A Measure of Economic Rationality in the Smallholder Tea Sub-Sector in Kenya

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ABSTRACT

The smallholder tea sub-sector in Kenya is considered the largest and one of the most successful smallholder schemes in the world. However, tea productivity in this sub-sector has been persistently low when compared with the estate sub-sector. Despite the smallholders planting high yielding clonal teas, the national average yield in the sub-sector was only 2,075 kg made tea/hectare (mt/ha) compared to 3,954 kg mt/ha in the estate sub-sector in 1998. This study investigated some of the factors contributing to low tea productivity in the sub-sector. Cross sectional data gathered in Kirinyaga, Nyambene, Nandi and Nyamira Districts in 1999 were used. It was hypothesized that the extent of rationality in allocation of resources in the smallholder tea enterprise is relatively low. Hence, smallholder tea productivity has remained relatively lower than in the estate sub-sector, high yielding clones and useful agronomic recommendations extended in the smallholder sub-sector notwithstanding. To determine "the extend of economic rationality", "A Test of Economic Rationality Model" was used whereby, the index of economic rationality, ρ is the product moment coefficient of correlation between log (total variable costs-excluding labour costs) and log (labour-in mandays) for each tea district and region. The results showed that the product moment coefficient of correlation, ρ was:- 0.647 in Kirinyaga District, 0.651 in Nyambene District, 0.793 in Nandi District, 0.743 in Nyamira District, 0.595 in East Rift Valley Region, 0.752 in West Rift Valley Region and 0.674 for all farms surveyed. It was noted that the lowest value of ρ was 0.595 in East Rift Valley Region. It means that at least 59 percent of the variance in the logs of both inputs is due to the variation in the systematic profit-maximizing component of these inputs. The balance of 41 percent is the maximum that could be occasioned not only by poor technology and/or knowledge gaps but also by errors in the model and noise in the universe. The null hypothesis was rejected in favour of the alternative hypothesis. The conclusion is that smallholder tea farmers in Kenya seem to be quite price efficient in tea production.

1.0 INTRODUCTION

The smallholder tea sub-sector in Kenya is considered the largest and one of the most successful smallholder schemes in the world (Lamb and Muller, 1982). The sub-sector has experienced tremendous increase in green leaf production since 1963. As of 1998, it had 315,270 growers operating 45 factories and producing 144.1 thousand metric tones of made tea (Tea Board of Kenya, 1998). One of the major concerns for smallholders is product quality. The Kenya Tea Development Agency insists that they should pick only two leaves and a bud, resulting in high quality tea, while the estates pick more than two leaves and a bud, reflecting more but lower quality of made tea. Nevertheless, according to the available data, the smallholder sub-sector has consistently produced greater amounts of tea than the estates sub-sector since 1988. However, the productivity of green leaf in the smallholder sub-sector has all along remained lower than that of the estate sub-sector. For example, the national average yield in the sector was only 2,075 kg made tea/hectare (mt/ha) compared to 3,954 kg mt/ha in the estate sector in 1998. The smallholders mostly have high yielding relatively young clonal teas that should be yielding much higher. Indeed tea researchers have released clones which are yielding in excess of 4,000 kg made tea per hectare per year (Othieno, 1992; 1994), and this should enhance increased green leaf productivity.

The policy objective of the Kenyan Government has been to produce 280 thousand metric tones of green leaf per annum by the year 2001 (GoK, 1997). The greater part of this production is expected from the smallholder sub-sector, which has been producing approximately 60 percent of made tea. To achieve this objective, the Government of Kenya emphasizes efficient use of strategic inputs particularly fertilizers and adoption of intensive technologies of tea production to enhance smallholder yields [Kenya, 1997]. Due to high quality considerations, the smallholder tea fetches high prices in the auction markets than the estates tea. It is therefore expected that farmers would be guided by the price factor in the output markets to make quality decisions in the allocation of strategic inputs, within the context of their variable factor price regimes and quantities of fixed factors. Hence, they would be price-efficient in their operations. A farm is price-efficient if it maximizes profits i.e. it equates the value of the marginal physical product of each variable to its price (Lau and Yotopoulos, 1971). The major thrust of this study therefore was to determine the extend of price-efficiency, which is a component of economic efficiency, among the small-scale tea farmers.

