# NON-TRADITIONAL VEGETABLE PRODUCTION IN THE NORTHERN REGION OF GHANA

## A Profit Function Analysis

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**ABSTRACT**

*Despite several researches in Ghana's agricultural sector, little has been done on the investigation of non-traditional vegetable production, particularly with respect to its profitability. The study was conducted within the context of non-traditional agriculture and in particular, the profit maximization behaviour of smallholder vegetable farmers. The present study is about the assessment of the factors that influence the profitability of non-traditional vegetable crop production in the Northern Region of Ghana. Cross-sectional data were fitted into a Cobb-Douglas profit function and estimated by the maximum likelihood estimation method. The major finding is that the profitability level of vegetable production in the Northern Region is determined by fertilizer and insecticide use. It is recommended that mechanisms should be put in place to ensure that the supply of fertilizer and insecticides in the market are readily available and accessible by farmers.*

**KEY DESCRIPTORS:** Profitability, Maximum Likelihood, Vegetable, Cobb-Douglas Profit Function, Urban Agriculture

## INTRODUCTION

### Background

Agriculture is the backbone of the Ghanaian economy. The Ministry of Food and Agriculture (MOFA) in 2002 reported that the agricultural sector is dominated by smallholder farming (80%). An important factor that characterizes small scale farming in Ghana is that the small scale farmers aim at farming to feed themselves (subsistent farming). Traditionally, small scale farmers own and operate small farm sizes and depend on nature (e.g., rainfall) as well as family labour for livelihood. The main food crops produced under small-scale farming are maize, yam, plantain and millet with rice produced mainly as cash crop.

Nevertheless, recent evidence shows that agriculture is becoming a business (Walter, 2008). Horticultural exports have been increasing as a result of a lot of attention that has been paid to the horticultural sub-sector by donors and the Ghanaian government. According to Wolter (2008) donors are increasingly taking a value chain approach and trying to link smallholder farmers to exporters via outgrower schemes. Vegetable production in Ghana, particularly in the urban centres is one area that is attracting smallholders. For example, more than 200,000 urban dwellers eat them daily in Accra, and in canteens and restaurants (Obuobie et al., 2006). Vegetables are preferred cash crops because of their potential for lifting poor farmers out of poverty[6]. Nugent (2000) reported that urban agriculture can meet large parts of the urban demand for certain kinds of food such as fresh vegetables, poultry, potatoes, milk, fish and eggs. In general, vegetable crop production in Ghana is for three main reasons; namely, food

[6] As high as 34% of Ghanaians are poor. Poverty varies across all ten regions in the country. For instance, 70%, 80% and 90% of the people living in Northern Region, Upper West Region and Upper East Region, respectively, are poor (Ghana Statistical Service, 2000).

production for consumption, income for smallholder farmers and nutrition.

**Statement of the Research Problem**

The effectiveness and efficacy of smallholder vegetable farmers in Ghana to adopt new technology and to achieve sustainable small-scale production depends upon their level of profitability. Profitability measurement is very important because it is a factor for productivity, growth and equity. The profit function provides an alternative approach to the analysis of production process because for any production function to satisfy desirable properties, a dual profit function should exist which satisfies certain desirable characteristics (Islam and Karim, 1997). Profitability studies help countries to determine the extent to which they can raise productivity by improving existing technology. Such studies could also help decide whether to empower smallholder urban farmers or to develop a new technology in the short run. More importantly, profitability analysis will not only enable vegetable farmers to increase the household nutritional values, but it will also give direction of adjustments required in the long run by policy makers to achieve increased, sustainable and equitable household income.

Despite the advantages of exotic vegetable crops as stated above the extent to which it affects farmer's income is not well researched. Results of previous studies (Obuobie et al., 2006; Mahama et al., 2006; Al-hassan, 2007) are biased towards the problems or challenges facing vegetable producers as well as levels and advantages of fertilizer use with no attention on the direction of farm profitability regarding non-traditional vegetable crops. Further, there are no records or documentations on the levels of costs and profit/losses associated with the cultivation of these vegetables. The lack of empirical evidence on the topic serves as a limitation for any meaningful policy intervention in search of alternative ways of empowering the poor smallholder farmers in the study area through increased agricultural production. There is the need

to improve upon the income level of smallholder vegetable farmers whose poverty situations are often neglected because they are 'hidden' in both rural and urban areas.

To do this we must assess the current levels of profit of vegetable farmers, and identify the factors which affect their profit levels. However, no study has been done to estimate the profitability of vegetable production in the Northern Region of Ghana. In view of this, it is unlikely that Ghana government's objectives of increasing incomes of urban poor (especially women), promoting youth employment and ensuring standard household nutrition as explained in the Growth and Poverty Reduction Strategy (GPRS II), would be fully achieved unless positive steps are taken to adequately improve smallholder farmer's levels of income.

