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To the Graduate Council:

I am submitting herewith a dissertation written by Joseph Tarmo Nagu entitled "The Development of Smallholder Tea Production in Tanzania: An Economic Analysis of Factors Influencing Green Leaf Tea Output." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Agricultural Economics.

Steven D. Mundy, Major Professor

We have read this dissertation and recommend its acceptance:

Luther H. Keller, John R. Brooker, William E. Cole

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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Vice Provost and
Dean of the Graduate School

THE DEVELOPMENT OF SMALLHOLDER TEA PRODUCTION IN TANZANIA: AN ECONOMIC ANALYSIS OF FACTORS INFLUENCING GREEN LEAF TEA OUTPUT

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Joseph Tarmo Nagu

June 1986

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ABSTRACT

This study focused on smallholder tea production as one strategy for Tanzanian economic development. The central research question was the economic evaluation of the potential of this strategy for increasing peasant farmer income streams in an economy comprised of mostly subsistence farming.

Two objectives were: (1) the assessment of the extent to which selected production factors explain the variability in the annual output of green tea leaf (output) and (2) the estimation of the physical resource productivities and the computation of marginal value products (MVP's) of selected resources for a sample 150 smallholder tea farms in Njombe, Tanzania to determine economic efficiency and the potential for enhanced utilization of selected resources.

A conceptualized production function was specified in a single equation model in which the annual output, the dependent variable, was a function of labor actually used, land area in tea, bush population, expenses for farm tools and expenses for fertilizer and insecticide. The model also included zero-one variables: two levels of education of the household head, no education and primary or more; and two farmer perceptions about tea processing plant capacity, adequate and inadequate. This was the main model called Model II. Three other models were specified. Two of the three were subproduction functions, referred to as Model I (output as a function of bush population categories) and Model III (output as a function of labor

categories). The fourth model was a modification of Model II with discrete zero-one farm organization variables added.

The functional form for Models II and IV was specified as a modified Cobb-Douglas (except for discrete variables). The functional form for Models I and III was linear statistical analysis and was performed using ordinary Least Squares.

The results of Model II indicated that the coefficients for total labor, land area, bush population and farmer perception of inadequate processing plant capacity were statistically significant at the 5 percent level. The coefficient for household head education level of primary or more was statistically significant at 10 percent. Except for expenses on farm tools, all signs were as expected.

The results of Model II suggested constant returns to scale. Labor was the most important factor, followed by land and bush population, in explaining variation in output per farm. The potential for enhanced utilization of labor, land and bush population was evident with each respective MVP being greater than its MFC.

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CHAPTER I

INTRODUCTION

This chapter provides a brief descriptive analysis of the Tanzanian economic system and the nature of the economic problem as it emanates from the structural problem in which the economy is based. The objectives to be accomplished by the problem analysis are stated along with the general hypothesis to be tested and a brief review of two opposing propositions usually found in the literature of smallholder[1] farming practices and development.

Economic Structure of the United Republic of Tanzania

In 1961 when Tanganyika[2] gained its independence from Britain, its real Gross Domestic Product (GDP), reflecting a measure of flow of goods and services resulting from the resource use in the country,

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[1]Controversy surrounds the definition of a smallholding. The definition used in this study is that the source of labor is largely derived from family labor. Other variants are discussed under methodological issues.

[2]Tanganyika and Zanzibar Republics united in 1964 to form the United Republic of Tanzania. To retain consistency and avoid confusing the reader, the name Tanzania was used throughout, but the reader should bear in mind that most of the information provided pertains to Tanganyika. No tea is grown in Zanzibar, so exclusion of Zanzibar would make no difference.

was about Shs 3,701 million.[3] In terms of the United States dollar, the corresponding equivalent value was $530 million. In 1980, about twenty years after the independence, the Gross Domestic Product in real terms grew to Shs 12,516 million or $1,545 million. Income per capita as an indicator of the standard of living rose from Shs 390 ($56) to Shs 690 ($85) between 1961 and 1980, respectively. Such low income per capita has thus categorized Tanzania among the Least Developed Countries (LDC) according to the United Nations (UN) classification.[4] The problem of severe poverty has become a matter of national and social concern.

The Central Importance of Agriculture

Though Tanzania is among the poorest countries of the world, its immediate potential comparative advantages appear to lie in agricultural production because of the relative abundance of the agricultural resources, land and labor. Tanzania has an area of 937,800 km^2 (361,800 square miles)[5] including 53,500 km^2 (20,650

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[3]The monetary unit of accounting used in Tanzania is a shilling (plural shillings) abbreviated as Sh (Shs). Until 1979, the official rate of exchange between the U. S. dollar and the Tanzanian shilling was approximately $1 = Shs 7. The shilling was devalued in 1980 to $1 = Shs 8 and from June 7, 1984, it was $1 = Shs 17.

[4]Three criteria used to classify countries into the Least Developed categories are:

(1) GDP of $100 per capita or less
(2) Manufacturing share of 10 percent or less
(3) Literacy rate of 20 percent or less

(Tanzania has over an 80 percent literacy rate but still meets the other two criteria.)

[5]One square mile = 2.59 kilometers^2 (km^2).

square miles) of water which consist of three major lakes: Lake Victoria, Lake Tanganyika and Lake Nyasa. Each of the three major lakes are situated on a national boundary which make them subject to international water laws. Their use for irrigation purposes becomes rather limited by riparian laws as well as by financial resources.

About one-third of the total land area, excluding the water area, receives rainfall about 7620 mm (30 inches) between October and May of each year with a 95 percent chance of occurrence. This rainfall rate is generally considered a minimum for crop growth without irrigation. About one-third of the land area has rainfall less than 5080 mm. With regard to land pressure, Tanzania, with a population of 17.5 million, has a density of 19.8 persons per km^2 (51 persons per square mile) according to the 1978 population census. The annual growth rate is 3.8 percent, which is much higher than the world average of 2 percent. However, less than 10 percent of the land is cultivated, though a larger proportion is grazed. Generally, Tanzania has no immediate problem of population pressure analogous to that of many countries in Asia.[6]

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[6]In the case of Asian countries (not including Japan) where few new technologies of farming systems have been available, low land-man ratios exist which result in diminishing returns to land as land-man ratios decrease. Population pressure may force up the land price or rent in situations where land markets exist such as in most parts of India. See also Tanzania, United Republic, 1978 Population Census: Preliminary Report (Dar-es-Salaam: Ministry of Finance and Planning, Bureau of Statistics, 1978).

Consequently, the two principal components that are decision variables in the context of the national economic development of Tanzania are the stock of land and the agricultural labor force. Furthermore, agriculture appears to have been the main preoccupation of the public authorities. As indicated on Table I.1, agriculture has historically accounted for a larger proportion of the GDP than any other sector. Between 1954 and 1980, agriculture accounted for 62 and 40 percent of the GDP, respectively.

Even if the nonagricultural sectors increase in the coming years, the bulk of the population likely will continue to be engaged in agriculture, which at present provides 90 percent of the employment. This situation implies that the task of securing an increase in income for a majority of the population will still come from agricultural development.

Importance of the Non-Market Sector

While the economic structure of Tanzania is largely based on the agricultural sector, the economy is generally less monetized than, for example, that of the U. S. A. A strong dependence of peasants on subsistence activities[7] is indicated in Table I.1.

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[7]Subsistence activities include such activities as family food production, forestry, fishing, blacksmith, and basketry. Though this sector is sometimes referred to as "informal" sector in the literature because it does not produce for the market, it is mainly comprised of agricultural activities in the case of Tanzania. Though there are no reliable data, non-agricultural activities are estimated to account for less than 10 percent of the subsistence sector.

TABLE I.1

TANZANIA: SECTORAL CONTRIBUTION TO GROSS DOMESTIC PRODUCT FOR SELECTED YEARS

	Value at Current Factor Cost					Relative Importance of Total GDP			
	1954[a]	1961[b]	1967[c]	1971[c]	1980[c]	1961[b]	1967[c]	1971[c]	1980[c]
	Million			Million Shs			(Percentage)		
Agriculture	80.2	2,282	2,855	3,324	5,143	62	42	38	41.1
Mining and Quarrying	3.0	110	198	122	66	3	3	1	0.5
Manufacturing	5.0	139	594	893	893	4	9	10	7.1
Electricity and Water Supply	0.4	27	64	92	195	1	1	1	1.6
Construction	5.6	117	309	465	458	3	5	5	3.7
Wholesale, Restaurants, and Hotels	13.1	445	862	1,192	1,104	12	13	14	8.8
Transport, Storage and Communication	5.7	171	536	800	1,238	5	8	9	9.9
Finance, Insurance, and Real Estate	--[d]	--[d]	729	922	1,123	--[d]	11	11	9.0
Public Administration	7.5	412	746	1,025	172	11	11	12	19.7
Less Imputed Bank Charges	NA[e]	NA[e]	101	131	2,468	NA[e]	1.5	1.5	1.4
Total	120.5	3,701	6,796	8,704	12,516		100	100	100
Amount from Subsistence[f]	NA[e]	1,247	1,770	2,406	2,989	34	26	28	24

TABLE I.1 (Continued)

[a]Data for 1954 came from C. Ehrlich, "Economic Policy in Tanganyika," Journal of Modern African Studies, II (1964):266. The values for 1954 are strictly not comparable with those given because of the different units of measurements but are included to illustrate the significance of the agricultural sector during the post war period. The data for 1954 are in pound sterling.

[b]Data for 1961 came from United Nations Yearbook of National Accounts Statistics (New York: United Nations, 1963).

[c]Data for 1967, 1971, and 1980 came from the United Republic of Tanzania: The Economic Survey, 1971-1981 (Dar-es-Salaam: Government Printer, 1972, 1980), Table 1, p. 6 (1972), and Tables 3-4 (1980).

[d]Included under wholesale, restaurants, and hotels.

[e]NA = Data not available.

[f]Million Shs or percentage contribution of subsistence activities to GDP.

About one-third of the GDP is derived at present from the subsistence sector comprised mainly of agricultural production to meet family consumption needs.

Some implications of the non-market sector would seem relevant in the Tanzanian context. For example, the large size of the subsistence sector likely could tend to hinder economic development because the sector could already be in a state of equilibrium in Schultz's sense of traditional agriculture. His traditional sector uses the same factors and constant "state of arts."[8] Consequently, the subsistence sector is characterized by low income and by lack of specialization and division of labor. These conditions, in turn, restrict capital formation and markets for non-farm products because almost all the income of the economy is spent on food. Subsequently, attempts to industrialize would also be restricted. The insignificance of the industrial sector in the Tanzanian economy, even after the two decades of independence as reflected in the preceding table, is then partly the consequence of the weak internal structural interdependence. That is, the agricultural sector is still geared toward survival needs and most agricultural products are produced and consumed at home. The bulk of agricultural inputs are largely supplied by the family in contrast to the market economy in which

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[8]T. W. Schultz, Transforming Traditional Agriculture (New Haven: Yale University Press, 1964), p. 30.

many inputs are purchased in the market place. The principle implied here is that of division of labor.[9]

Absence of market exchange dominates economic organization. This absence allows indigenous African production to take forms different from those in Western economies. Modern phenomena like trade cycles and depressions are capitalistic in origin. They are outgrowths of the development of technology, division of labor, economic interdependence, and the profit drive as one of the bases of production. A subsistence economy is almost invulnerable economically. Its vulnerability is a natural vulnerability from crop failure due to weather and diseases.

The limited development of exchange in the subsistence sector is sometimes characterized by limited needs. Because of the lack of division of labor, farm families have to produce for themselves. They must be content with what they are able to produce. Needs have to remain modest in quantity and quality because of limited means constrained by lack of specialization.

Importance of Agricultural Exports

Tanzania is one of those economies which has depended primarily on the growth of exports of primary products such as coffee, sisal, cotton, tobacco and tea. The extent of Tanzanian dependence on the world market for income and capital formation is

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[9]A. Smith, An Inquiry into the Nature and Causes of the Wealth of Nations Vol. I (2nd Ed.) (Oxford: Clarendon Press, 1880), p. 5.

indicated by the percentage of GDP exported, the composition of the commodities exported and the diversity of its agricultural exports. All these tend to suggest the extent to which the Tanzanian economy is highly vulnerable to world economic conditions. Table I.2 indicates that about 25 percent of the GDP was exported between 1954 and 1980. The proportion exported has fluctuated from time to time with a range of about 16 percentage points. Such fluctuation in the proportion exported is generally a common feature of agricultural exports largely because of relatively low elasticity of demand on the world markets and competition from other producing countries.

Despite the export of one-quarter of GDP, the composition of the export base continues to be narrow. As shown in Tables I.3 and I.4, sisal, coffee and cotton form what Dumont has referred to as a "tripod"[10] that accounted for over 90 percent of total exports in 1954 and about 45 percent in 1980.

Post Independence and Government Strategies for Agricultural Export Crop Development

Tanzania is currently the largest sisal producer in the world, accounting for 60 to 66.7 percent of total African output over the last year and for about 33 percent of the world output. However, increased competition has contributed to a reduction in

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[10] R. Dumont, Tanzania Agriculture After the Arusha Declaration, (Dar-es-Salaam: Ministry of Economic Affairs and Development Planning, 1969), p. 6.

TABLE I.2

IMPORTANCE OF THE EXPORT SECTOR IN GDP FOR SELECTED YEARS

	1954[a]	1962[a]	1965[b]	1968[c]	1972[c]	1976[c]	1980[c]
GDP (Mill. Shs)	2410	3796	5619	7128	8539	10165	12516
Total Export (Mill. Shs)	528	1076	1506.5	1628.1	2179.7	385.9	4070
Exports as a Percentage of GDP	21.9	18.3	26.8	22.8	25.5	37.9	32.5

[a]Tanganyika, Statistical Abstract 1960, 1963 (Dar-es-Salaam: Govt. Printer 1963-64).

[b]Tanzania, Economic Survey (Swahili), 1976-77, (Dar-es-Salaam: Govt. Printer, 1977), Table 3, p. 11, Table 10, p. 21.

[c]Tanzania, Economic Survey 1980, (Dar-es-Salaam: Govt. Printer, 1981), Table 3, p. 11, Table 10, p. 21.

TABLE I.3

TANZANIA: EXPORT VALUE OF LEADING CROPS FOR SELECTED YEARS

Crop	1954[c]	1962[a]	1964[a]	1968[a]	1972[b]	1976[a]	1980[b]
				(Million Shs)			
Cotton lint	68	148	197.6	282.9	336.4	613.5	359
Coffee	200	132	221.0	265.1	383.0	1282.7	1119
Sisal	218	315	437.3	158.7	144.8	239.7	246
Cashew nuts		47	65.8	111.4	172.8	207.4	114
Cloves		42	43.0	59.6	240.3	260.6	227
Tea		32	--	45.0	153.8	134.5	182
Others	48	360	541.8	705.4	748.6	1114.5	1822
Total	534	1076	1506.5	1628.1	2179.1	3852.9	4070

Source: [b]Bank of Tanzania, Economic and Operations Report, June 1980 (Dar-es-Salaam: Bank of Tanzania, June 1980), Table 22(a), p. 89.

[a]United Republic of Tanzania, Economic Survey 1976-77, (Swahili Version) (Dar-es-Salaam: Govt. Printer, 1977), Table 10, p. 17.

[b]United Republic of Tanzania, Economic Survey 1980 (Swahili Version) (Dar-es-Salaam: Govt. Printer, 1981), Table 10, p. 21.

[c]Tanganyika, Statistical Abstract: 1960, 1963, Budget Survey 1956-1966, quoted from Rutman, Gilbert L., The Economy of Tanganyika, (New York: Praeger Publishers, 1968), Table 33, p. 34, Table 34, pp. 84-85.

TABLE 1.4

TANZANIA: THE RELATIVE IMPORTANCE OF SISAL, COFFEE, AND COTTON IN EXPORT EARNINGS (FOR SELECTED YEARS)

	1954	1962	1964	1968	1972	1976	1980
Value of sisal, coffee and cotton (Mill. shs)	486	595	855.9	706.7	864.2	2375.6	1837
Value of total exports (Mill. shs)	528	1076	1506.5	1628.1	2179.7	3852.9	4070
Proportion of sisal, coffee, and cotton (Percent in total exports)	92.05	55.3	56.8	43.41	39.65	61.66	45.15

Source: Calculated from Tables I.2 and I.3.

Tanzanian markets, especially in the U. S. A. Sisal is grown largely on estates[11] and no increase in output occurred between 1967 and 1980. This lack of growth in output is due largely to the nationalization of sisal estates and shortage of labor since the village program was implemented in 1975.[12] Coffee and cotton productivities have not been high and increases have been due largely to increases in acreage.

The price fluctuations of export crops, the quota system, and other commercial barriers are well documented and known. Therefore, in the national context, Tanzanian export strategy must consider expansion of the export base in the short run by growing more types of cash crops such as tea. Most estates growing cash crops are owned by non Africans on alienated land[13] and account for

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[11]Estates, as they are locally known, refer to plantations which are generally owned by foreigners. They have historically been associated with foreign capital and geared to the export market. They usually reflect large-scale farming in terms of areal size, labor force, and capital inputs.

[12]In 1975, the Tanzanian government established the "Village Act" which reorganized most of the villages and grouped them. At present over 8000 villages form about 99 percent of the rural population. The objective of the policy was to provide services such as health, education, marketing, and fresh water supply more economically than when the population is dispersed. The effect of the village program was felt by the plantations in that the villages hindered labor mobility because the worker had the duty to his village first--participation in community development projects such as building schools, communal farming, etc.

[13]Alienated land is land made available for use by non-Africans (non-indigenous) as agricultural estates, urban land and trading centers. In Tanzania, land is owned by the government which may grant rights of occupancy. Compensation for land purchase is only limited to the value of the unexhausted improvement of the land

1 percent of the total land area of the country. The non-Africans are generally unwilling to expand their land useage on the private estates. Future uncertainties about security, increasing labor costs after the new government initiated legal minimum wages, an increased export duty on tea, and other local taxes have tended to increase production costs and to enhance this general unwillingness to change.

The Estates and African Socialism

Estate owners look with concern at the intentions of the new government which is striving to bring about social change and political consciousness. The estate economy is a long-term investment with full maturity at about ten years. Thus, security is an important requirement. The declaration that Tanzania is a socialist country, or at least intends to become one, is interpreted as a threat to private property.[14] The change in tenure of estates from

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and not for the land itself. However, with the enactment of the village programs of 1975, there is a move to grant such villages the rights of occupancy also. Individuals are entitled to the use of land in order to earn a living. One cannot have the right to live without also having the right to some means of maintaining life. He does not, however, have the right to own it. Traditionally, land was always recognized as belonging to the community in most African countries.

[14]In 1962, President Nyerere of Tanzania produced the first blue print of his version of socialism entitled "Ujamaa--The Basis of African Socialism" in J. K. Nyerere, Freedom and Unity: a Selection from Writings and Speeches 1922-65 (London: Oxford University Press, 1967), pp. 162-171.

"freehold" to "leasehold" has caused concern. Rights on land which were established during the German administration have now changed to 99-year leases. This is a shorter period than under "freehold."

Production of an export cash crop like tea that is exclusively in the hands of foreigners such as Europeans and Asians is often viewed by the nationalistic leaders as a dangerous situation, at least in the present social and political context. Arguments are bound to arise that foreigners try to keep a monopoly in one of the most important agricultural industries. In doing so, profits are likely to be transferred abroad. Economic power remains in the hands of plantation owners whose loyalites lie outside Tanzania. Consequently, economic in stability is created resulting in less investment in tea plantations. This will bring stagnation to an industry which is crucial to the national economy.

The principle of the government agricultural development policy in Tanzania was to introduce peasants to the production of crops grown on plantations. Plantations were to be used as the development nuclei. Of course, plantations have frequently functioned as development centers for neighboring peasants. The plantation economy has contributed to the spread of skills, new seeds and better cattle. Beginning in the late fifties, development strategies incorporated peasants in producing plantation cash crops by placing peasant production under "close supervision" and by processing their production in the plantation-owned factories.

1960 World Bank Report

In November 1960, the World Bank Report, the first extensive study on the economy of Tanganyika, was published. It contained recommendations for further economic development. The recommendations represented, for the most part, a continuation of the successful economic policies of the late fifties. The promotion of peasant farming without prejudice to the agricultural estates was regraded as the major task:

> The main development effort has to be concentrated on African Agriculture. Estates owned and managed by Europeans and Indians are at present major producers of export crops, producing virtually all the sisal and tea. ...African producers account for around 55 percent of Tanganyika's export crops and 65 percent of the value of all marketed crops.[15]

Apart from economic reasoning, the exclusive tea production on European and Indian estates has been regarded by the government as undesirable from an equity point of view. The social goals of Tanzania are well spelled out in the Arusha Declaration.[16]

Incorporating Peasants into Tea Production

Tea, Tanzania's fifth largest export crop in recent years, was almost exclusively produced in large plantations prior to

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[15]The International Bank of Reconstruction and Development (abbreviated as I.B.R.D.), The Economic Development of Tanganyika (Baltimore: Johns Hopkins Press, 1961), p. 16.

[16]In 1967 at Arusha, one of the northern towns of Tanzania, the government announced the historic document which socialized export and import trade, commercial banks, most sisal estates and insurance companies to control most of what was politically regarded

independence. African participation was largely restricted to small private individual producers who were living close to the plantations. The indigeneous farmers were often called "outgrowers" in that their emergence was attributed to the already established non-African estates. They were tied to the plantations as they sold their green leaf to the private owners. In terms of individual farm size, these farms were generally small with an average size of less than one-half hectare so that they posed little or no potential threat to the large foreign plantations as individual holdings. By 1960, African small farm hectarage accounted for 1 percent of the total planted area of tea.

From a social point of view, an agricultural industry that appears to be concentrated in structure so that production is controlled by a few large firms like the tea industry in Tanzania is regarded as undesirable by the government. Government intention is to Africanize at least some parts of the tea industry.[17] One way of achieving this objective is considered to be the widespread introduction of the cultivation of tea among African smallholders. In addition, tea cultivation by the smallholders

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as the "key" sectors in economic development. The document clearly defined the social goals of rural development. President Nyerere elaborated on these goals in his policy document "Rural Development" immediately after the Arusha Declaration.

[17]Production of tea is an integrated industry because of the perishable nature of green leaf. The processing plant must be close to the fields and is usually located on the same estate or group of estates.

represents transformation process in which a large segment of the economy that depends on subsistence activities would eventually be monetized.

As the share of the subsistence sector diminishes, the agricultural sector so developed allegedly is capable of providing food as well as other necessities of life. Because tea production among the smallholders represents introduction of a new product and techniques, risk elements may be introduced with respect to yield and price variations. These variations and accompanying risks are new experiences to smallholders who have functioned primarily in a subsistence economy.

An approach that is based on the production of smallholder tea as a strategy to economic growth is not based on the concept of the agrarian fundamentalists.[18] They advocate that agriculture is a basic sector of the economy and that the family farm is a "natural" economic unit in farming. The approach recognizes agriculture as one of the important sectors in the economic growth of many countries, at least in the short run, during which some production factors are fixed such as a processing plant in the case

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[18]The philosophy of agricultural fundamentalists differs from that of the physiocrats in that the fundamentalists have a long cherished belief that agriculture is the basic sector of the economy, that farm people possess social values superior to those of the urban people and the family farm is the "natural" economic unit in farming. The physiocrats advocated that agriculture is the only source of growth as it provides "surplus." Both concepts are generally not relevant to the Tanzanian environment.

of tea production. In doing so, analysis of those factors determining output become relevant in the short run.

The critical problem in transforming subsistence agriculture into a market-oriented agriculture is one of investment opportunities. These opportunities partially involve identification and analysis of the agricultural factors that are primarily responsible for the significant differences in contributing to the growth of smallholder tea farming. They also indicate the extent to which the resources are efficiently used.

Economic Justification for Promoting Smallholder Cash Crop Production

Apart from general social arguments, the central issue is whether tea can be produced more economically on smallholdings than on estates. The argument is generally based on the relative labor underutilization on small farms and land underutilization on the large farms. Consequently, agricultural production tends to be below its maximum potential output in both cases. The logic of the argument follows that agrarian reform which redistributes land from the large estates into new family farms of moderate size can combine the underutilized land with underutilized labor and raise the total product. The potential increase in output is generally sufficient to allow a substantial rise in incomes of the rural poor. There is

a substantial body of literature that investigates the theoretical relationship between farm size and utilization of land and labor.[19]

The main theme of this literature is that the incentives facing large estates systematically diverge from those facing small farmers. In contrast to small farmers, effective prices of land and capital are low for the large estate owners. In general, the family farm sector faces incentives that leads it to use its own labor up to a point where marginal product is likely to be below the rural wage.[20] The estates tend to use relatively less labor, only to the point where its marginal product equals or even exceeds the wage. Consequently, because of the lower price of labor on the family farms, they can exploit more marginal land, and place under cultivation a large share of the land on the farm. In summary, the divergence between the marginal products of labor on family farms and on estates leads to the phenomenon of higher underutilization of available land on large farms than on small farms.

A persuasive theoretical argument stems from the divergence between the marginal product of labor (MPL) in the subsistence

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[19] A. K. Sen, "Peasants and Dualism With or Without Surplus Labor," Journal of Political Economy 74 (October 1966):425-50; Chayanou, A. V., The Theory of Peasant Economy edited by D. B. Kerblay, et al. (Homewood, IL: Richard D. Irwin, 1966); Kanel, D., "Size of Farm and Economic Development," Indian Journal of Agricultural Economics 22 (2) (April-June 1967):26-44; Berry, R. A., and W. R. Cline, Agrarian Structure and Productivity in Developing Countries (Baltimore: Johns Hopkins University Press, 1979).

[20] J. W. Mellor and R. D. Stevens, "The Average and Marginal Product of Farm Labor in Underdeveloped Economies," Journal of Farm Economics 38 (August 1956):780-91.

(traditional) sector and that in the modern sector.[21] Empirical evidence suggests MPL is lower in the traditional sector than in the modern sector for three main reasons. First, the gap between the MPL on family farms and that on estates is often widened because opportunity costs of labor as perceived by the employer may be too high on estates. Risk of strikes exists where labor is organized into trade unions with monopoly or near-monopoly situations with higher wages and fringe benefits. Second, there is a danger that workers may establish claims to property rights in the event of land reforms involving the estate. Third, employers have employer associations with the potential to fix wage rates as labor needs increase if and when product prices increase. Such monopoly power in the local labor market as embodied in a bilateral monopoly situation may result in higher prices for labor. The monopsonist will tend to hire fewer workers and produce less than a group of small competitive farmers on the same total land area.

Other theoretical considerations include the maximization of output. It is suggested that products will be maximized on small farms on which the principal labor force consists of the operator and his family. The family labor force allegedly is more highly

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[21] A. W. Lewis, "Economic Development with Unlimited Supplies of Labor," The Manchester School 22 (May 1954):139-91; Fei, J. C. and Q. Ranis, Development of the Labor Surplus Economy: Theory and Policy (Homewood, IL: Richard D. Irwin, 1964); J. W. Mellor and R. D. Stevens, op. cit.

motivated than hired labor used by the large farmer. Hence, the necessity of close supervision is reduced.[22]

To a lesser degree, some policy makers believe that the tea industry has to expect a downward price trend as production increases.[23] The assumption that smallholdings are likely to remain more competitive than large estates as tea prices fall has been used as justification for embarking on a smallholder tea production program in the last decade. However, no general consensus exists among economists regarding this proposition and it will not be evaluated here because it is beyond the scope of this study.

Problems of Traditional Agriculture in the Transformation Process

A brief explanation of traditional agriculture as defined by Schultz, the reasons for the inability of such agriculture to become a potential source of growth, and the alternative(s) to sources of agricultural growth appear to be relevant. This explanation will help justify the Tanzanian strategy for promoting agricultural growth and economic development.

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[22] J. M. Brewster, "The Machine Process in Agriculture and Industry," Journal of Farm Economics 32 (February 1950):69-81.

[23] The major reason for this expectation is that tea, like most agricultural crops, has low income and price elasticities in most of the developed consuming countries. See for example S. Singh, J. de Vries et al., Coffee, Tea, Cocoa: Market Prospects and Development Lending: World Bank Staff Occasional Paper No. 22 (Baltimore: Johns Hopkins University Press, 1977), p. 64, Table 20.

Schultz treats traditional agriculture as a particular type of economic equilibrium based upon three assumptions:[24]

1. The "state of the arts" remains constant so that these are in fact known and used for generations such that nothing new has been learned either from trial and error or from other sources. In assuming so, the risks and uncertainties associated with new knowledge about the yields inherent in factors embodying advance in knowledge are thus absent.

2. The state of preferences and motives for holding and acquiring sources of income remain constant.

3. Both of these states remain constant long enough for marginal preferences and motives for acquiring agricultural factors as sources of income to arrive at equilibrium.

The particular economic equilibrium reflected by traditional agriculture is fundamentally in the spirit of classical economics in which one of the assumptions, the "static" state of arts, is met.[25] Consequently, there are no or few inefficiencies in traditional agriculture. Schultz (1964) has shown that traditional agriculture has few significant inefficiencies in the allocation of resources. Nakajima (1965)[26] has demonstrated the theoretical

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[24]Schultz, op. cit., pp. 30, 36-52.

[25]The notion of "static" has an abstract significance, expressing the idea of an economic environment that is supposed to remain in equilibrium owing to the elimination of all factors that might cause changes to occur. Economic forces are still present. Then forces are free to behave rationally within the limits imposed by economic stability.

[26]C. Nakajima, "Subsistence and Commercial Family Farms: Some Theoretical Models of Subjective Equilibrium," in Wharton, C. E. (Ed.), Subsistence Agriculture and Economic Development (Chicago: Aldine Publishing Co., 1969), pp. 165-185.

subjective equilibrium; that is, the stationary state on the production possibility frontier of family farms under different situations ranging from pure subsistence to pure commercialization. Yotopoulos (1968),[27] in his study of Empirus-Greece family farms, has demonstrated empirically the efficiency of traditional agriculture as Schultz has argued. The principal implication of the absence of inefficiencies in traditional agriculture is that no significant increase in agricultural production is to be gained by reallocating the factors at the disposal of farmers.

Traditional agriculture that is characterized by such a long-run established equilibrium and the restrictive assumptions is probably an idealistic situation at the present stage of economic development of Tanzanian agriculture. Agriculture is characterized by a large number of poor subsistence farmers and a low income per capita. Nevertheless, agricultural changes have been drastic and, in some cases, rapid. New cash crops such as tea, coffee, sisal, tobacco and cashewnuts have been introduced and incorporated into the subsistence farm economy to supplement incomes of small farmers who generally make up the majority of the farming population. With a high rate of population growth for countries in demographic transitions such as Tanzania in which the death rate falls faster

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[27] P. A. Yotopoulos, "On the Allocative Efficiency of Resource Utilization in Subsistence Agriculture," in Massel, B. F. (Ed.), Food Research Institute Studies in Agricultural Economics, Trade and Development VIII, No. 2 (1968):125-135.

than birth rate, no farm economy can possibly remain static in the classical sense. Consequently, a more realistic approach for agriculture in the Tanzanian situation, appears to be one which considers farming systems in a transitional stage. This stage is characterized by a continuous process of change which is likely to be more pronounced in systems with cash cropping, but also present in subsistence. Even in subsistence agriculture, superior inputs such as hybrid maize have been introduced in the post-independence period. In Njombe, the area of this study, over 90 percent of the smallholders are now growing hybrid maize as a major subsistence crop. This suggests that with the increase in subsistence requirements resulting from the increasing number of children in each family, traditional methods of producing food become inadequate and new inputs become critical in meeting the survival needs for the family. The system must produce enough food for the population. Even in pure subsistence with no sale of products, new techniques are likely to be used in maintaining minimum living conditions.

Because farmers are not limited to the traditional agricultural factors of production, elements of risk and uncertainty are present when adopting new techniques in new production activities such as cash crops. New innovations could be of critical importance to farmers who are producing so little with barely enough production for survival. In the initial stages, a farmer would be unlikely to abandon production for subsistence in favor of cash crops largely because he/she considers subsistence to still be important in

his/her preferences. Consequently, farming systems in a transitional stage that involves moving from one equilibrium position to a higher one, are likely to be removed from an optimum pattern under these circumstances in the usual neo-classical static sense.

