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Productivity and Resource Use Efficiency in Tomato and Watermelon Farms: Evidence from Ghana

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Abstract
This study examines productivity and resource use efficiency in tomato and watermelon farms in the Dangme East District of Ghana. Cross-sectional data of 200 farmers (100 tomato farmers and 100 watermelon farmers) were obtained from a field survey using structured questionnaires. The empirical results of this study show that, the value of output of watermelon is higher than that of tomato. The difference could be attributed to differences in output prices as well as labour and material input costs incurred in the production of each of these crops. Since prices of inputs are more or less stable over the season, output price difference could be said to be the main cause of this difference. For instance, it costs GH¢704.59 to produce a hectare of tomato whereas the average cost of producing a hectare of watermelon is GH¢509.03. Conversely, a hectare of tomato yields GH¢480.37 whereas a hectare of watermelon yields GH¢1738.68. Analysis of the factors affecting the value of output of tomato and watermelon shows that, land, labour and experience exert significant influence on the value of output of tomato; whereas land, non-agricultural activity and training significantly influence the level of output of watermelon in the study area. Marginal value products computed for land and labour for each crop were found to be higher than the market prices of these factors indicating that land and labour are inefficiently used in both tomato and watermelon production though labour did not significantly influence watermelon production. Also, neither did the amount of fertilizer used in tomato production nor the amount of capital used in watermelon production exert significant influence on their value of outputs; these inputs were found to be underutilized in each case. These results have implications for Agricultural policy in Ghana.

Key Words: Productivity, Resource Use Efficiency, Tomato, Watermelon, Farms, Ghana

1. Introduction

Agricultural productivity has improved from year to year (NEPAD, 2002). Unlike other regions of the world, productivity of agriculture per worker in Africa has declined during the past twenty years (NEPAD, 2002). Raising agricultural productivity can make a critical contribution to growth and the alleviation of poverty by generating surpluses that can be used for investment in agricultural and non-agricultural activities.

Africa is a rural continent and hence agriculture is very important to it. For the entire region including Ghana, agriculture has accounted for about 60 percent of the total labour force, 20 percent of merchandised export, and 17 percent of GDP (NEPAD, 2002).

It was found that strong increases in agricultural productivity per worker accounts for the rapid growth of many countries during the past fifty years. In Ghana, agriculture contributes 70 percent of labour force and

36.6% of the GDP in 2004, 36% in 2005, 35.8% in 2006 and 31.7 % in 2009, (Institute of Statistical Social and Economic Research (ISSER), 2005, 2006, 2007, 2010). Low productivity has seriously eroded African agricultural products on the world market. Also, low productivity is the result of low investment in all factors that contribute to agricultural productivity and effective use of available resources.

Productivity refers to the ratio of output to its inputs (Chavas *et al.*, 2005). In any economy, productivity and growth in productivity are very important determinants of how per capita income grows. Productivity is reinforced by efficiency. In production, efficiency can be defined in terms of resource use (that is, allocative efficiency), or achievement of the highest possible output level with a given set of inputs (technical efficiency). Economic efficiency then combines technical and allocative and scale efficiencies. With technical efficiency, a farmer must be on the highest production frontier whereas allocative efficiency denotes a balance or equality between marginal value product of input and product prices. Scale efficiency implies that firms are of appropriate size that no industry reallocation would improve output or earnings (Grifell *et al.*, 1992).

Empirical studies proved that productivity growth arises from improvement in efficiency brought about by advancement in technology. Advancement in agricultural productivity has led to abundant and affordable food and fibre throughout most of the developed world (Hughes, 1998). Public and private investment in research has been the basis for this growth and development.
One of the millennium development goals is to improve productivity of agriculture to an annual growth rate of six percent with special attention to small scale farmers. Another is to attain food security by the year 2015 (Todaro and Smith, 2006).
Latest figures for 1997-99 show that some 200 million people or 28 percent of Africa's population are chronically hungry compared to 173 million between 1990 and 1992 (NEPAD, 2002). It has been noticed that whilst there has been a slight drop in the proportion of hungry people, absolute numbers keep rising. This gives rise to the progressive growth of food imports in the 20th century. Until the incidence of hunger is brought down and the import bill reduced by raising the output of farm product in which the region has comparative advantage, it will be difficult to achieve high rate of economic growth (NEPAD, 2002).
In Ghana, agricultural activities are carried out mainly by small scale farmers who are either illiterates or semi-literates with only few large scale or literate farmers. It is, therefore, not wrong to say that it will be difficult for them to adopt innovations which would improve efficiency and hence productivity. The ability and willingness of a farmer to acquire and use a given set of inputs depends on his knowledge, experience, prices of inputs as well as the financial position of the farmer a particular time. It is an indisputable fact that farmers continue to be the lowest income earners and hence of the lowest standard of living throughout the country. This situation is very difficult to understand taking into account the good effort by the government to promote agriculture and wellbeing of farmers by instituting the National farmers Award Scheme to reward hardworking farmers every year. The effort of non-governmental organisations in agriculture cannot be overlooked. They carry out various activities in assistance of farmers aiming at improving the skills as well as knowledge of the farmers, lessening the burden of input prices and improving prices of output. Both the government and the non-governmental organisations provide credit to these famers at low interest.
The objectives of the study are four fold:

i) To estimate the level and value of output produced by farmers in the study area.
ii) To determine the types, level and value of input used by farmers in the study area.
iii) To determine the factors influencing the value of output produced by farmers in the study area.
iv) To measure the efficiency of resource use by farmers in the study area.