Schultz (1964) examined the efficiency with which farmers within the "traditional agriculture" allocate the factors of production at their disposal. In "traditional agriculture", the factors of production on which agricultural communities depend are known through long periods of experience and are in this sense "traditional". While the communities in this class differ appreciably one from the another in the quantity of factors they posses, in what they grow, in the arts of cultivation, and culturally, they have one fundamental attribute in common: they have for years not experienced any significant alterations in the state of the arts (Schultz, 1964). This means simply that farmers of this class continue year after year to cultivate the same type of land, sow the same crops, use the same techniques of production, and bring the same skills to bear in agricultural production. To determine the allocative behaviour of these farmers, the hypothesis proposed was that:- there are comparatively few significant inefficiencies in the allocation of factors of production in "traditional agriculture" (the so called poor but efficient hypothesis). In turning to the real world to test the hypothesis advanced, the main difficulty was the paucity of usable data. Hence the conventional methods used in efficiency analysis such as the Cobb-Douglas production function could not be applied. Fortunately, some social anthropologists studying particular communities for extended periods such as the Guatamalan Indian community, Indian agricultural community in Senapur etc. diligently recorded in tabular form the product and factor prices, costs and returns of major economic activities, and the institutional framework in which production, consumption, savings and investment occurs. All the evidence revealed in the careful documentation of the behaviour of these farmers strongly supported the inference that the people were remarkably efficient in allocating the factors at their disposal.

Since 1964, agricultural systems have changed in developing countries. For example in Kenya, there has been an elaborate introduction of biological technologies such as high yielding clones of tea, Ruiru 11 coffee variety, Katumani maize etc. Chemical inputs such as fertilizer and concentrates have been introduced and used extensively in tea and dairy production respectively. Agricultural support systems such as extension service and research institutions have been developed and expanded. Thus, there has been significant alterations in the state of the arts. Hence most Kenyan farmers are no longer "traditional". The majority of them are semi-commercial. Indeed production of industrial crops such as cane, coffee, tea etc. is fully commercialized. Therefore, it would be in the interest of economists and policy makers to ascertain the price-efficiency level among farms after various agricultural policies have been passed, implemented, extended and adopted by farmers.

This paper is an extract of a wide study on:- "Assessment of technological adoption and policy factors impending the production of green leaf in smallholder tea farms of the Kenya tea industry." The study examined various aspects of tea production; allocation efficiency of farm inputs (Kavoi *et al.*, 2000), assessment of technology transfer and adoption levels inclusive. The paper presents and discusses the results of "economic rationality" aspects. It uses the conventional methods of efficiency analysis unlike the study on "allocative efficiency on traditional agriculture" reported by Schulz (1964).

2.0 METHODOLOGY

Rationality means the ability of farm-firms to successfully apply the profit-maximizing rule of behavior (Yotopoulos and Nugent, 1976). By testing for the degree of rationality, one is therefore testing for price efficiency. The study of efficiency relates basically to the common observation that farms that produce a homogeneous product such as green leaf, have different factor intensities and varying average factor productivities. Suppose farms behave according to a certain decision rule termed as profit maximization, subject to a set of exogenous variables such as prices and fixed factors of production. The observed inter-farm differences in factor intensities and productivities could be explained by one or more of the following:-a) different farms face different prices; b) different farms have different endowments of fixed factors of production i.e. neutral differences in technical efficiency; c) different farms use different (non-ideal) systematic behavioural rules in production. The study of economic efficiency should therefore include two parts. First, given different regimes of prices of the variable factors of production and quantities of fixed factors, it should determine if farms behave according to a certain decision rule such as profit maximization and at what extent. Tea in Kenya is produced in two regions i.e. East of Rift Valley and West of Rift Valley. Tea farmers in the various districts and regions face different regimes of prices of variable factors such as fertilizer and labour for plucking tea. They also have different quantities of fixed factors particularly land. Economic rationality test therefore determines whether farmers are price efficient, by assuming that they behave in a certain systematic way conveniently termed as profit maximization.

Studies on efficiency in Kenya (Kilungo, 1998; Murithi, 1990 etc.) have all assumed that farmers are rational in resource use. However, the study of efficiency cannot take place in the narrow confines of the assumption of "rationality" and the same inter-farm prices and technology. It should first determine if farm-firms behave according to a decision rule, such as profit maximization and at what extent. Second, if and only if a substantial decision rule appears to be generally applicable, the question arises whether a given group of farms is more economically efficient than another (relative efficiency), because it is more successful in responding to the set of prices it faces (price efficiency) and/or because it has higher quantities of fixed factors of production (Yotopoulos and

Nugent, 1976). The results of this study therefore can provide a basis to determine "relative efficiency" between the two tea growing regions in Kenya.