Two Competing Theoretical Explanations: Non Economic vs. Economic Behavior of the African Peasant

In the literature on developing countries during the post World War II period, two opposing views have been presented on the causes of the failure of smallholder response to economic progress. Some scholars contend that the institutional behavior of the people in these countries is generally characterized by the absence of a motive for economic gain such as profit maximization (Moore, 1951, Boeke, 1953, Dalton, 1961, Berg, 1961).[28] Furthermore, the economic decision variables such as cost minimization, profit maximization, or output maximization may not be relevant.

Allegedly, non-economic factors dominate human motives in the performance of production activities. Some non-economic factors include the control of production by kinship, religion and political organization. These tend to limit the wants of the individuals in the community. The community determines the wants within which

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[28] W. E. Moore, Industrialization and Labor (Ithaca: Cornell University Press, 1951); J. H. Boeke, Economics and Economic Policy of Dual Societies (New York: Institute of Pacific Relations, 1958); G. Dalton, "Traditional Production in Primitive African Economics," Quarterly Journal of Economics 76 (1962):360-378; "Economic Theory and Primitive Society," American Anthropologist 63 (1) (1961):1-25.

social and political values are established. Consequently, transformation in the economic process must inevitably involve a change in social organization. Because of the absence of market exchange, indigeneous production must take forms different from those in a typical economy. The analytic tools--the market as a proposition, money price and trade--of Western economic theory are inapplicable or, at least, partially inapplicable to dual economies. These economies are generally characterized by communialism and original social bonds. Implicitly, self sufficiency is the goal of the community. Subsistence agriculture becomes an important feature of maintaining livelihood. Without purchased ingredients or inputs, decisions by producers cannot be based on factor prices. Factor prices do not exist in a direct, monetary sense.

Absence of market exchange implies absence of technological and market constraints. This means that the absence of western kinds of material insecurity--trade cycles which pose threats to the continuity of production and income--do not apply. However, the physical environment poses a serious insecurity in subsistence economies. Weather and plant or animal diseases are examples of natural calamities.

Furthermore, the argument is that farmers in the traditional sector, who are faced by institutional barriers, attach substantial value to leisure and low value to additions of material goods and services beyond the requirement for subsistence. Hence, the African producer appears to behave irrationally. He/she increases

supply when price is decreasing. He/she also provides more labor when the supply price is reduced and vice versa. So the laws of supply and demand are apparently inapplicable even when cash crop production has been incorporated into the local company. This has often been used as a justification for low producer prices and wage rates.

On the other extreme, economists led by Schultz (1964), have contested the above contentions. They have collected a considerable body of crucial evidence to support the view that economic theory is useful in the study of decision making in traditional peasant societies. Professor Schultz attempted to explain the causes of the failure of smallholder response to economic progress in terms of technological and capital shortages.[29]

Schultz's proposition is that the basic problems are the low level of traditional technology and capabilities of the farmers. He concludes that empirical evidence supports:

> The proposition that differences in land are least important, differences in the quality of material capital are of substantial importance, and differences in the capabilities of farm people are most important in explaining the differences in the amount and rate of increase of agricultural production.[30]

Various empirical findings appear to support Schultz's general theory. Research attempted by Walters concluded that shortages of

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[29]See for example, T. W. Schultz, op. cit., p. 16.

[30]Ibid.

working capital (chemical fertilizers) is an important constraint that seems to serve as an explanation for irrationality in smallholder agriculture during the process of economic development.[31] This partly supports Schultz's hypothesis. However, a shortage of working capital is by no means a universally accepted cause for smallholder resistance to technological change. Dumont has pointed out that the failure of the "transformation approach" was not because of shortage of capital but due to the lack of local knowledge about the effects of mechanization on soil, local employment, repair facilities, management and maintenance skills. He asserts that there is obviously strong evidence of a typical example of poor allocation of scarce resources during the process of agricultural modernization. The input mix may not reflect the efficiency objective of maximizing output as some African examples have shown:

> The settlement at Upper Kitete is first of all overequipped, with its 10 tractors for 1600 acres of corn. This is twice as many tractors as necessary, taking into account the possibility of night work. The settlement is further provided with too much labor, having 100 families for 1600 acres of corn. Say--one family for 16 acres: with such equipment, one cannot understand the reasons for the excessive number. The expenses incurred by the scheme...many more subsidies than expenditure on equipment.[32]

The above empirical evidence seems to suggest that while capital may be an important constraint in the transformation of

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[31] A. R. Walters, "Migration, Remittances, and Cash Constraint in African Smallholder Economic Development," Oxford Economic Papers, 25, No. 3, (November 1973):435-450.

[32] Dumont, op. cit., p. 16.

traditional agriculture, it is by no means an adequate explanation for the long-established resistance to adopt it. Likely preconditions seem to exist for capital intensification. If capital is introduced prematurely, as in the case of Tanzanian Village Settlements of 1962, the effects may well be negative.

Miracle argues that there is an inadequate knowledge of smallholder decision making among the rural communities in the subsistence economy.[33] He points out that decisions vary from one area to another because of differences in resource situations or because of institutional restrictions on land tenure and division of labor. He considers that understanding information pertaining to a specific area or community or family unit would help greatly in identifying and analyzing such differences. This understanding would also certainly help in the allocation of scarce resources.

While consideration of resource constraints seems to be important in the transformation of subsistence agriculture, other writers have emphasized the response of the subsistence farmer to risk and uncertainty as an aspect that seems to be less emphasized or neglected by planners in developing countries. Experience suggests that a typical African smallholder farmer seems reluctant to specialize in cash crops. Farmer reluctance occurs even when

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[33] M. P. Miracle, "Subsistence agriculture: Analytical Problems and Alternative Concepts." American Journal of Agricultural Economics, 50, No. 1, (May 1968):292-308.

economic calculations of benefits and costs clearly demonstrate that resources should be used for cash crop production to maximize income and the income from the crops used to buy food elsewhere. An implication is that the objective of the farmer is to minimize the worst outcome associated with product innovation. This has been the case with most cash crop production introduced in Tanzania. Because cash crops are generally new to the farmer initially, he/she has to learn the production techniques and the risks from price and yield variations. The learning process, coupled with risks may be sufficient in preventing rational decisions that could involve growing only cash crops. In doing so, the farmer foregoes the additional income gained by such specialization. The difference in the income the farmer would have gained and that which is guaranteed to meet minimum obligations by not taking the risk becomes the opportunity cost of minimizing the undesirable outcome such as no income. The difference in the income may also be thought of as insurance premium against any unfavorable outcome. The lower the minimum income to meet the basic needs--family food requirements for minimum living conditions as determined by physiological requirements (below which death occurs)--the greater the degree of risk aversion. As Wharton has suggested, risk and uncertainty are major causes of farmer resistance to adoption of new technology. Risk and uncertainty become even more critical when confronting subsistence levels of living and farm family situations attuned to

preservation of human life rather than economic development:[34]

> A subsistence farmer, whose output is close to minimum living standard levels, must be concerned not only with the most probable level of output using a new method or crop but also with its range of variability. If he thinks it has a chance of leaving him below his minimum level, then he will not try it.[35]

Hence, the basic distinction for the decision-making framework of a subsistence farmer is between the future events to which he can assign subjective probabilities and those to which he cannot assign probabilities. Wharton proposes that, because of the risk element, the rate of adoption of a new technology or crop would also vary among smallholders in the same community. One can find "progressive farmers" and "conservative" ones co-existing. Then, it is not surprising for such social differentiation to exist in the society where there are risk averters and risk takers. Even where the government attempts to promote cash crops through collective farms, programs may run into difficulties because the "demonstration effects" seem to have no impact.

Many scholars have shown that the behavior of the subsistence African farmer is consistent with economic theory. In the general context of Africa, Hicks describes the supreme "success" of Ghana coca farmers in adopting new crops, but they have not totally

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[34]C. R. Wharton, "Risk, Uncertainty and Subsistence Farmer," Development Digest, 7, No. 2, (April 1969):5.

[35]Ibid., p. 1.

abandoned subsistence crops in favor of cash crops.[36] A similar conclusion was also reached by Krishna about India during the twenties and thirties. He indicates that the lag in adjustment in producing cotton was about the same as it had been for cotton farmers in the United States.[37] A similar conclusion seems to be supported by a study of peasant cotton production in Tanzania by Professor Malima.[38] Both studies, done in different continents, arrived at the same conclusion. The suggestion is that the African smallholder is an "economic man,"[39] that is, the African smallholder responds to market incentives like price and his decision making process in the allocation of his resources is greatly influenced by the returns and costs of such undertakings. Even in the isolated instances of increasing income and a backward bending supply curve of labor, such behavior has been shown to be quite consistent with

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[36]P. Hicks, Quoted by G. L. Cunningham, "Peasants and Rural Development in Tanzania" in Africa Today, 20, No. 4, (Fall 1973):

[37]R. Krishna, "Farm Supply Response in Punjab" (India-Pakistan). (Unpublished dissertation: University of Chicago, 1961), quoted by Schultz, op. cit., p. 50.

[38]K. A. Malima, "The Determinants of Cotton Supply in Tanzania" in S. K. Kwan, R. B. Mabele, et al. Papers on the Political Economy of Tanzania (Nairobi: Heinemann Educational Books Ltd., 1979), p. 226.

[39]The term "economic man" is merely an analytical and essentially terminological device, referring to the economic aspect of behavior. It is an aspect universal to all behavior insofar as it is purposive and rational. The convenience of the concept is necessary to avoid confusion with non-economic behavior.

rational economic behavior in that an efficient producer under given market situations will always attempt to maximize output.[40]

The Economic Problem

Traditionally, an objective of research in many farm studies has been to provide means to improve the organization and operation of individual or group farms. Suggestions on policy issues from such investigations depend on identifying farmer goals as a necessary condition towards devising alternative ways or strategies of reaching them. Goals are complex, varied with individual farmers and usually tacit. The fundamental goal of assuring enough food for an individual or the community is common to all farmers in rural societies irrespective of their geographic location or socio-political system. Beyond meeting the basic needs for food, the goals of individual families become diverse. However, it is generally agreed that individual goals or wants are unlimited. These wants compete for "scarce" resources at the disposal of the individual farmer or the community as a whole. Because of this competition, these wants are ordered in an attempt to obtain the most satisfaction from those selected. The economic question can then be partially reduced to:

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[40]For an extensive discussion and summary of literature on the economic behavior of African peasants, see G. K. Helleiner, "Smallholder Decision Making: The Tropical African Evidence," in L. G. Reynolds, (Ed.), Agriculture in Development Theory (New Haven: Yale University Press, 1975), pp. 27-52.

1. What is the "decision rule" that helps choose among alternatives?

2. What are the structured rules for combining scarce resources in order to produce goods?

3. What are the institutionally imposed incentives in order for the farmer to participate in economic activity, that is, how is the farmer connected to his/her external environment?

The last two questions are concerned with the ways in which economic modernism functions in predominantly underdeveloped agricultural societies in which production is largely for self sufficiency. Economic theory, in this sense, deals with the livelihood of people from the material point of view. The first question addresses the methods of analysis. It suggests that the choice[41] must be made with the help of an indicator. The "choice" indicator is the criterion. It is an index by which alternatives are weighed by the producer according to his/her values.[42] This provides one with an "objective function" for an individual or group of farmers.

Basically, these questions are interrelated--they organize basic production by allocating family resources to meet farmer

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[41]Choice is induced by scarcity of means to meet unlimited wants. It is sometimes defined in operational terms such as scarcity and insufficiency.

[42]"Value" is here defined as a utility function. So an increase in preferences is interpreted as a steady, balanced increase in physical goods--primary basic goods consumed within the subsistence sector and non-consumable goods produced exclusively for the market. In the transitional period, this is accompanied by increasingly greater shares of goods for the market and higher utility functions.

wants. A practical economic question is how to select the "best" output and leisure combinations. This is the subject of economic analysis in the sense that it compares the "value" of output and the cost of producing the output. Answers to these questions attempt to identify and, in some cases, quantify the relationships within individual economic units--family or a group of family farms. Economizing actions, the central theme of rationality, is then regarded as a decision rule of disposing of time and energy of the scarce resources of the family. By doing so, the family is assumed to behave in a manner to achieve the maximum of goals from the man-environment relationship. The economy becomes the focus of such actions. But the central core of the economic operation-decision making process is still based on utilitarian rationality as a model of the smallholder economy.

Economizing behavior is in turn enforced by potential market penalities in terms of the monetary losses incurred in the context of private ownership and market organization. Individual farmers are in a economizing predisposition in the use of scarce resources in order to gain profit--which is the source of material livelihood for resource owners. In the context of state ownership or central planning such as the one found Tanzania, economic use of resources is required to fulfill the priority goals of maximum output and growth.

Research Problem

Rural poverty affects the bulk of the population today in most of the developing countries. A priority question in countries such as Tanzania is how to increase production, employment, and incomes for the rural poor who constitute nearly 90 percent of the population. Previous development policies typically have concentrated on a "modernization approach" that favored capitalized farms such as the sisal and tea estates in Tanzania. These policies encouraged settlements which were given subsidized inputs such as farm machinery. This development strategy appears to be "inefficient" for two major reasons. First, it is inefficient because countries like Tanzania possess abundant labor and land but lack capital. Or proportionally, there are high labor-capital and land-capital ratios. Consequently, the small farm sector has been most successful in achieving high levels of production relative to small inputs of capital. Second, the technology of high-yielding tea varieties (vegetatively propagated) has been applied on small farms because it demands no threshold scale.

Given this background, the research question can be broken into three parts. This study intends to investigate selected questions pertinent to a production function for the cash crop, tea:

1. What are the major influences on increasing small farm production of green leaf (unprocessed) tea as a cash crop?

2. If traditional subsistence agriculture is near or in a state of equilibrium while the modern sector, cash crop production, is perpetually in disequilibrium, then does the incorporation of cash crop production like tea into the subsistence sector lead to conditions of disequilibrium in resource allocation?

3. What are the policy implications for the continuing agricultural strategy of encouraging smallholder cash crops like tea?

Essentially, the problem is partially a question of determining the nature of the production function. From the point of view of the planner, the policy question resolves in part to this: In allocating scarce public resources such as extension services, fertilizer, insecticide and other capital inputs within the cash crop sector, does the allocation increase overall export earnings? If export earnings are increased at the expense of domestic food production, such impacts on food crops should be taken into account. For example, if reduction in domestic food production occurs, a rise in food prices or an increase in food imports would occur, all other things equal. This in turn would lead to an increase in foreign exchange spending and a likely reduction in export earnings generated by tea expansion.

In addressing the above questions, the following general strategies were employed:

a. A description of resources at the disposal of the small farmer based on a cross-sectional sample survey.

b. Specification, estimation, and analysis underlying production and subproduction functions for smallholder tea producers. The general components of the approach included a conceptual emphasis on a multiperiod production process, importance of various categories of labor inputs, and a qualitative analysis of processing capacity and management. Marginal productivities of selected individual resources were derived. In turn, these marginal productivities were helpful in evaluating efficiency of resource allocation in smallholder tea production.

c. Comparisons between computed marginal value products and the corresponding input prices or opportunity costs. Results from such an analysis were deemed particularly desirable in planning future development of predominantly exported cash crops like tea in Tanzania. Such information was considered especially important because of the long-term fear among the policymakers of a negative impact on foreign exchange earnings from such development.

Objectives

The objectives of the study were the following:

1. To assess the extent to which selected production factors explain the variability in the output of green tea leaf per farm.

2. To estimate physical resource productivities and marginal value products for a specific sample of Lupembe/Luponde smallholder tea farms to determine whether or not farmers were using quantities of different resources in a manner to maximize net returns.

Justification

The question of agricultural strategy based on the smallholder "approach" being in the interest of the individual farmer and of the nation deserves careful consideration. For example, some of the effects of smallholder tea production can be divided into the following:

a. The positive contribution of tea production to the national economy. The direct effect on increasing export earnings is considered a desirable aspect. It reduces vulnerability of export earnings dominated by a few crops such as sisal, coffee, and cotton and enhances diversification at the national level.

b. Its positive effect on the welfare of the African smallholder by substantially increasing cash income is in one sense an important step towards modernization.

c. The justification for this study goes beyond the interests of Tanzanian farmers and of their nation. Investigating the primary question calls for a theoretical analysis which hopefully will be a contribution to the application of formal economic analysis to peasant economies. Significant disagreements among economists and anthropologists indicate the extent to which knowledge of the process of entreprenurial decision making in peasant economies is insufficient. Through the use of primary data collected from a field survey, this study will provide a broader and perhaps a stronger and persuasive factual basis for an assessment of the economic behavior

of smallholders. With specific reference to Tanzania, the study aims at making some contribution to the scanty knowledge of the conditions of agricultural production processes for perennial crops.[43] However, the implications of the results from this study are not limited to perennial cash crops alone because they should be generally applicable to other strategies of rural agricultural development.

Having a better understanding of decision making by the small farmer is particularly important now that the "transformation" and "settlement" approaches to agricultural development have had little or no success in Africa. There has been a return to the more gradual and broader-based approaches to rural programs such as the encouragement of smallholder production of cash crops.

General Hypothesis

New investment opportunities in the form of new crops and inputs combined with the abundant resources, labor and land, account for significant positive differences in the amount and the rate of increase of farm output in a peasant economy.

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[43]Among the recent works on management in Tanzania and Africa is the pioneer work by M. P. Collinson, "Experience with a Trial Management Farm in Tanzania," East African Journal of Rural Development 2 (2, 1969); M. P. Collinson, Farm Management in Africa: The Principles of Production and Planning (London: Oxford University Press, 1973); D. M. Etherington, Smallholder Tea Production in Kenya: An Econometric Study (Nairobi: East African Literature Bureau, 1973).

The proposition is a logical consequence resulting from the proposition that an economy which depends upon traditional agriculture in the Schultz sense is not capable of achieving further growth because the agricultural practices as given by the constant "state of arts" are already in a state of subjective equilibrium in the static sense. Consequently, agricultural growth can only be achieved by new investment opportunities that are capable of increasing total product. Tanzanian agriculture is not really characteristic of traditional agriculture because a substantial part of the agriculture sector, especially the plantations, is modernized. The investment opportunities to transform smallholder practices appear to exist.

CHAPTER II

TEA CONSUMPTION AND PRODUCTION

Introduction

This chapter includes a brief general background of the social value of tea, its historical development, types of tea in commercial use, the botanical characteristics of the tea plant that are especially important in distinguishing it from other plants that are used as beverages today, and cultural production practices. Global output of tea, as well as output for individual countries and selected regions, and changes in output are also discussed.

About thirty-eight countries currently produce tea. However, the bulk of tea production comes from a few countries, namely India and Sri Lanka. Both together produce 41 percent of the world tea today. Tea is a beverage that has a long tradition in which it was first used as a medicine and later as a beverage. Tea is a perennial crop with a production life of fifty or more years. Consequently, the role of good husbandry practices regarding its cultivation and maintenance becomes critical in affecting farmer returns, especially over the long run. Understanding such general characteristics as well as a short description of its historical evolution become relevant.

Tea as a Low-Cost Beverage

Tea has become the most popular and perhaps the most economical of all beverages other than water. In terms of providing satisfaction, this statement implies that the Marshallian "consumer surplus," that is, the area between the price and demand curve, generally would be larger than for any other beverage except water. Tea has made the drinking of water more pleasant, which suggests that taste, as an important attribute of any consumer good, is perhaps of critical importance in increasing palatability of food, as tea has become a part of meals served in most homes. The prime reason that tea has become the most popular beverage is perhaps its stimulating effect. Its alkaloid caffeine content comprises up to 4 percent of the dry matter. Caffeine probably gives tea its pleasant aroma.

The consumption of tea has increased the practice of boiling water. Therefore, tea has helped reduce the health dangers from drinking unboiled water, especially in areas where sanitary conditions are not very satisfactory.

As a low-cost beverage, both its income and price elasticities are low, especially in the developed countries where most of it is consumed. This situation would imply that long-term export market potentials are rather restricted as production and supply increase. Consequently, promotion of tea consumption in low-income countries might be appropriate in increasing effective demand and lead to greater tea exports from producing countries.

Geographical Origin of Tea

While tea is now grown in more than thirty-eight countries, its origin is not known with certainty. Tea was clearly first domesticated in China where tradition ascribes the discovery of the tea bush to the Emperor Shin Nong about 3000 B. C. However, the first authenticated references on tea in China are found in the fourth century A. D. At this time, its therapeutic virtues, that is, its medicinal qualities, were well known. Beginning in the fifth century, its popularity as a beverage increased and its medicinal value declined.[1] Therefore, as a beverage, it has a recorded history of 2000-3000 years.[2]

Though the actual origin of tea (Camellia Sinensis) is not known with certainty, the region comprising Southeast China, Upper Indochina, Upper Burma, and Assam appear to be fairly well established as the geographical origin of the plant.

Small Scale Production: Historical Perspective

Even though most tea produced for commercial purposes today is grown on estates ranging from 200-600 hectares (500-1500 acres), evidence indicates that much of the early China tea was grown on

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[1] P. Griffith, The History of the Indian Tea Industry (London: Weidenfeld and Nicolson, 1967), p. 4.

[2] A. de Candolle, Origins of Cultivated Plants (New York: D. Appleton and Co., 1885), p. 118.

small farms. Small-scale production suggest that tea was largely grown to meet family consumption requirements and any surplus was then offered for sale. Because it was indigenous to the country, tea likely was discovered and used at a very early date. Simplicity of techniques required for its manufacture with the use of a simple stove for firing, drying pans, and furnaces appears to have been a contributing factor in establishment of the universal habit of tea drinking in China. The habit was well established many centuries before the British and European companies first thought of establishing their own large-scale production units to supply their markets.

Though tea was first traded internationally during the 17th century when Dutch and British companies brought it to Europe from China and Japan, these companies did not have an interest in undertaking its production. However, during the later part of the 19th century, the China supply was interrupted by wars. These companies and their governments thought that the logical (and long-term) solution to maintaining a steady supply was to cultivate tea on their own farms. The British first established large-scale plantations of of their own, primarily in India around 1810. British tea plantations were established later in Sri Lanka in 1867, following the outbreak of the coffee rust disease (Hemilea vastatrix) which devastated the coffee industry in that country. By the end of the 19th century, India had become the largest tea exporter by surpassing China. This lead has been maintained until this date though its influence has been declining over time because of new entrants from Africa and Latin America.

Tea Drinking

Chinese and Japanese smallholders apparently were the major suppliers of world tea until the end of the nineteenth century. A reasonable guess that the habit of tea drinking, now universal in Central Asia, likely spread from China to India in the 8th century. From here it then spread to Europe and other parts of the world at a much later date. When tea was first introduced in England is unknown. However, by the 16th century it was a widely accepted beverage among the English people. Today, the British and the Irish have the largest per capita consumption of tea in the world at about 3.5 pounds per person per year.

In Tanzania and in many African countries, tea consumption is relatively small, largely because tea was generally an export-oriented crop and restricted to the urban population who generally made up no more than 5 percent of the population. Most of the population is rural and generally they are unfamiliar with the tea drinking habit. Consequently, they did not offer an important market previously. However, with economic development this market may grow in importance over time.

Types of Tea in Commercial Use

Tea is a commodity that can be differentiated physically and/or chemically by various processing methods to cater to the needs of various consumers. Three main differentiated tea products are in

use in the commodity trade today. The degree to which such differentiation may pose a threat to the profitability of tea production in such countries as Tanzania becomes relevant in the promotion of tea production, especially to smallholders who are recent entrants into the industry.

Many ways exist in which green-leaf tea can be processed for commercial use and each process results in a particular kind of tea. Three major types of tea are in commercial use today--Black tea, Green tea and Oolong tea. The differences in the three result mainly from the differences in the processing (or manufacture) rather than from differences in the type of bush from which the leaf is plucked.

Black tea is generally the most widely produced tea in the world today for it represents over three quarters of world production. The leaves are fully fermented in the process of manufacture. It forms the major output of India, Sri Lanka, Pakistan, Indonesia, and East Africa, and represents about 90 percent of the world tea trade. This high percentage of the world tea market suggests that the bulk of world tea is a rather homogenous product even though tea can be differentiated by three major types and several minor types.

While black tea is completely fermented, green tea, on the other hand, is not fermented. It is steam heated to temperatures of

160°C[3] to kill the enzyme whose action is fundamental in the preparation of black tea. Green tea represents about 20 percent of the world output. Green tea makes up 90 percent of tea produced in Japan.[4] Green tea represents a small proportion of the world tea trade with only between 6 and 9 percent of the total world exports of tea during 1970 and 1980, respectively. Most came from the People's Republic of China. It is also produced in Indonesia and, to a smaller extent, in some parts of India.

The third major tea type is Oolong. Oolong differs from black tea only in the degree of fermentation. While black tea is completely fermented with 40-50 percent out turn of dry matter, Oolong tea is semi-fermented and hence is a "cross" between black and green teas. It is produced only in the People's Republic of China and Taiwan. Oolong tea is not an important type in the tea trade currently as it represents less than 1 percent of the total world volume.[5]

Botanical Characteristics

Tea has been recognized and accepted as an important beverage for a long time. However, its botanical characteristics are not

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[3]The Monopolies and Restrictive Practices Commission, Report on the Supply of Tea (London: H. M. S. O., 1956).

[4]R. L. Wickremasingha, "Some Observations of Tea in Japan," Tea Quarterly, 39: 25.

[5]See, for example, International Tea Committee, Annual Bulletin of Statistics, 1982 (London: International Tea Committee, 1982), pp. 26-27.

very familiar to the majority of consumers because most tea is produced in the developing countries and consumed in developed countries such as Western Europe and the U. S. A. Understanding the general botanical characteristics is not vital to this study, but it was important in the early botanical study of the plant, especially regarding controversy over the classification of different species of tea. A brief description of its general characteristics is helpful and relevant for the sake of completeness and for understanding the nature of production of green leaf.

Though the botanical classification of the plant has been a controversial one, a consensus among scientists is that the plant, bush, or tree, as it is invariably known, is an evergreen of the Camellia family, Camellia Sinensis. The plant grows well in tropical and subtropical countries. In its natural conditions, the plant grows into a small tree about 9 meters (30 ft. high or more). Though it is generally a tap-root dominant plant, it also puts out strong lateral roots. Apart from the usual functions of absorbing and conducting water and food from the soil to the other parts of the tree; roots also function as storage organs. They store carbohydrates that are not immediately required for active plant growth. The carbohydrate is stored as starch granules in the root cells. This starch, which is localized in the roots, becomes critical after the pruning operations begin because it becomes the only source of supplied nutrient to meet the physiological needs of the plant. As a perennial crop, such root functions become of crucial importance for the continued life of the tea plant.

While most tea species may reach a height of 9 meters or more, they are artificially kept at low heights when grown in a "tea garden"[6] by pruning operations:

1. to allow the leaves to be conveniently plucked (harvested) by hand because tea is generally a labor intensive enterprise in most producing countries.[7] The plant is usually kept to a height of about 3 feet for convenient plucking by hand.

2. to maintain the plant permanently in a vegetative phase. This helps the plant develop a strong spreading "frame" of lower branches which must be developed in the early period to encourage maximum possible sideways spread by stimulating new lateral growth which has the effect of increasing yields and lengthening the economic life of the plant.

3. to renew actively growing branches so that replacement of healthy wood and foliage (tea leaves) keeps pace with that destroyed by diseases or damaged by other things.

4. to provide uniform growth of individual parts of the plant. It is generally agreed, that under a uniform system of pruning, an extraneous stimulus, such as manuring, affects the growth of wood, foliage and crop proportionately. That is, a nutritive

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[6]The term usually refers to the tea field. Because tea is pruned and plucked, the appearance of the field looks like a well-tended lawn.

[7]Tea mechanization is not successful except in Japan and to some extent in the U. S. S. R.

stimulus such as manure does not produce the crop at the expense of the foliage or wood. The amount of green leaf produced over time is proportionately constant to the amount of foliage carried by the bush at the end of the pruning cycle. Consequently, the pruning operations on a mature bush tends to produce a constant amount of foliage. The productivity of the mature tree remains fairly constant which leads to a horizontal yield curve over the remaining useful life period.

Tea Cultivation

As has previously been pointed out, tea cultivation is conducted in close proximity to tea processing facilities because of the physical characteristics of the green leaf. The leaf is highly perishable; therefore, the processing plant must be located in close proximity to the farm source under the current poor transportation situation in Tanzania. Cultivation, transporting of the green leaf, and processing reflect typical characteristics of vertical integration where the heterogeneous activities are linked together vertically.

When treated separately, the cultivation of tea is affected by several factors such as size of land holdings, variations in soil and climatic conditions, and labor availability. Three major field operations in the cultivation of tea greatly affect yield and profitability of the tea enterprise: planting, pruning, and plucking.

Planting

Initial land clearing and transplanting the tea plants are of major importance in the eventual success of the estate or farm. Normally, the land is cleared by tractors provided by the individual farmer or by the government as in the case of smallholder production in Tanzania.

Tea is a monocrop and is grown on both estates and smallholdings. Planting material is obtained from private nurseries or those owned by the government. Transplants are planted so that about 8,000-13,000 bushes are planted per hectare.

Planting Material

Being a perennial crop with production life of over 50 years, the quality of the planting material is of critical importance because of its effect on total returns of a tea garden over its useful life. Two sources of planting materials are now being used. The traditional source of planting material has been seedlings generally raised in private or government-owned nurseries in Tanzania. A problem with seedlings is genetic variability of plants which leads to unpredictable differences in returns. The most common procedure is vegetative propagation (VP) for generating plant material for transplanting of clones from parent bushes selected on the basis of yield capacity and other important characteristics. This method (VP) has given two to three times greater yields than those obtained from the traditional seedling sources. The major

long-term disadvantage or risk of using VP-based production is disease. Because all the plants from VP are genetically identical, a disease, if it occurs, could have widespread disastrous results. Another problem is the capital cost of the VP clones which the farmer has to incur prior to or very early in the production period of the plant.

Pruning

The young plant is pruned to prevent vertical growth and to allow it to form a bush. The bush is pruned at regular intervals to maintain it under the somewhat artificial condition of constantly producing leaf. The pruning operation is a skillful job and requires great care to avoid damaging the bush which could make it susceptible to a number of pests and diseases. Consequently, the amount and quality of leaf are likely to be affected by the pruning operations.

Plucking

As bushes or stumps are planted close together in a tea garden and maintained by pruning to a height of less than 3 feet, the tea garden looks like an evergreen, luxuriant, and well-kept lawn which is raised 3 feet above the ground. The flat-top surface of the tea garden is generally referred to as a plucking "table." The act of harvesting the tea crop, handpicking the leaves, is generally referred to as "plucking." Plucking operations involve selection of two young leaves and the terminal, unopened buds. These are easily

broken off between the thumb and forefinger and are placed in a basket which is usually carried on the plucker's back. The plucked crop, prior to processing, is referred to as "green leaf."

After processing in the factory, tea is usually referred to as "made tea." About 5 kilograms of green leaf make one kilogram of made tea.

Plucking Rounds and Transportation

Every bush is plucked at intervals of 5-10 days, depending on whether the leaf is "flushing" or not. In the highland such as those in the study area, growth is generally slow so the plucking interval or "rounds," as it is sometimes known, is about 7 days. With mature tea, the plucking rate is about 2.5 kilograms (kg) of green leaf per hour. The working day is usually about 10 hours so that about 25 kg can be plucked by one person per day. The plucking operation is labor intensive in Tanzania and in most producing countries. This labor intensiveness implies that the quantity of labor is of decisive importance during the plucking season. Additional labor is also hired during heavy flushing usually associated with heavy rainfall.

Plucked leaf is delivered to a collection center where it is weighed and inspected for quality and then immediately transported to a processing factory. The transportation operation is also of vital importance. The leaves must not be crushed during transportation. Baskets or bags are used to avoid crushing the bulky crop.

A good quality of green leaf is the one usually plucked and transported from the field to the factory or processing plant within 4 hours. The maximum time constraint emphasizes the critical importance of efficient transportation and the need to have the fields in close proximity to the factory. The time constraint from plucking to processing is one of the major factors leading to vertical integration in the sense that field operations are linked to manufacturing vertically.

When plucking involves older leaf, quality is much lower and the tea usually brings lower prices and reduced profitability. This tea is often referred to as "banjil" or coarse tea. Excessive plucking, including coarse leaf, happens when market prices are unusually high. In turn, excessive plucking tends to increase green leaf supply and the consequence is to depress the market price and reduce farmer returns.