The rest of the study is organised as follows: Section 2 provides a brief review of literature on efficiency and productivity; Section 3 outlines the methodology used; Section 4 presents the empirical results of the study. Finally, section 5 provides the conclusions.

2. Literature review

Common methodologies used in efficiency studies include the parametric technique (deterministic and stochastic), non-parametric technique based on Data Envelopment Analysis (DEA) and other productivity indices based on growth accounting and index theory principles (Coelli *et al.*, 1998).

The deterministic frontier approach attributes all deviations to inefficiencies. It, therefore, does not take into consideration errors of measurement and other random noises hence it has not been usually employed to studies in transitional economies unless study with strong emphasis on methodological comparison (Piesse, 1999). In contrast, the stochastic frontier accounts for the effect of random factors such as errors of measurement or hazard factors (Aigner *et al.*, 1977; Meeusen and van den Broeck, 1977). It has been acknowledged that data from transitional economies are generally noisy compared to those from developed economies (Morrison, 2000). It could be inferred from this that the stochastic frontier approach is more appropriate than the deterministic frontier approach. The stochastic frontier methodology is more suitable in a single output case. Its appropriateness may be doubtful in efficiency studies involving farms which operate using different technologies.

Non–parametric approaches have been used more often. The Data Envelopment Analysis (DEA), for instance, requires arbitrary assumptions about the functional forms and distribution of the error term. It uses the linear programming procedure to minimize input per unit of output to determine the frontier of best practice firms, and determine the efficiency of each production unit relative to their frontier (Ali and Seiford, 1993). This approach is widely used due to its computational ease and the possibility of isolating scale efficiency from technical and allocative efficiencies. Another advantage of the DEA in comparison to the parametric approach is that it can handle multiple output and input situations simultaneously and cases where input and output are quantified using different units of measurement (Thiele and Brodersen, 1999). However, the DEA is based on a deterministic approach; hence all deviations from the frontier are attributed to inefficiencies. For this reason, data from transitional economies might not be suitable for this approach. Also, DEA estimates may be biased towards higher scores if the most efficient farms within the population are not contained in the sample. This could lead to over estimation of sample efficiency.

Allocative efficiency is said to be affected by factors relating to household life cycle. For instance, Todaro *et al.*, (2006) in their study of Technological Change and Economies of Scale in U.S. Poultry Processing found a strong negative relationship between allocative efficiency and gender of household head. The study found that while female-headed households tend to have the same number of adults as male-headed households, male-headed households have significantly more children per household. Consequently, female heads can spend less time taking care of their children and have more time to spend on other remunerative productive activities. Also, female-headed households have superior managerial skills and are less labour constrained in farm productive activities or choose a crop mix with higher marketed surplus. However, men are able to secure right to land better than women even though women hold larger proportion of the land under cultivation. They found that rigidities in land and labour rights within the household or community together with stronger control typically exercised by men contribute to lower allocative efficiency. Also, food insecurity resulting from low income status has negative effect on allocative efficiency. This may be due to either adverse effect on labour productivity, or liquidity constraints curtailing market access. Off-farm income was found to have positive effect on allocative efficiency that is, the income is used to acquire resources to prevent underutilization due to insufficient funds to purchase input (Leibeinstein, 1989). If markets work smoothly, the introduction of outside sources of income should not have affected allocative efficiency. There was the presence of poorly functioning capital or credit markets where liquidity and cash flow constraints are relaxed through income generating activities off the farm, particularly a peri-urban setting where off-farm activities tend to yield higher returns than farm activities. Land tenure was however not found to be a problem, that is, such institutions do not impede the maximization of household revenue or the responsiveness of household decision to output markets.

Turkson (1997) looked at the determinants and input use efficiency of vegetable production at Weija Irrigation Project. He employed the Ordinary Least Squares estimation procedure and the Cob-Douglas functional form to obtain the parameters of an output response function or yield response equation. Variables included in the function were irrigation, labour, fertilizer, tillage, pesticide, etc. This study, however, did not consider farmers involvement in non-agricultural activities as a factor.

3. Methodology

3.1 Value of Output and Input

The value of output (*VOPT*) in this study is computed as the product of per hectare quantity of output in its

appropriate unit and the weighted average price. The weighted average price is also computed as the summation of product of prices and quantities sold at the various prices divided by the sum of the quantities. The weighted average price is expressed as:

$$W_p = \sum P_i Q_i / \sum Q_i \quad (1)$$

where W_p denotes unit weighted average price of output; P_i denotes unit price of output sold at a given time; Q_i denotes quantity of output sold at a given price, P_i.

