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Resource use efficiency in Chili Pepper production in the Keta municipality of Volta Region of Ghana

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ABSTRACT

This research was carried out in Keta Municipality of Volta Region of Ghana to investigate how resources are used in the production of chili pepper. A simple random technique was used to select 100 chili pepper farmers from three communities in Woe, Keta Municipality. The data was collected from December 2010 to January 2011. The Cobb-Douglas production function was used to determine the resource use efficiency of inputs used by the farmers. The findings of the study showed that the farmers were operating in stage two of the production frontier. This was shown from the elasticities of the various inputs, showing diminishing return which is a characteristic of the stage two of the production function. However, the farmers were found not to be efficient in allocating the resources for production in the study area. The ratio of the marginal value product (MVP) and the marginal factor cost (MFC) was found to be less than unity for all the inputs except labour and organic manure. The study recommends that the farmers should reduce the level of those inputs that are being over used. They should rather increase the use of organic manure and maintain the quantity of labour use.

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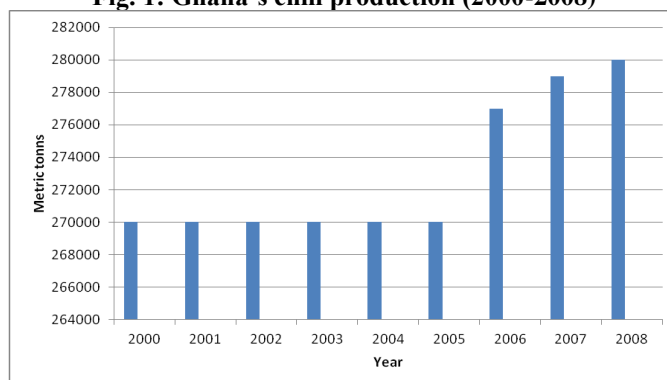
Introduction

Spices play a major role in our meals by providing the piquancy flavour, good aroma and taste which are acceptable to consumers. Spices used in medicine, pharmaceutical, perfumery, cosmetics and several products in other industries. There are over thousand and one spices used in the world, of which chili pepper is one of the important spices. Chili pepper, whose botanical name is *capsicum annum*, has numerous varieties that are cultivated on small scale. However, *C. annum* and *C. frutescens*, are the most common ones cultivated on large scale around the world. Capsicum (chili) has variety of uses based on its hotness and colour. The plant is cultivated by using seeds. Pepper belongs to the *solanaceae* and is related to eggplant, potatoes and tomatoes (Bosland *et al.*, 1996). In Ghana several species of hot pepper are grown. These include Bird's eye, Legon 18, M12, Fresno, Jalapeno and Scotch bonnet.

The use of chili ranges from salads preparation, adding flavour to cook dishes, adding pungency when used green or as powder (Bosland and Votava, 2000) to sauces using for example chili. It has now dominated the world's spices market.

Recently, the crop is grown for export to Europe and has become an important foreign exchange earner. The production of chili during 2008 was estimated to be 27,500,000 metric tons around the world. The top ten highest chili producing countries are India, China, Ethiopia, Myanmar, Mexico, Vietnam, Bangladesh, Peru, Pakistan and Ghana, and have contributed more than 85% of the world production in 2007 (Karvy, 2008). Fig. 1 shows Ghana's chili production from 2000 to 2008. In Ghana, the total chili production is estimated at 27900 mt (FAOSTAT, 2007) and that of Keta Municipality at 7840 metric tons (MOFA Keta, 2008).

Fig. 1: Ghana's chili production (2000-2008)



Source: FAOSTAT, 2007

Ghana has a diverse and rich resources base. The people are mainly into agriculture, with a majority (about 70%) of its population engaged in farming. In spite of this, the country still continues to be a net food importer. Ghana's agriculture is operating at just 20% of its potential (MoFA, 1999).

In agriculture, where production is not mechanized, farm performance is below potential. The level of output does not usually compensate the amount and cost of inputs used. Farmers use inputs such as land, labour, fertilizers, seeds and equipment for production. The level at which inputs are converted to output within the production process determines whether they are efficiently used or not (Umoh and Yusuf, 1999; Ehui and Spencer, 1990).

Also, it was manifested by Schultz (1965) that low 'agriculture' production is associated with traditional system of farming which is as a result of the factors of production at the 'farmers' disposal. It is indicated that farmers have carried production to the point where the marginal returns from

additional work is too low. They cannot make a substantial return from their operations in order to invest in or acquire more productive inputs. They are economically described as having attained economic equilibrium. They can make little or no contribution to economic growth since they are really inefficient in the allocation of resources. Knowledge in farm management is lacking with traditional peasant farmers. They lack education in farming methods which is a limiting factor in the adoption of new methods of production.

