RESOURCE PRODUCTIVITY AND ALLOCATION EFFICIENCY IN SMLALLHOLDER COFFEE FARMERS IN RUGWE DISTRICT, TANZANIA[1].

BY

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Abstract.

This paper presents empirical findings on resource productivity and allocation efficiency in smallholder coffee farmers in Rungwe district. The data used in this paper are based on a case study that involved interviewing 90 farmers. A Cobb-Douglas production function was used to estimate the production organization of the coffee farmers, and their efficiency in resource use. The results show that the farmers display inefficient use of available resources. The results indicate that farmers would increase farm productivity by the use of adequate capital-intensive input levels in order to maximize their efficiency. However, in order to achieve the use of capital intensive inputs, farmers should be encouraged to form groups/associations through which can take the advantages of increasing the bargaining power in both input and output markets. Farmers' groups/associations further provides group liability in the procurement of credit from both formal and informal financial lending institutions. This in turn will improve farmers input purchasing power.

Key words: Resource productivity, allocation efficiency, smallholder coffee farmers,

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1. Introduction

The period before SAP policies were implemented saw Tanzania's national economy and its agricultural sector being heavily controlled by the government. Price and Market interventions were important policy instruments during the period. The objectives of government interventions in agricultural marketing were to reduce price uncertainties to producers, and hence stabilize farm incomes; provide adequate food to urban population at reasonable price and maintain political stability. Other objectives were to protect farmers from exploitation by private traders; extract agricultural surplus for the development of other sectors of the economy; guarantee foreign exchange earnings; and reduce income inequalities between rural and urban areas and between regions (Amani, 1992).

During the same period the government influenced agricultural resource allocation at smallholder level using the official markets and the official pan-territorial prices for producers and consumers. Other mechanisms of interventions which influence farm resource allocation include technology support and input packages (Simon, 1998). There was as well an attempt by the state to either influence or change the social relations of production and thereby mobilize production forces for its effective use. All these were done in order to improve production and productivity at the smallholder sub-sector (Amani, 1992).

Other means by which the government influenced smallholder resource allocation include registration on minimum size of land put under cash and drought resistant crops (e.g. Cassava and sorghum) and land use directives related to settlements. Farmers were also forced by the government to apply fertilizers for the crop production (Amani, 1992).

But following the implementation of SAP policies, the government and its agencies no longer intervene and/or control resource allocation in the agricultural sector. There is a large and growing body of literature that removal of price controls and of the parastatal marketing monopolies has opened up great areas of economic space for trade in agricultural products (see Mwakalobo, and Kashuliza, 1999, Mwakalobo, and Kashuliza, 2000). Market reforms have been implemented in order to restore the basis for sustainable economic growth by providing increased incentives to agricultural producers. However, it has been also reported by many authors, that other market reforms have pushed up prices of farm inputs relative to outputs (Mwakalobo, 1998, Mwakalobo and Kashuliza, 1999; 2000; Turuka, 1995; Hawassi, 1997, Hammond, 1999); thus affecting the production efficiency in smallholder farmers in the country. These policy changes have important implications for farmers, as they directly affect their welfare. How farmers adopt to these changes, and how they ensure their better crop production, are ultimately dependent on the efficient use of production resources on the farm as well as the adoption of better strategies in resource use in copping with the changes (Amara, *et al.*, 1998).

For this reason resource productivity, allocation efficiency, and sound strategic resource use practice are important factors in predicating forth coming necessary structural changes in the farm sector and in designing public policies that increase farmers' chance of using resources efficiently in both the medium and long runs. This paper therefore is an attempt to present empirical findings on resource productivity and allocation efficiency in smallholder coffee farmers in Rungwe district.

2. Methodology

2.1 Data type and sources

The finding presented in this paper is based on the data that were collected from a field survey conducted during the months of March to April 1997. Primary data were collected from 90 farmers, randomly selected from six villages[2] in Ukwekwe and Pakati division in Rungwe district. A structured questionnaire was used to interview the farmers. In addition, information was also obtained form discussion with key informants (i.e. village leaders, village extension officers) and other farmers outside the formal sample to supplement field data.

2.2 Classification and definition of variables

[2] Three villages were selected from each division, (The three villages include; Kyimo, Mpandapanda, and Ibula from Ukukwe division and Segela, Katundulu and Mpuga from Pakati division)

The variables used in the analysis were defined as follows:-

- Output is the gross value of total production of maize during the 1996 crop season.
- Land is the total land in hectares under coffee cultivation during the survey.
- Capital is the value in Tshs of farm inputs (fertilizers, herbicides, and pesticides) used in coffee production.