Value of input (V_x) is computed as the sum of products of the quantity of the various inputs (X_i) used and the respective prices (P_i) as at the time they were bought. Unlike output, input prices were found to be stable throughout the year, hence, the absolute prices were used. These include material inputs such as seed, fertilizer and spraying chemicals as well as capital (cost of ploughing and depreciation of tools) and labour.

Labour is measured as the number of man-days used in performing the various farm operations. Farm operations commonly performed by farmers include land clearing, planting or sowing, fertilizer application, weeding, spraying and harvesting. Total cost of these is computed by multiplying per hectare cost of a particular farm operation by the number of times it was performed, and summing these up.

3.2 Determination of the factors influencing value of output produced by farmers in the study area.

The Cobb-Douglas functional form has limitations in terms of estimation of elasticities since it imposes a lot of restrictions. However, it has been extensively used due to ease of computation and simplicity in a lot of empirical studies to analyse farm efficiencies.

This study employs the Translog functional form which is more conveniently used because it allows interaction among variables. Unlike the Cobb-Douglas, the Translog does not generate elasticity of substitution equal to one and the isoquants and marginal products derived depend on the coefficients of the interaction terms (Kalijaran, 1990). The function is specified as:

$$InY = \beta_0 + \sum \beta_i \ln X_i + 0.5 \sum \sum \beta_{ij} \ln X_i \ln X_j + \varepsilon_i \quad (2)$$

Where; β_i, and β_{ij} denotes coefficients; X_i denotes a vector of inputs; Y denotes output; i, j are positive integers, $(i \neq j = 1,2,3,...)$; ε_i denotes stochastic error term.

The empirical models for tomato watermelon are specified using the Translog function in equation (2).

3.3 Estimation of Productivity

This could be expressed in several ways as partial factor productivity, multifactor productivity or total factor productivity. Total factor productivity is expressed as:

$$TFP = \sum P_y Q_i / \sum P_x X_i \quad (3)$$

Where TFP denotes Total factor Productivity; $P_y Q_i$ denotes total value of output; $P_x X_i$ denotes total value of input; Q_i denotes the quantity of output; X_i denotes quantity of input; P_y denotes price of output; and P_x denotes price of input.

3.4 Description of Variables

Variables considered for both productivity estimation and the empirical model include value of output, land, distance, experience, labour, total cost (total capital), fertilizer, non-agricultural activities and training (extension service).

Value of output (VOPT) is measured as the product of the quantity of produce obtained from a particular crop for the season and the weighted average output price of that crop. The weighted average price is used in order to correct for any inflationary influence.

Land (LAND) represents the area of land under cultivation for a given crop. Land area under cultivation is used in order to determine its influence on the value of output. This is measured in hectares and summed over plots.

Distance (DST) is measured as the number of kilometres a farmer travels from house to the farm. This was averaged over number of plots. Distance from a farmer's residence to his farm is included in order to determine whether the time and energy spent in travelling from house to the farm has a significant impact on the value of output produced by the farmer.

Experience (EXP) is measured as the number of years a farmer has been farming. The frequency with which person carries out an activity determines how specialised he would be which then enhances efficiency. Hence, this variable is expected to determine whether farmers are able to improve upon their efficiency through specialization.

Labour (LAB) refers to the number of working hours spent on the farm by a family or hired labourer from land preparation till harvesting of a particular crop. The more man-days or man-hours spent on the farm, the higher the expected output. Number of days spent in performing the various farm operations are summed up and multiplied by the average number working hours per a day, (that is, 8 hours), to obtain the labour supply for a given crop.

Total cost (TC) is estimated from summation of labour cost for the various farm operations, material input cost, (that is, cost of seed, fertilizer and spraying chemicals), ploughing cost and depreciation on equipment and tools. The straight line method was used in the depreciated values and each tool or equipment is assumed to have a salvage value of 10 percent. This variable is included in the model to find out whether the total cost incurred by the farmer on a hectare of land significantly influences the value of output produced.

Fertilizer (FEZ) refers to the amount of chemical fertilizer applied per hectare to a particular crop. This is measured in kilograms and averaged over crop area. Since the study area is located in the Coastal Thicket and Grassland Vegetation Zone, the fertility of soils in the area is generally low, hence it is expected that fertilizer would have a significant positive influence on the level of output and hence its value.

Non-agricultural activities (NNG) variable is included as a dummy variable, that is, one for all farmers who engage in activities other than agriculture and zero otherwise. When farmers engage in non-agricultural activities, they are expected to invest some of the income from these activities into the farming business which could influence the effectiveness and timeliness with which farm operations are carried out. This could also influence the level and value of output.

Training (EXT) refers to whether a farmer receives visits from extension agents or not. Extension agents are responsible for teaching farmers new and improved methods of farming. If farmers receive visits by extension agents, they learn more about farm operations and the entire farm business. This could influence output. Training is also a dummy variable. A value of zero is scored for farmers who did not receive any extension service for the cropping season under review as well as those who did not have at least primary education and one otherwise.