Global Output and Growth Trends During the Post-War Period

During the post-World War II period, during which production was generally not subjected to war-time resource restrictions, the tea industry, both in terms of output and land use, grew at a slow rate. The low rate of growth was due in part to past worldwide trends in production and consumption which generally resulted in excess supply in the world market. By 1948-52 the world output of

tea[8] was around 600,000 metric tons. The major traditional producers--India, Sri Lanka and Indonesia[9]--accounted for about 70 percent. Consequently, the three largest producers became the major exporters. Between 1960 and 1980, the global output steadily increased from 1,000,000 tons to 1,800,000 tons, respectively, as indicated in Table II.1. The share of the three countries declined gradually to around 46 percent in 1980. This implies that the International Tea Agreement was largely facilitated by the three major producers. Because they were few, it was not difficult to come to an agreement. The agreement was designed to strengthen the market by quantitative restriction of export supply as well as new plantings. In doing so, the supply of tea became relatively inelastic and prices fairly stable. The market was characterized by a fairly rigid supply with stable prices controlled by a few sellers facing an inelastic demand. The few sellers (with India, Sri Lanka, and Indonesia being the major ones) behaved generally as oligopolists until 1955. Then the International Tea Agreement was abandoned partly because of the favorable prices and partly due to the

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[8]This excludes China and the Soviet Union because the data are often incomplete. Since most of the production in two countries is for domestic consumption, their role on the export market was not significant. As of the later 1970s, China has increasingly become aggressive in its export of tea.

[9]Sri Lanka was formerly known as Ceylon. Since most of the producers in Sri Lanka and India were of British origin and the buyers were also British, it was often not difficult to reach agreement on marketing strategy between the sellers and buyers who were few in number.

TABLE II.1

TEA PRODUCTION FOR SELECTED COUNTRIES, REGIONS, AND THE WORLD FOR SELECTED YEARS

Country	Output				Proportion of World Production			
	1950[a]	1960[a]	1970[a]	1980	1950	1960	1970	1980
	(Thousand Tons)				(Percent)			
ASIA								
India	278.8	382.8	418.5	571.7	44.9	40.6	37.6	31.4
Sri Lanka	139.2	197.6	212.2	191.4	22.4	24.9	19.1	10.5
China	47.2	54.4	--	303.8	7.6	6.9	--	16.7
Japan	41.8	77.2	91.2	103.3	6.7	9.7	8.2	5.6
Indonesia	35.5	46.2	44.0	79.7	5.7	5.9	3.9	4.4
EAST AFRICA								
Kenya	6.7	13.8	4.0	90.0	1.0	1.7	3.7	4.9
Malawi	7.0	11.9	18.7	29.9	1.1	1.5	1.7	1.6
Mozambique	3.1	9.0	17.0	19.5	0.4	1.1	1.5	1.0
Tanzania	0.8	3.7	8.4	17.1	0.1	0.4	0.7	0.9
Uganda[b]	1.9	4.7	18.2	1.5	0.3	0.6	1.6	0
LATIN AMERICA								
Argentina	0.2	6.5	27.1	34.0	0	0.8	2.4	1.9
U.S.S.R.	30.0	37.8	66.8	129.8	4.8	4.8	6.0	7.1

TABLE II.1 (Continued)

Country	Output				Proportion of World Production			
	1950[a]	1960[a]	1970[a]	1980	1950	1960	1970	1980
	(Thousand Tons)				(Percent)			
SUBTOTAL	592.2	784.6	963.1	1570.1	95.0	98.8	86.6	83.0
OTHERS	28.8	8.4	148.9	310.3	5.0	1.1	13.4	17.0
WORLD	621.0	793.0	1112.0	1818.0	100.0	100.0	100.0	100.0

Source: FAO: Production Yearbook - various issues.

[a]Excludes People's Republic of China.

[b]The drastic decline of production in Uganda in the latter part of the 1970s was largely due to civil war and expulsion of the Asians who were largely owners and managers of most tea estates.

increasing number of new producers which made tea production more competitive and enforcing a market agreement more difficult.

Regional Changes in Output

While the dominant role of India, Sri Lanka and Indonesia continued in tea production and export, regional changes in tea production began occurring during the post-war period. Although world supply grew at about 2.6 and 3.1 percent during the 1960s and 1970s respectively, as shown in Table II.2, the regional growth rates for Africa and Latin America were higher. The cumulative percentage change for Africa during 1960-70 was 93, reflecting an annual rate of 9.3 percent, while that for Latin America was even higher, showing an annual increase of 16.8 percent in the same period.

The same pattern, with Africa and Latin America registering higher growth rates than traditional tea producers, continued during the 1970s though at a slightly lower rate of growth. The lower rate was due partly to increased energy costs and the political uncertainties of the foreign capital as the African countries achieved their independence. Also, tea is a perennial crop with a long gestation period of about three to four years between planting and production and about ten years before it fully matures. Hence the regional output increases that occurred in Africa and Latin America were a result of young tea bushes planted after the war reaching maturity. The higher proportion of younger bushes in the two regions had a higher growth rate than those in Asia where most the bushes were already mature.

TABLE II.2

REGIONAL AND WORLD CHANGES IN OUTPUT OF TEA FROM 1960 TO 1980

Region/ Country	Cumulative Percentage Changes		Annual Percentage Changes	
	1960-70	1970-80	1960-70	1970-80
World	26	31	2.6	3.1
Africa	93	51	9.3	5.1
Asia	16	23	1.6	2.3
Latin America	168	46	16.8	4.6
U.S.S.R.	54	59	5.4	5.9

Source: FAO Production Yearbook--various issues, International Tea Committee (I.T.C.), Annual Bulletins of Statistics, 1981.

[a]The cumulative percentage change approach was used in calculating the annual percentage change. Initially percentage changes for each year were derived and then added cumulatively. The annual percentage change, say, for 1960 and 1970, was then a simple arithmetic mean of the cumulative one. The value derived in this way, may not necessarily agree with the value derived by using the beginning and the end value such as 1960 and 1970. The cumulative method is more accurate than the simple mean because it takes into account year-to-year fluctuations that are common with many agricultural activities.

Regional Changes in Land Area Planted

One of the principal factors leading to higher growth rates in output in Africa and Latin America was increasing plantings and therefore increased total land under tea. Acreage, as a proxy for output intention, showed higher growth rates in Africa and Latin America (Table II.3).

While world acreage increased by 1 percent and 2.3 percent during 1960-70 and 1970-80 respectively, African acreage in the same two periods increased by 7 and 2.5 percent, respectively. The highest acreage increase was in Latin America with an annual growth rate of 9.5 percent and 4.3 percent in the same two periods, respectively.

Although the acreage response was a result of economic incentives like high prices during the later part of the 1950s, other factors contributed to the slow growth of acreage in the traditional producing countries. For example, the political independence of India in 1947 and the accompanying political and economic uncertainties of foreign capital investment in the wake of "economic nationalism" associated with Indian independence led to the search for new growing areas in Africa and Latin America by foreign investors.

Increases in production costs, especially labor costs and taxes levied on exported tea in India and Sri Lanka appeared to be higher than those in Africa. Hence foreign capital for tea production moved into Africa and Latin America at a higher rate than in the past.

TABLE II.3

REGIONAL AND WORLD CHANGES IN THE ACREAGE OF TEA PLANTED FROM 1960 TO 1980

Region/ Country	Cumulative Percentage Changes		Annual Percentage Changes	
	1960-70	1970-80	1960-70	1970-80
World	10	23	1.0	2.3
Africa	70	25	7.0	2.5
Asia	42	11	4.2	1.1
Latin America	95	43	9.5	4.3
U.S.S.R.	20	5	2.0	0.5

Sources: Calculated from FAO, Production Yearbook - various issues; I.T.C.: Annual Bulletin of Statistics, 1981.

CHAPTER III

TANZANIAN TEA PRODUCTION: SOME PHYSICAL AND STRUCTURAL FACTORS IN THE DEVELOPMENT OF THE TEA INDUSTRY

Introduction

Though tea is among the important export crops of Tanzania, production is generally small--about 1 percent of the total world output in 1980. Tea is a tropical and sub-tropical crop, and thrives well in a number of areas in Tanzania. There is adequate rainfall as well as suitable soils in most of the highlands in the country. Despite the potential resource availability in these areas, tea production traditionally has been done on large plantations generally owned by foreign companies that were predominantly of British and Indian origin. However, the changing structural pattern that included the introduction of cash crop smallholders appears to have been successful at least in the case of tea production in the country. The historical and economic aspects that restricted the growth of tea to large plantations in the early period prior to independence and the emerging role of the smallholder after independence are important in understanding the major characteristics of tea production in Tanzania. Knowledge of these aspects is helpful in analyzing and comparing smallholder production of tea with respect to productivity and competitiveness with plantation tea production, especially in the long run.

The Effect of the International Tea Regulation Scheme--1933-1955

Tea production has a long history of between 2000 and 3000 years as a cultivated tropical and subtropical crop in China, but its cultivation in the tropical countries such as Tanzania is a recent one dating back to the 1920s. The first tea production on a commercial scale in Tanzania was started by British companies. These companies were usually referred to as "sterling" companies because they were registered in the United Kingdom and were managed and controlled, as a rule, in the country of their incorporation. Other companies were registered in India, Pakistan, or locally in Tanzania and were usually referred to as "non-sterling" companies. In 1924, the first commercial tea estate was established near Tukuyu in the Southern Highlands of Tanzania. Another estate was established in the Usambara Mountains in northeastern Tanzania in 1931. The selection of the two areas was largely because of relatively easy accessibility, the land was previously occupied, and the price paid for acquiring the land was low. Tea production then spread to other parts of the Southern Highland such as Iringa and especially in Mufindi, Lupembe and Luponde in the 1950s.

Though tea production started in the 1920s, production did not increase rapidly during the period prior to the 1950s because of the quantitative restrictions on exports imposed under the International Tea Agreement of 1933 to which Tanzania was a party. The

salient features of the 1933 Agreement was the prohibition of new plantings except under special circumstances, restrictions on export of tea seed, and established export quotas for each country. The quotas were based on the maximum volume of exports in any of the three years, 1929-31, as a "standard" reference point.[1] The restrictive nature of the agreement to which Tanzania and the other East African British Dependencies, Kenya and Uganda, adhered to until 1947, appeared to prevent the growth of the industry prior to the 1950s. Although the regulation scheme had the effect of strengthening tea prices by restricting exports, the share of profits arising from such arrangements was seen to be unfairly distributed. The largest exporters--India, Sri Lanka and Indonesia--appeared to be the major beneficiaries based on volume of sales because they commanded the largest market share which, for example, in 1933 represented approximately 80 percent of the total export market. Growing dissatisfaction among small producers with concentration in the tea export market in three countries prompted the withdrawal of Tanzania and the other East African countries in 1947. Other reasons for the withdrawal was high tea prices after the war which tended to increase production. Such overproduction would have led to increased accumulation of tea stocks if Tanzania had remained a member of the Agreement. Indian independence in 1947 raised

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[1] V. D. Wickizer, Tea Under International Regulation (Stanford: Food Research Institute), p. 73.

concern over the security of British capital invested in the Indian tea industry because of uncertainties surrounding rising economic nationalism and high incidence of taxation. Consequently, Tanzania and other East African countries under British rule were viewed by British investors as providing a more secure environment than India. The new colonies appeared natural and logical areas for British capital investment in tea production as they apparently were much more politically secure than India and labor was relatively cheap because of few alternative employment opportunities outside of agriculture for the labor force.

Finally, an important undesirable feature of the regulation scheme for some of the producers like those of East Africa was that production was geared to a common price level as the blenders and distributors tended to make an increasingly standardized product. Such restrictions tended to lower the prices of the quality tea generally produced in East Africa. Consequently, the blending practice tended to lower the profit margins of the high quality tea producers[2] because the buyers were also mainly blenders and distributors who deliberately manipulated prices so that their profits were maintained.

The Tanzania Tea Authority

The Tanzania Tea Authority (TTA) was established by the Tea Ordinance of June 1968, as a corporate body to be responsible for

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[2]Ibid., p. 85.

all aspects of smallholder tea development. The TTA was also responsible for functions previously performed by the Tanzania Tea Board which, since its establishment in 1962, had been responsible for the coordination of tea production and marketing in Tanzania.

Under the Minister of Agriculture who appoints its members, TTA is empowered to:

a. promote, supervise planting, cultivation and harvesting.
b. inspect plantations and green leaf.
c. participate in the management and control of tea factories.
d. control tea marketing and act as a national marketing agent.

TTA, in its effort to promote smallholder tea production, provides extension services to those farmers who are participants in the scheme. Usually one field officer to 500 farmers and one assistant field officer to 100 farmers is considered adequate for the extension effort.

Tea Growing Areas in Tanzania

There are five main tea growing areas in Tanzania as indicated in Figure III.1. Three of these Rungwe, Njombe and Mufindi--are located in the Southern Highlands. The fourth one is situated in the northeast Usambara Mountains at Amani Lushoto and Korogwe, while the fifth one is located in the northwest in Bukoba. Rungwe, Mufindi, and Amani in the Usambara Mountains are the oldest tea plantings where cultivation began during the 1920s and 1930s. Those

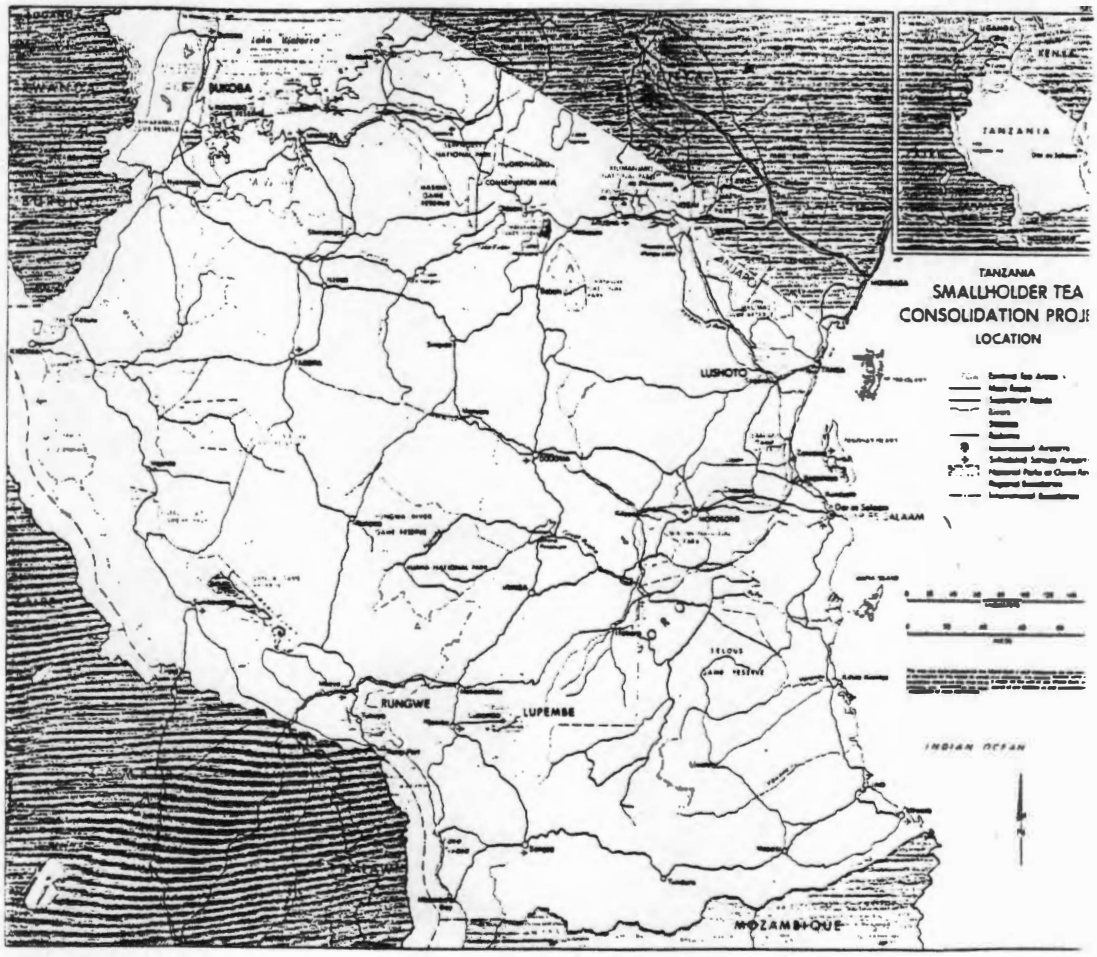

Figure III.1. Tea Growing Areas in Tanzania.

Source: The World Bank, Tanzania Smallholder Tea Consolidation Project, Report No. 2814-TA, May 1980.

in Bukoba and Njombe are of more recent origin, having been planted after World War II.

Rainfall

Specification of the ideal or average climate that tea requires is difficult, especially with respect to rainfall, because the amount of water requirements is influenced by the transpiration rate, soil conditions, sunshine and wind factors in the growing areas. However, a general consensus among tea scientists is that an annual rainfall of 1270 millimeters (50 inches) is a minimum for success in tea growing. While the absolute lower limit of rainfall is an important factor, no practical upper limit exists. For example, tea is grown in Sri Lanka in some districts receiving rainfall of over 5080 mm (200 inches). Rainfall intensity and distribution are more critical than the absolute minimum. As indicated in Table III.1 the annual rainfall, over at least 16 years for which records were available, for the three major tea growing areas in Rungwe, Bukoba and Njombe ranged between 1379 mm and 2518 mm. A marked concentration of rainfall occurs from November to May when the monthly average rainfall in most cases is above 100 mm. Very little rain falls during the months from June to October. Crop production in the dry months is very low and total annual production is correspondingly reduced as the months with low output tend to pull down the average.

TABLE III.1

AVERAGE MONTHLY AND ANNUAL RAINFALL (mm) IN THE TEA GROWING AREAS OF TANZANIA

Station	Altitude in Meters	No. Years Recording Up to 1976	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
								(Millimeters)							
RUNGWE															
Tukuyu	1,534	51	255	224	360	620	344	108	76	57	52	50	135	218	2,519
Ndala	1,600	7	277	308	437	378	132	56	23	11	24	55	214	243	2,158
Rungwe Estate	1,565	31	253	231	298	386	168	69	46	33	28	30	155	299	1,996
NJOMBE															
Lupembe Estate	1,600	21	264	261	359	309	64	10	4	23	37	79	139	286	1,835
Luponde Estate	2,232	18	245	226	313	206	42	7	8	3	4	10	75	249	1,388
BUKOBA															
Bukoba	1,500	48	147	163	248	374	318	85	49	79	110	137	182	191	2,083
Maruku	1,500	17	158	164	228	388	281	67	38	68	117	158	228	157	2,052
Katoke	1,650	18	140	123	212	355	193	40	22	74	101	115	195	209	1,779
USAMBARA															
Ambangulu	1,500	41	64	63	189	450	543	160	106	106	195	114	129	78	2,197
Merkulu	1,400	16	64	56	115	232	280	103	98	82	75	86	100	88	1,379

Source: East African Meterological Office.

Temperature

While rainfall may be a limiting factor in the cultivation of tea in Tanzania, it is not the only factor. Prevailing temperature is an additional conditioning factor and here elevation is an important characteristic in influencing transpiration losses. The minimum altitude at which tea is grown in Tanzania appears to be around 1400 meters or about 4600 feet above the sea level. In such growing areas the altitude is an important aspect in mitigating drought conditions because of overcast skies during dry weather and occult precipitation in the form of mist. Such occult precipitation can be influenced by the planting of wind belts and shade trees. Hursh has strongly emphasized this aspect in describing tea planting in the Southern Highlands of Tanzania.[3] Wind breaks are significant because wind is a vital factor in promoting transpiration. Eden has shown that at Kericho Tea Research Center, Kenya, during windy days the evaporation from a free water surface was increased by 45 percent in excess of that of windless days.[4]

At higher altitudes, however, such as those above 2000 mm, occasional frost may be an important factor in reducing crop production. In general, temperatures below 13°C are likely to be detrimental to tea foliage and results in reduced growth. Generally,

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[3]T. Eden, Tea (London: Longman, 1976), p. 8.

[4]For example, see T. Eden, "Tea and Drought," Tea Research Insitute of East Africa, 6 (1953), p. 9.

tea grows in areas where temperature variation is small and humidity is high for the greater part of the season.

Soils

Though climatic factors are important determinants in the growth of tea, soils in which tea is grown are also important. Soil scientists generally agree that tea grows well in soils that are permeable, well drained, with little lime or soda, but with plenty of aluminum, iron and manganese. Tea soils must also be moisture retentive and have an acid reaction of between pH 4 and 5.[5] The pH values for soils in the tea growing areas of Tanzania have been found to range between 5.0 and 6.0,[6] suggesting that tea grows well in moderately acid soils. With rainfall being above 1720 mm and tea being located in the highlands in most cases, drainage is usually not a problem.

Production

The production of black tea, the only tea produced in Tanzania, was about 17,000 tons in 1980. Tanzania is not a significant producer of tea in the world. It produces only 1 percent of total world

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[5]A pH of 7 indicates that soils are neutral while a value below 7 reflects that soils are acidic. A value above 7 would indicate that the soils are alkaline.

[6]A. N. Smith, "The Chemical and Physical Characteristics of Tea Soils," East African Agricultural and Forestry Journal, XXVIII, No. 3 (January 1963).

production and 10 percent of total tea production of East Africa.[7] However, tea is a commodity of increasing importance in the export trade. At present, tea is the fifth largest export crop in Tanzania. Its importance as a foreign exchange earner at the national level is expected to increase as smallholder tea matures. Its importance is then likely to have broad ramifications in broadening the export base necessary for strengthening the capacity of the country to finance a diversified import demand for economic growth.

Tea Estates

The long-term nature of the crop, the cost of establishing it, the specialized techniques of cultivation such as pruning, plucking, and the need for processing within a short period of time after plucking appear to have favored vertically integrated plantation production. Empirical evidence suggests that plantations are more efficient in achieving maximum output per unit of land than small farms.[8] The greatest documented yields per hectare on most tea plantations in the tea-producing countries have been on estate sizes

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[7] Kenya is the largest producer of tea in Africa. It provided 46 percent of total African tea production in 1980. East African countries--Kenya, Uganda, Tanzania, Malawi and Mozambique--as a group provide 80 percent of the tea produced in Africa. This is attributed largely to the initial British capital inflow during the British colonization in East Africa.

[8] G. K. Sarkar, The World Tea Economy (Delhi: Oxford University Press, 1972), pp. 21-22.

ranging between 200 ha and 600 ha (500-1500 acres).[9] An efficient processing factory requires an annual intake of about 450 tons (2 million pounds) of green leaf obtainable from 200 ha and should be plucked and supplied from the immediate vicinity as the green leaf is easily damaged. Economic efficiency in terms of minimum cost per unit of processing output is also achieved at this production unit size.

For economic reasons, tea production in Tanzania was initially based on estates owned by private companies. These companies were mostly British owned, missions and/or cooperatives such as those in northwest Tanzania where the Bukoba Native Cooperative Union owns a processing factory.

Significant changes in the structure of the domestic tea industry have occurred. Two different time periods are particularly important. The first time period was the post-war colonial period during which Tanzania became a United Nations Trust Territory under British administration until 1961, when Tanzania gained its political independence. The second time period in the development of the industry was the post-independence period when an increase in smallholder tea expansion was supplemented by foreign capital assistance.

Post-War Colonial Period

As reflected in Table III.2, the structural pattern of production during the 1950s was characterized by estate expansion. Tea was

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[9] Ibid.

TABLE III.2

TANZANIA: TOTAL PLANTED TEA HECTARAGE BY PRIVATE, TTA, AND SMALLHOLDERS FOR SELECTED YEARS

Ownership	Hectares (Ha) 1950[a]	1960[b]	1970[b]	1980[b]	Percentage Change in Planted Ha[c] 1950-1960	1960-1970	1970-1980
						(Percent)	
Private Estates	3700	7797	9259	9259	66	31	-8
TTA Estates	Nil	Nil	Nil	1240			
Smallholders	Nil	60	2665	8994		536	117
Total[d]	3700	7857	11924	19492	66	42	43
Percentage of Hectarage by:		(Percent)					
Private	100.0	99.2	78.0	48.0			
TTA	0.0	0.0	0.0	6.0			
Smallholders	0.0	0.0	22.0	46.0			

[a]ITC, Annual Bulletin of Statistics, 1965, op. cit.

[b]The United Republic of Tanzania, Ministry of Agriculture, Price Policy Recommendations for the 1981-82 Agricultural Price Review Annex 10 (Dar-es-Salaam: MDB, R5, Table 1.2.

TABLE III.2 (Continued)

[c]The percentage change during the ten-year periods are the aggregates of year to year changes; that is, the cumulative sum across the ten years in order to reflect year to year fluctuations. They should not be compared to those obtained from simple means using the beginning and end values.

[d]The low percentage change on the total was calculated from overall totals for each year and then summed. So it would reflect a lower rate than that for the private estates in 1950-60. This is to be expected for the subsequent periods because private estates expanded more slowly and even declined during 1970-80.

grown on alienated land and no attempts were made to induce Africans to turn to tea production. During this period, production, as measured by factor expansion such as land, doubled and nearly all of the expansion came from private companies. Private estates represented 99 percent of the total hectarage during the period. Smallholders, who were mainly outgrowers adjacent to the estate, were insignificant in terms of land under tea. The private estate total percentage increase during the period was 66 percent with an average annual increase of 6.6 percent. Three factors were significant in rapid estate expansion in Tanzania during the post-war colonial period. Tanzania had abundant resources for tea growing. The abundant supply of low-cost labor and land had low opportunity costs because of few uses. Third, the withdrawal of Tanzania from the International Tea Agreement in 1947 legally permitted the expansion of resources in producing a relatively high quality tea. With British companies being the major producers and buyers, market penetration was foreseen as no problem as both interested parties were British companies.

Finally, prices had been relatively stable due to the successful tea regulation scheme started in 1933 and continued through 1955. Because price uncertainty is usually a principal factor in affecting decision making, price stability brought by the scheme improved market prospects. With Tanzania and other East African countries producing a small proportion of world tea, their impact by increasing output through expansion of tea hectarage did not likely affect

industry stability. The proportion produced by Tanzania and other East African countries was about 5 percent at the end of the 1950s with 80 percent of total production being exported and the remaining 20 percent being for local consumption.

Post-Independence Period

With rapid estate expansion during the previous decade and the general absence of African participation in the cultivation of tea, the immediate post-independence decade experienced a slowing down in the rate of growth of private hectarage by increasing only 31 percent between 1960 and 1970 (3.1 percent annually) compared to 66 percent in the previous decade. The slowdown in hectarage expansion might have been indicative of the fear and uncertainty of private investors after Tanzania attained its political independence from Britain in 1961.

However, a preponderant share of tea output continued to come from the estates. The estates produced 90 percent of total output in 1970. While the smallholder share of hectarage increased to 22 percent, its output share was just around 10 percent due to low yields because most of the smallholder tea was still immature. Most of the smallholder schemes located in Rungwe, West Usambara (Lushoto and Korogwe), Lupembe and Pahati were provided with credit for the purchase of driers amounting to £50,000 by the Tanzanian Cooperative and Development Bank. Additional financing of £240,000 was also

provided for the purchase of tea transplants, fertilizer and pruning knives.[9]

Decline in Estate Expansion 1970-80

While estate expansion was slowly declining in the total hectarage in the 1970s, with virtually no change in the total hectarage in 1980 compared to 1970s, a real decline of 8 percent occurred in the hectarage planted by private companies between these years. This was partly caused by the high fertilizer prices during 1973-74. Though the proportion of estates in terms of total hectarage planted at the end of the 1970s declined to 48 percent, its relative share in the total production remained at 70 percent because of lower smallholder yields from immature plants.

Smallholder Expansion 1970-80

The decade of the 1970s was an important period for smallholder tea expansion. Smallholder hectarage increased from 2665 to 8994 between 1970 and 1980, an increase of 117 percent. Two main reasons account for this achievement. First, external financing was provided by the International Development Agency (IDA) totalling U. S. $10.7 million. This financing was about 67 percent of the total costs of U. S. $16 million for the smallholder tea development

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[9]The United Republic of Tanganyika, Tanganyika Five-Year Plan for Economic and Social Development 1964-69, Volume I: General Analysis (Dar-es-Salaam: Govt. Printer, 1964), p. 24.

project in all the tea-producing areas. The remaining portion, about U. S. $5.3 million, was financed by the Norwegian Agency for Development (NORAD) and the Tanzanian government. NORAD provided U. S. $1.9 million, while the government of Tanzania paid the remaining U. S. $3.5 million.

Consequently, foreign financial assistance and government commitment led to increased smallholder tea production. Coupled with the slowing of estate expansion, this effort provided an important viable cash crop alternative for smallholder farmers in areas where alternative cash crops are relatively limited due to high altitudes. Though most of these tea plants are still immature, the role of smallholder production will increase in the production of a commodity that has traditionally been considered an estate crop.

By 1980, smallholder share in terms of hectarage planted represented 46 percent of the total land under tea. The average size of holding per family remained small at about 0.3 ha for all the tea-growing areas. Tea produced on individual plots is marketed to TTA and the private factories in the area.

The impressive success in increasing smallholder hectarage has been largely due to joint efforts by TTA, government officials, and the willingness of farmers to join the smallholder tea production effort. Between 1972 and 1980, the number of smallholders participating in the project more than doubled. The number increased from 12,637 to 27,736 between 1972 and 1980 for a net increase of

15,099 new farmers. This increase in new farmers was higher than the 12,631 TTA had previously projected. The increased participation is suggestive of farmer interest in the scheme because of the perceived higher economic returns that tea provides for the smallholder.

CHAPTER IV

THE SMALLHOLDER TEA PRODUCTION FUNCTION: CONCEPTUAL AND METHODOLOGICAL ISSUES

Introduction

In most independent African countries that aim at some form of rapid economic development, attention is being focused on relevant and appropriate forms of farm organization for agricultural production for both food and export crops. The traditional plantation system, at one extreme, is being reevaluated, along with peasant-type, traditional subsistence farming, at the other end of the scale under various social and political conditions. In recent years there has been a tendency to examine the potential compatibility of the two systems. For example, in Tanzania, partnerships among foreign multinational financial institution such as the World Bank, NORAD and the Danish International Development Agency (DANIDA), the peasant and the host government have been emerging features in the transformation of peasant agriculture. The choice between the smallholding and the plantation as forms of agricultural organization of production has been made in many African countries such as Tanzania where about half of tea production hecterage is now under smallholdings.

Policymakers usually have three main reasons for seeking the most appropriate form of organization for agricultural production,

especially for export crops. Often these reasons that are sometimes stated as opinions reflect a mixture of values as well as objective judgement. First, the major reason for seeking an appropriate form of agricultural organization of production relates to poverty in rural areas. A desire to insure some minimum level of living for the majority of farm people is usually a top priority of most governments. Second, finding combinations of resources that are productive and then discovering ways to combine them successfully on individual farms is a management problem. Third, increasing the economic efficiency of the individual farms as individual units and across whole farm groups is viewed as a measure of appropriateness of change in organizational form.

Many theoretical and policy issues are involved in identifying the appropriate criteria for classifying farms by organizational type. Consequently, a brief review of the conceptual issues involved in identifying the smallholder becomes necessary.

Conceptual Issues

Theoretical and empircal evidence on smallholder (peasant-type) agriculture and smallholder development in low-income countries reveals that the concept is an ambiguous one. No general consensus exists among scholars engaged in studies of smallholders. The definitional issue may not be crucial in analyzing the production function because of the assumption that smallholders are generally

efficient in a technical sense of producing maximum output.[1] However, because of the controversial nature of the concept among different physical and economic environments, the definition applied in this study needed to be specified.

The Concept of Smallholder Agriculture

Four main variants of the smallholder can usually be identified in the literature.

1. Land area per farm as an indicator of size that is sufficient to produce products to meet minimum survival requirements is generally regarded as a sufficient definition in identifying small farmers. Sheer survival dominates decision making in such economies.

However, where soils, water availability, elevation and type of farming differ among areas, this criterion is likely to result in a different acreage for different areas and regions. Professor Lewis suggests that 10-12 acres may be used as an economic minimum size that would provide above average living in the West Indies.[2] On the other hand, a 100-acre Malayasian rubber plantation is officially

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[1] T. W. Shultz, Transforming Traditional Agriculture (New Haven, CT: Yale University Press, 1964), p. 39; P. A. Yotopoulos, "On the Allocative Efficiency of Resource Utilization in Subsistence Agriculture," in B. F. Massel (Ed.), Food Research Institute Studies in Agricultural Economics, Trade, and Development, VIII (2) (1968), 125-135; C. Nakajima, "Subsistence and Commercial Family Farms: Some Theoretical Models of Subjective Equilibrium," in C. E. Wharton (Ed.), Subsistence Agriculture and Economic Development (Chicago: Aldine Publishing Co., 1969), pp. 165-185.