2.3 Model Specification

The production function approach was used to estimate the production behaviour of the farmers. The general form of the function is specified as follows:-

$$Q_i = AX_i^{b_i} \ldots e^{U} \quad \text{------} 1$$

Where Q_i = total output of coffee of the i^{th} farm

A = constant term of the regression

b_i = elasticity of production with respect to the i^{th} input;

X_i = i^{th} input used in the production process

U = is the error term

e = the base of the natural logarithm

Specified in this form, its regression coefficients equal the elasticities of output with respect to various inputs. These elasticities are also independent of the unit of measurement. This model provides a compromise between an adequate fit of data, computational feasibility and sufficient degrees of freedom for statistical testing. It facilitates the estimation of the marginal resource productivity at the mean level, efficiency measures, and the computation of returns to scale.

The model is estimated in its log-linear form, which is specified as follows:

$$\ln Q_i = \ln A + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + U \quad \text{---}2$$

Where

ln is the natural logarithm

X_1 is area under coffee

X_2 is labour employed in the production process

X_3 is capital value (Tshs) of farm inputs

Other parameters are as specified in equation 1 above.

Assuming that errors are small and normally distributed such a logarithmic transformation of variables presumes a nearly normal distribution of errors in the data. It also enables the data to approach normality even if the errors are not normally distributed.

3.0 RESULTS AND DISCUSSION

3.1 Input use levels in Rungwe district

Table 1, shows results of fertilizer use levels by coffee farmers in Rungwe district. The results indicate that coffee farmers were applying fertilizers below the recommended rate. The reasons that contributed to use of less amount of fertilizer than the recommended rate is high prices of fertilizers. Also farmers reported that had no credit input and cash to purchase farm inputs.

Table 1. Fertilizer use levels by coffee farmers in Rungwe district

Fertilizer Used	Amount Used	Recommended Rate	Gap
Urea	60	100	40
CAN	75	160	85

Source: Survey data, 1997

Coffee requires different types of inputs within one growing season in order to meet optimal production. But following market reforms, price of these inputs have increased beyond the reach of farmers. This has resulted to low rate of application of inputs (i.e. fertilizers). The results show that the average rates of urea and CAN applied in coffee were 60 kg/ha and 75 kg/ha both amounts being less than the recommended rate.

3.2 Technical efficiency (Production Efficiency)

Technical efficiency evaluates the farm's ability to obtain the maximum possible output from a given set of resources. A farmer is said to be technically efficient if produce as much output as possible from a given set of inputs or if it uses the smallest possible amount of inputs for given levels of output and input mix. Technical efficiency (TE) was calculated to estimate how efficient coffee farmers used their resources. Technical efficiency was calculated as follows:-

$$TE = \frac{\text{actual output}}{\text{Potential yield}}$$

The results of TE are a show in Table 2 below.

Table 2. Technical Efficiency and Yield gap of Coffee, Rungwe district

Average Actual yield (kg/ha)	**Average Potential yield (kg/ha)**	**Yield gap (kg)**	**Average Technical Efficiency (percent)**
619.50	1250	630.5	49.2

Source: Computed from Survey data, 1997

The results in Table 2 show that farmers displayed inefficient use of available resources. The overall technical efficiency of coffee farmers was 49.2% far below the efficiency level and the yield gap was 630.5 kg/ha. Further analysis on how inefficient coffee farmers were producing was done through the use of the Cobb-Douglas production function.

3.3 Analysis of Efficiency in Resource Use and Productivity.

3.3.1 Production Function Estimation and analysis

The Cobb-Douglas production function specified in equation 2 above was estimated using the Ordinary Least Squares technique. The results of the regression for the coffee farmers are presented in Table 3.

Table 3. Production elasticities of the respective factors of Production for coffee farmers, Rungwe district, 1996

Variable	Coefficient	t-value	t-Significance
Constant	11.446	5.364***	0.000
X_1 (land)	-0.132	-2.588**	0.011
X_2 (labour)	0.067	1.455	0.202
X_3 (capital)	0.496	3.157**	0.003

F-ratio = 4.940** R^2 adjusted = 0.561 SEE = 0.695 D-W = 1.903 $\Sigma b_i = 0.562$

*** and **, Significant at the 1% and 5% level respectively

Source: Computed from Survey data, 1997

The results of the estimation show that R^2 for coffee farmers is statistically significant as indicated by the significance of the F-ratio at 5% level. However, the fit to the data could have been further improved had some more important explanatory variables, like the age of the coffee plants, level of management of the farmers, etc, were included in the regression equation. The F-value indicate that the hypothesis that all coefficients other than b_0 are zero should be rejected. From the specified variables, the elasticities of land and capital are statistically significant at 5% and 1% level for the coffee farmers respectively.