3.5 Data, Sources, and Uses

Cross-sectional data obtained from a field survey observation over one year period was used. The sampling technique employed was simple random sampling, that is, thirty-three one third percent of farmers from the various communities in the study area were picked to obtain a sample size of hundred. Data collection was done through questionnaire administration and interviews

Farmers were interviewed on the level of output per hectare and unit prices of output. These were then multiplied to obtain the value of output per hectare. Quantities of various inputs used per hectare and their prices were also obtained in the same way to compute the value of input. The OLS estimate of the Translog production function was used to determine the effect of various factors on total output. Factors considered include land, labour, capital (initial capital), agrochemicals, education, distance from farm, land fragment (that is, number of plots) and involvement in non-agricultural activities. Interactions between these variables are also determined. Some of these variables are eliminated from the models due to unsatisfactory results obtained by their inclusion. Finally, efficiency of use of the various resources is determined by computing marginal value product from the regression output and comparing with market prices of inputs. Assuming that the market clears, efficient use of a resource is achieved when the *marginal value product of the input equals its price*. On the other hand, if the marginal value product is less than the price, then the input (resource) is being over utilized, and it is being under-utilized if the marginal value product is greater than the price of input. Alternatively, allocative efficiency index could be computed by dividing the marginal value product by the price of input. That is, if this index equals unity, then resources are said to be efficiently utilized. On the other hand, if it is less or greater than unity, then resources are inefficiently utilized.

4. Empirical Results

4.1 Demographic Characteristics of farmers

Majority of the farmers are between 30 and 50 years indicating that they are quite active. About 30 percent of the respondents are over 50 years old. This implies that a good number of farmers are people who have taken to farming after retirement from public service.

Farmers who have at least primary education are considered educated in this study, nevertheless, a significant number of farmers (46%) are found to have no education.

Males are the dominant farmers (82%) in the area since their female counterparts are unable to cope with the rather strenuous farming activities. Rather than owning and operating farms, most female respondents said it was more lucrative acting as middlemen in the marketing of farm produce.

A lot of farmers (66%) engage in non-agricultural activities such as driving, truck pushing (on market days by those young men who live near markets), trading (by most women), salt mining (both men and women), masonry, carpentry, sewing as well as teaching in some few cases. According to them the risky nature of the farm business resulting from erratic and irregular rainfall patterns, price fluctuation due to poor marketing network, high post-harvest loses, high perishability of the farm produce in addition to difficulty in obtaining credit for farm purposes, demands that a farmer engages in some kind of non-agricultural activity in order to survive. Income from such activities is used as capital to start land preparation at the beginning of the season in order not to lag behind as well as meet good prices. Most often, income obtained from the first cultivation is ploughed back in the course of the season. Consequently, such farmers are able to get better returns from the business than most of those who concentrate fully on the farming business. Some can even act as money lenders to their colleague farmers and charge exorbitant interest rates.

Fragmentation of farms is not much of a problem since most farmers have between 1 to 4 plots. Distance from house to farm, however, could be considered a problem since about 52 percent of the farmers have to travel over 4 kilometers to their farms and back home. This is likely to negatively affect the number of hours as well as the energy available for working on the farm. Labour force was not a problem since hired labour was readily available. Extension service, on the other hand, is low. Only 40 percent of the farmers have access to some extension service. According to them, a farmer could have as low as one extension visit for the entire season.

Some of the respondents indicated that they used cow dung to fertilize their farms instead of chemical fertilizers. This according to them is due to the high cost of chemical fertilizers.

According to the respondents, the farm business is not as profitable as the other economic activities in the area; therefore, it is not encouraging to remain in it for a long time. Hence, day in and day out, the older hands are leaving and new hands are entering. Actually, after farming for a while and realizing the nature of income generation, people prefer to invest in other non-agricultural activities which they find more profitable. Others even decide to cultivate only small areas for subsistence. Also, most of the older hands are out of the business due to old age. On the whole, 80 percent of the farmers have between 1 to 30 years of experience in the business, whereas only 20 percent have experience of 40 years and above.

4.2 Estimates of Output and Input Analysis

Table 1 presents the computed values of output of tomato and watermelon. The results reveal that watermelon has a higher value of output (GH¢1738.68) than tomato (GH¢480.37) within the 2007 cropping year. Watermelon has a higher value of output because, the fruit, even though perishable, is readily consumed by almost every one and hence, it does not have much marketing problems as tomato during harvesting. Also, prices are relatively stable since harvesting occurs over a short period.

Tomato is more perishable than watermelon. However, some of the respondents choose to cultivate the former rather than watermelon. This is because, according to them, the fluctuating output price favours early and late cultivators. There may be a very high price at the beginning, a fall at the peak harvest and then a sharp rise toward the end. Also, when prices are low, discouraged farmers shift to other crops causing price to shoot up in favour of the few who cultivate in the minor season. Farmers, who harvest most of their produce at the periods when prices are high, make high profits.