The lack of empirical studies on this important subject makes it difficult for policy makers in Ghana to evaluate their agrarian policy for achieving growth and poverty reduction. The critical questions to be answered are: *What is the average level of profit for smallholder farmers engaged in the production of non-traditional vegetable crops (lettuce, spring onion, cabbage and green pepper) in Northern Region of Ghana? How do farmers' social, economic and demographic features relate to vegetable production? What factors influence the profitability of vegetable production in the study area?*

The priority of the research therefore was to investigate the profitability of smallholders engaged in non-traditional vegetable production with the aim of providing recommendations on how to increase the income of smallholder farmers through vegetable production. Specifically, the paper examined the level of profit associated with the production of lettuce, spring onion, cabbage and pepper in Northern Region of Ghana and investigates the factors influencing the profitability of vegetable production in the study area.

This study is particularly relevant for a country such as Ghana for three reasons. Firstly, the country possesses great potential for vegetable production because of its rich irrigable lands and abundant compost. Secondly, vegetable farming in Ghana has the potential of increasing productivity of vegetable crop farming, providing employment to the youth especially women and therefore contributing to women's empowerment through poverty reduction. Thirdly, the willingness of the government through the Ministry of Food and Agriculture (MOFA) to support the vegetable sub-sector will depend to a large extent on the profit efficiency of farmers.

## METHODOLOGY

Vegetable cropping in Ghana, especially exotic crops, is regarded as purely commercial. Every farm enterprise aims at making profit. Profit is the difference between total revenue and total cost. Under the theory of the firm, it is argued that profit is used to judge an enterprise's survival in the market. Profit has largely been used by efficiency studies as a measure of firms' performance. In developing the analytical tool, the study took these important factors into consideration because the approach adopted to assess the determinants of profit can lead to different conclusions. Once the total revenue and total cost of sampled vegetable farmers have been estimated and reasonable estimates of profits have been obtained, it is possible to examine the determinants of profitability in vegetable production. Thus, the study was cast in the framework of profit maximization of the firm.

### Data and sampling procedure

Farm-level data were obtained from 180 smallholder vegetable farmers across Tamale Metropolitan Assembly area during the 2007/08 cropping season. The technique involved the use of simple random sampling. The vegetable growers were sampled across all six major vegetable growing areas (Zagyuri, Water works, Sangani and Bilpela, Gumbihini and Gurugu) in the

Metropolis. The data covered the social, economic and demographic characteristics of the survey sample. Specifically, data were collected on age of the farmer, residential status, years of education, years of vegetable production and extension service contact. Data on farm features included farm size, input and output totals, yield and quantity of agro-chemicals used. Other important areas covered include urban agriculture development related microeconomic policies of Ghana, national vegetable specific policies and projects, input and output prices and availability and accessibility of farm resources. Data were obtained on employment with specific reference to total number of labour (family and hired labour), sex of labour, labour use and wage rate. Finally, data were obtained on revenue, gross margin and cost. Gross margin is total revenue (TR) minus total variable cost (TVC). Total revenue is arrived at by multiplying vegetable output by the price. Total variable cost (TVC) is the summation of total capital operating costs (TCOC) and total labour input (TLI). Examples of TCOC are cost of fertilizer, hire of simple equipment, irrigation, insecticides, manure and basket for harvesting. Labour cost was computed by aggregating the cost of man-days incurred with respect to land preparation, nursery, planting, bird scaring, harvesting and packaging. Total fixed cost (TFC) is the sum of cost of seed and watering can. Finally, net return (profit) is the difference between TR and TC as specified in equation 1.

$$\text{Net Return} = TR - TC \qquad (1)$$

**Empirical Model**

Kalirajan (1981) argued that, given the same access to inputs and equal terms, small farms will respond to economic opportunities in the same way as large farms. However, special institutional arrangements are necessary to ensure equal access to inputs by small farmers. Udry (1994) showed that virtually all fertilizer is concentrated in plots controlled by men, even though the marginal product of fertilizer diminishes. These differences in input use intensity between male- and female-managed plots persist even af-

ter land quality, measurement error, or risk management behaviour are taken into account. There are no hard and fast rules governing the choice of models regarding primal (production functions) and dual (profit and cost) approaches for agricultural analysis. The reasons for their use have largely depended on study objectives. Junankar (1989) argues that the use of the profit function for agriculture in less developed countries is inappropriate on theoretical grounds because most of the economic applications do not support the model. Thus, production functions or primal approaches have generally been used to examine economic efficiency of farmers in Africa (Lau and Yotopoulos, 1972).