[2] Quoted by V. D. Wickizer, "The Smallholder in Tropical Export-Crop Production," Food Research Institute Studies, 1, No. 1 (1960): 49-50.

defined as a smallholder.[3] Experiments have also shown that minimum living conditions could be obtained by a farmer holding less than 5 acres.[4] An arbitrary size of 10 acres has usually been explicitly or implicitly in farm management decision-making processes within the context of both traditional and transitional agricultural development in most African countries. This suggests that the concept of smallholder is a relative one but differs from one part of the world to another. The concept depends on the relative abundance of land, its productivity, and other resources. Where land productivities vary because of physical differences as well as from varying quantities of capital inputs among the farms, land area becomes less useful in defining the organizational form of the farming system.

2. The second criterion sometimes used is annual gross sales. For example, a farm with annual gross sales of U. S. $5,000 or less is considered a smallholding. The major shortcoming of this criterion, apart from being arbitrary, depends on market conditions, such as inflation. As Lin and Emerson pointed out for farms in the USA, about 60 percent of the growth in the number of farms with gross sales of U. S. $100,000 and above was due to inflation.[5]

3. The third conceptual problem is that pointed out by Harold and Johnston in which size was defined in terms of products that would

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[3]Ibid., p. 50. [4]Ibid.

[5]W. W. Lin and P. M. Emerson, Price Inflation and Changes in Farm Numbers by Economic Sales Class (U. S. Department of Agriculture, E. S. C. S. Mimeograph, 1977).

be equivalent in value to at least the wages of a hired laborer.[6] Stanton stated that many farms exist which do not meet the criterion and thus do not qualify as farms.[7]

4. The fourth criterion is the source of labor. One definition commonly used by USDA for a smallholding is that based on family labor:[8]

> One operated by a farmer and his family where the farmer provides much of the labor needed for the farming operations, makes most of the decisions, assumes most of the risks and reaps the gains or suffers the losses from those decisions.[9]

This definition distinguishes farms by source of labor--those who rely on family labor are expected to differ from those who depend on hired labor, both in their decisions on allocations of labor and in their response to innovation. Reliability of labor supply is greater when the farmer depends on his/her family labor and usually needs to make no decision with respect to size of the labor force which is fixed. When some of the labor is hired, part of the labor

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[6]H. O. Carter and W. E. Johnston, Farm-Size Relationships, with Emphasis on California. A review of what is known about diverse forces affecting farm size and additional research considerations (Davis: Dept. of Agri. Econ., 1981), p. 4.

[7]B. F. Stanton, "Perspectives on Farm Size," American Journal of Agricultural Economics, 60, No. 5 (1978): 727-737.

[8]U. S. Department of Agriculture, Status of the Family Farm: A Report to Congress, prepared by Donn A. Reimund (USDA, February 1978), pp. 2-3.

[9]Ibid.

becomes a variable input. Hiring usually takes place only during peak periods imposed by markets.

The definition that categorizes farmers into smallholders by the proportion of the total labor that is supplied by the family is essentially an analysis of the household-firm.[10] Two characteristics of this conceptual analysis which are generally crucial for economic theorizing are:

a. A part of the output goes to the household; that is, the household simply transfers in kind a part of its output.

b. A part or all of the input comes from the household.

The consequence of this hybridization is that models of the household firm have also become theoretical hybrids of the productive firm and the consumer household. This appears to be a major distinguishing feature of those farmers categorized as smallholders in the Tanzanian environment. The household firm then contrasts the theory of a "pure firm" which "purchases" almost all its inputs and "sells" almost all its output(s) in the market at market prices and receives money payments as income.

In addition to most of the labor being family labor in the smallholder farming system, the survival goal becomes a critical factor in the allocation of family labor. The drive to survive has a value in which the household utility function would be an ordered

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[10] R. K. Krishna, "Models of the Family Farm," in R. C. Wharton (Ed.), op. cit., pp. 185-190.

set of goods and services for survival needs. The existence of an optimal utility may not always be guaranteed. Hence, insurance premiums to safeguard against risks assumes a greater motivational role than the economic objective of maximizing profit under a survival situation. Consequently, the production function associated with such behavior may not reveal an efficiency objective.

The criterion of labor source (No. 4 above) is used in this study as an operational definition because it is consistent with the survival objective in poor agricultural countries like Tanzania. To distinguish smallholder farmers in other countries who may use family labor for most of their operations from smallholders in Tanzania, most of the smallholders in Tanzania are generally tied to tribal cultural organizations.[11] Tribal organization determines social values with respect to division of labor, allocation of resources such as certain tasks being assigned to women like cooking and household cleaning, the distribution of income according to the family needs, and certain communal obligations. This type of farmer generally requires significant outside resources in a transition stage. As pointed out earlier, over 90 percent of rural farmers are smallholders. They appear to be the most neglected sector in the process of economic development because government modernization efforts have generally been focused in urban areas.

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[11]The definition may blur the conceptual definition of a farm as a unit of inquiry in this study.

Therefore, an emphasis on family resources and employment as key policy variables in the economic study of smallholder farming seems more logical than focusing on land because people and not simple physical resources take final priority. Too little emphasis has been given to family labor and management. As the Japanese and Dutch have demonstrated, quite different combinations of land, labor, and capital from those of countries like the U. S. A. may be combined efficiently by able entrepreneurs in smallholder farming systems.

Technological Production Possibility (Frontier)

A production function is a technological relationship confronting a firm in which the entrepreneur chooses factor proportions and output levels.[12] Generally the representation of all possible different activities is best described by using the language of set theory. For example, the production possibility set for a particular firm i, Q_i is defined as the set of all activities which are technologically possible for firm i. It is defined without regard to resource availability and prices and describes pure technology.

Then with Q_i as a set of all possible activities for firm i, an element of Q is a possible production, a production possibility vector, or an input-output vector. For example, in a simple production activity, two goods q_1 and q_2, labor and green tea leaf, respectively, can be represented mathematically as:

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[12] A. A. Walters, "Production and Cost Functions: An Econometric Survey," Econometrica, 31 (1963): 1.

$Q \subseteq R^m$

Q = set of possible activities

C = "contained in"

R = Euclidean space valued in real numbers (1, 2, . . . , m; -1, -2, . . . , -m)

where

m = number of commodities or dimension of the Euclidean space; i.e., the set of all vectors with m components.

An element of Q consists of a collection of quantities of all various goods q, i.e., q E Q, where E = "element of", suggests q_i = q_1, q_2 . . . q_m where q_i is some amount of good i. By convention,

If $q_i < 0$, it implies good i is an input in the possible production set q.

If the $q_i > 0$, the good is referred to as an output.

If the two activities are represented geometrically in the ordinary Cartesian plane (two dimensions), the second quadrant is the only quadrant with meaningful economic significance for the two goods. Labor is nonpositive to include the possibility of no input at the origin and output of green leaf is non-negative.[13] Then one gets a production possibility set with the two activities as OBC in Figure IV.1.

If q_1 = labor input

q_2 = output,

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[13] J. M. Henderson and R. Q. Quandt, Micro-Economic Theory: A Mathematical Approach (2nd Ed.) (New York: McGraw-Hill), p. 54.

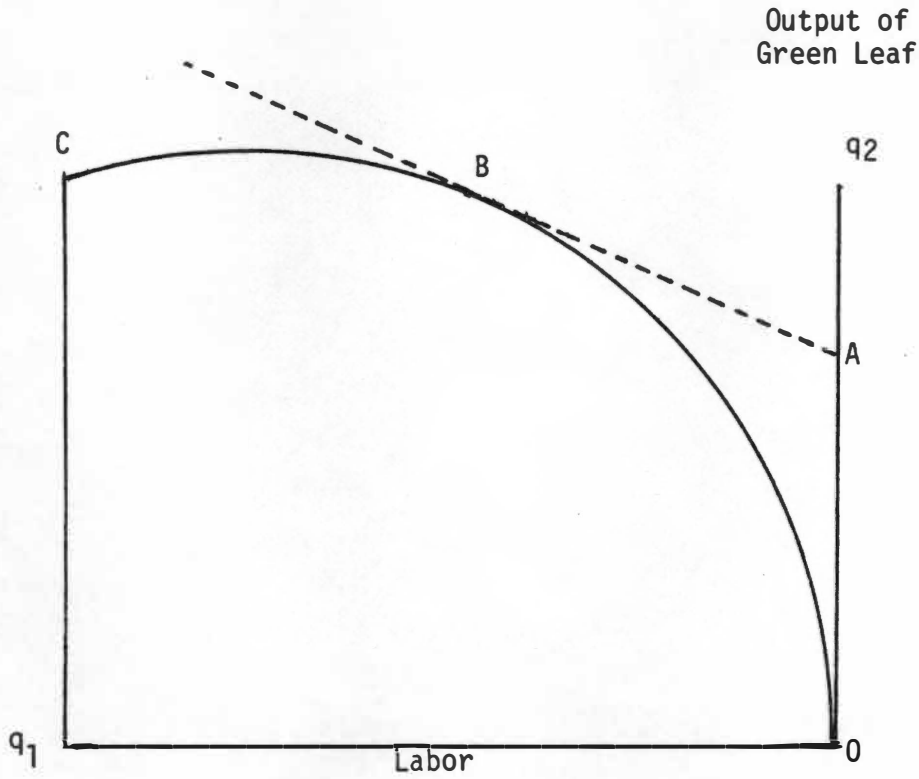

Figure IV.1. Production Possibility Set for Labor and Green Tea Leaf.

then the production input set is defined as the different quantities of input required to produce a given level of output.

The production function can thus be rewritten in set form using an input-output vector as:

$$q = (q_1, q_2) .$$

The production function defined in this way implies two crucial axioms required for the existence of a production function. First, it postulates that the set is closed. That is, it is compact and has a boundary such as the one depicted by the curve OBC in Figure IV.1. Each point on the boundary is a member of the production set. The boundaries of the production set in our example suggests that there are limits to the amount of labor available. In this case, Oq_1, is the physiologically possible maximum quantity of labor that an individual (or family) can provide. For example, 24 hours per day would be such a maximum for a worker. Neither input/output can be increased or decreased indefinitely. With a compact set and a linear function specifying the fixed market rate of exchange between labor and output, the solution reaches a maximum on point B of the boundary as given in Figure IV.1. The market rate of exchange is given by the line AB. Thus the production set has a boundary point at which profits are maximized. All the other points on the production surface OBC are merely hypothetical. They tell us what the output of a firm would have been if it had found it profitable to use the relevant quantities of the factors.

Existence of the Production Function

The existence of a production function, the physical maximization of output from given inputs, is generally based on the convergence of the production function. While the boundaries postulates essentially guarantee that any given collection of inputs cannot yield an infinite quantity of output, much of competitive economics depends on a more restrictive condition than that of being compact and bounded, namely the convexity axion.[14] The major advantage of convexity assumptions is that they guarantee the existence of a price system that is necessary for efficient decentralized decision making.[15] The convexity axioms imply the existence of positive price vectors necessary to achieve an optimal output from given input vectors. In a market economy, this physical maximization of output can be viewed as the first of the prerequisites for profit maximization by guaranteeing that the production function has an upper bound which may or may not be feasible in a sense of economic efficiency. That is, the marginal value product of an input must at least be equal to its marginal factor cost. These convexity axioms have provided significant information about the market behavior of the profit maximizing firm. Responsiveness of the firm to price changes

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[14] K. J. Arrow and G. Debreu, "Existence of an Equilibrium for a Competitive Economy," Econometrica, 22 (1954): 265-289.

[15] J. D. Koopmans, Three Essays on the State of Economic Science (New York: McGraw-Hill, 1957), p. 54.

in both input and output markets has been studied extensively using production functions based on convex properties. Perhaps the convexity and boundedness properties of the production function have enabled the determination of classical equilibrium of individual firms in a competitive market system to be optimal (unique) in the Pareto sense. That is, no reallocation of resources can improve the position of an individual firm without making at least one individual firm worse off. Conversely, every Pareto optimal resource allocation can be realized by a competitive equilibrium.

The mathematical technique that uses the set theoretic approach to represent technological possibilities is a comprehensive one in the analysis of production. However, it is somewhat general for practical and for some theoretical applications. The set must be restricted and specialized. One such specialized concept is the production function.

The traditional approach to the theory of the firm has been to specify the production function which describes the maximum output that can be obtained with existing technological knowledge and with given quantities of inputs. For a firm producing more than one commodity, as in joint output, the production function describes the maximum value of one particular output as a function of quantities of inputs with all other outputs held constant.

The production function defined in the traditional way describes only efficient techniques. Consequently, each firm in the industry is on its equilibrium position on the same expansion path.

However, no justification exists for extending the productivity principle, maximum output per variable input, from the individual firm to the industry because the general equilibrium concept is a static notion.[16] The notion is based on the assumption of fixed quantities of productive resources. This suggests that an individual firm may obtain an increment of some factor by bidding it away from another firm to increase its output. To the expanding firm it makes no difference whether the newly acquired increment is newly created, thereby suggesting an increase in the total supply of the resource, or whether it is acquired at the expense of other firms. The source of acquired increment is extremely important to the other firms whose output would be affected and is apparent from the general equilibrium theory. If an increase in the total industry output occurs, then static conditions have been temporarily disturbed while the adjustment process is taking place to the new conditions. This motion is quite familiar in agricultural development where there are "progressive," "average," and "less progressive" farmers. When the increment in the newly acquired factor reflects an increase in the total industry output, then the adjustment to equilibrium conditions is a dynamic one in the sense that a new equilibrium at a higher output is now obtained.

The consequence of different output levels for individual firms implies that the input(s)-output(s) of each firm cannot be on the same

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[16] D. Durrand, "Some Thoughts on Marginal Productivity with Special Reference to Prof. Douglas' Analysis," Journal of Political Economy, 45 (1937): 746.

expansion path even with the assumption of perfect competition in both product and factor markets because of the "entrepreneurial factor."[17] This management capacity (supervision and coordination) and risk or uncertainty-bearing ability are attributes which are unique to each firm and do not have a market price since they have no use to other firms. The production function of an individual firm cannot be homogeneous of first degree in inputs because the entrepreneurial capacity of the individual firm (farmer) is limited. If entrepreneurial capacity is not important, then homogeneous production functions would imply no limit to the size of the firm.[18]

The implication of different entrepreneurial capacities is that firms will not be on the same expansion path at least for Tanzania smallholder tea production. If Tanzanian smallholder farmers are faced with a fairly competitive input market and receive a fixed price for their product because TTA is the only buyer (a monopsonistic product market), then rational smallholder tea producers would allocate their resources to maximize net return. For tree crops such as tea, the product will have a different value prior to maturity. Hence a stream of different outputs is produced over time. Output can be represented as

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[17] M. Friedman, Price Theory (Chicago: Aldine Publishing Co., 1976), p. 106; N. Kaldor, "The Equilibrium of the Firm," Economic Journal, 44 (1934): 67-68.

[18] Friedman, op. cit.

$$Q_T = q_3, q_4, \ldots, q_9 \qquad \text{IV.1}$$

where

Q_T = total output from first production of green leaf to maturity,

$q_3, q_4, \ldots q_9$ = quantity of green leaf during individual years from year 3 through year 9, respectively.

Viewing the same commodity at two or more different points in time can be regarded as two or more different commodities. The concept of multi-period products or multi-point outputs becomes relevant. Hence, a finite number of commodities exists when the concept is extended to include temporal specification and is in the Arrow-Debreu[19] spirit only in that intertemporal analysis is used to differentiate commodities. It differs from the Arrow-Debreu analysis in that the differentiation is restricted to one commodity while Arrow-Debreu explain the various commodities in the economy. In both cases, the product has a beginning and an end--a finite number of commodities.

Theoretically, a maximizing individual would maximize the discounted future values of net value product. With a constant price, the maximization problem would be:

$$NVP_p = \sum_{t=1}^{n} [TVP_t - TFC_t] (1 + r)^{-t} \qquad \text{IV.2}$$

where

NVP_p = present value of net value product

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[19] K. Arrow and G. Debreu, op. cit.

TVP_t = total value product in period t

TFC_t = total factor cost in period t

t = 1, . . . , n time periods

and

$$TVP_t = P_t f(X_1, X_2, \ldots, X_m)$$

$$TFC_t = b_{k_t} \sum_{k=1}^{n} X_{k_t}$$

where

P_t = price of output in period t (assumed constant here)

f = functional notation to depict the production function

X_{k_t} = quantity of variable input k used in period t, k = 1, . . . , m inputs

b_{k_t} = price of input k in the t-th time period (market, inputed or administratively set)

r = discount factor reflecting time preference for money with its value 0 < r < 1.

Then, the first-order optimizing conditions would be

$$\sum_{t=1}^{n} \left[\frac{\partial TVP_t}{\partial X_{kt}} - \frac{\partial TFC_t}{\partial X_{kt}} \right] (1 + r)^{-t} = 0 \qquad \text{IV.3}$$

which becomes

$$\sum_{t=1}^{n} [MVP_{X_{kt}} - MFC_{X_{kt}}] (1 + r)^{-t} = 0$$

where

$MVP_{X_{kt}}$ = marginal value product of input k in period t

$MFC_{X_{kt}}$ = marginal factor cost of input k in period t.

Provided the second order conditions are fulfilled, the optimal solution is guaranteed when the present value product equals present value of marginal factor cost. This implies that

$$\sum_{t=1}^{n} MVP_{X_{kt}} (1 + r)^{-t} = \sum_{t=1}^{n} MFC_{X_{kt}} (1 + r)^{-t} \qquad \text{IV.4}$$

for k input where k = 1, . . . , m.

The traditional production function that presupposes a physical maximization of output from given inputs implies that all farmers have the same entrepreneurial capacity with respect to future prices and psychological makeup to assess the appropriate discount rate as given in equation IV.2. Then there is a justification to assume that the production function is on the same expansion path as postulated by traditional economic theory of the firm.

Most of the farmers in Tanzania are poor and the market structure is fairly imperfect with respect to information and institutional constraints such as poor credit facilities. Achieving the optimality postulates in the Pareto sense is seriously open to question. Allocative inefficiencies are likely which result in welfare losses. Then the observations reflecting the production function of all smallholder farmers in tea production would be a scatter of observations on the production surface. The justification for such a hypothesis is partly based on previous experience of cash production in the areas under study.

The Lupembe area experienced on economic coffee failure resulting from low prices in the 1950s. Consequently, coffee

production (a perennial crop) was abandoned. Though coffee is now being revived in recent years, it is no longer an important crop in the area. Naturally, some of the farmers growing tea are likely to be rather pessimistic about the future prices of tea because of historical experience for similar crops like coffee.

As tea is a multi-period product, its yields are likely to vary among individual farmers depending upon cultural practices like planting and pruning operations which are likely to affect tea yields. The result of different individual future expectations of crop profitability are likely to be reflected in different yield paths such as those shown in Figure IV.2 with the yield curves for four firms, a_1-a_4. Lamb, in his observation of smallholder tea production in Sri Lanka, concurs with this yield pattern.[20] He remarked that experience seems to suggest that with massive expansion of tea production by smallholders (single proprietors or farm household units), returns per unit of land normally fall far below returns for the plantations. The major reason, in the first place, for the lower output per unit of land of smallholders is the lack of managerial competence. Also, with tea being a new crop, they are without previous experience in many cases. The different production units (firms) are likely to be operating on different production functions especially when cross-sectional data are used as in this study.

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[20] J. Lamb, "Tea as a Crop for Smallholders in Ceylon," World Crops, 6 (No. 5) (May 1954): 206-207.

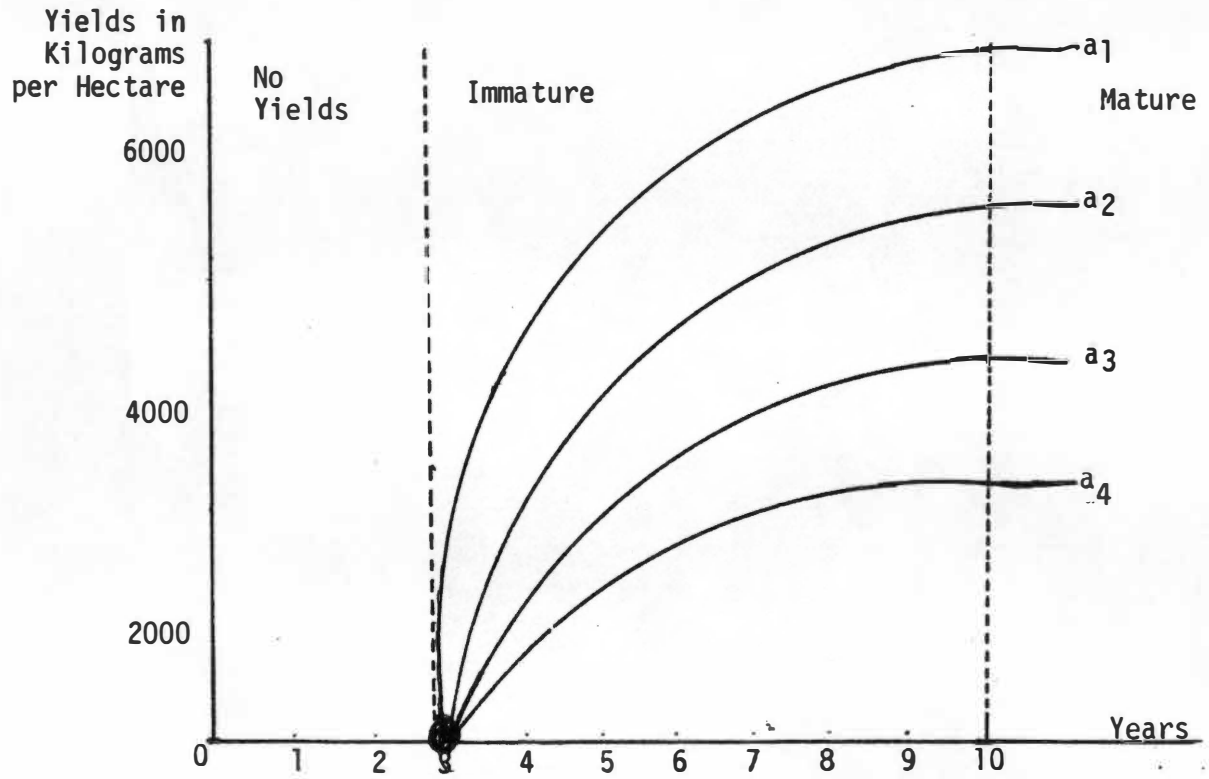

Figure IV.2. Possible Time Paths of Smallholder Tea Production in Tanzania.

Economic Specification of the Production Function

The Problem of Logic

One problem of planning production research is specifying the production function in an economic sense. The economic production function is one which reflects the "true" structure of the production process in an analytical economic sense. Before estimating a production function, one has to make several choices as to what will be estimated and how.[21] Ideally, correct answers to these questions lie in the economic, biological, and/or physical logic underlying the production process. In such terms, a given production process has an "approximate" functional representation involving a set of variables given as a single or simultaneous set of equations. Economic logic provides the conceptual framework of the production process in terms of the economic theory. All relevant information is not known with certainty, especially in the institutional environment in which the economic agents (producers and consumers) operate with inadequate information. Information is incomplete regarding economic variables as well as the logic of the entrepreneurial decision making processes. The problem of economic logic using incomplete information is also compounded when biological logic suggests that the biological processes are not completely known. This is generally true in cases where the underlying logic involves such

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[21] E. O. Heady and J. Dillon, Agricultural Production Functions (Ames: Iowa State University Press, 1962), p. 195.

phenomenon as plant cell mechanisms, photosynthesis, and nutrient absorption. Consequently, omissions of unobserved, but relevant variable factors that affect the biological or physical production function likely occur. Such is likely in tea production where the biological process is not fully understood.[22] The result of estimating such a production function is one of getting biased estimates[23] resulting from specification error. That is, when the model specified to estimate the production function is inadequate in terms of logic and appropriate functional relationships, such bias can occur.

However, because of practical research problems such as limited time and money, "hybrid average" production functions have generally been used such as in the use of cross sectional data in the estimation of the smallholder tea production function in this study. The production function estimated from such cross sectional data is different from the production function encountered in economic theory. It represents an "inter-firm" rather than the "intra-firm" production

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[22]See, for example, T. Eden, Tea (3rd Ed.) (London: Longman, 1976).

[23]Z. Griliches, "Specification Bias in Estimates of Production Functions," Journal of Farm Economics, 39 (1957): 8-20; J. Johnston, Econometric Methods (2nd Ed.) (New York: McGraw-Hill, 1972), p. 168; Y. Mundlak, "Empirical Production Functions Free of Management Bias," Journal of Farm Economics, 45 (1961): 44-56.

which depicts the theoretically correct production surface along which all firms would tend to move.[24]

An interfirm production function (in its cross-sectional variant used in this study) gives the relationship between the output of any firm (among those included in the study) and the quantities of the factors that it actually uses. It is thus an "average" production function reflecting the locus of the output and factor quantities of all the firms included in the study. It was assumed that these quantities are the profit-maximizing quantities.[25] The "average" production function is an ambiguous concept in the sense that it does not say what the word "average" refers to. Though there is considerable debate in the literature about the definition of the "average" production function,[26] the assumption in this study was that firms use average technology.[27] To the extent that the estimated production function is an average one (hybrid), it is still useful. Intuitively, firms are likely to move along the average (hybrid) surface rather than the theoretically correct product

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[24] M. Bronfenbrenner, "Production Functions: Cobb-Douglas, "Interfirm, Intrafirm," Econometrica, 12 (1944): 36-37; M. W. Reder, "An Alternative Interpretation of the Cobb-Douglas Function," Econometrica, 6 (1938): 143-153.

[25] Ibid.

[26] H. Mendershausen, "On the Significance of Professor Douglas' Production Function," Econometrica, 6 (1938): 143-153.

[27] See for example discussion by D. I. Aigner and S. F. Chu, "On Estimating the Industry Production Function," American Economic Review, LVIII, No. 4 (1968): 826-839.

surface. With respect to policy issues, the hybrid production function is of interest in that it depicts a growth path of the input-output relationships of the firm over time.

Choice of Variables

Generally, the construction of econometric models indicates that, due to the hybrid nature of such models, the researcher has to compromise between what is practical, in terms of data availability, the resources available for estimation, and theoretically ideal models. Also, the number of variables is limited by ease of management both in terms of estimation and of testing hypotheses. This study contains nine variables which are considered as depicting the input-output relationships of smallholder tea production in Tanzania.

The short-run conceptual production function (input-output relationship) for the production process for a smallholder tea farmer was represented in a general form as:

$$Q_j = f\,(X_{1_j}, X_{2_j}, \ldots, X_{9_j}) \qquad \text{IV.5}$$

where

Q_j = output of green leaf measured in kilograms per year for the j-th farm

X_{1_j} = labor spent in tea production in mandays per farm per year

X_{2_j} = land area under tea cultivation in acres

X_{3_j} = bush population or number of trees per farm

X_{4_j} = tools and equipment in shs per farm per year

X_{5_j} = fertilizer and insecticide expenses in shs per farm per year

X_{6_j} = zero-one dummy variable for household head education at least at the primary education level

X_{7_j} = zero-one dummy variable for household head with no formal education

X_{8_j} = zero-one dummy variable for farmer perception of local tea processing plant capacity--inadequate capacity

X_{9_j} = zero-one dummy variable for farmer perception of local tea processing plant--adequate capacity.

Measurement of Economic Variables

Output. The measure of output used was in terms of the physical units, green leaf in kilograms, which is a standard practice of measuring green leaf at the marketing point, the village center. A measure of output in physical units was appropriate in this case because green leaf output is a homogeneous product and measurable in physical terms. Because the concepts of productivity and the production function are basically in terms of physical units, the measure conforms to the traditional concept of the production function. In practice, however, a widely used indicator of physical output is net value product (gross value product less variable factor costs).[28]

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[28]The concept is useful in the determination of marginal values as a common denominator. This can be compared to resource cost. This approach is useful in evaluating resource reallocation efficiency among enterprises.

Because the data were from cross-sectional observations, the problem of price variation was absent when net return is used as a measure of gross economic performance.

Labor. Labor is a primary input in that it is not produced like capital equipment. In traditional, as well as in smallholder cash crop African agriculture, labor is the most important input and accounts usually for over three quarters of the total cost (actual or implicit as an opportunity cost) of production.[29] However, considerable controversy exists over its empirical measurement, especially during the 1960s with conceptual problems such as disguised unemployment and underemployment. These aspects are no longer popular theoretical concepts because the criteria of peak labor need is more relevant in the sense that this need is an operative constraint in African farming systems.[30]

Two approaches to measure labor input are manhours and mandays. The first measurement requires records of hours of work which are generally not available because most farmers do not possess clocks or watches. So this approach is usually considered an impractical

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[29]D. S. C. Spencer, "Micro-Level Farm Management and Production Economics Research Among Traditional African Farmers: Lessons from Sierra Leone," African Rural Employment Study Paper, No. 3 (East Lansing: Michigan State University, 1972), p. 12.

[30]Byerlee and C. K. Eischer, "Rural Employment, Migration and Economic Development: Theoretical Issues and Empirical Evidence from Africa," African Rural Employment Study Paper, No. 1 (East Lansing: Michigan State University, September 1972).

method. The second reason for not using manhours is that hired labor is usually paid by the day and not by the hour. The second approach to measuring labor input is to use mandays. The working day is a given part of the cultural pattern of the society. Furthermore, farm workers, whenever hired, are paid by the day and not by the hour. The concept of labor used in this study was the actual number of days worked rather than the available labor.

Standardizing labor input: man-equivalent. Many management decisions in farming are made with due regard to the family situation in the context of a family firm. Usually, under given farm resources, one of the most important decision variables concerns the input of available family labor in the farm operation. As a household, the size of the family is fixed, at least in the short run, but the supply of effort by individual family members might be varied by their own choice,[31] among other reasons, and this labor becomes a variable factor. Generally, the critical determinants of changes in the output levels of plucked green leaf hinge on family labor. The supply of effort by individual family members is in turn determined by relative values attached to leisure and material goods which may be earned or produced by the transformation of their labor into productive processes.

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[31] E. D. Domar, "The Soviet Collective Farm as a Producer Cooperative," American Economic Review, LVI, 4 (1966): 735-749.

In both cases, family and hired labor, the labor input consisted of adult male, adult female, and child labor. Hence, expressing different labor into standardized quantities for comparison purposes became necessary. The theoretical basis for such standardization is generally based on the relationships among the various kinds of labor with regard to skill, sex and age. One assumption is that skills are homogeneous among various age or sex groups. This assumption is reasonable in that most rural workers perform simple agricultural operations and have little or no alternatives for non-agricultural employment.

Conversion of different categories of labor into man-equivalents requires appropriate weights. Considerable controversy is present in the literature as to the appropriate weights. Decisions to adopt one type of weights over others have largely been arbitrary. In this study, two assumptions were made in determining weights:

1. Physical labor productivity is initially positively correlated with age up to a certain age after which productivity declines--the retirement ages of 60 for men and 64 for women in Tanzania are considered to represent the beginning of a decline in productivity with age and negatively correlated thereafter with age. The largest rate of increase in productivity occurs up to age 16 years and tends to flatten, but remains positive after that age.

2. The physical productivity of women is lower than that of men.

These assumptions are similar in principle to those of Collinson's[32] but differ in the adopted weight because his weights are detailed and rather difficult to apply.[33] Any precision gained by this method is probably not significant in affecting the results because the differences in his weights and the ones used in this study are not great. The weights used here are similar to those adopted by Norman in his study of farm management in Northern Nigeria.[34]

Labor Group	Age	Man-Equivalent (ME)
Children	7-15	.50
Female Adults	16-64	.75
Male Adults	16-60	1.00
Female Adults	65 or More	.50
Male Adults	61 or More	.50

Such arithmetic weights are simple in making each farm receive equal weight. Similar weights have been used by the World

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[32]M. P. Collinson, Farm Management in Peasant Agriculture, A Handbook for Rural Development Planning in Africa (New York: Praeger Publishers, 1972), p. 15.

[33]One can justifiably argue that plucking operations are not hard so as to require physical exertion. Experiences from crops such as tobacco do suggest that women do as much work as men. However, in the African context, where household chores are generally done by women, one may also argue that by the time they arrive on the farm, they may not compare with men.