Table 1: Average Annual Revenue per Hectare for Tomato and Watermelon

Crop	Average Yield/ha (kg)	Price/kg (GH¢)	Value (GH¢)

Tomato	2825.68	0.17	480.37
Watermelon	14489.02	0.12	1738.68

Table 2 shows labour, capital and material input cost of tomato and watermelon. Labour cost of tomato is higher than that of watermelon. Capital invested in each of the crops does not differ significantly because the cost components are almost the same. The significant difference between the material input costs of the two crops is explained by the difference in the quantity of input used. Each of them is cultivated by seeds and also need spraying chemicals; however, watermelon does well with very little fertilizer whereas tomato requires a lot of fertilizer. Of the three cost components, labour cost stands out as the highest and is even higher than the other two components put together. This is because whereas the other costs are only incurred at certain stages of the production process, labour cost continues until the last fruit is harvested.
Table 3 shows the level and value of some material inputs. Spraying chemicals were not included because it was difficult for the farmers to tell the amount of the various components used on the farm. They were however, able to mention how much expenditure they incurred in the purchase of the amount used for a season. This was shared among the crops according to the area cultivated and the frequency of spraying. Cultivation was done for two seasons in a year; the major season which occurs between April and July and the minor season which begins in August and ends in November. It is not common to find farmers reserving some of their inputs for the subsequent year.

Table 2: Average Cost of Inputs for Selected Crops per Hectare

Input	**Crop**			
	Tomato (GH¢)	**%**	**Watermelon (GH¢)**	**%**
Land	16.00	0.23	16.00	0.31
Labour	453.17	64.30	318.33	62.40
Capital	241.42	34.30	174.70	34.20
Total	704.59	100.00	509.03	100.00

Table 3: Material Input Analysis

Crop	**Seed**			**Fertilizer**		
	Quantity per hectare (g)	Price per gram (GH¢)	Value (GH¢)	Quantity per hectare (g)	Price per gram (GH¢)	Value (GH¢)
Tomato	0.74	33.33	24.66	185.25	0.54	100.40
Watermelon	1.11	26.67	29.64	30.88	0.54	16.67

Seed and fertilizer, on the other hand, have a different story. Farmers were able to state the various quantities they used per hectare as well as the prices at which these inputs were bought. Where a number of hectares were cultivated using a given quantity of seeds and fertilizers, per hectare quantities were calculated and used. Tomato requires more fertilizer than watermelon. This is because whereas watermelon needs only one dose of fertilizer application, tomato needs at least two doses.
There are three main material inputs namely, seed, fertilizer and spraying chemicals. Spraying chemicals used include karat, plant food or harvest more, and furadan. Furadan and karat are insecticides whereas

plant food is a growth promoter.

Table 4 presents the average productivity of tomato and watermelon. Average productivity of watermelon is higher than that of tomato due to the high yielding capacity of watermelon. Thus, every one cedi invested in tomato production yields GH¢ 0.68, a loss of GH¢0.32. On the other hand, every one cedi invested in watermelon production yields GH¢ 3.41, a gain of GH¢ 2.41. This results from the fact that whereas total input cost per hectare in water melon production is GH¢508.03, that of tomato is GH¢704.59, an increase of GH¢ 195.56. Meanwhile, the value of output per hectare of watermelon far exceeds that of tomato.

Table 5 presents the average productivity indices of tomato and watermelon. This is the ratio of the productivity of one crop to the other. At a particular point in the analysis, a crop is as base crop and its productivity value is compared with that of the others. For instance, taking tomato as the base crop, its productivity value is used to divide the value of watermelon to obtain the productivity index of watermelon. The ratio of the productivity of a crop to itself is unity. One is subtracted from each value to find out the extent to which the productivity of one crop is higher or lower than the other. The results reveal that productivity of tomato forms 20 percent of that of watermelon whereas that of watermelon is 511 percent of tomato.

Table 4: Average Productivity Estimates

Crop	Estimated Parameters		
	Value of Output (GH¢)	**Total Cost (GH¢)**	**Value of output / total cost (GH¢)**
Tomato	480.37	704.59	0.68
Watermelon	1738.68	509.03	3.41

Table 5: Productivity Indices between Crops

	Tomato	**Watermelon**
Tomato	1.00	5.11
Watermelon	0.20	1.00

4.3 Empirical Results of Factors affecting Value of Output

In other to determine the effect of various factors on the value of output of farmers, a Translog production function was estimated. Value of output of the selected crops was regressed on the various factors affecting output. Output functions for both tomato and watermelon were estimated. Factors included in the tomato function are land, distance from house to farm, experience, labour, fertilizer and training. The variables are in their natural logarithms. This gives the coefficients as elasticities.

The empirical result for tomato and watermelon are presented in Tables 6 and 7, respectively. Other variables of interest are the level of education of farmers, age, non–agricultural activities, total cost of production, number of plots cultivated by farmer and quantity of seed used. The R^2 value for the regression is 0.40, indicating that 40 percent of the variation in value of tomato output of farmers is explained by the model. The F-statistic is 0.188 and this is significant at 5 percent. This means that the independent variables jointly explain the variations in the dependent variable.

