THE ANALYSIS OF LABOUR UTILIZATION IN SMALLHOLDER TEA FARMS IN KENYA

by

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D E C L A R A T I O N

Except where otherwise indicated, this dissertation is my own work.

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ABSTRACT

Rapid growth has taken place in the smallholder tea sector in Kenya and the dynamic response to incentives, by which this has been accomplished, is remarkable. This study undertakes to examine the role of one of the major inputs in tea production, labour, which in addition to working on tea must also work on subsistence production, household activities and off-farm jobs.

The introductory chapter traces the historical development and success of the smallholders in Kenya growing tea, a crop originally thought to be unsuited for smallholdings. The developmental aspects of tea in providing rural employment, income and foreign exchange are highlighted.

The role tea plays in absorbing labour in the rural areas is considered in the context of some of the existing development models. It is argued that since the labour absorption capacity of the urban sector is limited, models of the Lewis-Fei-Ranis type may not be suitable to the Kenyan situation while models emphasising rural labour absorption such as that of Fisk (1962) and Myint's 'Vent for Surplus' model (1964) may be useful.

Survey data originally collected in 1965-66 is used to examine the allocation of labour to various activities and the inter-relationship between them. It is found that while other agricultural activities have a seasonal pattern, tea after establishment has some evenness and flexibility of labour demand. Tea is found to be closely

associated with increasing hiring of labour (a positive correlation existing between tea acreage and hired labour). The hired labour either supplements family labour or is used where the family has off-farm work. There was no evidence of a labour constraint for tea production.

The production function of tea is revisited in an attempt to include harvest labour in the function under the hypothesis that, at the margin, there may be some substitution between the labour and the tea bushes. This relaxes the earlier assumption of fixed factor proportions hypothesised by Etherington (1973). However, the study concludes by not rejecting the earlier hypothesis and asserts that in a situation where there is no labour constraint, provided that capital and other inputs like management have been correctly specified, there may be no need to include harvest labour because output will determine it and this will be available in the family or through hiring.

The study concludes with some suggestions for further investigations into the current situation on the smallholder tea farms of Kenya following the continued rapid expansion of the tea area and increased maturity of the tea bushes over the last fifteen years.

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GLOSSARY

Boma = Homestead

Jembe = Hoe

K£ = Kshs.20 = $US2.4 ≃ $A2.0

Shamba = Farm

CHAPTER 1

INTRODUCTION

Smallholder tea has become a vital export crop for Kenya in a relatively short period - less than 20 years. Given its significance and the rapidity of its growth, data collected on it is likely to be out of date before it is analysed. This can be discouraging but a thorough analysis of what data is available needs to be undertaken, in spite of a boom in 1976/77 when the tea price was at a record 185 US cents/kg at the London Auction (the major tea market for Kenya) and with an upward price trend (FAO 1976/77).

In the relatively early years of promotion of the smallholder tea sector, a small sample survey was undertaken at the University of Nairobi but all the data from it were not analysed exhaustively. This thesis is focussed on that data because one of the crucial inputs in tea production, labour, had detailed data but formed a minor part of the subsequent analysis of the productivity of smallholder tea. An attempt will be made to include the labour data in this study both in relation to tea production and also in its use in other activities.

1.1 A Brief History of Smallholder Tea Production in Kenya

Tea was first planted in Kenya in 1903, but before the mid 1950s it was produced entirely on estates, nearly all of which were owned by private companies. Since their entry to the tea

industry, the smallholders have achieved great success in the production of tea. A brief history of smallholder tea development may indicate some possible reasons for this success.[1]

It is questionable to begin with why small scale production of tea was not encouraged at an earlier date (because small scale production was usual in places like Japan or China). With smallholder production, there would have been a considerable saving in the cost of clearing new land (as done by the estates) for some land was already cleared and being used for other crops by peasants in these areas. There were several reasons why smallholders were initially not encouraged to grow tea in particular, and in fact cash crops in general.

In the case of tea, in addition to technical reasons regarding the methods of production, there appear to have been real fears on the part of the estates that smallholders would be detrimental to the industry.

On technical and economic grounds, there was scepticism about smallholder tea cultivation. The economies of scale were such that large and extensive factories dominated production. This meant that the collection area serving a factory had to be large. At the same time, green leaf had to reach the factory within a few hours of plucking. The difficulties of organising production and a transport and collection system to meet these requirements were thought

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1 For a detailed history of the smallholder tea industry in East Africa, see Moynagh (1976) and for the early history of the East African tea industry in general see MacWilliam (1957).

to be too great to justify smallholder tea production. However, Etherington (1971), discussing the question of scale in tea production, concludes that the economies of scale in tea production lie only in manufacture, research and transport, not in cultivation. One of the general arguments advanced by Wickizer (1960) was that the husbandry involved in tea production was such that the skill requirement was too much for the peasants to fathom. Their entry into the industry would result in producing poor leaf with a consequent deterioration in the quality of tea to be marketed and hence would reduce the reputation and prices of all Kenya tea. Also, there was the fear that they would insist on bad plucking practices to raise the quantity of tea at the expense of quality.