The estimated coefficients are the elasticities of production with respect to the factors of production showing in average the percentage change in the value of output resulting from a given percentage in the given input. Traditional theory of production stipulates that the large the value of the constant term the more technically efficient the farmers are. Among the specified variables, all had the expected signs. The coefficient of capital input was 0.496 and that of land was 0.132, implying that, capital had the potential to contribute more to output than any other variable among the coffee farmers. This means that a one percent increase in capital is associated with a 0.49% increase in output of coffee while land it will lead to a 0.132% decrease of output. The coefficient for land is negative. It is expected that increased of area cultivated would have been associated with increased gross output, so the sign of the coefficient for land could have been positive. However, the negative sign could have been associated with the fact that increased farm size diminishes the timeliness of input use. In fact, on large farms activities are spread over time. It thus become more difficult for larger farmers than for smaller farmers to conduct their farm operations at the optimal times, hence an inefficient use of farm inputs. Also given the importance of inputs in farming system and the low access to these inputs and their high cost, increasing the area cultivated implies a wider application of insufficient inputs.

However, the relatively high elasticity of production with respect to capital input among the coffee farmers than that of land and labour; could be due to the fact that coffee farmers are using lower levels of these inputs and substantial increase in production can still be realized among these farmers by increasing the level of utilization of these inputs. The relative importance of these factors in contributing to output is also identified by ranking the factors based on the magnitude of their absolute t-values. Based on this ranking it is observed that among the coffee farmers farm capital input has the highest contribution to output. Capital input, therefore appears to be relatively more important in terms of its contribution to output.

Returns to scale are used to show the proportionate increase in output resulting form a given proportionate increase in inputs. The returns to scale are increasing, constant, or decreasing if the sum of the estimated elesticities (Σb_i) is greater than, equal to or less than unit respectively. The results indicate that the Σb_i is less than unity, showing that the coffee farmers are experiencing decreasing return to scale. This implies that farmers are operating on the rational part of the production process.

However, an important issue here is how efficiently are these farmers organizing their production activities so as to maximize their profits given the prevailing input and output prices. In order to measure productivity of different agricultural resources, marginal value products (MVPs) were worked out.

3.3.2 Marginal Value of Productivity Measures

The MVPs of resources were computed for only those resources whose regression coefficients were statistically significant in the production function. From the Cobb-Douglas production function, the marginal factor productivities can be computed from the estimated production elasticities and the average productivity measures (Atieno, 1995) as follows:-

MVP $= b_i$ AVP $= b_i \; Q_i/X_i$---3

Where:

MVP = marginal value product for the given factor of production

b_i = the estimated elasticity of production for the i^{th} input;

AVP = the average value product;

Q_i = the total value of production

X_i = the value of the i^{th} input

The MVP gives the absolute response per unit of factor input and enables the comparison of relative efficiencies of resource use within the given farms. With all the variables (inputs and outputs) measured in monetary units using the sample mean prices, the marginal products represent the net increase in gross income realized from the application of an addition shilling's worth of a given input. Using the estimated production elasticities and the average value of productivities (AVP), the MVPs were estimated and are presented in Table 4 below.

Table 4. Marginal Productivity Measures of the Specified Factors of Production for coffee Farmers; Rungwe district, 1996.

Variable	MVP
Land (TShs/ha)	90. 94
Labour (TShs/Monday)	
Capital (TShs/kg)	341.72

Source: Computed from Survey data, 1997

The MVP for labour was not computed because it was not significant. The marginal value product for capital input is higher among the coffee farmers, implying that one additional kg/ha of fertilizer applied would add more to the output of coffee. This shows that coffee farmers are using less amount of input (i.e. fertilizer, pesticides and herbicides) in proportional to other resources. This high marginal value product of capital input among the coffee farmers can also be attributed to the high production elasticity of this resource among them and the low level at which it is used. Therefore given the production elasticity, the high marginal productivities and low level of utilization of these inputs, production levels could be substantially increased by increasing the level at which they are used.