A by-product of the test of economic rationality is the estimation of supply elasticities for the variable factors of production. The index of economic rationality gives a measure of the extent to which farm-firms are successful in setting their variable inputs at *ex ante* correct, that is the profit- maximizing levels. This study investigated the levels of systematic behavioral rule in green leaf production in various tea growing districts and regions. Given different price regimes for variable factors and quantities of fixed factors of production for the districts and regions, a test of economic rationality should determine the extend at which farms operate in relation to an assumed decision rule of profit maximization.

The theoretical framework for determining the degree of economic rationality and how it is linked with price efficiency was developed by Lau and Yotopoulos (1971). The approach begins by considering the following theoretical deterministic model which consists of the Cobb-Douglas production function, constant elasticity supply functions for the inputs and a constant elasticity demand function for the output.

$$Q_i = A_i f(K_i, L_i) = A_i K_i^a L_i^b \quad \text{.......} \quad 1$$

$$K_i = kP_{ki}^n \quad \text{or} \quad P_{ki} = (K_i/k)^{1/n} \quad \text{.......} \quad 2$$

$$L_i = lP_{Li}^m \quad \text{or} \quad P_{li} = (L_i/l)^{1/m} \quad \text{.......} \quad 3$$

$$Q_i = qP_{Qi}^{-h} \quad \text{or} \quad P_{Qi} = (Q_i/q)^{-1/h} \quad \text{.......} \quad 4$$

Where in physical terms: Q_i = output for i^{th} farm; K_i = capital for i^{th} farm; L_i = labour for i^{th} farm; P_{ki} = price of capital for farm i; P_{li} = price of labour for farm i; P_{Qi} = price of output for farm i; A_i = the technical efficiency parameter which varies from farm to farm; a, b = elasticity coefficients of production for capital and labour assumed constant across farms; and n,m,h = price elasticities of supply for capital, labour and demand elasticity for output, all three presumed constant across farms.

The total revenue from output for farm i is

$$V_i = P_{Qi} Q_i = (Q_i/q)^{-1/h}.Q_i = q^{1/h} Q_i^{(1-1/h)} \quad \text{.......} \quad 5$$

If the market-clearing assumption is made, the total revenue for firm I can be obtained by substituting the production function, equation 1 into equation 5 i.e $V_I = q^{1/h} (A_I K^a_I L^b_I)^{(1-1/h)}$ and setting

$$A_I' = q^{1/h} A_I^{(1-1/h)};$$

$$V_I = A_I' K_I^{a(1-1/h)} L_I^{b(1-1/h)} \quad \text{.......} \quad 6$$

Where: A_i' = technical efficiency parameter that represents exogenously determined inter-farm variations in the volume and quality of the fixed factors of production (e.g. land entrepreneurship).

The total expense for capital and labour can be derived from equations 2 and 3 respectively as:

$$C_k = P_{ki} K_i = (K_i/k)^{1/n} K_i = (1/k)^{1/n} K_i^{(1+1/n)} \quad \ldots\ldots 7$$

$$C_l = P_{Li} L_i = (L_i/l)^{1/m} L_i = (1/l)^{1/m} L_i^{(1+1/m)} \quad \ldots\ldots 8$$

Using equations 6, 7 and 8, one can obtain the total profit equation under the assumption of constant returns to scale as follows:

$$\pi_i = V_i - P_{ki} K_i - P_{li} L_i \quad \ldots\ldots 9$$

$$\pi_i = A_i' K_i^{a(1-1/h)} L_i^{b(1-1/h)} - (1/k)^{1/n} K_i^{(1+1/n)} - (1/l)^{1/m} L_i^{(1+1/m)} \quad \ldots\ldots 10$$

The assumption made so far is that farms have knowledge of their production functions, cost functions and returns functions. Therefore, the economic rationality hypothesis implies that, given this knowledge and the level of the other factors, farms maximize profits with respect to each factor of production i.e. $\delta\pi_i/\delta K_I = 0$ and $\delta\pi_i/\delta L_I = 0$. From equation 10 and by substituting from equation 6, the profit maximization condition for capital inputs (whether or not labour inputs are at their correct levels) yields:-

$$\delta\pi_i/\delta k_I = a(1-1/h) V_i/K_i - (1-1/n)(1/k)^{1/n} K_i^{1/n} = 0.$$

