrigation (x_4)	0.3±0.1	0.2±0.1
Labour (x_5)	0.3±0.1	0.2±0.1
Summary statistics		
R^2	0.6	0.7
F value	1516.7	1843.2
Return to scale $\Sigma_i b_i$	1.4	1.2

production by 0.4%. Equally, the production coefficient of fertilizers in the semi-intensive farming system was 0.2, which showed that increasing fertilizers input by 1 % and keeping other factors constant would increase production by 0.2%. In line with this, is also the production coefficient of all other inputs (Table 4).

Interestingly, the summation of the entire production coefficient ($\Sigma_i b_i$) in the extensive farming system is equal to 1.4 which is greater than 1. This showed that the function exhibit increasing returns to scale, signifying that any percentage increase in all the inputs specified in the function will lead to increase in farm production by a larger proportion. Take for instance, as earlier pointed out, if all the inputs are increased by 1%, production will definitely increase by 1.4%. Similarly, if all the inputs are increased by 1%, production will increase by 1.2% in the semi-intensive farming system. It could be stated therefore, that the Cobb-Douglas production function model demonstrated that production variables have significant effects on farms productivity as well as farm incomes in the two farming systems. The return to scale showed that there are enough scope to increase production and income from the *Talinum* farms using any of the two farming systems.

Production and Marketing Constraints of Talinum Farming

A number of constraints were reported by almost all the respondents to include poor resources, scarcity of improved planting materials, poor technical knowledge, water scarcity, theft and pests problems and inadequate credit facilities. According to our investigations, the most single constraints to *Talinum* farming were said to be lack of money for embarking on this farming ventures, seconded by pest including theft which in recent times constitute a bane in the progress of rural farmers.

The survey closely investigated access to financial resources at the disposal of farmers and found out that about 50% of respondents cited NGOs as the major helpful agent in this respect, 20% mentioned produce associations, for example, Cassava grower associations, Rice grower association and *Talinum* grower association and so on, through the monthly contributions of members (Osusu). Bank loans did not feature as popular sources of funding. The idea of organizing farmers into produce and marketing associations or groups seek to help producers grow good quality crops, have easy access to market, eliminate middle man and sell their goods at a fair price. Farmers organizations protect the interest of their members to advantage, disseminates technical knowledge and skills among members among others.

CONCLUSION

In Nigeria, the main sources of income for 70% of the populace comes from agricultural sector, of which fruit and vegetables production contributes about 30% of the sector. This is usually cultivated by small and resource poor rural farmers whose main sources of livelihood is farming. The sector provides food, family income, foreign exchange and raw materials for the growing industries. Small scale farmers in general play significant role in this respects, producing mostly vegetables as compared to cereals, root crops and pulses.

Vegetables is said to score high among the most widely grown crops in developing countries (AVRDC, 2003). In terms of value of production, vegetables ranked amongst the cereals, root crops and grain legumes. However, a well founded vegetable sector can lead to vibrant economic growth and opportunities, support agribusiness and related service industries, creating employment opportunities for women and youths. In developing countries resourced poor farmers produce most of the vegetables supply to the market. These farmers are confronted with numbers of production issues. For instance, in adverse climatic conditions they faces difficulties to be self-dependent on supply of irrigation water, leading to short fall in production of primary commodities i.e., vegetables to the market (Sumberg *et al*., 2004). The level of *Talinum* production was attributed to some inherent factors, ranging from sustainable soil conditioning with organic manuring/inorganic fertilizers to application of good management practices and skills. Mixed farming method as against monocropping is widely practise, tailored to meeting the specific needs of the farmers and stems the prevailing environmental challenges of the tropics. However, lack of capital had prevented most farmers to engage in meaningful farming ventures, despite the awareness of farming as the potential means of creating wealth among the people. The study urged the government to do more by training and providing adequate extension services to help improve farms profitability and reduced risk to farming business. Furthermore provide easy access to interest-free credits or loans at low interest rate to farmers as a way of encouragement to farming as a business.

However, based on the finding of this study, we conclude that increase in yields is the main means to increasing profit in *Talinum* farming ventures. And based on the Cobb-Douglas production function model, production factors such as farm size, improve planting materials (Cuttings/seeds), fertilizers/manures, water and labours are all seen to influence yields and profitability in *Talinum* farming.