3.3.3 Marginal Return to Opportunity Cost Ratios (MROCRS)

The marginal returns to opportunity cost ratios provide a measure of the efficiency of resource use prevailing on the average throughout the sample. It statistically measures the mean efficiency of resource use by each sampled farm population. It is computed as the ratio of the marginal product to marginal input cost given as the opportunity of the respective resource. For profits to be maximized, the ratio of the marginal product to the marginal cost must be equal to one. This means that the revenue from using one additional unit of input is equal to the cost of acquiring that additional unit. A ratio of less than one implies that too much of the resource is being used under the existing price conditions, implying inefficient resource use. If the ratio is greater than one, it indicates that too little of the resource is being used, and increased use of the resource would result in increased profits.

For a given production resource used their opportunity costs represent the market prices that prevailed on the average during the production period. For land its rental value is used as the market price. For the capital farm inputs (i.e. fertilizer, pesticides and herbicides) the marginal input cost was taken as the market price of these input. Since the inputs were measured in monetary terms, the marginal input cost is taken as equivalent to Tsh. 250. This is because it is the extra amount spent to acquire an extra unit of these inputs. The marginal cost for each resource input together with the computed efficiency is depicted in Table 5 below.

Table 5. Marginal Return to Opportunity Ratios for the Specified Resources among Coffee Farmers, Rungwe district, 1997

Factor resource	MC	MVP	MROCR
land		90.94	
labour			
Capital input	250	341.71	1.37

Source: Computed from Survey data, 1997

The results reveal that the MROCRs are greater than unity for all factors. These ratios indicate that too little of the respective resource inputs that is land and capital input are being used in relation to the prevailing market conditions. Hence the farmers are allocatively inefficient in the use of the available factors of production. This implies that production could be increased by increasing the use of these inputs.

The value of MROCR is higher than unity for capital input among the coffee farmers indicating that these farmers are using too little amounts of these factors in relation to the level at which they are to be used if these farmers were efficient. Given the prevailing market conditions, the farmers are using these factors inefficiently.

Too little use of the inputs by the coffee farmers is a reflection of high prices of inputs, lack of input credit and inadequacy of cash for purchasing fertilizer, which could have improved crop productivity and hence efficient resource use by farmers.

4 CONCLUSIONS AND RECOMMENDATIONS

The findings of this study indicate that if and only if coffee farmers need to increase their coffee productivity should make sure that they make use of capital intensive inputs such as fertilizers. Based on the Cobb-Douglas production function estimates, capital input had the highest production elasticity for the coffee farmers. A unit increase in the use of fertilizer for example would have led to the highest percentage increase in the output of coffee of the sample farmers. Ranking the factors according to their relative contribution to output shows that capital input have the highest contribution than any other factors. The coefficient for land is negative. It is expected that increased of area cultivated would have been associated with increased gross output, so the sign of the coefficient for land would have been positive. The negative sign for land implied that increased farm size diminished the timeliness of input use. In fact, on large farms activities are spread over time, thus it has been difficult for larger farmers than for smaller farmers to conduct their farm operations at the optimal times, hence an inefficient use of farm inputs. Also given the importance of inputs in farming system and the low access to these inputs and their high cost, increasing the area cultivated led to a wider application of insufficient inputs.

From the measure of return to scale obtained, coffee farmers experienced decreasing return to scale for the factors of production employed. This implies that a one-percentage increase in the use of these factors would have led to a less than one- percent increases in the value of output. However, this is the rational level of production, farmers are not allocatively efficient yet as it is shown by the efficiency measures.

Better utilization of resources is important and should be emphasized through increased use of capital intensive inputs such as fertilizers. However, given the prevailing situation with farmers to access and buy these inputs because of high prices use of capita intensive inputs can be achieved through;

- Promoting and encouraging farmers form groups/associations through which can take advantages of bargaining power in the input and output markets. Group liability have also be said to increase farmers chance to procure credit from financial lending institutions. This in turn will increase farmers' input purchasing power in the input and output markets.

- Encourage farmers to diversify their production by not only engaging in farm production but also in non-farm income generating activities in order to get cash that can be used to purchase farm inputs.

- Farmers should also enter into contract farming with traders and/or input supplies. This can be an effective way of delivering agricultural services (such as inputs, credits, etc.) to smallholders, enabling an intensification of production and diversification into more profitable crops. Contract farming and co-operation has the potential for increasing access to new market opportunities and services required to support smallholder intensification.

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