[34]D. W. Norman, Methodology and Problems of Farm Management Investigations: Experiences from Northern Nigeria (East Lansing: Michigan State University, 1973).

Bank in the appraisal of the smallholder tea project in the area.[35]

The standardization of labor that assumes homogeneous labor has one major drawback. It does not take into account the intensity of individual workers such as the endurance of effort. This aspect was not taken into account because of the lack of data and of an appropriate cardinal measure. However, in normal years, such as the one under study, differences in the intensity of effort is not likely to affect the measure of this variable because it is assumed that normal intensity is used. It is only in abnormally prosperous years that higher intensity becomes necessary in "excessive" plucking that this item becomes relevant.

Land. Land is a unique factor of production in having a number of properties not possessed by other factors in agriculture or non-agriculture. These characteristics are the legal description which identifies a particular location, size and/or shape in order to distinguish it from another area. Land as space is immobile in that it cannot be moved to combine with other factors of production. Each farm is unique with respect to qualitative aspects such as soil, location and accessibility; these have long been recognized by Ricardo.[36] Because of qualitative differences, land cannot easily

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[35]The World Bank, Tanzania Smallholder Tea Consolidation Project: Staff Appraisal Report, Report No. 2814-TA (May 1980).

[36]D. Ricardo, The Principles of Political Economy, Vol. 1, P. Sraffa and M. H. Doll (Eds.), p. 67.

be substitutable like other factors of production and therefore is a specialized factor of production.

Using size as a proxy for the quantity of land has been a subject of considerable debate in the economic literature. Hawtrey argues for the exclusion of land as a factor of production because it has no market price when it is not traded in the market place.[37] Consequently, it has no market value. The theoretical ground for such a conclusion appears to be based on marginal productivity theory in which land is treated as a fixed factor with no marginal productivity. However, the Ricardian concepts of rent is based on differential rent which presumes that land is abundant and fertile so as to have no rent if only productive and fertile land is cultivated. Ricardian rent arises only where qualitative differences in the land exists so that land receives the remainder of the product above the marginal productivities of the other variable factors employed on the poor land.[38]

Whether land receives residual return or has no marginal productivity of its own is really an unimportant one. The difference is really an apparent one because it is assumed that there is no way of acquiring additional land. Clark has argued that the

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[37] R. Hawtrey, "Production Functions and Land: A New Approach," Economic Journal, 70 (1960): 114-124.

[38] D. Ricardo, op. cit.

producer who secures additional land (as in the Ricardian case of boundless or elastic supply of land) to utilize with given resources, it is likely to be freed from the diminishing returns to which he has been subject and yield would be increased.[39] This increase in the marginal product of land is mathematically identical with the residual share found in the traditional way. In the case of Njombe, with a population density of about 23 persons per square mile and with estimated arable land for both tea and other crops of 7681 sq km and only 748 sq km cultivated (10 percent) at present, a potential opportunity exists for expanding area under tea before the quantity of land becomes a significant constraint to tea production. Therefore, land size variation is a critical factor in affecting the total output of green leaf.

Another method of valuing land is by a capitalization method which is a ratio of net return to an appropriate discount factor. As an income earning factor, use value that may or may not be imputed is used rather than the market price. This method is perhaps more appropriate in areas such as Tanzania where land is generally owned by the government. Under this particular situation, land would not have a meaningful supply curve. A serious drawback of the capitalization method in land valuation is the selection of the appropriate discount factor. These practical problems with land valuation prevented distinction of land by quality and led to a simple size measure for quantity of land in this study.

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[39] J. M. Clark, "Inductive Evidence on Marginal Productivity," American Economic Review, 18 (1928): 457.

Bush population. While the quantity of land is a proxy for land input, it does not measure the planting density of individual trees or bushes on each farm. Because the number of individual trees on a farm is a reflection of spacing, population density of trees is critical in determining yield per land area. The closer the trees are planted (i.e., over some range of bush population), the higher the output of tea per land area. The output of each farm does not only depend on the plant population but also on age of the plant. Younger and immature trees are likely to have lower yields than mature ones.

Tools and equipment expenses. Though tea operations are generally labor intensive, a number of items are required to perform the various tasks efficiently. Among the major capital items, tools and equipment required are pruning knives, matchet, axe, hoes, plucking baskets, plucking caps and plucking coats. These items represent a small proportion of the total costs and their aggregation would not present serious problems. Ideally, the concept of the amount of capital employed corresponding to the services provided is generally accepted. However, in practice, empirical studies have used the concept of net capital; that is, gross capital less depreciation (Cobb-Douglas).[40] This concept, though used here, suffers

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[40] C. W. Cobb and P. H. Douglas, "A Theory of Production," American Economic Review, 18 (1928): 139-165, clearly pointed out the problems of using book value and the ideal measure of capital. Ideally capital should reflect annual input rather than net investment. If they are perfectly correlated, it would pose no problem except in the interpretation of the estimates.

from one major problem. It reflects age of the equipment rather than a decline in efficiency as the equipment ages. The assumption is that older equipment when placed in service with new equipment would provide the same services at the same rates.

However, the approach that uses net capital (book value less depreciation) has been a standard practice used in the measurement of capital. The book value reflects the acquisition price and does not account for any price changes that might have taken place. Since most of the tools were estimated to have an average life of three years, the price effect is not expected to affect significantly the precision of the variable because capital represents a small fraction of the total input costs. Therefore, no attempt was made to adjust this factor for any changes in capital values. Because depreciation is a noncash expense and reflects a loss in value from age, wear, tear, and obsolescence, an accounting procedure was used in this study to estimate the decline in value by subtracting it from the original book value.

Capital services. Two aspects of crop services in the tea production are (1) manure or chemical fertilizer as triple super phosphate (TSP) and nitrogen-phosphorus-potassium (NPK) and (2) insecticide expenses. These two items are distinguished from capital in tools because they are provided by TTA.

Soil is a capital asset which, when used over a long time, depreciates in some situations. According to Mann, Eden and Milne,

the Njombe tea producing soils are of the Catena type with lower layers reflecting red soils while at the bottom of the slopes, black organic matter is found.[41] These soils are generally leached due to the high rainfall and the subtropical temperatures. They are acidic and low in fertility.

Because of the perennial nature of the tea crop and the permeability of the soils used in its production, the root system has greater scavenging power than coffee and some other crops.[42] Consequently manuring the tea crop becomes necessary to help maintain soil fertility and tilth. Evidence seems to suggest that manuring tea land of moderate fertility over a period of years even enhances its fertility.[43] The amount of capital spent on the purchase of fertilizer was used as a proxy for measuring the quantity of this variable. The hypothesis was that as fertilizer is added in units of uniform size as recommended by TTA, the output of green leaf will also increase up to a point after which additions of fertilizer units to a fixed quantity of land would result in diminishing total yields.

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[41] H. H. Mann, Report of Tea Cultivation in Tanganyika Territory and Its Development (London: Crown Agents for the Colonies, 1933), as quoted by Eden, op. cit.; G. Milne, A Provisional Soil Map of East Africa 1936 (London: Crown Agents for the Colonies), as quoted by Eden; T. Eden, "Some Agricultural Properties of Ceylon Montane Soils," Journal of Soil Science, 2 (1951): 43.

[42] T. Eden, Tea (3rd Ed.) (London: Longman, 1976).

[43] Ibid.

The major insecticide used in maintaining the bush trees is Gramazone. Because tea is a perennial crop with substantial capital requirements at the beginning, such as in clearing bush, plowing, and the purchase of tea transplants, the maintenance of the tree stock becomes of vital importance. Expenses on insecticide are an important factor in the successful cultivation of tea. Finally, because of the relatively small expenses for fertilizer and insecticide, these two items were combined into one category and referred to as "capital services" in this study.

Education. An important difficulty with most practical studies of production functions is that all factor inputs cannot easily be measured in a cardinal sense or at best can be quantified only roughly. Consequently some factors are omitted from the analysis. Griliches has examined the effects on estimates of such omissions for relevant immeasurable factors such as management.[44] The estimates are biased if excluded variables are related to the included independent variables in the model. For this reason, omission of management is likely to be a problem. To overcome partially the difficulty of measurement, a proxy for the management variable was used. The proxy for management that was used was the number of years of formal education the farmer had attained. Two categories of education level were selected; no education and at least a primary

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[44] Z. Griliches, op. cit.

education. The hypothesis was that a positive correlation exists between amount of green lead produced and management. Increasingly better management, as measured by level of education, is reflected by the farmer being increasingly aware of the importance of sound cultural practices such as proper plant spacing, pruning and plucking. Such practices depend upon understanding the importance of supervision which, in turn, generally depends upon the level of education the farmer had previously acquired. Therefore, the differences in education of individual farmers (household heads) are hypothesized to exert a positive role in accounting for differences in productivity.

Local Processing Plant Capacity

There are two local processing plants in the area under study--Lupembe and Luponde plants. Lupembe processing plant had a capacity of processing a maximum of five million kilograms of green leaf tea. Luponde plant had a maximum capacity of about two million kilograms of green leaf tea. There was unprecedented increase in the green leaf tea output in recent years. Part of the increase came from "illegal" planting which TTA and the World Bank were not aware when they initially planned for the plant capacity at Lupembe. At Luponde, there was political pressure from the local politicians who encouraged tea plantings on collective farms without consideration of its impact on the local processing plant. The result of tea expansion has been overproduction. This led to rationing of output

from individual or collective farms. To an individual farmer, this may be interpreted as a "reduction" of the "potential" local plant processing capacity.

Algebraic Form

The problem of selecting and using appropriate equations to describe input-output relationships is first a theoretical economic problem and then an empirical one. The algebraic function depends on the logic of the production function which is not precisely known. Specifying the equation(s) that describe the complicated "true relationships" found in the physical and social spheres of the agricultural production process is a difficult one. While the appropriate equations are usually described in terms of logic, disturbances created by numerous uncontrolled physical, biological, and institutional variables tend to obscure the "true relationships." Consequently, the logic of the production function (the nature and causality of such input-output relationship(s)) is not known with certainty. In geographical areas, such as Njombe, production function studies are scanty and little or no experience is available to help the researcher determine the type(s) of equation that best expresses the relationship(s). Subsequently, the choice of equation type and number of equations becomes a fairly subjective one.

In most productivity studies related to agriculture, one of the widely used functional forms is the "modified" Cobb-Douglas type expressed in power form without restricting it to be a homogeneous function of degree one in inputs (or exhibiting constant

returns). The function used in this study is of that type. It permits any one of the three possibilities concerning returns to scale including increasing, constant and decreasing returns. In general form, it is expressed as:

$$Q = f \left[A X_1^{b_1}, X_2^{b_2}, \ldots, X_m^{b_m} \right] \qquad \text{IV.6}$$

where these variables correspond to those in equation IV.5. Because of lack of information, TTA has arbitrarily fitted similar functions in its estimation of smallholder tea production in Tanzania.

The major advantage of using this functional form is that the continuous variables can be transformed into logarithmic form and the parameters estimated by ordinary least squares. For continuous variables, the estimates of the parameters reflect the elasticity coefficients of the production function. This estimation procedure provides the most convenient way to derive and analyze production elasticity directly. Consequently, the analysis of marginal productivity of the selected inputs in the production function is somewhat simplified. The respective marginal productivities are assumed to be positive but declining; that is, the production function is classical in nature with well behaved mathematical properties reflecting diminishing returns throughout.

The marginal productivity of each factor is one of the most important concepts in the theory of production. It is the partial derivative of the output with respect to a given factor used in the production process with all other factors held constant. From

equation IV.6 the marginal product of the k-th input can be rewritten as

$$\frac{\partial Q}{\partial X_k} = b_k A\, X_0^{b_1} \ldots X_k^{b_{k-1}} \ldots X_m^{b_m} = b_k \frac{Q}{X_k} \qquad \text{IV.7}$$

The elasticity of production of the k-th input can be derived using the marginal and average products. The elasticity of production is defined as the percentage change in output with respect to a percentage change in one input while others are held constant.

$$E_k = \frac{\partial Q}{\partial X_k} \frac{X_k}{Q} \qquad \text{IV.8}$$

By substituting IV.7

$$E_k = (b_k \frac{Q}{X_k}) \frac{X_k}{Q} = b_k \qquad \text{IV.9}$$

From equation IV.9 one can see that in the case of the Cobb-Douglas production function, the coefficient of the estimate is also the elasticity of production. It is also constant and its value lies between one and zero if $0 < b_k < 1$. This suggests that a 1 percent change in any variable will always change output by less than 1 percent if $0 < b_k < 1$. This also implies that diminishing marginal productivity occurs as factor levels are increased. This is algebraically shown by differentiating equation IV.7.

$$\frac{\partial^2 Q}{\partial X_k^2} = b_k\,(b_k - 1)\,\frac{\partial Q}{\partial X_k} \qquad \text{IV.10}$$

which will be negative if $0 < b_k < 1$.

Use and Limitations of Production Function Analysis

1. Estimated marginal physical products can be used to derive marginal value products (MVP's). Marginal value products show the marginal impact on returns that can be obtained from the use of different amounts of individual resources for the particular sample of farms. From the MVP's one can evaluate the extent to which resources can be varied to satisfy the first-order conditions of net value product maximization; that is MVP = MFC for all imputs simultaneously, along with satisfying the second-order conditions.

2. Production functions can be used to show substitution rates among production factors.

3. The method does not imply, as does conventional record analysis, that one can continuously add resources to increase output.

4. The basic concepts and estimates of production function analysis provide a basis for using principles of economics. They permit estimation of limits on resource use and substitution of resources. The production function incorporates estimates into a framework to which accepted economic principles can be applied.

5. No claim is made that production function analysis, using the modified Cobb-Douglas function, provides refined guides as to which specific practices or resources a farmer should use. At best it is a broad, rough approximation for examining resource efficiency. It provides suggestions regarding resource allocation. One cannot refine resources sufficiently to allow recommendations for specific

individual farm adjustments. While the method provides resource productivities and suggests directions for reorganization, it cannot give full considerations to functional relationship between products and resources which fall in the complementary and supplementary categories. Because tea is a specialized monocrop, the supplementary relationships with other products are minimal or nonexistent. However, the functional relationships among the inputs, especially the plucking labor and knives and baskets as complementary inputs, are not well defined.

6. Questions arise at the outset regarding the efficiency of the particular algebraic model as compared to others, particularly for estimation of resource productivities at points other than at input means. Further study would be required before any conclusive judgement can be made.

7. Though the method of production analysis uses a "hybrid" or "average" on marginal-type production functions to approximate resource efficiency, it suffers from a statistical problem of overestimation when small farms are expected to increase output on the "theoretical" or "average" production function. For example, in Figure IV.3, I, II, and III are three levels of soil productivities representing three possible yield curves. The points f, g, and h reflect the yields of the three soils. The hybrid function suggests that the farmers who are on production function I at point f can increase yield to OD by increasing the input to OB. It is clear that if the farmer were on I he would increase yield to OC when he

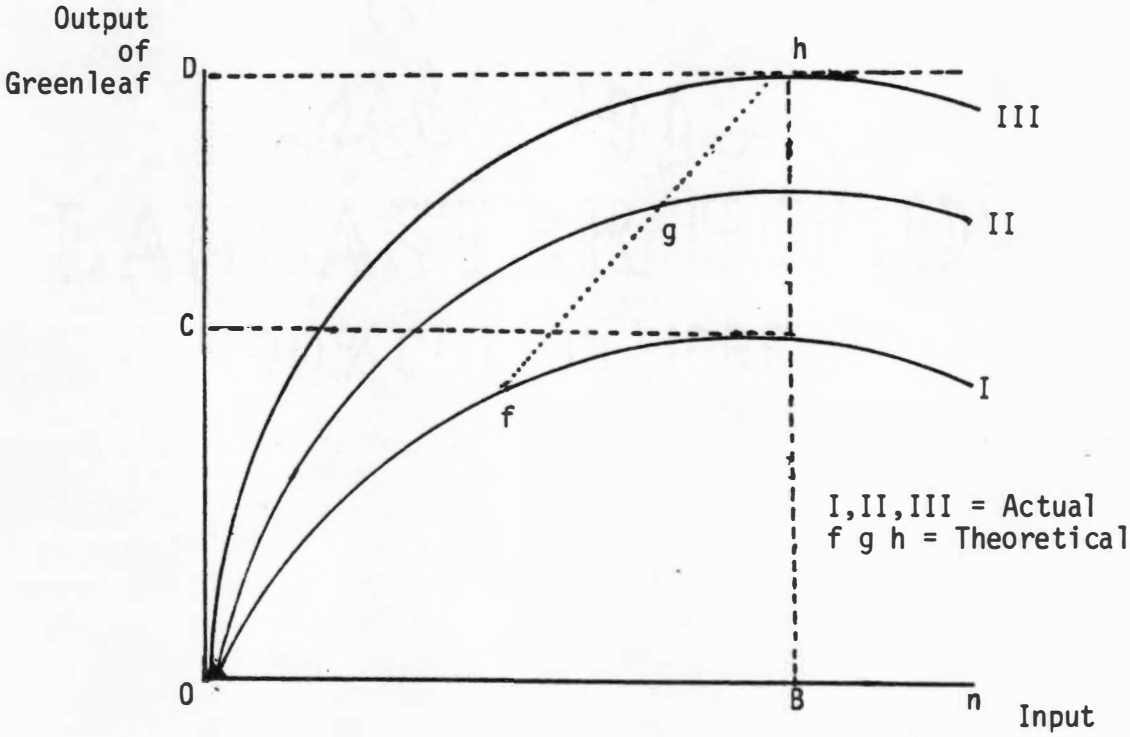

Figure IV.3. Production Function: Actual and Theoretical (Average) Functions.

increases the input to OB. The production function overestimates the average and the marginal productivities of inputs. The slope of the f g h curve is greater than the OI curve. Even if the production function reflected by the f g h curve did not show increasing returns, decisions based on the "hybrid" would still be erroneous. Though the use of homogeneous classification may usually reduce this problem, it does not disappear completely because homogeneity in all respects is not always possible.

8. The study is restricted to a single agricultural reference year, 1982-83. Consequently, output fluctuations common to agricultural activities--due to such factors as climate and market conditions--are absent. To the extent that 1982-83 was an average year in terms of rainfall and prices, this problem was deemed to not be serious in this study.

9. The personal survey method used consisted of a single visit with each respondent to obtain the necessary data for the production function analysis. Hence, some memory bias was likely. Most of the records at TTA were not well kept and were subject to error and memory information from the respondents had to be obtained. Memory bias was not likely serious because of the time of the year the data were collected. Required information was still fresh on the minds of the respondents.

CHAPTER V

VILLAGE AND AREA DESCRIPTION, SAMPLING, AND DATA COLLECTION PROCEDURES AND FORMAL MODEL STATEMENTS

The Village--A Basic Economic and Spatial Unit

In Tanzania, a village may be viewed as an organizational form in which human settlement patterns were transformed into clusters by an Act of Parliament in 1975. The Act gave a legal recognition to all clusters with at least 250 settlers. An average family in Njombe consists of eight persons--the head of the family, the spouse, five children, and one elderly person. The objective of such clustering was to provide infrastructural services on an economical scale. Furthermore, clustering hopefully would increase agricultural productivity. Whether the results of such reorganization improved the quality of life for the settlers has been a subject of both practical and theoretical controversy.[1] Nevertheless, the village is still the smallest economic unit at which most market organization of agricultural products takes place.

In 1980, 238,973 families were living in the Njombe district. Of the total settlers, 217,331 were settled into 159 registered villages. This represented about 91 percent of the total settlers.

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[1]See, for example, A. Mascarenhas, "After Villagization--What?" in B. U. Mwansasu and C. Pratt (Eds.), Towards Socialism in Tanzania (Toronto: University of Toronto Press, 1979), pp. 145-165.

About 5.626 of the settlers (0.2 percent) lived in six unregistered villages. The average number of settlers per village was 1,351.

Apart from providing the smallest economic unit for marketing, a village is also a source of labor. Generally, Njombe as a district has a potential labor supply of 143,520 able-bodied workers which represent about 60 percent of all settlers. Most of these live in the villages. A village is therefore more than a corporate body; it is a natural community. Boeke gives three fundamental principles that distinguish its determination.[2] First, the village is genealogical in the sense that its members are bonded by blood relationship, tradition, or religion. Second, it is territorial because it has geographical boundaries defining the limits of the community. Third, it is communal in character. It is limited by tradition and customs; subsistence agriculture provides the means of livelihood. These are generally valid criteria of village programs in Tanzania. Most of the villages are generally homogeneous because they comprise one tribe or clan. About 120 tribes are in Tanzania.

Description of the Study Area

As indicated in Table V.1, 21 clusters or villages produce tea. They are distributed about evenly between two administrative

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[2]J. H. Boeke, Economics and Economic Policy of Dual Societies as Exemplified by Indonesia (New York: Institute of Pacific Relations, 1953), pp. 21-27.

divisions, Lupembe and Igominyi. However, about 90 percent of cultivated hectarage is found in Lupembe division while only 10 percent is in Igominyi. The two administrative areas also differ in the organizational form of tea production. In Lupembe all smallholder tea is produced by individual farmers from private gardens. In the Igominyi division, tea is produced on collective farms. These are also known as "Ujamaa" farms. Work is done on communal basis or sometimes they hire people from the village or even outside the village.

Three principal factors help explain the uneven distribution of tea production in Njombe. First, Igominyi area has lower rainfall than Lupembe. As has been shown previously, Igominyi receives about 1300 mm (50") of rainfall compared to 1800 mm for Lupembe. The high altitude in Igominyi increases the incidence of frost and cold temperatures which tend to inhibit growth of tea bushes. Second, Lupembe division has a processing factory located at Lupembe. This factory was acquired by TTA in 1967. Its annual capacity was increased to 1.2 million kilograms of processed tea. In Igominyi, one processing plant is located at Luponde. It is owned by a private foreign company, The Patel Printing Press, located in Nairobi, Kenya, and is managed by the Ndugu Sisal Estate located at Tanga, one of the main ports on the northern coast of Tanzania. Luponde factory has a capacity of 560,000 kilograms of processed tea. This plant processes tea from the Luponde estates. If the processing of smallholder tea is added, the capacity is inadequate. This situation has

TABLE V.1

NJOMBE: SMALLHOLDER TEA PRODUCTION

Scheme/ Division	Village	Number of Farmers or Households	Total Land Area in Tea[b] (Hectares)	Proportion of Total Land Area in Tea[a] (Percent)	Location of Processing Factory
LUPEMBE	Lupembe	329	229.3	17.0	Lupembe
	Isoliwanya	208	144.9	10.7	Lupembe
	Igombola	160	112.0	8.3	Lupembe
	Matembwa	15	10.1	0.8	Lupembe
Subtotal		712	496.3	36.8	
IKINDA/LUPEMBE	Ikang'asi	139	97.2	7.2	Lupembe
	Mfinanga	122	85.3	6.3	Lupembe
	Iwafi	163	113.8	8.4	Lupembe
	Lwanzali	66	45.5	3.4	Lupembe
	Itambo	65	23.5	1.7	Lupembe
Subtotal		555	365.3	27.0	
UKALAWA/LUPEMBE	Kanikelele	253	176.4	13.1	Lupembe[c]
	Ukalawa	172	120.0	8.9	Lupembe[c]
	Nyave	72	50.5	3.7	Lupembe[c]
Subtotal		497	346.9	25.7	

TABLE V.1 (Continued)

Division	Village	Number of Farmers or Households	Total Land Area in Tea[b] (Hectares)	Proportion of Total Land Area in Tea[a] (Percent)	Location of Processing Factory
IGOMINYI[d]	Ihanga	332	25.4	1.9	Lupembe
	Itipula	207	34.9	2.6	Lupembe
	Uwemba	473	20.4	1.5	Luponde
	Njoomlole	182	18.6	1.4	Luponde
	Iwungilo	309	15.7	1.2	Luponde
	Igoma	270	9.1	0.7	Luponde
	Uliwa	310	6.7	0.5	Luponde
	Luponde	442	5.9	0.4	Luponde
	Miva	236	3.5	0.3	Luponde
Subtotal		2761	140.2	10.5	
TOTAL		4525	1348.7[e]	100.0	

[a] $\frac{\text{Total village land area in tea}}{1348.7} \times 100$ where 1348.7 is the total hectarge in smallholder tea in Njombe.

[b] In addition to the smallholder tea program in Lupembe, Lupembe estate, comprising 100 hectares, was acquired by all villages growing tea in Lupembe. It was formerly owned by a foreign company--Jiwanjee Co. It is now run as a company known as "Muungano wa Vijiji Lupembe" (Muvilu)--meaning Union of Villages Lupembe.

TABLE V.1 (Continued

[c]A new factory is being built at Ukalawa. When it is completed, Lupembe factory will cease processing tea from these villages.

[d]Tea is produced on collective farms with all households in the participating villages being owners and/or members.

[e]An additional 895.3 hectares of tea is under cultivation on estates. Luponde has 560 hectares which are owned by a foreign company. The remaining hectarage is located in Lupembe. Of the hectarage in Lupembe, 215 are owned by a foreign company, 102 by TTA, and 18 by a Catholic Mission in Njombe. These estates also provide the major alternative source of wage employment in the predominantly nonindustrial Njombe District.

led to rationing of tea leaf for processing from the villages in the Igominyl scheme. Third, because tea is generally produced on "Ujamaa" farms, low labor participation is likely to be an important factor during the plucking period.[3]

Sampling and Data Collection Procedures

In planning research like this study, a state is reached at which decisions must be made about the procedures for collecting factual information. Such decisions include the sampling procedure and the method of gathering information from the units of inquiry.

Selection of Villages

Five villages were selected out of the 21 villages classified as smallholder tea schemes. Three villages came from Lupembe division and two from the Igominyi division. The choice of five villages was largely dictated by the resources at the disposal of the researcher. It was thought detailed studies of a few villages would permit an objective sampling procedure. Because the villages were selected at random, they were assumed to be representative of the

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[3]Considerable arguments have arisen among both policy practitioners and academicians. For example, some critics of "villagization" have argued that villagization is to be viewed as a "technocratic" solution to development. It created an atmosphere in which it was thought that the only thing necessary to promote increased labor participation was to put people into villages. Encouraging people to work together has generally proved to be much more difficult than getting them to live together. See R. Yeager, Tanzania: An African Experiment (Boulder: Westview Press, Inc., 1982), pp. 59-70.

other villages. Hence, in a statistical sense, any measurements made from the villages, such as mean farm size or tea output were equivalent to the same measurements made on the population of all tea farms in the Njombe district.[4] In other words, the sample estimates were assumed to be unbiased estimates of the population parameters.[5]

A representative sampling unit, the village, in the above sense, can clearly be obtained by giving every unit in the population an equal chance of being included in the sample. The sampling design in this case was a two-stage cluster sampling. Because the population elements, farm households, were already grouped into 21 villages or clusters, the first stage in sampling involved the selection of five villages. The list of villages participating in the tea scheme was obtained from TTA. The five villages selected at random were Lupembe, Isoliwanya, Igombola, Uwemba and Luponde. The first three villages were located in Lupembe division while the other two came from the Igominyi division.

Although the key principle in any sampling is representativeness, significant variations exist in the distribution of natural resources, such as soil, micro climatic factors, and cropping patterns. On the other hand, the possibility of wide differences in

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[4]W. G. Cochrane, "The Use of Analysis of Variance in Enumeration by Sampling," Journal Amer. Stat. Assoc., 34: 492.

[5]J. Johnston, Econometic Methods (2nd Ed.) (New York: McGraw-Hill, 1972), p. 125.

resource and enterprise combinations in a peasant economy such as the one under study are limited and, therefore, simplifies the selection of representative villages.[6]

Selection of Household Farms

The second stage in the two-stage sampling procedure was the selection of farms. The farm was the unit of investigation in this study. Information was collected at the farm level and provided the basis for analysis. Because a list of farms was not available. the heads of households producing or participating in the production of tea became the sampling frame. The list was provided by TTA. From this list, 30 households were selected from each village by a simple random drawn technique.

Determination of Sample Size

Apart from representativeness of a sample, accuracy is a second important consideration. The size and structure of the sampling unit is important in determining the validity of the sample. In the two-stage sampling, a village and a farm were considered sampling units. Five villages were selected at the first stage and thirty farms for the second stage. Two considerations were taken into account. The first was for economizing on data collection and

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[6]See, for example, E. S. Clayton, Agrarian Development in Peasant Economies (London: Pergamon Press, 1964) and M. P. Collinson, Farm Management in Peasant Agriculture: A Handbook for Rural Development Planning in Africa (New York: Praeger Publishers, 1972).

the second was for statistical efficiency. A general agreement among economists and statisticians is that a very large sample implies a waste of resources because the additional benefit gained in precision as a practical matter is likely to be outweighed by the cost of additional required research resources. On the other hand, a small sample size may diminish the utility of the results because of unreliability due to high sampling error. The question becomes one of determining optimum sample size. Cochrane lists several factors that are likely to determine sample size. These factors range from the use of the results, the required precision, and available resources.[7] Some equation form that relates the sample size to the desired precision of the sample would be desirable.

Ideally, the sample size should be determined by the above factors, among others, but in particular by the degree of precision required. One problem with the Cochrane procedure is that it presupposes some prior knowledge about the variances with respect to the variables under investigation. With such knowledge one could use formal statistical procedures to get the optimal sample size for given resources and the degree of tolerable error.

None of the above procedures was used in determining the sample size because no prior variances were known. Instead, a sample size

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[7]W. G. Cochrane, Sampling Techniques (3rd Ed.) (New York: John Wiley and Sons, 1977), pp. 73-74.

[8]Ibid.

of five villages was selected. This represented 23.8 percent of the total number of villages under a tea scheme. Because the villages are defined naturally by geography, they were assumed to be mutually exclusive and independent of each other in that no one unit is located in two or more areas.

In the second stage of sampling, 30 household farms were taken to be an adequate sample size with the selected sample size of 30 being the usual minimum acceptable value for large samples. This sample size was assumed to be large enough so that the sample mean has an approximately normal sampling distribution. The sample variance S^2 was used as an unbiased estimate of the population variance σ^2 with $n = 30$.[9]

Degree of Precision

In this study, the confidence coefficient selected was .95. The error limit was therefore 0.05. The choice of 0.95 as a coefficient of the degree of precision in the estimate seemed reasonable for the purposes of the study. Although both the degree of precision and the error to be tolerated are to some extent arbitrary, from the point of view of general policy guidelines, these coefficients are generally adequate and widely utilized. Presumably, the relative penalties of committing Type I and Type II errors are the

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[9] J. T. McClave and P. G. Benson, Statistics for Business and Economics (2nd Ed.) (San Francisco and Santa Clara: Dellen Publishing Co., 1982), p. 329.

guiding incentives (or disincentives) for the researcher in choice of confidence interval and error level.

Data Collection Method

In most cases, a personal interview method was used to collect factual information. Personal interviewing was the most advantageous method because it generally elicited a complete response. The mail questionnaire method was inappropriate in this study because of a high degree of expected nonresponse and ignorance. Postal services were also not efficient. Finally, it was not easy to get the list in advance.

Interviews were done during the months of February and March 1984. The author, assisted by a TTA field assistant and a secondary school graduate who came from the area, traveled from village to village in a four-wheel drive vehicle provided by TTA. All the interviews were conducted by the author and the secondary school graduate. The TTA field assistant was helpful in elaborating various issues with respect to tea during the interview with the respondent. In most cases, output, transplants, fertilizer and insecticide sales were obtained from TTA records.

Description of the Models

Four classes of models were analyzed in estimating the output of green leaf. These models were (1) a linear output-planting sub-production relationship, (2) a multifactor modified Cobb-Douglas

type production function, (3) a linear output-labor categories subproduction function, and (4) output-organizational structure relationship. An important objective in specifying an analytical and descriptive model is to have sound economic logic and statistical properties. Discussion of these properties also helps explain how the system works in a predominantly peasant economy irrespective of the sociopolitical organizational system.

Of the above four models, only the multifactor modified Cobb-Douglas type production function was judged as being appropriate in satisfying the properties of sound economic and statistical characteristics. Hence, (2) above was the main model of conceptual and statistical concern. The model class (1) and (3), being subproduction functions, found specifically on the disaggregated input classes, bush population and labor, respectively, found in (2) as aggregate quantities. These subproduction functions were used to show relationship between the dependent variable and a class of input categories and not on all hypothesized inputs found in (2). Therefore as it will be demonstrated later, model classes (1), (3), and (4) were simply viewed as intermediate steps in establishing a better understanding of the relationship underlying (2). As the models (1) and (3) were specifically found on disaggregated input classes, it would have been ideal to specify model (2) using the disaggregated classes. However, data could not permit one to do so as the data on disaggregated classes was not balanced since there were cells with zero values.