Variables found to have significant influence on the value of output of tomato include land, labour and experience. These variables are in their natural logarithms, hence their coefficients represent elasticities or percentage changes in the value of output. The coefficient of the natural log of land is 1.79 and this is significant at 1 percent indicating that a 1 percent increase in the number of hectares of land cultivated will

lead to a 1.79 increase in total value of output produced. In the same way, the coefficient of the natural log of experience being 1.06 and significant at 5 percent means that a 1 percent increase in the number of years of experience of the farmer in tomato production will result in 1.06 percent increase in the value of output of tomato produced. Also, the coefficient of the natural log of labour is 0.96 and is significant at 10 percent which implies that a 1 percent increase in the number of hours spent on the farm will yield a 0.96 percent increase in the value of tomato produced.

The model also makes it possible to analyze the cross effect of the variables. Those variables with significant cross effects are land and distance, land and labour, land and training, experience and labour. The coefficient of each of these has a negative sign indicating percentage reduction in the value of tomato output. They are 0.17, 0.24, 0.16 and 0.12 respectively. This means that when land and distance from house to farm both increase by 1 percent, value of output of tomato will decrease by 0.17 percent. This is so because, increase in the size of land may imply more plots and farmers are likely to cultivate the plot closest to them first and additional plots which are farther away later. From this, it could be inferred that tomato farmers cultivated plots closer to them. It could also be that with larger plots to cultivate and longer distances to the farms, these farmers would be less efficient thus, negatively affecting the value of the output. Further, traveling longer distances to farm would lead to tiredness and less time available for working on the farm and, therefore, leads to a decrease in output which in turn reduces the value of output.

A 1 percent increase in both the area of land cultivated and the number of man-hours used on the farm causes a 0.24 percent decrease in value of output produced. The explanation to this is that as more labour is employed on land which is relatively fixed, law of diminishing returns may set in and hence output falls.

In addition, high postharvest losses are recorded when weather conditions are poor within the harvesting period. The value of output, therefore, falls since it depends on both the quantity and the price. Training is measured as the number of times a farmer is visited by an extension agent. An increase of 1 percent in the number of hectares cultivated and the number of extension visits lead to a decrease in the value of tomato output by 0.74 percent. This may due to the fact that the extension officer-farmer ratio in the area is very low.

Table 6: Regression Results for Tomato
Dependent Variable: Natural Logarithm of the Value of Tomato Output (LNVOPT)

Variable	Coefficient	Std Error	t-Statistic

C	-0.2425	1.9977	-0.1214
lnLAND	1.7853	0.6338	2.8168***
lnDIST	0.6673	0.6430	1.0379
lnEXP	1.0629	0.4405	2.4133**
lnLAB	0.9641	0.5555	1.7357*
lnFEZ	0.6207	0.8865	0.7002
lnEXT	-0.1127	0.7340	-1.0045
SQlnLAND	0.0153	0.0869	0.1764
SQlnDST	-0.1127	0.0949	-1.1869
SQlnEXP	-0.1269	0.0668	-1.8985*
SQlnLAB	-0.0347	0.0919	-0.3775
SQlnFEZ	-0.1906	0.1691	-1.1270
lnLANDDST	-0.1716	0.0724	-2.3693**
lnLANDEXP	0.0108	0.0558	0.1937
lnLANDLAB	-0.2432	0.1034	-2.3535**
lnLANDFEZ	-0.2432	0.0973	-0.6005
lnLANDEXT	-0.0584	0.0937	-1.7617*
lnDSTEXP	-0.1650	0.0553	-0.2812
lnDSTLAB	-0.0156	0.0975	-0.5268
lnDSTFEZ	-0.0514	0.1152	-0.2162
lnDSTEXT	-0.0115	0.0888	-0.1293
lnEXPLAB	-0.1277	0.0610	-2.0957**
lnEXPFEZ	-0.0472	0.0782	-0.6034
lnEXPEXT	0.0160	0.0160	1.0005
lnLABFEZ	-0.0624	0.1226	-0.5089
lnLABEXT	0.1514	0.1154	1.3119
lnFEZEXT	-0.0290	0.1237	-0.2344
R-squared 0.4049		F-statistic	1.8843**
Adjusted R-squared	0.3502	Durbin-Watson	1.7993

*** denotes 1 percent significance level, ** denotes 5 percent significance level and *denotes 10 percent significance level.

Table 7 shows the regression output of watermelon. Value of output is regressed on the various factors such as land, experience, distance, labour, total cost, non-agricultural activity and training. The R^2 is 0.54 showing that 54 percent of the variation in watermelon output value is explained by the model. The F–statistic is 2.42 and this is significant at 1 percent level. This means that the independent variables have a joint effect on the value of watermelon output.

Variables which have significant influence on the value of watermelon output include land, training and non-agricultural activities. Since these values are in their natural logs, their coefficients represent the elasticities.

The results reveal that 1 percent increase in the value of output of watermelon will lead to a 4.46 percent increase in the value of output of watermelon and this is significant at the 5 percent level.

On the other hand, a 1 percent increase in the farmer's engagement in non-agricultural activities will lead to 5.81 percent decrease in the value of watermelon produced and is significant at the 1 percent level. This means that when a farmer engages in non-agricultural activities, it deprives him of the time to work effectively on his watermelon farm. This is due to the fact that, any delay in sowing or harvesting of the crop has a very significant adverse effect on the quality of yield obtained.