Making V_i/K_i the subject then,

$$V_i/K_i = [(1-1/n) / a(1-1/h)] [1/k]^{1/n} K_i^{1/n}$$

In logarithmic form;

$$\log V_i = c + (1+1/n) \log K_i \quad \ldots\ldots 11$$

Where: $c = \log [(1+1/n) / a(1+1/h)] [1/k]^{1/n} =$ Constant

By analogy, the maximization condition for labour inputs (whether or not capital inputs are at their correct levels) yields:-

$$\log V_i = d + (1+1/m) \log L_i \quad \ldots\ldots 12$$

Where: $d = \log [(1+1/m)/ b(1-1/h)][1/l]^{1/m} =$ Constant

Equations 11 and 12 represent linear relationships between log Vi and log Ki, and log Vi and log Li respectively. The economic interpretation of these relationships is clear. Equation 11 describes the maximizing behaviour of the farm that can control the quantity of capital it employs but must take the quantity of labour as constant, and vice versa for labour in equation 12. Each of these conditions, taken by themselves, is necessary but not sufficient condition for complete profit maximization. The two taken together are both necessary and sufficient conditions and imply the third. The third partial condition for profit maximization refers to the firm that controls both capital and labour and has to achieve a specified level of output (whether or not the scale of output is correct). In other words, the factor proportions that a maximizing farm would employ to achieve a planned level of output can be derived from equation 11 and 12 as follows:

$$\log K_i = [(d\text{-}c)/(1+1/n)] + [(1+1/m)/(1+1/n)] \log L_i \quad \ldots\ldots\ldots\ldots \quad 13$$

Equation 13 represents a linear relationship between log Ki and Log Li and is thus independent of Vi. This equation, if satisfied, implies that the two variable vectors; capital and labour have been combined in such a way that the cost of achieving a specified level of output, Vi, is minimized. Thus equations 11, 12 and 13 represent, in a sufficiently simple form, the three partial conditions for profit maximization in a Cobb-Douglas model. Since equations 11 to 13 involve parametric constants that are the same for all farms, they would seem to lead to identical profit-maximizing input levels and output levels for all farms. However, the model does allow for systematic variation in the profit maximizing inputs and output of the individual farm via the assumption that the technical efficiency term, Ai in equation 1 is an exogenous variable that varies among farms. This becomes the source of the systematic variation in profit-maximization of the inputs and output between farms. The profit-maximizing variables of equations 11 to 13 must therefore be expressed as functions of the exogenous efficiency parameter of the individual farm.

By combining equations 11 and 12 with the production function equation 6 it can be shown that Log Ki and Log Li are linear functions of A_i '(the exogenous efficiency parameter of the individual farm). The same can also be shown for Vi. Thus, the profit-maximizing inputs and output of the individual farm are subject to systematic variations that are caused by the difference in the exogenous efficiency parameter between farms.

The equivalent systems of equations 11 to 13 are written in terms of profit-maximizing variables, which are of course, non-observable variables. Furthermore, if profit-maximizing behaviour is to be tested, it should be formulated in a stochastic model that also allows for random variation. This is done with an errors-in-variables model. The conceptual framework assumes that what a farm does is determined by profit maximization considerations plus an error term. In other words, the observed variables of capital, labour, and output each have two components: the systematic component, completely determined by *ex ante* profit maximization and expressed in the systems of equations 11 to 13; and the random component, which represents deviations from profit maximization. Thus, the following equations are defined:

$\log K_i = X^*_{1i} = x_{1i} - u_{1i}$

$\log L_i = X^*_{21} = x_{2i} - u_{2i}$

$\log V_i = Y^*_i = y_i - v_i$

$\log A_i' = Z_i$ 14

Where: X^*_{1i} = systematic and unobserved component of log capital; X^*_{2i} = systematic and unobserved component of log labour; Y^*_i = systematic and unobserved component of log output; x_{1i}, x_{2i}, y_i = observable actual amounts of inputs used and output produced (in the logs); u_{1i}, u_{2i}, v_i = stochastic deviations from the profit maximizing terms.