Economic Properties: The Optimizing Peasant

Generally, each farmer is assumed to be able technically to grow any of the crops commonly grown in his/her area. One may therefore speak meaningfully of a "typical farmer." The farmer has fixed resource endowments including labor and technology. Consequently, each farmer does not select input levels randomly. He/she chooses input levels according to some decision rule(s) such as to optimize utility. Under these conditions, the farmer would seek to maximize some objective function which is assumed to be the total utility derived from the product of chosen inputs and nonproduction activities like leisure. With labor as an example, analysis of the discounted value of marginal product and the opportunity cost of his labor become relevant over time. It is therefore not surprising, as Ruthenberg observes in Tukuyu (Rungwe), that the same peasants who neglect their coffee, carefully husband their tea gardens even though there is a lag period of three or four years before the bushes come to bearing.[10] It implies that the small farmer is usually conscious of the time value of money. The farmer is aware that discounted future income streams depend on the care of the trees during the initial period. This practice is particularly prevalent

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[10] H. Ruthenberg, Agricultural Development in Tanganyika (New York-Berlin: Heidelberg Springer-Verlag, 1964), p. 90. The point, being made here, is the willingness of the farmers to experiment with the new crop. Coffee has been grown there for many years and when no new technology is learned, the farmer becomes less interested. Tea has a higher return than coffee. This also provides an incentive to attend to his crop carefully.

when the crop is new. The farmer is readily willing to learn and adopt new techniques of growing the crop.

Ujamaa Block Farms: Optimizing Dividends

While an objective function of an individual farmer with private holdings would be to maximize total utility subject to his/her production function, the question arises regarding the farmer members in the Ujamaa tea schemes: Do they have the same objective function as individuals under purely private schemes? There is a considerable controversy over this issue. The central argument deals with the rules of allocating labor in a centralized economy. There are two criteria: "according to work" and "according to needs."[11] In "Ujamaa" villages, as experience elsewhere suggests competition cannot play quite the same role as it does in villages based on private plots. The rates at which commodities can be exchanged by the buyer and the seller will have to be decreed by the authority. Values, instead of being left to the market forces, are found by a process of calculation by the planning authority.[12]

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[11] For example, see F. A. von Hayek (Ed.), Collectivist Economic Planning (London: Routledge Press, 1935); A. P. Lerner, The Economics of Control (New York: Macmillan Co., 1944); A. Bergson, "Market Socialism Revisited," Journal of Political Economy, 75 (5) (October 1967): 655-672.

[12] A. K. Sen, "Labor Allocation in a Co-operative Enterprise," Review of Economic Studies, XXXIII (4) (1966): 361-371; F. A. Hayek, "Socialist Calculation: The Competitive Solution," Economica, VII: 26 (May 1940): 125-149.

Even though competitive forces may not play as strong a role in the determination of values, members of Ujamaa villages like those in cooperatives are likely to be rational human beings bent on maximizing the benefits from their participation in the "Ujamaa." Therefore, the production function of a profit-maximizing firm would have all the necessary and sufficient properties for a stable equilibrium under perfect competition. Instead of paying wages to its members, the pure Ujamaa organization divides all or part of its discounted net return (above its costs and rent) equally among its members who supply allegedly homogeneous labor inputs in the form of a dividend.[13]

Because labor is the most important input provided by the members, the output and land area are then imputed when aggregate production and total land area are known for a given year. It is assumed that each labor input is paid according to its effort using a "fairness" principle. Where a Ujamaa member is employed, he/she is paid as a laborer as an expense of the collective farm. These wages would be regarded as operating or variable costs. This is done in cases where members are not required to participate because it is not their turn to work. A standard practice is to pay them a daily wage. This is an important factor because it gives the Ujamaa villages freedom to make production decisions provided they do not disband the "Ujamaa" principle altogether.

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[13] E. D. Domar, "The Soviet Collective Farm as a Producer Cooperative," American Economic Review, LVI (4) (1966): 735-749.

The conclusion is that the decision rule under socialism is still the market system. Because of the universal principle of unlimited human wants, the choice principle is still valid.

Model I: Output--Planting Relationship: Capital Stock Adjustment Model

Introduction

From the usual viewpoint of annual production models, perennial crops generally require special conceptualization on nearly every level of analysis. The basic reason for departures from the method employed in the studies of annual crops is the longer time horizon that must be considered by the producers of perennial crops. The time element as suggested by equation IV.2 of the previous chapter affects yield expectations, farm output, and expected income, among many other things. The planting of perennial crops such as tea, is like acquiring a capital asset which lasts for more than the current time period. Therefore, perennials have a multistage profile of annual yields in which several years can pass after planting before any output is realized in some cases like tea. This is then followed by semi-maturity during which yields continue to increase for several years before peak output is realized. Once the tea tree or bush matures, usually around the tenth year, the annual yields level off for about 25 years.[14] This period is then

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[14]Most of the trees in the study were immature. There were no trees above 25 years of age. So the conceptualized model did not include periods greater than nine years.

followed by a gradual decline to levels where it is no longer profitable to maintain the plant--usually around 50-70 years.

In the preceding chapter a suggestion was made that the bush population per land area and the age profile of the existing stock of trees will certainly affect yields per land area. Consequently, this population-age profile will influence the output in any given period. This profile is determined not only by the new plantings but also by decisions to eliminate older trees. For example, if expected tea returns outweigh costs, new plantings will continue and uprooting are not likely to prevail.

In annual crop estimation, land area may be used as a dependent variable to approximate output since the period is only a year. In the estimation of perennial crops, the influence of various inputs on output, require more information. These input-output relationships indicate only "potential" output. This is measured as annual harvested green leaf per farm in this study.

The subproduction function specified in this way reflects capital stock adjustments to changes in expected net value products. However, other factors also operate during the early period. First, the crop is new and farmers may not be willing to risk their resources. So plantings are staggered through time. This has been the case in Tanzania. Second, the Five-Year Planning Program attempts to reach the goal of about one acre (.4 hectare) of tea bush per farm. The program did not start at the same time in all 21 villages. For example, in the Igominyi division, the planting started in the

1974-77 period, while in Lupembe it started in early 1972. Third, shortages of transplants were also experienced during the early period. If all the villages had tried to start planting simultaneously, the problem would have been even more acute. TTA, the sole supplier of transplants was not able to supply these inputs due to inadequate resources. Consequently, the desired bush population level could not be achieved in the same year for all villages and farmers.

Formal Statement of Model I

Because any planting decision about a perennial crop affects output over a period of several years, an assumption was that when tea planters made their decisions they were motivated by a desire to maximize the present discounted value of future revenue streams less discounted cost streams; that is to maximize present value of net value product. Then equation IV.2 can be restated as:

Maximize

$$\pi = \sum_{t=1}^{n} P_t Q_t (1 + r)^{-t} - \sum_{t=1}^{n} \sum_{k=1}^{m} P_{k_t} X_{k_t} (1 + r)^{-t} \qquad \text{V.1}$$

$t=1, \ldots, n$ for input

$k=1, \ldots, m$ for number of inputs used

Subject to the production function

$$Q_t = f(X_{1t}, X_{2t} \ldots, X_{mt}) \qquad \text{V.2}$$

where

π = discounted value of future income streams of net value products

P_t = expected real producer price of tea in period t

Q_t = output per farm expected in period t

r = peasant's subjective rate of discount as defined in the previous chapter

P_k = expected price of input k in period t, k=1, . . . , m

X_k = quantity of input k used in period t

t = time period in years

f = functional notation to depict production function.

Model V.2 (IV.5 in Chapter IV) as multifactor model did not account for output in any one year that is related to the number and yields of bush planted in the preceding years. Hence, the stock of bushes and their ages could be an important set of variables. Output in period t (Q_t) likely depends on a cumulative planting. Bushes less than three years of age yield nothing and could therefore be ignored. Bushes planted at least three years but less than n + 1 (10 years) likely yield notably less than those 10 years old or older. Therefore, a more specific model was formulated as a linear subproduction function which focused only on plant populations of various ages as they affected green leaf output per farm:

$$Q_t = (N_3, N_4, \ldots, N_s) \qquad \text{V.3}$$

where

Q_t = output of green leaf from an individual farm in period t.

$N_3, \ldots, N_s$ = number of bushes of different leaf-bearing ages per farm. Leaf production starts in year 3 and continues through year s.

Hypothesis

Tree stock or bush population age distributions were hypothesized to influence output. Net new plantings were viewed as additions to the capital stock and had the effect of shifting bush population to the "desired" stock level.

The decision to undertake net new plantings was hypothesized earlier to be based on present value of net value product. With production costs and tea yields fairly well predictable, farmer expectations regarding real output prices became important. Empirical evidence suggests that a temporary decline in output prices does not induce uprooting because of the capital investment required during the establishment period.[15] What appears to be an irrational behavior in quite consistent with the long-run perception of the individual household farmer. Producer behavior in this situation was also in agreement with the theory of fixed assets where prior net additions to the bush population were fixed.[16]

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[15]Decisions are based on permanent expected prices (and net value product) rather than temporary fluctuations.

[16]G. I. Johnson, "Overcommitment of Resources in the Production of Farm Products," in Implication of Changes on Farm Management and Marketing Research, CAED Report 29 (Ames: Iowa State Univ., 1967), pp. 180-196.

Model

The specified model for each farm was

$$Q_j = c + B_3N_3 + B_4N_4 + \ldots + B_sN_s + E_j \qquad \text{V.4}$$

where

$j = 1, 2, \ldots, w$

which was rewritten as

$$Q_j = c + \sum_{a=3}^{s} B_aN_{aj} + E_j \qquad \text{V.5}$$

where

Q_j = green leaf output per farm where $j = 1, 2, \ldots, w$

c = intercept term

B_a = yield of bush stock of age a where $a = 3, 4, \ldots, s$

E_j = random error term for farm j.

The hypothesis for testing was

$$B_3 = \ldots = B_s = 0$$

The yield coefficient of bush of varying ages were estimated by using ordinary least squares (OLS). Because this was a subproduction function, the model failed to satisfy the more stringent criteria of economic logic and statistical properties. Therefore, the results must be interpreted with extreme caution.

Model II: The Output-Input Relationship

Introduction

In Model I the capital stock adjustment variables were assumed to be the only variables affecting output. In doing so,

yield estimates could be obtained. A major drawback of this model is that other important factors were excluded so that estimates from it were still efficient but biased. Output, whether it was "potential" or harvested was considered to be already plucked. Of course, output cannot exist without inputs in neither a physical or economic sense. Model I was considered only as yield-age profile or capital stock adjustment model for achieving the "desired" capital stock level. A more extended model such as the one specified in equation IV.5 was deemed to be more appropriate for representing the nature of the output-input relationships. This model is discussed in this section.

Hypothesis

Output variation among individual farms is influenced by the amount of labor provided by the individual family as well as hired labor, the tools used in plucking, the amount of capital services used, level of education of the manager operator, processing capacity of the plant as perceived by an individual farmer., the quantity of land under tea production, and the bush population.

Model

The general production function of equation IV.5 was rewritten in nonlinear form as a Cobb-Douglas type function with a constant term (A) and an error term (E_j)

$$Q_j = A\, X_{1_j}^{B_1}\, X_{2_j}^{B_2}\, X_{3_j}^{B_3} \ldots X_{5_j}^{B_5} + B_6 X_{6_j} + \ldots + B_9 X_{9_j} + E_j \qquad \text{V.6}$$

where

$j = 1, \ldots, w.$

which was then summarized algebraically after converting the continous variables in the model to logarithmic (log) form:

$$Q_j = A' + \sum_{k=1}^{5} \beta_k X_{kj} + \beta_6 X_6 + \ldots + \beta_9 X_9 \qquad \text{V.7}$$

where

Q'_j = log of output of farm j where j=1, . . . w

A' = log of constant term

β_k = elasticity of production for input k, where k = 1, . . . , 5 continuous variables as defined in an earlier chapter in equation IV.5

$\beta_6, \ldots \beta_9$ = coefficients of zero-one variables as defined in earlier chapter as IV.5

E_j = random error term for farm j.

The coefficients of equation V.7 were estimated by OLS methods after reparameterizing by excluding one variable in each of two discrete classes to permit matrix inversion. The hypothesis for testing was

$B_1 = \ldots = B_6 = B_8 = 0.$

Model III: Output-Labor Relationship

Introduction

In defining the concept of a smallholder, family labor was suggested as the major distinguishing feature, especially because tea plucking is labor intensive. For example, in Njombe, plucking labor for 5-year-old immature tea bushes constitutes 70 percent of the total production labor requirement for tea production. As the tea plant matures, the proportion of labor spent in plucking increases so that about 90 percent of total production labor is required for plucking 9-year-old tea bushes.

Apart from plucking operations, labor requirements also include planting, weeding, mulching, pruning and delivery to the buying center as discussed earlier. The first three operations are performed in the early life of the tea plant, the first three years before leaf bearing age. This period was excluded in this model because no output was forthcoming. However, this exclusion was hypothesized to not result in any serious estimation problems because such operations, if and when performed after the third year, are not usually crucial. For example, weeding requirements are minimal after the fourth year. The dense spacing of bushes, the wide lateral growth of branches and their dense foliage all prevent light from reaching the ground. Consequently, growth of weeds is inhibited. The other two operations, pruning and delivery, are not important in their labor requirements when compared to plucking.

Major pruning operations are usually done at intervals of two to three years. Each year, however, some minor pruning is done. With respect to delivery, most of the tea schemes have been planned so that fields are located within a radius of about one mile from the buying centers. Transportation was not therefore considered to be a major limiting factor. Hence, it is hypothesized that the exclusion of these operations did not impose a serious problem provided that an adequate management proxy was included in the model.

Hypothesis

The labor input was hypothesized to be a crucial factor in explaining variations of green leaf plucked. The composition of family labor--men, women and children--was critical because the size of the family labor component is generally fixed for all practical purposes in the short run. Hired labor, which was assumed to be less reliable than family labor, was only used during certain periods.[17]

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[17]Tea has no noticeable peak periods as stated in the previous discussion. However, there is usually a constraint on the family labor due to market conditions. Each village or a group of villages is assigned plucking rounds once a week. If some family members are unable to work, or for some other reason, labor is sometimes hired. In addition, there is usually family reciprocity. Families have traditionally helped each other. This labor was treated as if it was hired. The reason for doing so was because the family usually pays this labor in kind such as local beer and food. This is generally approximately equal to a day's wage rate.

Model

The research hypothesis was that different categories or types of family labor in a subproduction sense were significant factors explaining variations in the amount of tea harvested. Theoretically, the utility function of an individual household head and his family was assumed to be a function of the money income earned from the labor effort used in cash crop and food production, and the amount of leisure time he preferred. He was also assumed to maximize the net present value product, then his subproduction function showing the relationship between output and different labor classes was defined as:

$$Q_{t_j} = f(L_{1_j}, L_{2_j}, \ldots, L_{6_j} | X_{2_j}, X_{3_j}, \ldots, X_{9_j}) + E_j \qquad \text{V.8}$$

where

Q_{t_j} = output of green leaf plucked on the j-th farm in period t

L_{ℓ_j} = quantity of labor category ℓ used in plucking tea (in days per year) on the j-th farm where $\ell = 1, \ldots, 6$

$X_2, X_3, \ldots X_9$ = fixed inputs (inputs as defined in equation IV.5).

Let

L_{1_j} = family adult male labor per farm j per year (days per year per farm)

L_{2_j} = family adult female labor per farm j per year (days per year per farm)

L_{3_j} = family child labor per farm j per year (days per year per farm)

L_{4_j} = hired adult male labor per farm j per year (days per year per farm)

L_{5_j} = hired adult female labor per farm j per year (days per year)

L_{6_j} = hired child labor per farm j per year (days per year)

E_j = random error term for j-th farm.

The linear subproduction function specified for estimation using OLS methods was

$$Q_j = d + \sum_{\ell=1}^{6} B_\ell L_{\ell j} + E_j \qquad \text{V.9}$$

where

Q_j = output of green leaf plucked per farm j where j = 1, 2, . . . , w

d = intercept term

B_ℓ = coefficients on the continuous labor variables L_ℓ where ℓ = 1, . . . , 6

E_j = random error term for farm j.

Model IV: Output-Organizational Relationship

Introduction

Prior to the Arusha Declaration, agricultural activities in Njombe were essentially of the pre-industrial peasant type. The transformation of peasant agriculture in Njombe, as elsewhere, required both technological and organizational changes. During the early sixties, a significant number of workers, particularly from the Njombe district, migrated to Ismani, about 15 kilometers from Iringa. Ismani was the largest producer of maize in the region. Progressive farmers produced the maize. The form of organization was technically capitalistic. The farmer purchased most of his inputs from the market. However, during the Arusha Declaration, these farmers were discouraged and the decline of maize cultivation was the consequence of political action. The workers returned to their homes. Maize cultivation was started in Njombe in the late 1960s. Hybrid maize was planted. Fertilizer was used. Consequently, Njombe became the largest producer of maize replacing Ismani. Most of the maize production was done on small individual private farms. The farms averaged about 0.9 hectares. Lupembe was the largest producer. Its sales of maize to the National Milling Corporation (the monopsonist) amounted to about two-thirds of the total marketed maize in the region[18] every year. Because of

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[18]Tanzania is divided into administrative units. These are (in descending order) region, district, subdistrict, division,

using hybrids and fertilizer, Njombe has come to be regarded as the "Granary" of Iringa. It has a surplus of food and sells a significant amount to the rest of the region and some to other regions in the country.

Organizational Dichotomy

Unlike other tea-growing areas in Tanzania, Njombe represents two interesting forms of organizations in tea production--private and collective, or locally known as "Ujamaa" (familyhood).

A system of organizing production into group rather than individual production is just one aspect of the national agricultural strategy. According to Galeski, Tanzanian collective farms like those found in Njombe are "Type Three."[19] The main distinguishing feature of "Type Three" collective farms is that they were imposed upon the members by an outside force. These were created by the national government and not by peasants themselves. During

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subdivision, village, and the ten-house unit (cell) which is the smallest. Iringa region is comprised of four districts--Iringa, Mufindi, Njombe and Ludewa.

[19]B. Galeski, "The Models of Collective Farming," in P. Dorner (Ed.), Co-operative and Commune: Group Farming in the Economic Development of Agriculture (Madison: Wisconsin Univ. Press, 1977), pp. 17-42. In model (2) this aspect was not included earlier because it was assumed that the behavior of households was the same irrespective of organizational type. It was only in the advanced stage of this study that there was a concern about participation in collective activities, that it became apparent to modify model (2) to evaluate the differences in the organizational type.

the early 1970s, Mr. Kossoky, the Regional Commissioner at the time, successfully forged ahead with collective programs in the relatively poor villages like those under "Ujamaa" tea farms. The major reason for "Ujamaa" tea production was usually to achieve goals of national development and in particular the maximum growth of agricultural export cash crops. This type of collectivization or "Ujamaa" is usually characterized by pooling of resoures, in particular, labor.

The nature of the "Ujamaa" organization can be more clearly viewed as a "producer" collective. But the term "producer" collective is rather ambiguous. It implies that production can be organized on a collective basis and still behave like a capitalistic firm. The collective can purchase all or most of its labor from its members or hire from the outside. The collective organization, that not only pools its land and capital but also its labor, is perhaps appropriately characterized as a "worker-producer" collective. This is perhaps the type of collective farms found in Njombe. The organization that pools its labor resources implies that members can claim a right to employment even when labor supply exceeds demand at the perceived market price of labor. This is not the distinguishing feature of Tanzanian Ujamaa farms such as those found in Njombe because only tea and a small proportion of the production activities are collectivized. The majority of crops under cultivation is not collective.

It is important to distinguish between the two organizational forms for farming because of their hypothesized effects on

productivity. With the Ujamaa farms, the members ideally are required to perform equally for homogeneous labor categories. Consequently, each member receives an equal share of the total product = $\frac{Q}{L}$ as a dividend, where Q is the total product and L is the homogeneous labor input.

Considerable evidence in the literature has suggested that collective farms have generally performed poorly when compared to private individual farms. The close association between the farm firm and the household, as pointed out in the preceding chapter, suggests that the maximization of farm income also maximizes the household income because the two are intertwined. In the collective farm, such a relationship does not exist. Each individual member is different from other members. A central political issue is that those who had more income and production before collectivization tend to lose to those who were poor. Therefore collectivization results, in part, in a transfer of income from rich farmers to relatively poorer ones. Once this aspect is taken into account, one should not be surprised to find a weak response to government appeals for cooperative farming from land owners, especially wealthier farmers. The Tanzanian situation would seem to suggest that collective farms were embraced in the relatively poor villages and not in the wealthier villages as reflected by the tea production programs in Njombe. Igominyi division, which has collective farms, is relatively poor compared to Lupembe division which has no collective farms.

Hypothesis

The null hypothesis for testing was that collective tea farms have the same output as privately organized farms. In other words, the pooling of villages as was done in the previous models was economically justified. The assumption in the previous models was that there were no organizational differences. The question of interest was determining the major source of differences in green leaf output per farm between those farms under private ownership and those owned collectively. If organizational dichotomy is an important influence, then pooling of the farms from the two organizational groups could lead to specification error. Some factors were omitted in Model II. One of these factors is the nature of the organization of tea production. Model II was reformulated to account for the possible effect of organizational type. Organizational type was allowed to enter the equation as a qualitative variable without having any specified interaction with other variables and had the effect of shifting the intercept only.

Model

The reformulated conceptual Model II (Cobb-Douglas type except for dummy variables) was respecified by adding the discrete variable class, organizational type, to the model:

$$Q_j = A\, X_{1_j}^{\beta_1} X_{2_j}^{\beta_2} \ldots X_{5_j}^{\beta_5} + \beta_6 X_{6_j} + \ldots + \beta_{11} X_{11_j} + E_j \qquad \text{V.10}$$

where all variables were as defined in IV.5 except

X_{10_j} = zero-one dummy variable for collective farm organization

X_{11_j} = zero-one dummy variable for private farm organization.

The Cobb-Douglas-type regression model, after reparamaterization to avoid matrix singularity and conversion to linear form logarithmic transforation of the continuous variables was

$$Q'_j = A' + \sum_{k=1} \beta_k X'_{k_j} + \beta_6 X_{6_j} + \beta_8 X_{8_j} + \beta_{10} X_{10_j} + E_j \qquad \text{V.11}$$

where

Q'_j = logarithm of output of green tea leaf from farm j, j = 1, . . . , w

A' = log of intercept term

β_k = elasticity of production for input k where k = 1, . . . , 5

X'_{k_j} = logarithm of input k where k = 1, . . . , 5 continuous variables used by farm j

$\beta_6, \ldots, \beta_{10}$ = coefficients of zero-one variables

$X_6, \ldots, X_{10}$ = discrete variables (defined in IV.5 and V.10)

E_j = random error for farm j

The coefficients of equation V.11 were estimated by OLS methods for testing the null hypothesi s,

$\beta_1 = \beta_2, \ldots, = \beta_{10} = 0.$

CHAPTER VI

EMPIRICAL RESULTS AND ECONOMIC ANALYSIS

The Survey

Appendix A summarizes the major numerical results of the survey. All the variables presented are averages of the pooled sample farms. There were 150 farm households from the five selected villages producing tea. On the average, tea cultivation is a recent activity with an average cultivation period of about six years.

There appeared to be no alternative employment outside the agricultural sector. Nearly 99 percent of the farm households were peasants. The average family size was relatively high by Western standards with about eight persons per household--five children equally distributed between both sexes. There was at most one elderly person per family, suggesting that in the traditional society the responsibility of taking care of the elderly is still a family obligation. Most of the dependents were children below 15 years of age. Seemingly, the household head and his or her spouse were predominantly the major labor income recipients for supporting the young children and the elderly dependent. Because primary education was compulsory, this group was unavailable for plucking tea some of the times.

Average utilization of labor was about 28 mandays per year per farm. Most of the labor, 21 mandays (75 percent), was provided

by family members; the remaining 25 percent or 7 days was casual labor. Casual or part-time labor was usually employed because of the nature of the crop. The time between plucking and delivery to the factory was four hours. In addition, buying centers usually closed between 3 and 4 o'clock in the afternoon. Consequently, plucking had to be finished and the green leaf delivered to the buying center before closing time. This time constraint usually necessitated the employment of part-time labor.

While labor utilization is a flow concept, the average available labor supply as expressed by the survey respondents was about 87 mandays. Sixty-six (76 percent) of the total mandays was the average amount the family was willing to supply if tea production was expanded. This situation suggested the absence of a labor constraint problem which was understandable given no alternative source of employment outside of agriculture within Njombe. At current prices, tea was the most profitable crop with a net return of about shs 1234. Tea prices were raised during the 1984-85 crop season to shs 4.1 with a resulting net return of shs 2097 (Appendix A, No. 28). In fact, the peasants preferred to expand cultivation of tea from their current acreage of 0.59 acres to about two acres. The intended average aspirations for tea expansion appeared to be higher for private individuals (2.9 acres) compared to the collectives (0.79 acres).

Average expenses on tools and equipment was about shs 202 per year. Operating capital or capital services such as fertilizer

and insecticide was shs 192 and was divided approximately equally between the cost of fertilizer and insecticide. A limited amount of income was received from livestock. However, milk sales were insignificant as most of the milk produced was for domestic consumption (Appendix A, No. 23).

Average capital in the form of tools and plucking baskets was shs 505, which was over twice the amount for fertilizer and insecticides. Tools and baskets are durable items with average lives of three or four years, respectively, and were purchased in advance. They were lumpy inputs in the sense that they are not used fully in a single crop year.

Most of the tea bushes were still immature. The average bush per farm was about 2261 bushes which were unevenly distributed among the various bush age groups. The mode was 485 bushes in the seventh year with fewer for the ninth (350) and fourth (197) years. The remaining age groups had bush population ranging between 332 for fifth year to 441 for eighth year. No three-year-old trees were found in this survey. Mature trees (10 years or more) were few with an average of 21 bushes per farm.

Among the major problems of tea expansion were inadequate labor participation on collective farms and inadequate processing capacity (Appendix A, Nos. 15 and 22). The incentive to work on Ujamaa farms appeared to be largely caused by absenteeism of heads of households who usually sent children as their representative. The major cause of such absenteeism was lack of proper incentive

schemes in rewarding the hardworking individuals. Because the total product was equally distributed among the members, some individuals likely lost through this procedure. The losers were usually those who contributed more than the others. While incentive schemes were mainly an internal problem, inadequate processing capacity was an external problem. At Elmiwaha Sister's Convent in Igominyi division, 1.2 acres of tea were cultivated by the nuns. Their productivity was about 2429 kg per acre. They complained of the inadequate processing capacity at Luponde which resulted in rationing their green leaf. Similar complaints were expressed by almost all the respondents in the survey.

Model I

Agronomic analyses of tree yield responses have been based on the premise that a functional relationship exists between the yield of immature bushes and their ages, other things remaining the same. This relationship was not precisely known because the yield response relationship to age is not well developed for Tanzanian smallholder conditions. The results obtained from empirical findings, whether from experimental or cross-sectional data, likely only provided an approximation of the mathematical relationship.

The results of Model I equation V.3 were obtained and were:[1]

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[1]Unless otherwise stated throughout this chapter the values in the parentheses under each coefficient are t-ratios, S_0 refers to standard error of estimated (predicted regression line), and CV means coefficient of variation.

$$\hat{Q}_j = 21.0017 + 0.0822N_{4_j} + 0.1062N_{5_j} + 0.2217N_{6_j} +$$
$$(0.075) \quad (1.25) \quad (1.87)^* \quad (3.64)^{**}$$
$$0.3452N_{7_j} + 0.5071N_{8_j} + 0.0628N_{9_j} \qquad \text{VI.1}$$
$$(5.18)^{**} \quad (11.39)^{**} \quad (1.78)^*$$

$F = 119.21 \quad S_Q = 182.9939; \; SE_Q = 15.4108$

$\bar{R}^2 = 0.835$

*Coefficient is significant at the 10 percent level.

**Coefficient is significant at the 5 percent level.

The variables were:

$\hat{Q}_j$ = estimated green leaf output per farm in kilograms per year for the j-th farm (j = 1, . . . , 150)

N_{4_j}-N_{9_j} = number of trees of leaf bearing ages 4 through 9 years.

As the results from the cross-sectional study suggest, 83.5 percent of the total variation in output of green leaf per farm was accounted for by differences in the stock of trees of various ages prior to maturity.

All signs of the coefficients were positive and consistent with the economic logic of production. Except for the coefficients of the number of bushes for years 4, 5 and 9, all remaining coefficients were significantly different from 0 at the 5 percent level--the selected risk level. However, all coefficients (except year 4) were statistically significant at the 10 percent level.

The model results suggested, for example, that an additional six-year-old tree would increase output by .22 kilograms per farm, all other bushes of other ages remaining unchanged. In addition, as the trees mature, output increased, as expected from physiological growth and increase in the number of branches as described earlier. For instance, an increase of one seven-or eight-year-old tree would increase output by .345 and 0.507 kilograms per farm, respectively, all other variables held constant. The reason for the slightly lower output for year nine in this study might be attributed to the smaller number of observations for this age group. As stated earlier in the survey summary, the average number of nine-year-old trees was 350 compared to six-, seven-, and eight-year-olds, which had over 430 each per farm. A similar argument might be used for the lack of significance at the 5 percent level for the four-, five-, and nine-year-olds also. For the coefficients for the four-, five- and nine-year-old bushes to be conclusive, additional observations might have been needed. However, the coefficients, at least, had the expected signs.

Finally, one point concerning the interpretation of results was the intercept term. Ideally, a subproduction relationship must have economic meaning. In this particular case, the intercept implied the effects of the true intercept or constant term as well as other variables not included in the model. A more complete specification of the production function might have permitted a reasonable economic interpretation. However, as specified, the

intercept value had no real economic interpretation and "nonsensical" in this model. It was also insignificant.

The results from a subproduction function like this one are subject to specification errors. They tend to overestimate the influences because of the omitted variables which were likely to be correlated. The estimates obtained from this model are still efficient but biased. Therefore the results obtained from this model must be interpreted with extreme caution.

Model II

The economic production function, as earlier discussed, tended to reflect a more complete structure, in an analytical, economic sense, of the production process. Economic logic partially determines the pattern of production process. The behavior of the entrepreneur is a prime example. Because the economic process was not known with certainty, the production functions estimated from the cross-sectional data were "hybrid" ones. One such estimate for Njombe smallholder tea producers was given in a general form as IV.5. This equation was estimated using OLS in the forms of equation V.6 and V.7 after converting continuous variables to logarithms and omitting X_7 and X_9 to permit estimation.

$$\log Q_j = f(\log X_{1_j}, \log X_{2_j}, \ldots, \log X_{5_j}, X_{6_j}, X_{8_j}) \qquad \text{VI.2}$$

where

$\log Q_j$ = logarithm of green leaf output from farm j in kilograms per year (j = 1, . . . , 150)

$\log X_{1_j}$ = logarithm of total labor in mandays per farm per year

$\log X_{2_j}$ = logarithm of land area in acres per farm under tea cultivation

$\log X_{3_j}$ = logarithm of bush population in number per farm

$\log X_{4_j}$ = logarithm of capital in tools, shillings per farm per year

$\log X_{5_j}$ = logarithm of capital services, shillings per farm per year

X_{6_j} = dummy variable, X_{6_j} = 1 if the household head had at least a primary education, otherwise zero

X_{8_j} = dummy variable, if farmer perceived local green leaf processing capacity was inadequate, X_{8_j} = 1, otherwise zero.

And, by using prime (') to designate logarithms, the estimated equation was

$$\hat{Q}'_j = 3.1604 + 0.4195X'_1 + 0.3388X'_2 + 0.2872X'_3 - 0.0645X'_4 +$$
$$(2.54)^{**} \quad (7.23)^{**} \quad (2.09)^{**} \quad (2.09)^{**} \quad (-1.72)^{*}$$
$$0.0092X'_5 + 0.0751X_6 + 0.0379X_8 \qquad \text{VI.3}$$
$$(0.11) \quad (1.70)^{*} \quad (2.05)^{**}$$

$F = 326.45$; $\bar{R}^2 = 0.941$; SE = 0.266; CV = 4.4607

*Coefficient is significant at the 10 percent level.