ACKNOWLEDGMENTS

The Corresponding author is grateful to the Akwa-Ibom state ministry of Agriculture and Natural Resources for funding HOS/ES/DMMT/S/43/S.29/87 and other logistics to embark on the study.

REFERENCES

Adebooye, O.C., F.M D. Ogbe and J.F. Bamidele, 2003. Ethno-botany of indigenous leaf vegetables of Southwest Nigeria. Delpinoa, 45: 295-299.

Akinlosotu, T.A., 1977. A checklist of insects associated with local vegetables in South Western Nigeria. Research Bulletin, IAR and T. Ife, pp: 18.

Akoroda, M.O., 1985. Morphotype diversity in Nigeria land-races of *Corchorus Olitorius*. J. Hortic. Sci., 60: 557-562.

Arens, A.A. and J.K. Loebbecke, 1981. Applications of Statistical Sampling to Auditing. Prentice Hall Inc., New Jersey, USA.

AVRDC, 2003. A strategic plan. Vegetables for Life; Confronting the Crisis in Africa. AVRDC Shanjua-World Vegetable Centre. AVRDC Publication No. 00-489, pp: 470.

Badra, T., 1993. Lagos Spinach (*Celosia* sp.). In: Pulses and Vegetables, Williams, J.T. (Ed.). Chapman and Hall, London, pp: 131-163.

Bumb, B.L. and C.A. Baanate, 1996. The role of fertilizer in sustaining food security and protecting the environment to 2020. Food Agriculture and the Environment Discussion Paper 17. http://ideas.repec.org/p/fpr/2020dp/17.html.

Chambers, R., 1992. Rural appraisal: Rapid, relaxed and participatory. IDS Discussion Paper No. 311. International Development Studies (IDS), Brighton, UK. http://community.eldis.org/.59b4ab37/Dp311.pdf.

Chambers, R., 1994. The origins and practice of participatory rural appraisal. World Dev., 22: 953-969.

Chong, K. and M.S. Lizarondo, 1982. Input-output relationships of Philippines milkfish aquaculture. Proceedings of Workshop on Aquaculture Economic Research in Asia, Singapore, June 2-5, 1981, International Development Research Center, Ottawa, Canada, pp: 35-44.

Franzluebbers, K.L., R. Hossner and A.S.R. Juo, 1998. Integrated nutrients management for sustained food crop production in Sub-Saharan Africa. Tropsoil/TAMU. Bull. No. 98-103. Department of Soil and Crop Sciences, Texas A. F. M University pp: 50. http://orton.catie.ac.cr/cgi-bin/wxis.exe/?IsisScript=CATALCO.xis and method=post and formato=2 and cantidad=1 and expresion=mfn=012778.

Hart, A.D., C.U. Azubuike, I.S. Barimalaa and S.C. Achinewhu, 2005. Vegetable consumption pattern of households in selected areas of the old Rivers State in Nigeria. Afr. J. Food Agric. Nutr. Dev., 5: 1-9.

Hauser, S. and B.T. Kang, 1993. Nutrient Dynamics, Maize Yield and Soil Organic Matter in Alley Cropping with *Leucaena leucocephala*. In: Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture, Mulongoy, K. and R. Merckx (Eds.). Wiley Sayce, Chichester, pp: 215-222.

Hue, N.V. and I. Amien, 1989. Aluminium detoxification with green manure. Comm. Soil Sci. Plant Anal., 20: 1499-1511.

Hulse, H.J., A.R. Neal and W.D. Steedman, 1982. Aquaculture economics research in Asia. Proceedings of a Workshop held in Singapore, June 2-5, 1981, International Development Research Center, Ottawa, Canada, pp: 5-6.

Juo, A.S.R. and B.T. Kang, 1989. Nutrient Effect of Modification of Shifting Cultivation in West Africa. In: Mineral Nutrients in Tropical Forest and Savannah Ecosystems, Proctor, J. (Ed.). Blackwell Scientific Publication, London, UK., pp: 289-299.

Juo, A.S.R., J. Caldwell and B.T. Kang, 1994. Place of alley cropping in sustainable agriculture in the tropics. Trans. Int. Soil Sci. Congr., 7: 98-109.

Kang, B.T., G.F. Wilson and L. Sipkens, 1981. Alley cropping maize (*Zea mays* L.) and leucaena (*Leucaena leucocephala* Lam.) in Southern Nigeria. Plant Soil, 63: 165-179.