It is assumed that the errors in the input and output in the definitional equations 14 are due entirely to deviations from profit-maximizing behaviour. In this framework, a suitable index of the extend of economic rationality is the proportion of the variance (in the logs) of the (observed) quantities of a farm's inputs of labour and capital that is caused by the variation in the (unobserved) systematic profit-maximizing component of these inputs:

$$\text{var } X_{1i}^* / \text{var } x_{1i}^* = \text{var } X_{2i}^* / \text{var } x_{2i}^* = \rho \qquad \text{.......................... } 15$$

ρ is thus a measure of the extent to which the individual farm is successful in setting its inputs at the ex *ante* correct, that is, the profit-maximizing levels. By employing the definitions in equation 14 and assuming that:

$E(u_{1i}) = E(u_{2i}) = 0$;

$Cov(u_{1i}, Z_i) = Cov(u_{2i}, Z_i) = 0$;

$Cov(V_i, Z_i) = 0$;

$Cov(u_{1i}, u_{2i}) = 0$;

$E(v_i) = 0$;

the following systems of equations 11 through 13 can be derived:-

$$y_i - v_i = c + [1+1/n][x_{1i} - u_{1i}] \qquad \text{.......................... } 11a$$

$$y_i - v_i = d + [1+1/m][x_{2i} - u_{2I}] \qquad \text{.......................... } 12a$$

$$x_{1i} - u_{1i} = [(d - c)/(1+1/n)] + [(1+1/m)/(1+1/n)][x_{2i} - u_{2I}] \qquad \text{.................. } 13a$$

Equations 11a - 13a are cast in terms of observable variables and can be directly estimated. Because of the use of the errors-in-variables model, the appropriate estimates of 1 + 1/n, 1 + 1/m and (1 + 1/m) / (1 + 1/n) obtained from equations Eq.11a, 12a and 13a are the diagonal regression estimates. Yotopoulos and Nugent (1976) showed that the diagonal regression coefficient relating x_{1i} and x_{2i} is also equal to the square root of the proportion of the variances of the inputs i.e.

$$(1+1/m)/(1+1/n) = (\text{var}\, x_{2i}^{*} / \text{var}\, x_{1i}^{*})^{1/2} = \rho \quad \text{.................................} \quad 16$$

and it is the product moment coefficient of correlation between x_{1i} and x_{2i}. Thus it was established that the product-moment correlation coefficient gives an estimate ρ which is defined as the proportion of the variance of the log in both inputs due to variation in the systematic profit-maximizing component of the inputs.

In this study, the test of economic rationality was applied to on-farm primary data which was collected from smallholder tea farms in Kirinyaga and Nyambene in East Rift Valley and Nandi and Nyamira Districts in West Rift Valley, in 1999. The data collected was on agronomic practises, inputs, outputs, prices and extension in tea enterprise. Equations 11 to 13 as shown in the text, with the profit-maximizing variables transformed into observable ones in the error-in-variables context of equations ' ' . to 13a were used for empirical estimation. A by-product of the test of economic rationality is the estimation of supply elasticities for the variable factors of production. The above equations therefore were used to estimate the elasticities of the variable inputs and also to determine the diagonal regression coefficients relating log Ki and log Li. The derived product moment correlation coefficient of log (TVC) and log (Lab) for each district, region and all surveyed farms gave an estimate of economic rationality in the tea enterprise. Thus, the test of economic rationality degree for all farms, regions and districts was given by the simple correlation coefficient of the relationship of log total variable costs -excluding cost of labour on log labour in mandays. The labour variable, Lab was the sum of mandays for hired labour and family labour used in tea in the course of the year. The variable, TVC was the sum total of variable cost in (Kshs.) of fertilizer, weed control, pest control and disease control per farm per year. The variable, TOV was total revenue (Kshs.) of tea per farm per year. It was a product of the total number of kilograms of green leaf delivered multiplied by the producer price of tea in the year. The index of economic rationality degree, ρ, gave a measure of the extent to which tea farms are successful in setting their variable inputs at the *ex ante* correct levels that is the profit-maximizing levels. An index of one suggests that farms perfectly maximize profits, given the constraint that some inputs must be considered as fixed.

3.0 Results and Discussions

The results reported in Table 1 below were used to test the hypothesis that the extend of rationality in allocation of resources among the smallholder tea farmers is relatively low. Hence, that is why tea productivity has remained relatively lower in the smallholder sub-sector than in the estate sub-sector, high yielding clones and useful agronomic recommendations extended in the smallholder sub-sector notwithstanding. The alternative hypothesis was that the extent of rationality in allocation of resources among the smallholder tea farmers is relatively high. Thus, they employ the maximizing rule of behaviour in tea production. Hence the search for the causes of continued low tea productivity should be directed elsewhere.