**Coefficient is significant at the 5 percent level.

The overall statistical significance of all the variables included in the model was given by the F ratio. The observed F ratio of 326.45 exceeded the critical $F_{.05}$ value of 2.01, suggesting that the influence of the variables considered together was statistically significant and not attributed to mere chance.

The adjusted R^2, reflecting the predictive power of the model, was 0.94; that is, 94 percent of the total variation in Q_j was explained by the variables in the model. The standard error of the estimate, reflecting the extent to which actual observations in the sample deviate from the regression line, was also small at 0.266. The relatively high R^2 and the small standard error of the estimate and the coefficient of variation suggested that the model was fairly predictive.

While the overall significance of all the variables taken together was affirmative, the analysis of individual factors was necessary because of evaluating the marginal productivity of each factor. Such an analysis is central to the analysis of resource allocation and distribution theory.[2] In general, all the signs were positive and conformed to the economic theory, except capital expenses for tools and equipment. All coefficients, except capital, had values less than one and greater than zero. That is, the estimated production function was in the zone of rational action

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[2]A thorough analysis of factor distribution would also require consideration of the supply conditions for factors.

for a typical neo-classical production function. It allows for substitution of factors crucial to allocation efficiency and diminishing marginal returns throughout.

The coefficients for continuous variables were taken as simple approximations of elasticities at their geometric mean. The sum of elasticities was 0.9901. This was approximately equal to one. This sum implies that if the quantities of all the variables in the model were increased simultaneously by 1 percent, output would increase by about 1 percent. This result suggested that the returns to scale are nearly constant in smallholder tea production, as has previously been shown for India, Brazil, and the United States.

The analysis of marginal productivity is important in the theory of production; hence, the magnitude and direction of the coefficients become crucial in this analysis. The contribution at the margin of individual inputs becomes critical. Of the seven variables included in Model II, four were statistically significant at the 5 percent level. At the 10 percent level, all the variables were significant except capital services.

In terms of relative statistical importance, total labor--family and part-time or casual labor--appeared to dominate the others in terms of relative contribution. For example, for every one percentage increase in mandays, output of green leaf per farm increased by 0.42 percent. Similarly, this result was followed by land with 0.34, and bush population at 0.29 percent. These results suggested that labor, land, and bush population, the most important

resources available locally, seemed to exert a major influence on the output of green leaf tea as earlier had been pointed out in the literature. The results seem to support these local resources as key decision variables in smallholder development programs as paralleled in the literature.

The sign of capital expenses for tools was unexpected. The coefficient was small and slightly negative. One plausible explanation for the inverse relationship was that tools, such as plucking baskets, knives, hoes, and machetes, are usually purchased beforehand and used irrespective of the amount of green leaf plucked. Furthermore a minimum number of tools is required. Therefore, they could be regarded as "quasi" fixed assets and independent of production level at the typical size of the smallholder. Given that most of the smallholder tea was still immature in the survey area, one may regard the relationship between output and capital for tools as being zero or very close to zero intuitively. The decision to purchase a minimum number of working tools is taken in anticipation of fully mature tea at an anticipated size of operation. Because tools are to be used in the future, the smallholder tends to purchase tools in advance to avert risks of nonavailability at time of need. That is, in countries such as Tanzania where the supply of such tools is likely to be small and availability risky because of low tool factory production at about 20 percent, the smallholder likely will buy in advance to be assured of having tools.

Farmer perceptions about the inadequacy of local tea processing capacity relative to perceived need was statistically significant at the 5 percent level.[3] The problem of low capacity utilization had led to "excess" capacity of plant because of shortages of inputs. Though this has been one of the problems in both tea processing plants at Lupembe and Luponde (usually shortages of imported inputs such as furnace oil), it has not been a major problem in the tea industry. There has been an unprecedented increase in the supply of green leaf produced by smallholders. This unplanned increase in the supply of green leaf was apparently due to "illegal and secret" nurseries from individual private gardens.[4] These nurseries provided an additional source of transplants which led to increasing plantings. TTA was not aware of the impact of these nurseries until it was too late. One result was inadequate processing capacity at Lupembe. A new factory was being planned for construction at Ukalawa to cope

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[3]Farmer perception of inadequate local processing plant capacity was viewed as if it were a reduction of the plant capacity. Since the plant capacity was viewed as a "reduction," the output moved in the same direction. Therefore the positive sign was to be expected.

[4]Personal interview with the Honorable Mr. Jackson Makwetta, member of Parliament for Njombe and also Minister for National Education during February 1984 at his office in Dar-es-Salaam. He provided valuable information on historic and economic development of tea in Njombe. Among the major problems seen today with regard to utilization of capacity were inadequate crop statistics collected by the government and the World Bank. The major statistic that the two sources relied on was the sale of tea transplants. No data were taken of new plantings resulting from private nurseries.

with the increased supply of tea leaf. Expansion and modernization programs were also being discussed by the government and the owners of the Luponde tea processing plant.[5]

Simple correlations were used to measure collinearity between pairs of independent variables and to serve as an indicator of multicollinearity. Consequently, capital services was apparently insignificant because of higher correlation with bush population and land. Application of fertilizer depended on the number of bushes. The number of bushes was also related to the quantity of land. The simple correlation between capital services and bushes was 0.86 and was significantly different from zero at the 1 percent level. The correlation between land and capital services was 0.97. This high correlation was expected because TTA provided fertilizer by the amount of land under tea cultivation. Consequently, because of the correlation between independent variables, one of the OLS assumptions of independence among explanatory variables was violated.[6] The consequence of this was that the precision of the estimates fell because of the difficulty of separating the relative influences of the various inputs included in the model. Larger standard errors

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[5]The United Republic of Tanzania, The Rehabilitation and Expansion Project, Luponde Prefeasibility Study (Dar-es-Salaam: Ministry of Agriculture, TTA, April 1982).

[6]J. Johnston, Econometric Methods (2nd Ed.) (New York: McGraw-Hill, 1960), p. 160.

for specific estimates resulted over what would have been the case without multicollinearity.

Model III

As pointed out in the preceding chapter, the hypothesis presented was that in underdeveloped economies, a tendency exists or recently existed towards a low but positive marginal product of labor. Actual labor services were used instead of available services; that is, the stock of labor. The estimates of the marginal products of labor categories in the subproduction function, equation V.9 of previous chapter, were determined from the following estimated equation:

$$\hat{Q}_j = -30.7743 + 24.7677L_{1_j} + 17.5051L_{2_j} +$$

$$(-2.41)^{**} \quad (6.81)^{**} \quad (6.04)^{**}$$

$$8.4085L_{3_j} + 23.4057L_{4_j} + 11.6058L_{5_j} + 14.8650L_{6_j}. \qquad \text{VI.4}$$

$$(6.39)^{**} \quad (8.39)^{**} \quad (5.07)^{**} \quad (8.55)^{**}$$

$F = 597.28$; $\bar{R}^2 = 0.962$; SE = 9.33; CV = 14.7.

**Coefficient is significant at the 5 percent level.

The variables were identified as:

$\hat{Q}_j$ = estimated output of green leaf in kilograms per year for the j-th farm (j=1, . . . , 150)

L_{1_j} = family adult male labor in mandays per year

L_{2_j} = family adult female in mandays per year.

L_{3_j} = family child labor in mandays per year

L_{4_j} = hired adult male labor in mandays per year

L_{5_j} = labor of hired adult female labor in mandays per year

L_{6_j} = hired child labor in mandays per year.

From the results, all the variables considered as a group were statistically significant as reflected by the high F value of 597.28 compared to the critical value of 2.10 when $\alpha = 0.05$. The predictive power of the model was given by the adjusted $\bar{R}^2$ at 0.962. The standard error showing the spread of observations from the predicted line was 9.33 kilograms which is a relatively modest value for the sample size used. The coefficient of variation reflecting the ratio of the standard deviation to the mean output was 14.7 percent, also a modest figure. Given these statistics, it is suggested that the model was reasonably predictive and fairly precise for the kind of sample used.

The model was also consistent in terms of expected signs. All the signs were positive, suggesting positive marginal products for all labor categories which was contrary to the alleged phenomenon of possible negative marginal product.

The "marginal product"[7] of labor has several interesting features. First, in both cases, adult males appeared to have higher

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[7]Strictly speaking marginal product of labor is likely affected through interaction with other inputs used in the production process. Realistically, output is jointly determined by labor and other inputs. Hence, estimation of marginal products in this case is somewhat limited and should be used cautiously since the model was incomplete.

productivity than adult females. For example, for each additional manday used, output of green leaf plucked increased by at least 23.4 kilograms, other labor categories remaining unchanged. Adult female productivity was slightly less than three-fourths of adult male productivity as argued in Chapter IV. Two main reasons likely led to this difference in productivity. First, adult females performed the domestic chores such as cooking, milking, firewood collection, and house cleaning. They were likely to be more physically exhausted and therefore could not put in as much effort as adult males in plucking. Second, they were likely caring for young children while working because the women were on average, 40 years of age.

The productivity of family child labor was slightly less than half that of family adult male labor. Though the plucking tasks demand less physical effort, the lower productivity of children was likely explained by the younger age as was assumed in Chapter IV. The children required more supervision than adults. Productivity was expected to be lower than adult males because of age and experience differences.

Model IV

The null hypothesis tested in this model was that collective farms have the same output as privately organized farms, while including other production inputs in the model. This model was similar to the Cobb-Douglas function, Model II except for discrete variables

to allow for the effect of form of organization on the intercept term (equation V.11 of the preceding chapter). All variables were the same as those identified in Model II and organizational type was added. The variables in the statistical model were

Q'_j = logarithm of annual output of green leaf in kilograms per farm j (j=1, . . . , 150)

A' = logarithm of constant term

X'_{1_j} = logarithm of total labor per farm in mandays per year

X'_{2_j} = logarithm of land under tea cultivation

X'_{3_j} = logarithm of bush population per farm

X'_{4_j} = logarithm of capital in tools per farm per year

X'_{5_j} = logarithm of capital services per farm per year

X_{6_j} = dummary variable = 1 if the household had at least a primary education, otherwise zero

X_{8_j} = dummy variable - 1 if farmer perception of local tea processing plant capacity was inadequate, otherwise zero

X_{10_j} = dummary variable - 1 if output came from collective farm, otherwise zero.

The results of the estimated output Q_j for Model IV were:

$$\hat{Q}'_j = 0.3144 + 0.9608X'_{1_j} + 0.2589X'_{2_j} + 0.3532X'_{3_j} - 0.0224X'_{4_j} +$$
$$(0.30) \quad (33.01)^{**} \quad (2.07)^{**} \quad (2.92)^{**} \quad (-1.35)$$

$$0.0197X'_{5_j} + 0.0304X_{6_j} + 0.0161X_{8_j} - 0.0182X_{10_j}$$
$$(0.57) \quad (1.77)^{*} \quad (0.91) \quad (-0.64) \qquad \text{VI.5}$$

$F = 2006.52$; $\bar{R}^2 = 0.991$; SE = 0.103; CV = 1.7; DF = 141

*Coefficient is significant at the 10 percent level.

**Coefficient is significant at the 5 percent level.

The high F value of 2006.52 and $\bar{R}^2$ of 0.991 both suggested that a large proportion of the variation in the output of green leaf was explained by the eight explanatory variables included in the model. Total labor, land, and bush population were statistically significant at the 5 percent level. Primary education or higher was significant at the 10 percent level. All remaining variables, namely capital services, perceived inadequate processing plant capacity, capital in tools and the collective form of organization were insignificant, but all had the expected signs except capital in tools.

A potential problem in a model with this many variables is multi-collinearity as discussed earlier in this chapter. For example, discrete zero one dummary variable for the collective form of organization, X_{10}, was insignificant and was correlated with labor, X_1, with a simple correlation of 0.67 which was statistically significant at the 1 percent level.[8] The effect of form of organization was difficult to separate from effects of other factors like labor because of labor participation attitudes that in turn affected

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[8]In order to detect multi-collinearity, a simple regression was run with output Q_j, the dependent variable and X_{10j}, the independent variable. The result showed that the collective organizational variable was statistically significant at the 5 percent level. It had also the expected sign.

labor in plucking and conversely. However, even with the data stringency, organizational aspect could not be separated from such factors as labor because the aspect involved here was the question of labor attitudes toward participation in the plucking operation. Because labor was extremely important in the production of tea, one would suspect the "masking" of the organizational variable, X_{10} by X_1 in VI.5 because they were highly correlated. However, the coefficient on the sign of X_{10_j} being as hypothesized implied that tea output per farm in the collective villages tended to be lower than that of farms located in the villages where private ownership prevailed.

Economic Analysis of Elasticities, Marginal Productivities and Economic Efficiency

Table VI.1 presents the estimated elasticities of the various factors for Models II and IV. No elasticities are presented for the discrete variables because these entered both models as shifters. Therefore they affected the intercept only and not the slopes.

Production Elasticities

In the Cobb-Douglas model, the coefficients of the continuous variables were interpreted as elasticities of the production function. Elasticities were independent of the factor ratios for the continuous explanatory variables such as the land, labor, bush population, capital tools and capital services.

Sum of Elasticities

In interpreting the sum of elasticities, one usually assumes that the economic and statistical models reflect the real world. The statistical model is unbiased if it includes all relevant variables. In this case, the sum of the eleasticities provides an indication of returns to scale. If the sum is less than unity, it reflects in part the extent of the effects of the omitted variables. If the sum is greater than unity, it suggests perhaps, among other things, the various anomalies within the sample data. In terms of returns to scale in this study, Model II, Table VI.1 appeared to exhibit constant returns to scale while Model IV indicated increasing returns. This difference likely was due to the way the model was constructed, among other things.

Marginal Productivities[9]

From equation VI.3 (Model II), the shares of the factors of production were consistent with a priori expectations. The estimated input coefficients was interpreted as elasticities of production for the Cobb-Douglas production function. Labor had the highest coefficient at 0.419. Next in order of magnitude were the coefficients for land, 0.339; bush population, 0.287; capital services, 0.0092; and capital tools, -0.0645.

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[9]Analysis of the factor shares and marginal productivities was based on Model II, the main conceptual model of this study.

TABLE VI.1

ESTIMATED ELASTICITIES FOR THE INTERFARM SAMPLE[a]

Model[b]	Equation[b]	Labor	Land	Bush Population	Capital Tools	Capital Services	Sum of Elasticities
II	VI.3	0.4195**	0.3388**	0.2872**	-0.0645	0.0092	0.9902
IV	VI.5	0.9608**	0.2589**	0.3532**	-0.0224	0.0197	1.5702

[a]*Coefficient significant at 10 percent level.
**Coefficient significant at 5 percent level.

[b]Model and equation specifications can be found in earlier section of this chapter.

One who is familiar with the nature of tea production in the developing countries is not surprised to find the share of labor to be just under one-half of total output. As pointed out earlier, the plucking operation is the most labor intensive activity in the cultivation of tea. Land is also an important decision variable. The expansion of tea farming in Tanzania has been generally the result of extensive farming and has involved the expansion of the land frontier. More land area has been placed in tea production; therefore, it is not surprising to find land second only to labor.

Marginal products of individual factors used in the estimation of the output can be computed by multiplying the elasticity of an individual factor by its average product.[10] Given the relevant production elasticities, marginal productivities can be determined at any point on the production function provided that the input-output levels lie within the range of the sample observations. Even though marginal products can be calculated at any point on the production function, typically it is considered convenient to present the values in terms of an "average farm." Because the data were derived from a cross-sectional study of small farms, it was not reasonable to assume on an a priori basis that all firms were homogeneous and were on the same production function. In the context of the Cobb-Douglas model, computation of marginal productivities

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[10]This method is only applicable for the Cobb-Douglas type models in which the variables are expressed in double logarithms. It is therefore not a general approach.

at the geometric means of outputs and inputs were deemed to be the most relevant approach.[11] As a matter of convenience, marginal products were expressed in terms of marginal value product rather than in physical terms to compare the marginal value of resources to their respective prices. This approach is an appropriate method of evaluating the economic efficiency of resource use in a particular production activity.

The formula used for calculating the marginal value product was

$$MVP_k = E_k \frac{TVP_k}{\overline{X}_k} \qquad \text{VI.6}$$

$$= E_k AVP_k$$

where

MVP_k = marginal value product of factor k used to produce an output in shillings per input unit

E_k = elasticity of k-th factor in producing output

$\overline{X}_k$ = k-th factor used to produce output measured at geometric mean in respective physical units of input

TVP_k = value of output per farm in shillings valued at geometric mean for the k-th factor

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[11] Usually the marginal productivity of any factor depends on the quantity of it already used and on the levels of other factors with which it is combined in the production process. Hence, the estimates widely used in much of the literature are those derived at the mean levels. For the Cobb-Douglas function, the relevant means are the geometric means, the geometric means also provide information about the scale of operations to which each estimate of production refers.

AVP_k = average value product of k-th factor used to produce output in shillings per respective input unit.

Marginal Value Product of Labor

Means for the X_k's are listed in Table VI.2 and AVP_k's appear in Table VI.3. These values were used in computing the respective marginal value products. Table VI.4 presents computed marginal value productivities of the five most important factors for the sample of smallholder tea producers in the Njombe district. Estimates were presented for two models (Model II and IV) for the sake of completeness. The marginal productivity of labor was shs 25.42 per manday worked (or $1.50) based on equation VI.3, while it was shs 58.23 ($3.43) based on equation VI.5.

Opportunity Cost of Labor

Production elasticities indicate the sensitivity of output response to changes in input levels. A question that arises is whether the increased efficiency could be achieved by varying the levels of input utilization by moving along the output curve; that is, on a given production function. This analysis requires the comparison of the marginal value product (MVP) of the input and its marginal factor cost (MFC). In a perfectly competitive economy, this would mean the comparison of discounted MVP and discounted MFC. However, in the case of developing countries such as Tanzania, factor markets are poorly organized. Labor is an example with the economy generally characterized by lack of specialization, the

TABLE VI.2

SAMPLE MEANS OF TOTAL VALUE PRODUCT OF TEA AND QUANTITIES OF RESOURCES USED PER FARM IN SMALLHOLDER TEA PRODUCTION[a] (GEOMETRIC MEANS)

Variable	Value
Mean total value product of tea per farm (shs)	1665.6
Mean input per farm	
Labor (mandays)	27.48
Land (acres)	0.59
Bush population (number of bushes)	2261.4
Capital in tools (shs)	504.77
Capital services (shs)	191.58

[a]Data source from survey summary in Appendix A; means are at geometric means.

TABLE VI.3

GROSS AVERAGE VALUE PRODUCTS PER FARM AT GEOMETRIC RESOURCE MEANS FOR THE SAMPLE OF TANZANIAN SMALLHOLDER TEA PRODUCERS[a]

Labor	60.61
Land (shs/acre)	2823.05
Capital in tools (shs/shs)	0.74
Capital services (shs/shs)	8.75

[a]The gross average product of each factor was computed by dividing the mean gross average value product by geometric resource mean. The computed average included the product returns to all inputs and not simply the return attributable to a single factor. Generally, average value products are used as one measure of efficiency when data on marginal products cannot be obtained.

TABLE VI.4

MARGINAL VALUE PRODUCTS FOR SELECTED FACTORS OF PROMOTION IN THE SMALLHOLDER TEA PRODUCTION SAMPLE[a]

		Variables		
Model[b]	Equation[b]	X_1 Labor	X_2 Land	X_3 Bush Population (Shs)
II	VI.3	25.42	956.45	0.20
IV	VI.5	58.23	730.89	0.26

[a]Calculated only for variables with coefficients that were significant at the 10 percent level or better. The values have been derived from the information in Tables VI.1, VI.2 and VI.3.

[b]Model and equation specifications can be found in earlier sections of this chapter.

marginal factor cost for labor cannot be determined in the market place directly in many cases. The marginal factor cost of labor has to be indirectly determined by computing its opportunity cost. In this study, this was done under two scenarios: (1) Tea expansion did not replace any major food crop,[12] and (2) tea expansion replaced the major food crop.

Under the first scenario, tea and maize were assumed to be supplementary enterprises initially. Tea acreages were planned to be one acre per participating family to ensure enough labor for food production. Under scenario 1 family labor was used to produce both cash and subsistence crops. However, in reality, family labor was not fully utilized during the dry season because most of the maize operations were completed. When the tea plucking rounds were completed, labor was idle. This was not surprising because of the low degree of industrialization and no alternative nonagricultural employment opportunity exists during the dry season. During the dry season, the opportunity cost of family labor was low. However, the only major alternative was employment on the tea estates where operations were usually carried on throughout the year. The average wage rate found at the privately-owned Luponde factory was shs 25.25 per manday.[13] The wage rate was weighted by the potential labor

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[12]The main food crop in this area was maize.

[13]There are no major differences in the wage rates offered among the estates since this is usually a legal minimum wage rate. Obviously, this may be slightly high because during the "slack"

supply in the Njombe district to reflect the opportunity cost of labor.[14]

$$\text{Weighted opportunity cost of agricultural labor} = \frac{L}{p}(W) \qquad \text{VI.7}$$

where

L = potential labor supply in Njombe district

p = population of Njombe district

W = money wage rate in shillings per day paid by Luponde factory.

About 60 percent of the total population was of working age in Njombe; consequently, the weighted opportunity cost of labor was[15]

= 0.60 (shs 25.25) per day

= shs 15.15 per day.

The ratio of marginal value product to opportunity cost provides one version of an efficiency index. Using the results in Table VI.4 for

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season, the supply may exceed the demand at the legal minimum creating "unemployment gap." Even though there are workers willing to work at a lower rate, they cannot do so.

[14]See, for example, P. A. Yotopoulos, Allocative Efficiency in Economic Development: A Cross Section Analysis of Epirus Farming (Athens: F. Constantimidis and C. Milalas, 1967), pp. 194-196.

[15]The weighted opportunity cost is an average rather than a marginal concept. It is used here because the opportunity cost was considered to depend on the alternative employment during the dry season. Since most of the agricultural activities were at their low peaks during this season, there likely was a large "potential" labor force during the off-season. This supply likely would impact on depressing the wage rate. Since there is likely to be an "excess" supply, a weighted opportunity cost was deemed to be a better measure than the marginal factor cost. Because the labor markets are imperfect,

the marginal productivity of labor for Model II at 25.42, the index was 1.68 for the weighted opportunity cost and approximately unity for the unweighted opportunity cost. Under this assumption, it appeared that inefficiency was present under this scenario since the MVP of labor exceeded its opportunity cost.

These computations tended to suggest that in instances of government-regulated pricing of labor such as wage-fixing, the opportunity cost of family labor would tend to be below the minimum wage rate. The tea estates were more likely to fully employ a permanent labor force throughout the year, and the opportunity cost of wage labor was likely to be higher than on the small family farms. Hence, an implication was that on the estates, marginal productivity of labor is equated to its opportunity cost at a value above shs 15.15. In this study, the opportunity cost of labor on the estates was likely somewhat closer to its wage rate of shs 25.25. The efficiency index is therefore approximately equal to unity.

By assuming a constant "true opportunity cost" for family labor of shs 15.15, the quantity of labor that would restore the necessary equlibrium between the marginal value product of labor and its marginal factor cost was derived.

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there are probabilities of different wage rates. This leads to a probability distribution of the wage rate which now becomes a random variable. So the expected wage rate was obtained by multiplying the probability of the labor force during the off-season by the observed wage rate at the Luponde factory. The situation in the study suggested this possibility in which there were many people looking for jobs during the "off season."

By using equations VI.9 and VI.10 the marginal value product of labor was set to equal its marginal factor cost to find the quantity of labor required to restore equilibrium.

$$E_k \frac{TVP_k}{\overline{X}_k} = W_k \qquad \text{VI.8}$$

which was expressed as

$$\overline{X}_k = E_k \frac{TVP_k}{W_k} \qquad \text{VI.9}$$

where E_k is the production elasticity of input k; TVP_k is mean total value product in shillings; W_k and $\overline{X}_k$ are the opportunity cost and quantity of labor, respectively.

The required input changes were computed by assuming successive increases in the quantity of input.[16] This provided a MVP curve depicting the demand for labor with all other factors held constant to bring about the necessary equality between MVP and marginal factor cost (MFC).

Changes in the input elasticity in this case accounted for the changes in the output. For example an increase of 5 percent in the

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[16]Because the problem was to find relative magnitudes in factor changes required to restore labor equilibrium, equation VI.9 could not be used directly to obtain the required changes because of the law of diminishing returns. Consequently, the MVP had to be computed at different input changes using the input elasticity approach. As pointed out in the previous section, the coefficient of production is also the elasticity of production with the Cobb-Douglas type function. Hence, output changes were reflected in changes in b values of the production function. For this method, see, for example, P. A. Yotopoulos, op. cit.

quantity of labor, the marginal value product was computed as

$$MVP_k = \left[\frac{b + 0.05b_k^2}{1.05}\right] \frac{TVP_k}{\bar{X}_k} \qquad \text{VI.10}$$

which was rewritten as

$$MVP_k = b_k \left[\frac{1 + 0.05b_k}{1.05}\right] \frac{TVP_k}{\bar{X}_k} \qquad \text{VI.11}$$

and reflected diminishing marginal productivity as the input is continuously increased while others were held constant. From this property, the marginal productivity curve was traced. This curve also suggested the potential demand for labor that would result in factor equilibrium.[17] A curve for increases of 10 percent, 20 percent, 25 percent to 260 percent is depicted in Figure VI.1. By starting at the geometric means of output and labor input of 1665.6 shs and 27.48 mandays, respectively, the marginal value product gradually diminished as labor was increased. Because the price of the product was held constant, the decline in the MVP was the result of the law of diminishing returns in the physical product. In Figure VI.1 the magnitude of the factor changes was substantial. To achieve equality between the MVP of labor and its marginal factor cost (opportunity cost), the quantity of labor had to increase by about 230

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[17] If one considers only effects internal to the firm, and assumes perfect competition, the demand curve for labor would more realistically cut through a series of MVP's for labor as other factor quantities were adjusted for changes in the employment and price of labor while holding product price and factor prices constant (M. Friedman (1976), pp. 176-189)).

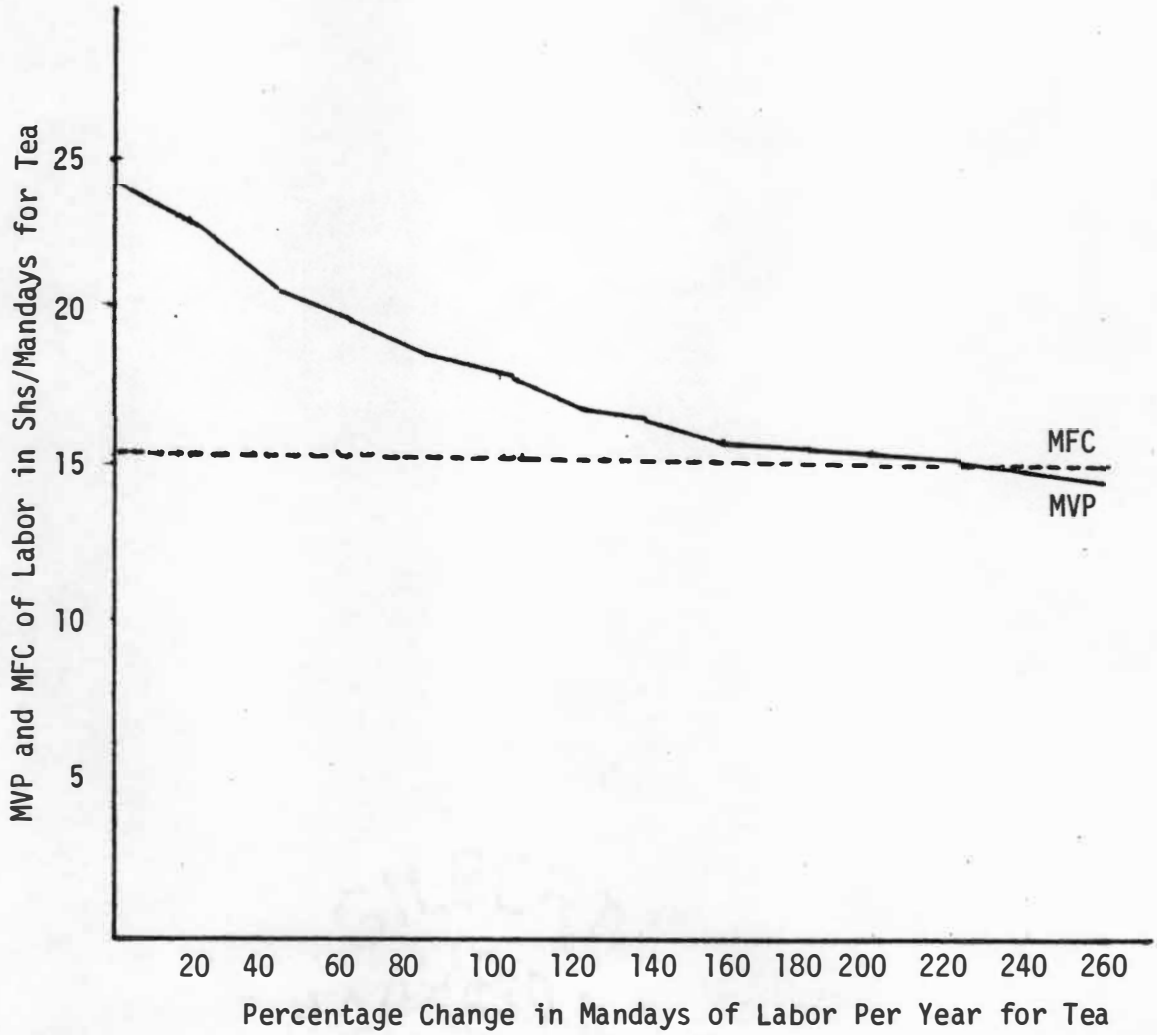

Figure VI.1. Marginal Value Product and Marginal Factor Cost of Labor for Smallholder Tea Farms in Tanzania.

percent from its current level. That is, the required increase of 63.2 mandays per farm per year from its current level of 27.48 mandays was just enough to restore factor equilibrium and implied that the total labor requirement would be 90.68 mandays per farm per year in tea. If this was the case, the question arose if adequate labor existed to attain equilibrium, i.e., if this was within the range of the sample. As pointed out in the survey results, the total potential labor supply was about 87 mandays. Family labor comprised 66.2 mandays or 76 percent of the total potential labor supply. This quantity likely could be realized to achieve the necessary optimum under scenario 1.

Assumption 2 suggested that expansion of tea would be done at the expense of the principal food crop, maize. In this case, the unchecked expansion, as the one assumed under scenario 1, likely involved family labor throughout the year. First, as more land was placed under tea, more labor was required. Plucking operations were arranged in such a way that family labor was occupied daily, especially when the area under tea was increased and partitioned into "mini" estates so that only one of these estates could be plucked in one day. Then both food crops and tea competed for family labor. The opportunity cost of producing tea was the quantity of maize foregone. This situation implied that the utility function was of the form:

$$U = f(M,F,L) \qquad \text{VI.12}$$

where U was utility function, M was the annual cash income derived

from the expansion of tea, F was the quantity of food the individual household produced for home consumption per year, and L was the annual amount of leisure an individual head of the household preferred for himself or herself and the family during the year.

The value of the amount of maize foregone along with leisure was the opportunity cost of the effort used in production of tea. The estimated opportunity cost for one acre of tea was the value of hybrid maize shown in Appendix B (shs 1051.9 per acre) plus the value of foregone leisure. Family labor was assumed to be the main source of labor for food production and its cost per day was estimated to be about shs 10. However, the average return per labor day was equal to shs 14.8, which appeared to be a reasonable approximation of the opportunity cost of tea per day.[18] By equating this value to the MVP of tea, the magnitude of factor change required to bring about equilibrium was determined. Labor input in tea production had to be increased by about 260 percent to reach equilibrium. Under the assumption of competitiveness, the family specialized in tea production with a complete or partial commercial transformation of the family farm. The family produced for the market because green tea leaf cannot be consumed directly. With this scenario, food prices would likely increase as food had to be purchased from

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[18]No quantitative consideration was given to leisure because of practical problem of quantifying it.

outside the local economy. This result is quite consistent with the principle of comparative advantage.[19]

Opportunity Cost of Land

The value of land could not be obtained directly. First, land is not saleable in Tanzania because it is owned by the government. This monopoly situation led to difficulty in evaluating directly the market price of land. Second, land was also not rented as in many countries of the world. Hence, no rental value existed to approximate land services. However, some of the institutional restrictions were overcome by imputing a use value for land.