However, farmers in the Keta municipality are no exception to those who inefficiently use resources. There is a mismatch between output and inputs used for production. (MOFA, 2008). Generally, resources are scarce and this is a major concern to production economist. The economist has to think about ways to allocate the existing resources to have more output with minimum input combination. The farmers should be able to prescribe the level of input with the least cost without changing the production technology to a more expensive one.

Production Function

Farm production is a function of farm inputs including land, labour capital, management and other inputs. Coelli and Bettess (1998) defined production function as maximum output attainable from given level of inputs and for a given technology. According to Goni (2007), modeling and estimation of the production efficiency of farm relative to other farms or the best practice in an industry has become an important area of economic study. An econometric method was used to estimate the production function in this study. From a general production function, $Y = f(X_1 + X_2 + \dots + X_n + \mu)$, the neoclassical test was incorporated to derive marginal physical product (MPP) and elasticities of various inputs out of which average physical product (APP) was calculated. The ratio of allocative efficiency is given as:

$$r = MVP / MFC$$

Where MVP = value added to the chili output due to the use of additional unit of input, calculated by multiplying the marginal physical product by the price of the output (i.e. $MPP_{X_i} * P_i$).

MFC = marginal factor cost, which is the cost of one unit of a particular input. Hopper (1965), proposed the rule for making a decision on the use of a particular resource, i.e. if $r = 1$, then resource is efficiently utilized, if $r > 1$, the resource is underutilized, and if $r < 1$, resource is over utilized.

Meanwhile, economic optimum is reached when $MVP = MFC$. If r is not equal to 1, it suggests that resource is not efficiently utilized. Adjustment could therefore be made in the quantity of the inputs used and costs in the production process to restore $r = 1$.

Methodology

Study Area

The study area, Keta Municipality, is one of the seventeen districts in the Volta Region of Ghana. It covers a land area of about 1082 sq. km. The municipal share boundary at the north with Akatsi District, in the west with Volta Lake, east with Ketu South and in the south with Gulf of Guinea.

The municipality has a population of about 15,689 people with male constituting 60% and female of 40% (MoFA, 2007). The main occupations are fishing and cropping, with animal rearing on small scale. Specifically, Woe a suburb of Keta, was purposively selected for the study. This is because most of the farmers in this area grow chili pepper.

Data collection

Data was collected by interviewing the individual farmers with structured questionnaires. The questionnaires were administered to 100 chili pepper farmers selected through simple random technique from three communities, also selected out of ten communities by the same sampling technique.

Data Analysis

The production function model, as stated by Cobb-Douglas (1928), which employed linear regression to evaluate the productivity of the major inputs was used to analyse the efficiency of the inputs used in the production of chili. However, using ordinary least square estimator, the production function model was expressed implicitly as:

$$Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, \mu)$$

Where Y = chili pepper output
 X_1 = quantity of seed (kg)
 X_2 = quantity of fertilizer (kg)
 X_3 = quantity of foliar fertilizer (L)
 X_4 = labour (man-day)
 X_5 = hired labour (manday)
 X_6 = quantity of pesticide (L)
 X_7 = organic manure (kg)
 X_8 = farm size (acre)
 μ = error term.

The functional form of the model was given as:

$$\ln Y = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 + \mu$$

Determining Allocative Efficiency of the Resources

The allocative efficiency of the resources used by the farmers was estimated by using the ratio (r) below. It shows the relative efficiency of resource use (r)

$$r = MVP / MFC$$

Where MFC = the cost of one unit of a particular resource.

MVP = value added to chili output due to the use of an additional unit of input. This is calculated by multiplying the MPP (marginal physical product) by the price of output (i.e. $MPP_{X_1} * P_1$)

Determining the Technical Efficiency of Resource Use

Goni (2007) measured the elasticity of production of rice farmers in the Lake Chad area. Philip (2009) also used the ratio (r) to estimate the allocative efficiency of resource use in rice production in Dangme West District of the Greater Accra Region of Ghana by using the formula below:

$$EP = MPP / APP$$

Where EP = elasticity of production
MPP = marginal physical product
APP = average physical product

Farrel (1957) said that the elasticity of production which is the percentage change in output as a ratio of a percentage in input was used to calculate the rate of return to scale which is a measure of firm's success in producing maximum output from a set of inputs. He suggested a decision rule that if:

EP = 1: there is a constant return to scale

EP < 1: there is decreasing return to scale

EP > 1: there is increasing return to scale

Results and Discussion

The effect of inputs on the production of chili pepper was determined by a Cobb-Douglas production function analysis. The *a-priori* expectations were positive for all inputs considered in the model. From the results of the study, the sign of the independent variables were found to be positive Table 1.