Mcintire, J., 1986. Constraints to fertilizer use in Sub-Saharan Africa. Proceedings of Symposium on Management of Nitrogen and Phosphorus Fertilizers in sub-Saharan Africa, March 25-28, 1985, Martinus Nijhaff Publisher, The Netherlands, pp: 35-57.

Misari, S.M., 1992. Further observations on the insect attacking bitterleaf in Samaru, Northern Nigeria. Savanna, 13: 1-3.

National Research Council NRC, 1979. Measurement and Interpretation of Productivity. National Academic of Sciences, Washington DC. USA., pp: 35-205.

Nya, E.J. and M.J. Eka, 2007. Genetic variability and heritability studies of desirable metric characters in *Talinum triangulare* land races in South Eastern Nigeria. J. Agron., 6: 459-463.

Nya, E.J. and M.J. Eka, 2008. Hybridization and heterosis of desirable metric characters of *Talinum triangulare* land-races in South Eastern Nigeria. Int. J. Plant Breed. Genet., 2: 19-27.

Odiaka, N.I. and R.R. Schippers, 2004. *Telfairia occidentalis* Hook.f. In: Plant Resources of Tropical Africa 2: Vegetables, Grubben, G.J.H. and O.A. Denton (Eds.). PROTA Foundation, Netherlands/Backhuys Publishers, Leiden, Netherlands/CTA Wageningen, Netherlands, pp: 522-527.

Opabode, J.T. and C.O. Adebooye, 2005. Application of biotectnology for the improvement of Nigerian indigenous leafy vegetables. Afr. J. Biotechnol., 4: 138-142.

Renard, G., A. Neef, K. Becker and M. Von Oppen, 1997. Soil fertility management in West Africa land use systems. Proceedings of the Regional Workshop, March 4-8, Niamey, Niger, pp: 237-242.

Sanyang, S.E., K. Te-Cheng and H. Wen-Chi, 2008. Comparative study of sustainable and non-sustainable interventions in technology developmentand transfer to the womens vegetable gardens in the Gambia. J. Technol. Trans., 34: 59-75.

Scheaffer, R.L., W. Mendenhall and L. Ott, 1990. Elementary Survey Sampling. 4th Edn., PWS-KENT Publishing Co., Boston, Massachusetts, USA., pp: 390.

Schippers, R.R., 2000. African Indigenous Vegetable-an Overview of the *Cultivated* Species. National Resources Institute (NRI), University of Greenwich, United Kingdom, London, pp: 214.

Shang, Y.C., 1990. Aquaculture Economic Analysis: An Introduction. The World Aquaculture Society, Los Angeles, USA.

Shang, Y.C. and C.A. Tisdell, 1997. Economic Decision Making in Sustainable Aquaculture Development. In: Sustainable Aquaculture, Bardach, J.E. (Ed.). John Wiley and Sons, Inc., Honolulu, Hawaii, USA., pp: 127-148.

Smith, I.R., 1982. Microeconomics of existing aquaculture production systems: Basic concepts and definitions. Proceedings of a Workshop held in Singapore, June 2-5 1981, International Development Research Center, Ottawa, Canada, pp: 15-25.

Steiner, K.G., 1984. Intercropping in Tropical Small Holder Agriculture with Special Reference to West Africa. 2nd Edn., German Agency for Technical Cooperation, Germany.

Sumberg, J., E. Gilbert and M. Blackie, 2004. New Income diversity, technology choice and agricultural research policy in Sub-Saharan Africa. Dev. Policy Rev., 22: 131-146.

The World Bank, 2008. Agriculture for development. World Bank Development Report, 2008. http://siteresources.worldbank.org/INTWDR2008/Resources/WDR_00_book.pdf.

Theis, J. and H.M. Grady, 1991. Participatory Rapid Appraisal for Community Development a Training Manual Based on Experience in the Middle East and North Africa. International Institute of Environmental Development (IIED) and Save the Children Foundation, London, pp: 56.

Wong, M.T.F., S. Akyeampong, S. Nortcliff, M.R. Rao and R.S. Swift, 1995. Initial responses of maize and beans to decreased concentrations of monomeric aluminium with application of manure or tree pruning to an Oxisol in Burundi. Plant Soil, 171: 275-282.