Nevertheless, one of the main criticisms leveled against studies that rely on the production function method for assessing economic efficiency is that the method suffers from problems of simultaneity bias because input levels are endogenously determined (Quisumbing, 1994). Quisumbing (1994) concluded that such problems of endogeneity can be avoided by estimating profit or cost functions instead of production functions. Thus, the profit function provides an alternative approach to the analysis of production process because for any production function satisfying the desirable properties, a dual profit function exists which satisfies certain desirable characteristics (Islam and Karim, 1997). The advantage for using the profit function approach[7], for example, is that when input and output prices are exogenous to farm household decision-making, they can be used to explain input use and output supplied. The resulting parameter estimates will in general be statistically consistent (Abdulai and Huffman, 2000).

Suppose a farmer has the following production function:

$$Y = f(X_i, Z_k), \qquad (2)$$

[7]In the profit function approach, economic efficiency can be defined as the ability of a firm to achieve potential maximum profit, given the level of fixed factors and prices faced by the firm.

with the conventional neoclassical properties where Y is the output, $X_i$ represents the variable inputs, and $Z_k$ stands for the fixed factors in production. The variable profit function defined as current revenue less current total variable costs can be written as:

$$\pi = P.f(X_i, Z_1\tilde{e}., Z_k) - \eta w_i X_i \quad (3)$$

Where $\pi$ is the variable profit in normal terms, $P$ is the output price, and $w_i$ is the price of variable factor $i$. Without loss of generality, equation 7 can be expressed in terms of the normalized profit function by deflating all nominal values by output price, $P$ such that equation 7 becomes:

$$\pi = f(X; Z) - \eta w_i X_i \quad (4)$$

Where the $X$ and $Z$ are in vector form, with $\pi^1 = N/P$ and $w_i = W_i/P$, the normalized prices respectively.

A profit function is capable of showing the influence of input prices, output price and fixed factor on profit in vegetable production. In the study area, the inputs employed for producing vegetables are mainly seed, labour, fertilizer, manure[8] and insecticides. Seed is regarded as a fixed factor in producing vegetable. The input prices, output price and cultivated land size are considered as, a prior explanatory variables responsible for the profit of vegetable production. Accordingly, a Cobb-Douglas profit function is specified to determine the possible relationship between the profit of vegetable and explanatory variables as specified below. The Cobb-Douglas profit function is specified as follows:

$$ln\,\pi = A + a_1 lnW_1 + a_2 lnW_2 + a_3 lnW_3 + a_4 lnW_4 + e \quad (5)$$

[8]Organic manure in the study area is mostly obtained from dropping of cattle, sheep, goats, poultry and composted household waste.

Where,
ln = natural log
$\pi$ = Profit (Cedis/ha)
$W_1$ = Wage rate (Cedis/person day)
$W_2$ = Price of manure (Cedis/Kg)
$W_3$ = Price of fertilizer (Cedis/kg)
$W_4$ = Price of insecticides (Cedis/ml)
e = error term

The parameters of the profit function were estimated using maximum likelihood method in the LIMDEP econometric software. The maximum likelihood estimation (MLE) produces better results than ordinary least squares (OLS) and corrected ordinary least squares (COLS) in larger samples (Olson, Schmidt & Waldman, 1980).

## RESULTS

Results of field visits show that the vegetable production sub-sector is dominated by male (over 90%). This might be largely attributed to the fact that women's inability to own land in the study area as a result of traditional practices. This finding is similar to the conclusion by Ofori and Dennis (1996) that women's participation in agricultural production is related to the decline in farm size and persistent poverty. Average age of vegetable growers is 34 years. The average age indicates that the vegetable sub-sector is dominated by the youth. With an average of 12 years of education it suggests that vegetable growers have attained a minimum level of education (primary) that may not be sufficient to enable them to learn and adopt new farming technologies. However, the vegetable farmers have acquired an average of 12 years of accumulated farming experience. The over a decade farming experience enables them to effectively manage their farms in terms of vegetable seed selection, seasonality, planting, manure and insecticide use, weeding, harvesting and storage. This finding confirms the conclusion of Kalirajan and Shand (1985) that although schooling is a productive factor, a farmer's education is not necessarily related

significantly to his yield achievement. That, an illiterate farmer, without the training to read and write, can understand a modern production technology as well as his educated counterpart, provided the technology is communicated to him properly.

Average farm size is small ranging between 0.3 and one hectare. In terms of beds the results show that the average number of beds per farm is 26. The small nature of farm sizes in the study area is expected because of limited availability of irrigable land in the Metropolis. Input use varies from farm to farm with an average of 2 employees per farmer. The mean quantity of fertilizer use is 33 sachets followed by 0.9 litres and 136 kg for insecticides and manure, respectively. See Table 1 below.