Farmer training has a negative effect on the value of watermelon output and is significant at 1 percent level meaning that 1 percent increase in the number of extension visits to the farmer will lead to 4.52 percent

decrease in the value of watermelon output. This does not conform to the a priori expectation of a positive effect. However, the negative sign supports complaints by the farmers that some extension agents demanded payment of a fee each time they visited their farms. Judging from the fact that the fees would be paid from the income obtained from the produce, the negative effect is justified.

Further, interacting variables with significant effects include land and total cost, distance and total cost, total cost and non-agricultural activities, and total cost and training. The combined effect of land and total cost on the value of watermelon output is negative and is significant at 1 percent. Hence, a 1 percent increase in the size of land under watermelon production and total cost of production would reduce the value of output by 0.84 percent. This is because both of these are cost components and the cost they bring is more than the addition to the value of output, hence the net effect is negative.

A 1 percent increase in total cost and non-agricultural activities increases the value of output of watermelon by 1.33 percent and this is significant at 1 percent, whereas, a 1 percent increase in total cost and training increases the value by 0.76 percent and this is significant at 10 percent. This is due to reinvestment of income from non-agricultural activity on timely basis to meet high output price. Total cost and training together yield a positive effect on the value of output of watermelon because, even though the effect of training alone is negative, the returns to output due to a unit cost of production of watermelon is so high that it off-sets the negative effect.

Table 7: Regression Result for Watermelon

Dependent Variable: Natural Logarithm of the Value of Watermelon Output (LNVOPT)

Variable	Coefficient	Std Error	t-Statistic

C	-8.1245	15.8564	-0.5124
lnLAND	4.4588	2.0752	2.1486**
lnDST	1.9283	1.9283	1.0544
lnEXP	-1.3085	-1.3958	-0.9375
lnLAB	0.3486	1.9743	0.1766
lnTC	4.9153	5.9080	0.8320
lnNNG	-5.8163	2.0736	-2.8049***
lnEXT	-4.5282	2.3354	-1.9389*
SQlnLAN	0.0274	0.1397	0.1959
SQlnDST	0.1805	0.1331	1.3561
SQlnEXP	-0.0378	0.0873	-0.4331
SQlnLAB	-0.1179	0.1145	-1.0215
SQlnTC	-1.0464	1.2739	-0.8214
lnLANDDST	0.1734	0.1081	1.6049
lnLANDEXP	0.0998	0.0736	1.3552
lnLANDLAB	-0.0740	0.1498	-0.4938
lnLANDNNG	-0.0352	0.1142	-0.3081
lnLANDEXT	0.1577	0.1367	0.1530
lnDSTEXP	-0.0111	0.0740	-0.1500
lnDSTLAB	0.0849	0.1097	0.7742
lnDSTTC	-0.5489	0.3259	-1.6842*
lnDSTNNG	-0.0335	0.1013	-0.3312
lnDSTEXT	0.1741	0.1113	1.5646
lnEXPLAB	-0.0488	0.0861	-0.5671
lnEXPTC	0.3134	0.2646	1.1846
lnEXPNNG	-0.1099	0.0913	-1.2040
lnEXPEXT	0.1107	0.0989	1.1193
lnLABTC	0.1145	0.3440	0.3328
lnLABNNG	-0.1226	0.1665	-0.7361
lnLABEXT	-0.0204	0.1421	-0.1435
lnTCNNG	1.3319	0.3911	3.4056**
lnTCEXT	0.7590	0.4235	1.7919*
R-squared	0.5402	F-statistic	2.4230***
Adjusted R-squared	0.3173	Durbin-Watson stat	1.911

*** Represents 1 percent significant level, ** represents 5percent significant level, and * represents 10 percent significant level.

4.5 Marginal Value Productivities

To determine the input allocative efficiency of the farmers, marginal product are computed for some inputs from the regression output and multiplied by the weighted average price of output to obtain the marginal value product. This is then compared with the market prices of the inputs.

The marginal product is computed from the OLS estimated Translog production function by taking account of the sole effect of the explanatory variables as well as their squares and interaction with other variables.

Marginal Value Productivity Analysis in Tomato Production

The marginal product of land in tomato production is 7.21 which mean that addition of one more hectare of land adds 7.21 units to the total value of output. Also, the marginal value product of GH¢64.89 is greater than the market price of a hectare of land, GH¢16. This indicates underutilization of land.

Similarly, the marginal value product of labour GH¢5.85 and capital GH¢834.3 are far above the market prices of these factors, that is GH¢0.5 and GH¢27 respectively, showing that they are also underutilized.

Probably, farmers are not willing to use the various factors to the optimum for fear of incurring losses due to the expected fall in price of output.

Marginal Value Productivity Analysis in Watermelon Production

The marginal product of land in watermelon production is 33.58. This means that for any additional land put into watermelon production, 33.58 units are added to total output. Also, the marginal value product GH¢30.56 is greater than the market price per hectare of land, GH¢16 indicating underutilization of land.