From Table 1, the value of R^2 shows that approximately 35.4% of variation in chili pepper output in the study area can be explained by the independent variables. However it was realized that seeds and farm size significantly influence output at 1%. It means that an increase in these inputs will increase chili pepper output significantly in the study area.

Technical efficiency

This aspect of the result gives an indication whether the farmers are technically efficient or not. A focus was placed on how the farmers in the study area combine the resources mentioned above to achieve efficiency.

From Table 2, the elasticities for all the inputs were less than unity. This means that there are diminishing returns with regards to the use of each input. However, a 1% increase in the level of each input would lead to an increase in chili pepper output by 0.021, 0.031, 0.005, 0.006, 0.047, 0.171 and 0.022 percent respectively.

Return to scale

From theory, it is known that a 1% increase in all inputs must have corresponding effect on the total output or greater effect on the total output. Meanwhile, from Table 2, the sum of all the input elasticities gives the total production elasticity of 0.304. This value is less than unity and hence the production exhibit decreasing returns to scale. This means that the farmers in the study area use more inputs in return for less output.

Allocative Efficiency

According to Goni *et al.* (2007), a resource is said to be optimally allocated if there is no significant difference between the marginal value product and marginal factor cost (i.e. ratio of MVP to MFC = 1).

With reference to Table 3, the ratio between MVP and MFC as seen in column (4) shows that the return for both family labour and hired labour were unity (i.e. '1') and it means that they were efficiently used. Meanwhile the 'r' value of 3.52 indicates that organic matter was under used. However, inputs such as seeds, fertilizer, foliar fertilizer, and pesticide and farm size had 'r' value less than unity meaning they were over used.

Conclusion

The findings showed that the farmers are in the stage two of their production, indicated by the elasticities of the various inputs. This is because all inputs demonstrate positive coefficient but diminishing returns throughout, and this is the characteristic of the stage two of the production function. However, considering the allocative efficiency, the farmers are found not to be efficient in allocating the resources in the study area. This is because the ratio between the marginal value product (MVP) and the marginal factor cost (MFC) was identified as less than unity for all the inputs, except labour and

organic manure. It means that when the farmers use one unit of an input, the revenue derived from the use of the particular input does not equate the cost of that input. On the basis of the findings of the study, the study recommends that the farmers should reduce the level of those inputs that are being over used. They should rather increase the quantity of organic manure and maintain the quantity of labour use to help attend efficiency.

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Table 1 Regression results for chili pepper production in Keta municipality

Inputs	Coefficient	t	P - value
Inseed	0.518***	4.68	0.000
Infertilizer	0.046	1.05	0.298
Infoliar fertilizer	0.080	0.93	0.355
Inpesticide	0.007	0.60	0.550
Infamily labour	0.028	0.28	0.778
InHired labour	0.133	1.22	0.226
Inorganic manure	0.145	1.23	0.224
Infarmsize	0.379***	2.97	0.004
Constant	5.103	5.06	0.000
R^2	0.354		

Note *** significant at 1%. Source: *Field survey, 2011*

Table 2: The ratio between marginal physical product and average physical product

Inputs	MPP	APP	Elasticity
Inseed	0.518	24.67	0.021
Infertilizer	0.046	1.480	0.031
Infoliar fertilizer	0.080	16.00	0.005
Inpesticide	0.007	7.000	0.001
Infamily labour	0.028	4.667	0.006
Inhired labour	0.133	2.830	0.047
Inorganic manure	0.145	0.848	0.171
Infarm size	0.379	17.23	0.022
Total	1.336	74.73	0.304

Source: *Field survey, 2011*

Table 3: Ratio of marginal value product to marginal factor cost

Inputs	MVP	MFC	MVP/MFC	Comment
Seeds	3.63	7.77	0.47	Overused
Fertilizer	0.32	2.39	0.13	Overused
Foliar fertilizer	0.56	0.96	0.58	Over used
Pesticide	0.05	0.10	0.50	Overused
Family labour	0.20	0.20	1.00	Efficiently used
Hired labour	0.93	0.93	1.00	Efficiently used
Organic manure	1.02	0.29	3.52	Underused
Farm size	2.63	72.77	0.04	Overused

Source: *Field survey, 2011*