**Table 1: Means of variables used in the analysis**

| Variable | Mean | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|
| Age (Years) | 34 | 11.6 | 19 | 65 |
| Experience (Years) | 12 | 9.5 | 2 | 40 |
| Education (Years) | 15 | 6.0 | 3 | 40 |
| Farm size (Number of beds) | 26 | 12.1 | 8 | 64 |
| Farm size (ha) | 0.5 | 0.2 | 0.3 | 1 |
| Labour (Number of employees) | 2 | 1.0 | 1 | 5 |
| Fertilizer (Sachets/bed) | 33 | 24.0 | 3 | 100 |
| Insecticides (litres/bed) | 0.9 | 0.3 | 0.3 | 1.5 |
| Manure (kg/bed) | 136 | 153.3 | 12 | 600 |
| Extension service (Number of contact) | 4 | 4.3 | 1 | 20 |
| Wage rate (Ghana cedis/day) | 3 | 2.5 | 1 | 15 |
| Price of fertilizer (Ghana cedis/ Sachet) | 1 | 1.1 | 0.5 | 5 |
| Price of Manure (Ghana cedis/ Sachet) | 2 | 0.9 | 1 | 6 |
| Price of insecticides (Ghana cedis/litre) | 5 | 2.6 | 1 | 10 |
| Net return (Profit) | 477 | 752.8 | 7 | 3,958 |

**Source:** Field survey, 2008.

An average of two workers is employed by each vegetable grower. Fertilizer use is, on average, 33 sachets per bed per farmer. Insecticides use ranges between 0.3 and 1.5 litres per bed. Vegetable growers received an average extension contact for 4 times per cropping season. The farmers explained that this was enough for increasing productivity. The findings show that dry season gardening is very profitable and far less risky compared to rain fed agriculture. Dry season vegetable farming is less risky partly because the vegetable growers, unlike those who depend on rain, water their vegetables regularly (twice a day). Mean profit stands at GH 47.70 per annum. The parameter estimates of the profit function are shown in Table 2.

**Table 2: MLE of Profit function for Urban Vegetable Production in Tamale Metropolitan Assembly: Dependent variable is Net Return on vegetable use**

| Variable | Equation 1 | Equation 2 | Equation 3 |
|---|---|---|---|
| Labour | 20.7130<br>(0.977) | - | - |
| Fertilizer | -0.6405<br>(-2.991)*** | -0.6332<br>(-2.959)*** | -0.6570<br>(-3.154)*** |
| Manure | 27.2681<br>(-0.481) | -28.6150<br>(-0.505) | - |
| Insecticides | -0.6834<br>5.915)*** | -0.6621<br>(-5.837)*** | -0.6530<br>(-5.843)*** |
| Constant | 97.4254<br>(0.608) | 169.6700<br>(1.195) | 233.5776<br>(3.628) |
| $R^2$ | 0.19 | 0.18 | 0.18 |
| Adjusted $R^2$ | 0.17 | 0.17 | 0.17 |
| N | 180 | 180 | 180 |
| F-statistic | 9.93*** | 12.93*** | 19.35*** |

**Source:** Field survey, 2008. Significance levels *** = 1% and figures in brackets are t-ratios.

Three equations (equations 1, 2 and 3) were estimated using the ordinary least squares (OLS) estimator. The $R^2$ is 0.19 for equation 1 and 0.18 each for equations 2 and 3. The results show that for equation 1 the explanatory variables used in the model jointly explain 19% of the variations in the dependent variable (profit) and 18% of the variation in the dependent variable with respect to equations 2 and 3. Estimates of all parameters have the expected signs except the labour variable. The results signify that fertilizer and insecticides use significantly explain the profitability of vegetable production in Tamale Metropolitan Assembly. The significance of fertilizer implies that non-traditional vegetable production in the study area can be increased by making these inputs easily accessible to growers. This finding agrees with previous conclusions reached by Abban (2003), Kessler, Streiffeler, and Obuobie (2004), Ofori and Dennis (1996) and Zibrila, and Salifu (2004) that fertilizer and insecticide use enhances urban agriculture.

## CONCLUSION AND POLICY RECOMMENDATIONS

The study revealed that dry season vegetable production in the Tamale Metropolis is indeed a profitable venture. The average age of vegetable growers suggest that the vegetable sub-sector is youth dominated. The implication is that the industry is capable of attracting more energetic youth as a way of providing them with job opportunities in the Metropolis. Vegetable farming in the Metropolis is, however, on small scale largely due to land scarcity. Input use is also low compared to national averages. Fertilizer and insecticides significantly explain profitability levels in the vegetable sub-sector.

Consequently, it is recommended that mechanisms be put in place to ensure that the supply of fertilizer and insecticides in the market are readily available. This is important for increasing access to these important inputs for increased production. In addition, there is the need to constantly monitor the prices of fertilizer and insecticides so that farmers are not denied of them on the basis of affordability. Lastly, thee vegetable industry could be targeted for the attainment of the current Youth Employment Programme by the government because the industry is dominated by the youth.

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