Marginal product of labour is 0.95, meaning any additional hour spent on watermelon farm adds 0.95 units to the total output of watermelon. Also, the marginal value product is GH¢ 0.86 which is greater than the market price GH¢0.5 showing that labour is not efficiently used.

The marginal product of capital is 1.87, meaning that for any additional cedis spent on watermelon production, 1.87 kilograms of watermelon is produced. The marginal value product, GH¢1.70, is also greater than the market price per cedi invested.

5. Conclusions

Productivity and efficiency are two basic interrelated concepts that must be understood and pursued by any serious developing nation. The interrelationship is such that whereas each of them measures the ratio of one factor to another, productivity is a broader concept which considers the use of overall resources whereas efficiency deals with getting the highest possible output from a given set of resources.

The results of this study show that, the value of output of watermelon is higher than that of tomato. The difference could be attributed to differences in output prices as well as labour and material input costs incurred in the production of each of these crops. Since prices of inputs are more or less stable over the season, output price difference could be said to be the main cause of this difference. For instance, it costs GH¢704.59 to produce a hectare of tomato whereas the average cost of producing a hectare of watermelon is GH¢509.03. Conversely, a hectare of tomato yields GH¢480.37 whereas a hectare of watermelon yields GH¢1738.68.

In the present study, analysis of the factors affecting the value of output of tomato and watermelon shows that, land, labour and experience exert significant influence on the value of output of tomato whereas land, non-agricultural activity and training significantly influence the value of output of watermelon in the study area.

Marginal value products computed for land and labour for each crop were found to be higher than the market prices of these factors indicating that land and labour are inefficiently used in both tomato and watermelon production in the study area even though labour did not influence watermelon production significantly. Even though, neither did the amount of fertilizer used in tomato production nor the amount of capital used in watermelon production exert significant influence on their value of outputs; these inputs were found to be underutilized in each case.

The study provides the following recommendations:

It is important that the government implements good policies that would improve the prices of output of non-traditional export crops in the entire agricultural sector. Specifically, farmers in the traditional area should be encouraged to form co-operatives to enable them improve upon their bargaining power, erase the activities of middle men as well as enjoy the advantage of bulk purchase of inputs. This will reduce input prices and relatively increase output prices and hence improve upon productivity.

Since high and relatively stable input prices and fluctuating output prices negatively affect the value of output and hence productivity, it is important that where necessary, price support policies such as price ceiling for input and floor price for output should be pursued as an economic policy in the agricultural sector. Neither tomato nor watermelon has a storage facility. Of these, tomato needs more urgent attention since it is produced on a larger scale and is also highly perishable.

Tomato, even though could not be stored by farmers, is consumed all over the country throughout the year. In the lean season, there is very little or no supply of this vegetable. Its price therefore shoots up abnormally. This problem could be solved if the government provides an irrigation facility in the area. As at the time of the study there was no such facility in the area. Every farmer was at the mercy of the natural rain.

From the regression results of both tomato and watermelon, land stands out as a very significant factor influencing the value of output. Also, in each case, land is found to be inefficiently utilized. This is due to the fact that apart from the area being sparsely populated; most of the youth are not into farming since they

find other economic activities more lucrative.

Land being a significant factor affecting the value of output also implies that the issue of land tenure in the area is given a critical look. From the results obtained, land has a positive influence on the value of output meaning that an increase in the size of land increases the value of output and vice versa. The government could reserve cultivable land through consultation and compensation of the traditional authorities. This would ensure easy access to land by prospective farmers or farmers who wish to expand their farms.

The allocative efficiency analysis shows that fertilizer is underutilized in tomato production despite its insignificant influence on the value of output. This could be attributed to its high price. Some farmers have resorted to the use of organic manures such as cow dung and pig dropping as a solution to this problem. It is important to encourage them as well as convince others to also adopt this practice through extension services, since it is a relatively better and more environmentally friendly way of fertilizing the soil.

Provision of extension services or training as used in the study needs to be increased in the study area since it has been found to exert positive influence on the value of output of watermelon. Watermelon as a cash crop has been recently introduced in the area hence farmers need more knowledge about it. Therefore extension service should be improved in the area in terms of both extension officer-farmer ratio and quality of service.

The study bears the following limitations.

This study considers factors affecting output; however, it does not consider fertility of the soil which is also a very important factor due to the difficulty encountered in measuring it. Also, this study limits itself to the analysis of only allocative efficiency and did not consider technical efficiency which is also very relevant to the issue of production due to insufficiency of time and other resources involved. Future studies could therefore look at this aspect.

Some important variables such as age of farmer, level of education and fragmentation of farms were eliminated from the regression model due to unsatisfactory results. The sample size of 100 (for each crop-tomato and watermelon) was also too small to capture all the variations in the characteristics of the people. This was chosen due to time and financial constraints. Since large sample sizes reduce sample error, future studies should consider larger sample sizes.

This study focuses on only one out of the two hundred and thirty districts in Ghana. It is, therefore, important that similar studies should cover other districts. This would give a better idea of the productivity and efficiency situation in the country.

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