A number of enterprises can be grown in Tanzania. One of the major agricultural uses is for food crop production, especially maize. By assuming a high substitutability of land between tea and maize, the opportunity cost of land for tea was the value of the maize that was not produced.[20] This proposition appeared reasonable in Njombe. When coffee prices dropped during the 1960s, hybrid maize was introduced in those areas where coffee was abandoned, such as Lupenbe. Given MVP of land for tea, Model II at shs 956.48 in Table VI.4, page 187, the opportunity cost of land for tea was shs 305.34 which was the return to land from maize as shown in Appendix B. The

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[19]No consideration was given to the importance of risk aversion and remaining in subsistence farming as discussed in an earlier chapter.

[20]Ideally land price = net return to land through time from maize in terms of net present value. However, neither the MVP of land for tea nor the opportunity cost (net return to land from maize) were discounted.

efficiency index was $\frac{\text{shs } 956.54}{\text{shs } 305.34} = 3.13$. This suggested that the marginal value product of land exceeded its marginal factor cost.

Marginal Factor Cost of Bush Population

The Tanzanian Tea Authority (TTA) provided transplants to all participating farmers at a price of shs 0.15 per transplant.[21] This price was partially set administratively and included the cost of producing the transplants on the TTA nurseries. Labor for making the cuttings made up about 65 percent of the total production cost; polyethylene bags, about 5 percent; and distribution cost about 30 percent. If one assumed that the transplant price was a monopolistic one, then it was above the "competitive market" price. However, this proposition was inapplicable for two reasons for smallholder tea development in Tanzania. First, monopoly power presumably permitted TTA to raise prices above the levels that would prevail under competition. This has not happened because TTA was a government agency and its task was to promote smallholder tea production. One of the ways of doing this was to provide subsidies to farmers. For example, fertilizer was given to the farmers at about half the market price. Obviously, these costs were eventually borne by the taxpayers. The basic issue was that the TTA structure did not reflect the conduct that would have been expected under a monopoly

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[21]The price of shs 0.15 per seedling was raised during the 1983-84 fiscal year to shs 0.20.

market structure.[22] Second, TTA price fixing was largely determined by the cost of production and distribution. Assuming that TTA only covers its cost of production, one could then take this price to be close to the market price in which the producer only breaks even as is the case in the neoclassical long-run equilibrium. The cost of transplant production was then taken as a proxy for the market price of the transplant. Given the MVP of the bush population in Table VI.4, page 188, the efficiency index was 1.3. The index value suggested that an increase in bush population would be necessary to attain equilibrium between the MVP of the bush and its price or marginal factor cost. This could also have implied the interesting phenomenon during the early 1970s when many farmers started their "secret" nurseries and "illegal" plantings. The objective was perhaps to attain the equilibrium between the MVP of the tea plant or bush and its marginal factor cost. The required magnitude of factor changes in this case meant an increase in plantings by about 70 percent as shown in Figure VI.2. This was within the range of the sample data. However, if it were not so, then little confidence can be placed in this required change because the equilibrium would have been outside the range of the observed data.

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[22]Theory also reveals that under monopoly, certain cases of price discrimination prevail.

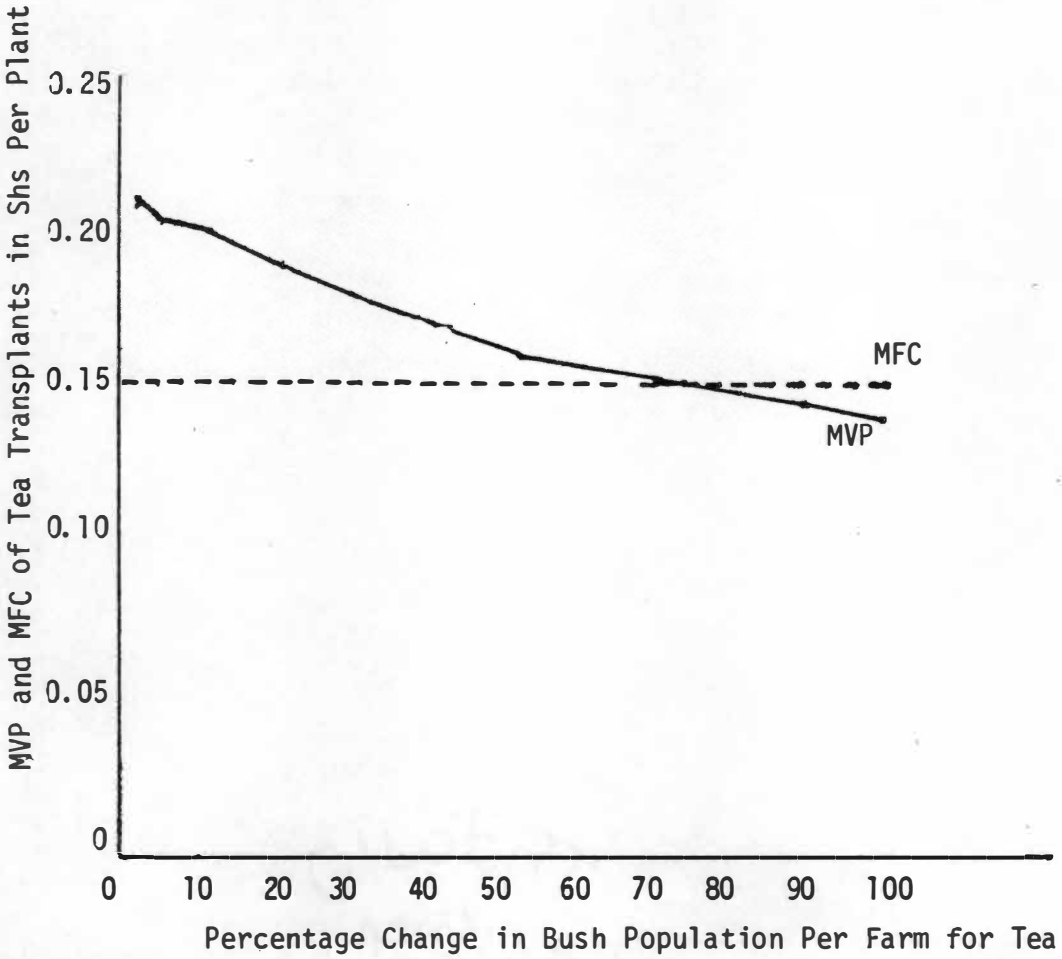

Figure VI.2. Marginal Value Product (MVP) and Marginal Factor Cost (MFC) of Tea Transplants for Percentage Changes in Bush Population Per Farm.

CHAPTER VII

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

This chapter presents a summary of the study, some conclusions with regard to the stated objectives and some implications with respect to resource use, impact on food and national export earnings ramifications.

Summary

The tea plant is an evergreen of the Camellia family, Camellia Sinensis which grows well in tropical and subtropical countries. India, Sri Lanka and Indonesia have traditionally provided the bulk of world tea production. However, their share has been declining over the time because of new entrants into the industry. Africa and Latin American countries are becoming increasingly important producers outside the Asian countries. In Africa, production is concentrated in the East African countries of Kenya, Malawi, Uganda and Tanzania.

Green leaf tea production has tended to be closely integrated with tea processing because of the physical characteristics of the green leaf. The leaf is perishable which requires that the processing plant be located in close proximity to the farm. Hence, most tea production has been carried out in a system of plantation agriculture.

At present, Tanzania produces about 17,000 tons of tea annually, which represents around 1 percent of the world total tea output. About 19,492 hectares are under tea production in the country at present. About 46 percent of the total hectarage is currently under a smallholder tea program while private estates account for 48 percent and TTA estates provide 6 percent.

The Economic Problem

A central question in this study of smallholder tea production as one strategy of economic development in Tanzania, a relatively poor country, was determining some of the means for increasing the permanent income streams of the economy comprised of predominantly subsistence farming activities. Economic analysis of the production process is one tool that provides some insights regarding this question. Permanent income streams can be increased in two general ways. First, income flows can be increased by increased output by using the resources at hand more efficiently. However, increased efficiency means improving resource utilization in the traditional sector. Empirical evidence suggests that few inefficiencies exist in the traditional sector. Therefore, the proposition of shifting the smallholder production possibility curve to the "theoretical frontier" is unrealistic in the case of many smallholders. Second, consideration of new investment opportunities in the form of new crops and inputs combined with abundant local resources, land and labor, is a potential strategy

that likely is capable of increasing total product. This approach likely helps shift the smallholder production frontier outward and to the right because it presumably improves the qualities of local resources.

Objectives of the Study

The objectives of this study were: (1) to analyze economically and statistically the important factors that accounted for the variability in the output of green tea leaf per farm and (2) to estimate resource productivities for a specific sample of Njombe smallholder tea farms to test for efficiency in resource use. A better understanding of the direction and magnitude of the estimated co-efficients on the green leaf output per farm was deemed particularly desirable for two main reasons: (a) to contribute to the application of formal economic analysis and (b) to provide results as inputs in various policy applications that deal with smallholder agriculture development.

Procedure and Results

This study of the smallholder tea production function implicitly involved consideration of the shift of the production frontier and involved the following steps:

1. Profit maximization was assumed a primary objective of tea producers.

2. A conceptual smallholder tea production function was specified in a single equation model in which the annual quantity

of green tea leaf the dependent variable, was a function of the independent continuous variables, annual quantities of labor, total land area under tea cultivation per farm per year, total bush population of all ages per farm per year, total annual expenses for capital services, total annual expenses for farm tools and equipment and the discrete zero-one variables: two levels of formal education of the head of the household, no education and at least a primary school level education, and two farmer perception levels about tea processing capacity, adequate and inadequate. This equation was specified formally as a Cobb-Douglas type production function (except for the discrete variables), and was referred to as Model II. This was the main conceptual production function of the study.

3. A modified conceptual model was also specified and called Model IV. This model was the same as Model II except that it included discrete zero-one variables for two organizational types, collective and private farms. These variables were excluded in Model II because of the assumption that organizational variable did not affect behavior of the farmer.

4. Two model variants treated as subproduction functions from Model II were also specified using a single-equation format and referred to as Models I and III. These two models were not completely specified in both economic logic and statistical sense. The results obtained from these had to be interpreted with extreme caution. Model I consisted of a single linear equation in which annual quantity of green tea leaf per farm, the dependent variable

was a function of bush populations per farm of different leaf-bearing ages. The ages considered were from three through nine years. Model III was specified as a subproduction function in which the total annual green leaf plucked per farm was a function of the number of days worked annually in tea for six different labor categories. The labor categories were total family adult male labor in days per farm per year, total family adult female labor in days per farm per year, total family child labor in days per year, total hired adult male labor in days per farm per year, total adult female labor in days per farm per year and total hired child labor in days per farm per year.

5. The absence of reliable data on the production activities of agricultural households in Tanzania has been a major limiting factor in recent attempts to analyze the behavior of farmers. Consequently, a field survey was deemed necessary for collecting data for model estimation. A special field survey using personal interview techniques was conducted by the author during the months of February and March 1984. The collected data were for the single crop year 1982-83. A two-stage random sampling method was used. The first stage involved selection of five villages out of the twenty-one that produce tea in Njombe district. The five selected villages were Lupembe, Igombola, Isoliwanya, Luponde, and Uwemba. In the first three villages, tea was grown on privately-owned holdings while in the latter two villages tea was grown on collective farms. The choice of the number of villages was rather judgemental

and was dictated by resources at the disposal of the author. The second stage involved selection of 30 farm-households from each of the five villages. The farm household was the unit of inquiry in this study. Therefore, this sampling approach resulted in a total of 150 farm-households.

6. Model I was a single-equation linear model estimated by ordinary least square (OLS) method. The regression results suggested that over 83 percent of the total variation in output of green leaf was accounted for by differences in the stock of trees per farm of various ages prior to maturity. All signs of the coefficients were positive and consistent with the agronomic and economic logic of production. Except for the coefficients of the number of bushes for years four, five and nine, all the remaining coefficients were significantly different from zero at the 5 percent level. Except for the nine-year old trees, the magnitudes of the coefficients increased as trees matured as expected from the physiological yield pattern of the plant through year nine.

Model II was hypothesized to reflect the physical structure of the production process in an analytical sense. The Cobb-Douglas type, single equation model was estimated using OLS after transformation of the continuous variables to logarithms. Ninety-four percent of the total variation in annual green leaf output per farm was explained by the seven independent variables included in the model, namely the five continuous variables; total labor, land, bush

population, capital expenses on farm tools, expenses on capital services; all on an annual basis; and the discrete variables, two farmer perceptions of local tea processing capacity and education levels.[1] In general, all signs were positive and consistent with economic theory except capital expenses for farm tools and equipment. All the coefficients, except capital expenses for tools and equipment, had values less than one and greater than zero. The sum of the elasticities was approximately equal to unity, which suggested that returns to scale were nearly constant in smallholder tea production as previously suggested in the literature.

In Model III, output of green leaf was hypothesized to be a linear function of the number of days worked annually in tea for six different categories of labor as distinguished by age and sex. The six categories were: family adult male, family adult female, family child, hired adult male, hired adult male, and hired child. All values of labor were in days worked in tea production per year per farm. Results indicated that 96 percent of the variation in annual green leaf output per farm was explained by the six discrete categories of labor. All signs were consistent with economic theory; that is, the "marginal products" were positive in this rather limited subproduction function. The "marginal products" suggested

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[1]One variable in each of the two classes of discrete 0, 1 variables was omitted from the regression model to allow estimation--for household head education level, no education was omitted.

adult males had a slightly higher marginal product than adult females as hypothesized. The "marginal product" of child labor was also lower than adult males as hypothesized earlier. All coefficients were significantly different from zero at the 5 percent level.

Model IV was like Model II except for the inclusion of discrete variables for organizational type. The Cobb-Douglas type function was estimated with OLS after converting all continuous variables to logarithms. The $\bar{R}^2$ was 0.99, suggesting that 99 percent of the total variation in annual green leaf output per farm was accounted for by the independent variables included in the model. Total labor, land and bush population were significant at the 5 percent level. Household education of at least the primary level was statistically significant at the 10 percent level. All the remaining variables were insignificant, likely due mainly to the problem of multi-collinearity. Though the organizational variable, collective farms was insignificant, it had the expected negative sign and suggested that for farms with a collective form of organization, the output was lower than those cultivated privately.

7. Estimated elasticities for Models II and IV were obtained. Using the estimated elasticities and computed average value product for each factor, marginal value products were computed for the significant variables--labor, land, and bush population. Comparison of marginal value products were made to respective opportunity costs (marginal factor costs) for labor, land, and bush

population to allow the computation of an economic efficiency index.[2] The results for labor, land, and bush population suggested economic inefficiency existed in resource use because marginal value products exceeded opportunity costs. Attempts to find the required magnitude of factor changes to reach the equilibrium conditions were made for labor and bush population. At current prices, labor, had to be increased by 230 percent from the sample survey mean level of 27.48 mandays per farm spent in tea production. Bush population needed to be increased by about 70 percent from its current mean value of 2261.4 tea plants per farm.

8. Processing plant capacity was also a major factor in affecting tea production. The local processing plant capacities seemed inadequate to handle all the green leaf tea plucked. Processing plant capacity, likely is going to be a "serious problem" as the smallholder tea reaches maturity. This has already led to rationing of the amount of plucking.

Conclusions

The problem of increasing per capita income for the majority of smallholders in poor countries like Tanzania partly involves commercialization of the traditional sector. This involves, in part, introduction of new cash crops using improved technology and

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[2]Opportunity costs were treated as proxies for marginal factor costs. Comparisons were made for Model II only since the organizational variable was insignificant in Model IV.

purchased inputs which is expected to shift the production frontier of the traditional sector outward and to the right. Improved technology such as high yielding seeds and plants and new forms of capital services like commercial fertilizer when combined with the relatively abundant local resources such as family labor and land are examples of the changes that will be needed. Therefore, the problem of increasing permanent income streams is, in part, a better understanding of the smallholder production process, particularly enhancement of resource utilization, as one strategy of economic development.

Two hypotheses regarding resource utilization by smallholders were advanced in this study: (1) Smallholders use their resources efficiently during the transitional process of agricultural commercialization and (2) smallholders are poor because they use their resources inefficiently during the transitional process of agricultural commercialization.

According Hypotheses (1), market signals are transmitted to the farms and provide a decision rule regarding adopting a new enterprise. If markets are perfect, the market is the only, or is at least, the main guide in governing the behavior of the smallholder. Expected net returns to various resources (relative prices of resources in various alternatives) provide a decision rule that helps the household-firm choose among alternatives. Therefore, the applicability of economic theory is a direct implication of

this hypothesis. By applying the principles of economic theory, the hypothesis implies that farmers who participate in the agricultural transformation process are also efficient in the economic sense of price efficiency.

Hypothesis 2 suggests that though the market signals are transmitted, they are disregarded or ignored. Non-economic factors such as customs govern the behavior of the household-firm. Therefore, the principles of economic theory cannot be applied in analyzing the problem of raising per capita income of poor farmers. They are poor because they are inefficient. Analysis of non-economic factors is one implication of this hypothesis.

The results of the estimated production function (Model II) revealed constant returns to scale. When all inputs are increased by the same proportion, the output increases by the same proportion. First, on "the average," the model results using the survey data revealed that the smallholder is technically efficient and appears to be close to the long-run expansion path. The returns to scale were nearly constant. Essentially, the results seemed to provide evidence in support of Hypothesis 1.

Second, in estimating the production function, the results revealed that labor was technically the most important factor in smallholder tea production accounting for about half of the output variation. The results verified that tea production is a labor-intensive crop enterprise for Tanzanian smallholders, coefficients on the independent continuous variables except capital services had

the hypothesized signs. Consequently, the production elasticity and, hence the marginal product of each resource were positive. Smallholders appear to be rational in the sense that they do not overemploy their resources to the extent that their marginal productivity becomes zero or negative. Except in one case, generally, no evidence of resource overutilization existed.

While technical efficiency is one aspect of production efficiency, it is, however, a technological feature. According to Hypothesis I, economic efficiency is the important consideration. Economic efficiency is an important criterion in combining resources. It reflects comparisons of marginal value product and the marginal factor cost of the resource. Because the smallholder was hypothesized to be an "economic man," computed marginal value products were compared to marginal factor costs. All the factors, which were found to be statistically significant and where proxies for their marginal factor costs were available, appeared to exhibit factor disequilibrium. Marginal value products exceeded marginal factor costs. Two questions arise: Does this suggest that smallholders are inefficient in the sense that they do not respond to market conditions? Does this suggest that the farmers use fewer resources though their marginal value productivities appear to be high? This apparent inconsistency seems to discredit the fact that the farmers in Africa have generally been found to be price responsive and their behavior is not different from those in the developed countries such as U. S. A.

A number of factors explain the apparent inconsistency. One of the critical factors in tea production is the capacity of the processing plant. Because of the nature of the crop, the plant must have adequate processing capacity. So when farmers responded to the price, they assumed that the expected processing capacity would be large enough and would pose no constraint. This is an external factor (external to the farm) which farmers cannot influence because of the high capital costs of processing capacity. It is an external constraint that became a "binding factor"[3] rather than any internal economic or technical constraint. Limits on local processing capacity became a major factor that imposed a limit on the utilization of other resources.

For the existence of equilibrium in the Arrow-Debreau sense, the implied market structure has to be purely competitive. Pure competition does not exist in this case. TTA is the monopsonist. The price is partially determined by an administrative process. Therefore, the TTA price which is usually set administratively for a period of time, likely deviates from a more open market price. When production is competitively organized on the one side with a monopsony on the other side, disequilibrium in resource use is

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[3]The personal experience of the author during the interview process was that generally unanimous agreement existed among the farmers that they could not pluck all their output due to "rationing" resulting mainly from the small processing capacity at both Luponde and Lupembe.

likely to prevail, generally resulting in fewer resources being used.

All in all, given the technological and market structures, the farmer is likely forced to be in disequilibrium during the transformational commercialization process of the peasant economy. He likely is still seeking factor equilibrium as reflected by the market signals as he perceives them. Therefore, this is quite consistent with Hypothesis 1 when one considers that tea is a multi-period enterprise in which adjustments take time.

Implications

Several implications of this study can be summarized:

Resource Use in General

Resource utilization may not be in equilibrium. Also, as the government program continues in Tanzania to transform traditional agriculture, the movement from the lower traditional equilibrium to a higher new equilibrium will not likely be reached instantaneously. This is particularly true in the case of tea, a perennial crop, in which the adjustment process takes time over several years. Therefore, this does not mean that smallholders undertaking the commercialization process are poor because they are inefficient. It means that the adjustment process has not been completed during the transition of moving from the traditional to the modern sector.

Labor

Tea is a labor-intensive cash crop. Its expansion beyond the current level would not endanger food production if labor use per farm in tea does not exceed 100 mandays per year per farm. However, a tradeoff between labor and leisure within the household utility function will be necessary. If leisure time is sufficiently long such as during the "slack" season, one would argue that its marginal utility may be low and the marginal utility of obtaining additional cash may be higher. Therefore, substituting labor for leisure would be quite rational in that case. In this study, the substantial potential labor supply available for tea production seems to lend credence to this argument.

However, if tea production is pushed beyond the 100 mandays per farm per year danger exists that food production would suffer and disequilibrium between the marginal utility of leisure and labor would likely occur. Food must be purchased outside if the extreme of complete specialization in tea became the norm. Food prices would likely rise. For small farmers at the margin of survival, it is unlikely that they would engage in increased tea production because the drive to survive has a greater weight than cash in their utility function. Also, the value attached to producing one's own food may have other values like pride and independence. Even if tea prices were much higher, it is unlikely that total abandonment of food production would occur.

Family labor is the most important factor in tea plucking. There are two issues with respect to labor supply and productivity. First, family size is fixed and the labor supply is fairly inelastic. Expansion beyond a certain limit is physically impossible in the short run. Second, it was stated that productivity is directly related to age, up to a point. The average age of the farmers was 48 years in the survey. This is close to the age at which productivity allegedly starts declining. Future tea expansion among smallholders will likely mean recruiting younger people into continuing the traditions of their parents. Whether this is feasible or not is indeterminant given current information. However, one point is that future productivity trends are likely to decline with age of current producers given present technology.

Land

Land was second to labor in importance. Does this imply that land is a binding constraint? Tea leaf is a perishable commodity and productive land must be in close proximity to the processing factory. Hence, land has site value because the distance from the processing plant makes land a critical factor more so than the total amount of productive land available. Tea expansion would imply acquiring distant productive land and involving more villagers who are geographically separated. If this were the case, then the need for additional processing plants becomes one implication of increased tea cultivation. Also, a minimum quantity of land would

have to be put under tea to support a given size of new plant. Satisfying this requirement would likely involve more villages.

Another dimension involves labor participation, especially on collective farms. Smaller production may be a result of low labor participation on collective farms. A need to provide a more viable method of reward for labor appears to be a crucial factor for further tea expansion, especially in those areas where tea is cultivated collectively. Maybe a co-operative form of organization rather than a collective organization would be an alternative in the Tanzanian case.

Bush Population

Bush population was third in importance. In part, shortages of transplants have led to illegal plantings. The question is whether TTA is able to cope with increased demand for transplants. TTA is a young organization without adequate financial resources to cope with increased demand.

Education

There appears to be a need to increase extension services in order to disseminate information and educate farmers. Few extension services are presently available. Present extension workers largely function as marketing coordinators rather than imparting knowledge to enhance the efficiency of farmers.

Processing Plant Capacity

The results suggest a potential need for increased processing capacity of the plant if farmers were to increase the quantity of labor, land, bush population in order to attain the suggested equilibrium conditions between MVP and MFC of those resources found to be in disequilibrium. Furthermore, most of the tea bush that is currently in production is immature as shown in the survey data. As this bush matures, even with no new plantings, processing plant capacity will need to be increased.

Export Earnings

Given that about 80 percent of Tanzanian tea is exported, one may speculate that tea may contribute significantly to export earnings but this was not addressed in the analysis. At present, the bulk of the tea is sold in the traditional markets namely Britain and Western Europe. The per capita demand for tea is rather inelastic to changes in price or income in the traditional markets. The population in the developed countries is growing very slowly, if at all. Population in the developing countries is increasing much faster than in the developed countries, particularly in the Middle East. If exports are to be increased substantially, a need is evident to increase exports to developing countries, especially the petroleum producing countries where demand is relatively elastic. New markets for tea exports are likely to raise export earnings more so than traditional markets.

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APPENDIXES

APPENDIX A

SUMMARY RESULTS OF 1984 SURVEY OF SMALLHOLDER TEA PRODUCERS IN NJOMBE DISTRICT IN TANZANIA FOR CROP YEAR 1982-1983

1. Sample Size

Farm households interviewed	150
Villages	5
Farm households from each village	30

2. Average number of years tea was cultivated 6

3. Household Head Formal Education Level-(Percentage of Respondents %)

No formal education (0 years)	57
Primary education (4-8 years)	42
Post Primary education (more than 8 years)	1

(Percentage of Respondents %)

4. Occupation

Peasant	99
Other	1

(Average number per family)

5. Family Background

Average number of children per family	5.16
Sex of children	
Girls	2.63
Boys	2.53

Average sex distribution of children per family by age group

Age group (in years)	(Average number per family)		
	Girls	Boys	total number of children
Ages less than 10	0.85	0.55	1.4
Ages 10-14	1.1	0.84	1.94
Ages 15 and older	0.68	1.14	1.82
Total	2.63	2.53	5.16

Average age of husband per family	48.57[a]
Average age of spouse per family	40.24
Average number of elderly persons per family	0.92

6. Perceived Average Potential Labor Supply Available for Tea (Mandays per year per farm).

Family Labor	66.22
Regular hired	0.52
Part-time hired labor	20.22
Total Labor	86.96

7. Actual Average Utilization of Labor at Present (Mandays per year per farm).

Family Labor	20.63
Part-time hired labor	6.63
Total Labor	27.48

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[a]In Njombe, men are generally heads of the households. Women are household heads in such cases as divorces or unmarried women.

8. Present Labor Requirements by Categories

Type of Labor	Average days per year per farm (Unadjusted for sex and age)
Family	
Adult Male	7.19
Adult Female	9.95
Children	12.42
Part-time hired	
Adult Male	2.67
Adult Female	3.38
Children	4.32

9. Average Land Area per farm in Tea Production by Type of Organization

	Acres	Hect rs
Private	0.79	0.32
Ujamaa (Collective)	0.28	0.11
All	0.59	0.24

10. Average yearly expenses per farm for tools and equipment used in tea plucking was Shs. 202.48 per year.

11. Average yearly operating capital services per farm was Shs. 191.58 of which fertilizer was Shs. 104.09, and insecticide was Shs. 87.76.

12. Average number of years in crop rotation was nil.

13. Method of land acquisition was communal with local authority.

14. Preferred average acres per farm for tea

		Actual average acres per farm for tea
Private	2.9	0.79
Ujamaa	0.79	0.28

15. Labor Participation in Ujamaa Activities

Category	(Percentage of all Respondents %)
Participate all the time	58
Participate half of the time	17
Rarely or never participate	20
Others (no response)	5

16. Reasons for Lack of Participation

Category of Reasons	Those who participated one-half time or less as a percentage of all labor (%)
Illness	10.0
School	3.0
Off farm work	6.7
Estate employment	0
Holiday	1.3
Work on own fields	6.7
Other reasons	9.3
Total	37.0

17. If unable to participate, a family member is sent

Category	(Percentage of the time %)
Spouse sent by head of household	70.67
Children sent by either head of household or spouse	99.33

18. Sample respondents' opinion regarding disciplinary action for lack of participation

(Percentage of all respondents %)

Only 0.6% of the sample respondents were subject to disciplinary measures for non-participation

a. Favored a Fine	68.0
Refused to answer regarding a fine	32.0
b. Favored Expulsion	67.3
Refused to answer regarding expulsion	31.3
c. Favored other actions	1.3

19. Major Problems stated for Poor Attitude Toward Participation

Problem	(Percentage of all respondents %)
Lack of motivation	100
No answer	0
Absenteeism of others	52.67
No answer	47.33
Lack of Money Wage	56.67
No answer	43.33
Lower wage rate than estate	84.0
No answer	16.0

20. Average quantity of labor that would be offered for communal activities per month for given wage rates.

Wage rate per day (Shs)	Mandays per month
12	2.6
20	6.12

21. Opinions on how dividends should be used.

Type of use	(Percentage of all respondents %)
Capital accumulation	59.33
Non-response	40.67
Paid to Members	68.67
Non-response	31.33

22. Major problems of tea production and processing rated from 1 to 4 where

1 = very serious

2 = serious

3 = slightly serious

4 = not serious

Problem:	Score
Inadequate processing	0.58
Inadequate transport of green leaf	1.59
Late payment for green leaf	3.79
Inadequate extension services	3.97

23. Average income from livestock = Shs. 524.33

Average milk produced per year (litres)	=	12.16
Average milk sold per year (litres)	=	2.73
Average milk consumed at home per household per year (litres)	=	9.10
Average price of milk per litre (Shs)	=	.20

24. Average capital investment in farming tools = Shs. 504.77

25. Bush Population per Farm:

Category	Age (Years)	Average number of trees per farm
All bush	All ages	2261.4
Immature	4	197.4
Immature	5	332.3
Immature	6	434.8
Immature	7	485.4
Immature	8	440.6
Immature	9	350.1
Mature		20.8

26. Average Production, Price, and Gross Return from Green Leaf Tea Per Farm:

Average Production (kg)	Price[b]	Gross Return
616.9	Shs. 2.7	Shs. 1665.6
616.9	Shs. 4.1	Shs. 2529.3

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[b]During 1984/85 crop season, tea prices were raised to Shs 4.1 per kilogram (kg) of green tea leaf. In calculating marginal value products in this study, the price used was Shs 2.7/kg of green leaf that was prevailing during the period of survey. Comparisons of the two gross/net returns are made purely on what would have been, if the price was say Shs 4.1/kg.

27. Average Variable Expenses Per Farm Per Year:

Type	Total Costs
Tools, operating costs	Shs. 392
Part-time labor	Shs. 40
Total Var. Exp.	Shs. 432

28. Net return to land, family labor, and management

Price[b]	Net Return
Shs 2.7	Shs 1233.6
Shs 4.1	Shs 2097.3

APPENDIX B

ESTIMATED RETURNS AND EXPENSES PER ACRE OF IMPROVED MAIZE

Item	Description	Unit	Quantity	Prices (shs)	Amount (shs)
REVENUE					
Maize		kg	810	1.75	1417.50
VARIABLE EXPENSES					
Seed	Hybrid	kg	10	11	110.00
Sulphite Ammonia		bag	0.8	93	74.40
Triple Super Phosphate (TSP)		bag	0.4	106	42.40
Insecticide		kg	4	9.7	38.80
Tools					10.00
Packing Bags		each	9	10	90.00
Total Variable Expenses					365.6
Net return to land, labor, capital and management					1051.90
Net return to labor		Mandays	71	10	710.00
Net return per Manday					14.80
Net return to land, capital and management					341.90
Net return to capital		.10 (365.6)			36.56
Net return to land and management					305.34

Sources: Survey by author. Marketing Development Bureau, Agricultural Price Review Annex I (Des-es-Salaam: Ministry of Agriculture, 1982).

VITA

Joseph Tarmo Nagu was born in Endasak Village, Tanzania, on August 8, 1946. He is the oldest son of Mr. and Mrs. Gadiye Ami. He attended primary school, Endasak, and Ndareda, Tanzania from 1953 to 1960. He graduated from Secondary School at Umbwe, Tanzania in 1964. From 1965-1966, he attended high school at Mkwawa, Tanzania before he entered University College ar Dar-es-Salaam, Tanzania, in 1967. He received a B. A. Degree in Education and Economics/Geography in 1970.

He taught geography and general paper in 1970-1972 at Mzumbe Secondary School, Tanzania.

In February 1973, he accepted a position as Assistant Lecturer in Economics at the Institute of Management Development (IDM) at Mzumbe, Tanzania. In July 1973, he was awarded a United States Government Fellowship (African American Institute Fellowship) for graduate study in the U. S. at The University of Tennessee at Knoxville where he was awarded a M. S. degree in economics in 1975.

The author taught economics in 1975-1981 at IDM.

He was married to the former Mary Micheal of Katesh, Tanzania. They have two daughters, Tumaini and Neema.

In September 1981, the author was awarded a Fulbright Fellowship to pursue advanced studies in Agricultural Economics at The University of Tennessee, Knoxville. He completed the Doctor of Philosophy Degree in June 1986. After graduation he will return home to his former employer IDM.