Now, suppose that tea farms operate under different price regimes and with differing endowments of fixed factors of production in the various districts and regions. How successful are these farms in employing the maximizing rule of behaviour? The question here is therefore about the price efficiency component of the tea farms. This was given by ρ, the index of the extent of economic rationality. The results showed that the product moment coefficient of correlation, ρ was: - 0.647 in Kirinyaga District, 0.651 in Nyambene District, 0.793 in Nandi District, 0.743 in Nyamira District, 0.595 in East Rift Valley Region, 0.752 in West Rift Valley Region and 0.674 for all farms surveyed. It was noted that the lowest value of ρ was 0.595 in East Rift Valley and did not vary significantly between districts. It means that at least 59 percent of the variance in the logs of both inputs is due to the variation in the systematic profit-maximizing component of these inputs. The balance of 41 percent is the maximum that could be occasioned not only by poor technology and/or knowledge gaps but also by errors in the model and noise in the universe. The null hypothesis was rejected in favour of the alternative hypothesis. The conclusion is that smallholder tea farmers in Kenya seem to be quite price efficient in tea production.

A study in India (Yotopoulos and Nugent, 1976) investigated the extend of economic rationality among small and large scale farmers. The index of rationality, ρ was found to be 0.849, 0.833 and 0.912 for small scale farmers, large scale farmers and for all the farmers respectively. Thus, Indian farmers on farms of all sizes were remarkably price efficient when compared to Kenyan tea farmers. It was also observed that ρ in East of the Rift Valley was unexpectedly lower than in the West Rift Valley. This scenario could be explained by the fact that there was no significant difference between labour use levels in the two regions. However, there was quite a significant difference in the Total Variable Costs between the two regions at 5% level. East Rift Valley spent more money than West Rift Valley on chemical inputs, for almost the same amount of labour combined with it in tea production. As a result, a sample scatter of the log variables for the inputs was found to be more closely distributed to the 45-degree line in West Rift Valley than East Rift Valley. This resulted in a higher ρ in West Rift Valley than East Rift Valley.

Table 1: Economic Rationality Coefficients and Related Statistics.

Relation Estimated	Quantity Estimated	Diagonal Regression Coefficients						
		Kirinyaga District	Nyambene District	Nandi District	Nyamira District	East Rift	West Rift	All Farms
N=Sample size		70	44	39	106	114	145	259
Log Output, TOV on log (TVC)	(1+1/n)	0.989 (8.077)	0.711 (4.584)	0.992 (3.416)	0.748 (7.269)	0.907 (9.734)	0.788 (7.171)	0.877 (12.120)
Log Output, TOV On log (Lab)	(1+1/m)	0.557 (4.190)	0.434 (2.676)	0.861 (1.940)	0.597 (7.581)	0.469 (4.239)	0.608 (5.692)	0.557 (7.069)
Log (TVC) On log (Lab)	$\frac{(1+1/m)}{1+1/n}$	0.558 (6.845)	0.615 (5.422)	0.984 (5.974)	0.589 (11.042)	0.560 (7.660)	0.658 (12.127)	0.619 (13.703)
ρ		0.647	0.651	0.793	0.743	0.595	0.752	0.674
n		-90.909	-3.460	-125.000	-3.968	-10.752	-4.717	-8.130
m		-2.257	-1.767	-7.194	-2.481	-1.883	-2.551	-2.257

Where: TOV = Total output value of green leaf (Kshs.) per farm per year; TVC= Total variable costs in tea but excluding labour costs i.e. (Costs of Fertilizer, weed control, pest control and disease control) per farm per year; Lab = Total labour used in mandays (Hired plus family) per farm per year; n = Elasticity of supply of TVC; m = Elasticity of supply of Lab; ρ = index of the degree of economic rationality.

Another interesting aspect arises from the test of economic rationality. In the theoretical framework, farm-firms may operate within different price regimes. This assumption may be checked up by referring to the estimated elasticity of supply of variable costs (excluding labour costs) and labour. The slope coefficients of log (TOV) on log TVC and log (TOV) on log (Lab), from the diagonal regression results differ from unity-the limiting value for perfect input markets. This difference is small enough to justify the assumption of relatively competitive markets. It suggests that interfarm differences in prices cannot be great and cannot account for much of the remaining interfarm variance in inputs used and output produced. This suggests that technical efficiency, the component that has been subsumed in the constant term in the analysis, might assume a major role in explaining the differences in observed behaviour among tea farms.

ACKNOWLEDGEMENTS

We thank African Technology Policy Studies Networks (ATPS) for funding the research work on "Assessment of Technological Adoption and Policy Factors impending the production of Green Leaf in the smallholder Tea Farms of the Kenya Tea Industry." Part of the cross-sectional data was used to write this paper. Thanks to Tea Research Foundation of Kenya and Kenya Tea Development Agency for supplementing the resources ATPS provided.

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