Whatever the technical reasons, there were also the fears on the part of the estates regarding competition for labour, the quality of products and the possible theft of product or even planting material. The small scale producers are known to be low cost producers. Labour costs of tea production account for about 60 per cent of total production costs in Kenyan estates (Stern 1972). The entrepreneurs feared that if small farmers had cash incomes, there would be a reduction in labour supply to the estates. In addition, meanwhile, tea prices were good and there was a favourable climate for investment (Moynagh 1976). The estate cultivation ensured that profits made on green leaf accrued not to peasant producers but to the tea companies. Thus, the form of organisation adopted in India and Ceylon was perpetuated in Kenya.

In effect, tea was among the cash crops declared illegal for small farmers before 1950. Africans, meanwhile, were pressing to

be allowed to grow tea because they found that the few bushes that they grew 'illegally' grew well. At last the increasing imbalance between the large scale producers and the subsistence producers made the government do something positive about the situation.

The private estates initially refused to join in experiments with African grown tea organised by the government in the 1950s through the Department of Agriculture. Moreover, the Tea Research Institute (TRI) established in 1951 and financed by private estates through the East African Tea Board, initially and quite understandably did not undertake any research to aid smallholder tea production. However, despite the constant lack of co-operation from the estates and the TRI as regards the promotion of smallholder tea production at the beginning, the Department of Agriculture insisted that tea (being a highly valued cash crop in acid soils where no comparable highly valued cash crop could be grown) had to be encouraged on social grounds to increase smallholder incomes.

In 1947, the Director of Agriculture in a memorandum to the Minister[1] recommended that, in appropriate areas and under close supervision, tea could be successfully grown by smallholders. The government then actively explored the best way of going ahead with smallholder tea production. In 1950, Mr G. Gamble was sent to study tea cultivation in India, Malaysia and Ceylon with a view to making recommendations for Kenya. In his report, Gamble (1951) indicated

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1 Memorandum on the 'Future of the Tea Industry' to the Minister of Agriculture and Natural Resources, 15 November 1947, Department of Agriculture.

how the mistakes of the Asian smallholder scheme could be avoided in Kenya. These mistakes included:

(1) using poor planting material;

(2) poor standards of cultural practices because of lack of close supervision;

(3) growing of tea in backyard gardens;

(4) growing tea where there is ash, hence alkaline soils; and

(5) growing tea in poorly drained soils.

Gamble's recommendations included:

(1) planting material to be supplied centrally from nurseries and no unauthorised seedlings to be used;

(2) careful selection of sites - no planting in old 'boma' (homestead) sites or old charcoal burns; ground where wattle trees were removed recently to be avoided because of the risk of Armallaria root disease; if virgin soils were to be used, a cleaning crop like potatoes to precede tea planting; no badly drained soils;

(3) careful land preparation;

(4) every grower to be registered or licenced; tea to be grown in individual consolidated land holdings, not communally owned blocks;

(5) other husbandry techniques to be undertaken with precision; and

(6) the smallholders to be told exactly why every step taken was necessary for the success of the scheme.

These recommendations formed the guide to the subsequent approach for development of smallholder tea in Kenya and were tried first on an experimental basis in the Nyeri District in Central Province and Kericho District in Rift Valley Province in 1952. All the recommendations implied that labour input in tea production would be high.

The Swynnerton Plan (Swynnerton 1954), which emphasised the intensification of agricultural production, did great service to the smallholders because it removed altogether the restrictions on the growing of cash crops by smallholders. The plan required that there should be a programme of land adjudication to establish boundaries between farms, consolidation to amalgamate fragmented holdings, and registration to establish title to the land. These conditions would thereafter enable a farmer to have security of tenure and the incentive to develop his land by acquiring credit (using the title as a collateral if need be). Although the plan has been criticised by some authors (see Okoth-Ogendo 1976) on the grounds of creating landlessness among others, the plan formed a landmark in Kenyan small farm agricultural development. In the areas where the plan was implemented first, there was indeed a dramatic upsurge in cash crop production and income such that Clayton has termed it "the Agrarian Revolution" (Clayton 1964).

Swynnerton proposed that tea should be a major component in his plan for the diversification of African agriculture and recommended that 12,000 acres be planted by 1968, mentioning the potential of 70,000 acres. In fact, a subsequent survey showed this to be almost a ten-fold underestimate of the potential area for tea (Brown 1966).

The potential land for tea growing in Kenya is limited by rainfall and temperature to areas between 5500 feet and 7500 feet in altitude and to soils of pH 4.5 to 5.5. The survey by Brown (1966) indicated that smallholder farming areas had a potential of about 600,000 hectares of tea land. Table 1.1 shows the potential smallholder tea areas by district while Figure 1.1 shows the distribution of estate and smallholder tea growing areas in Kenya.

TABLE 1.1

POTENTIAL SMALLHOLDER TEA AREAS IN KENYA BY DISTRICT

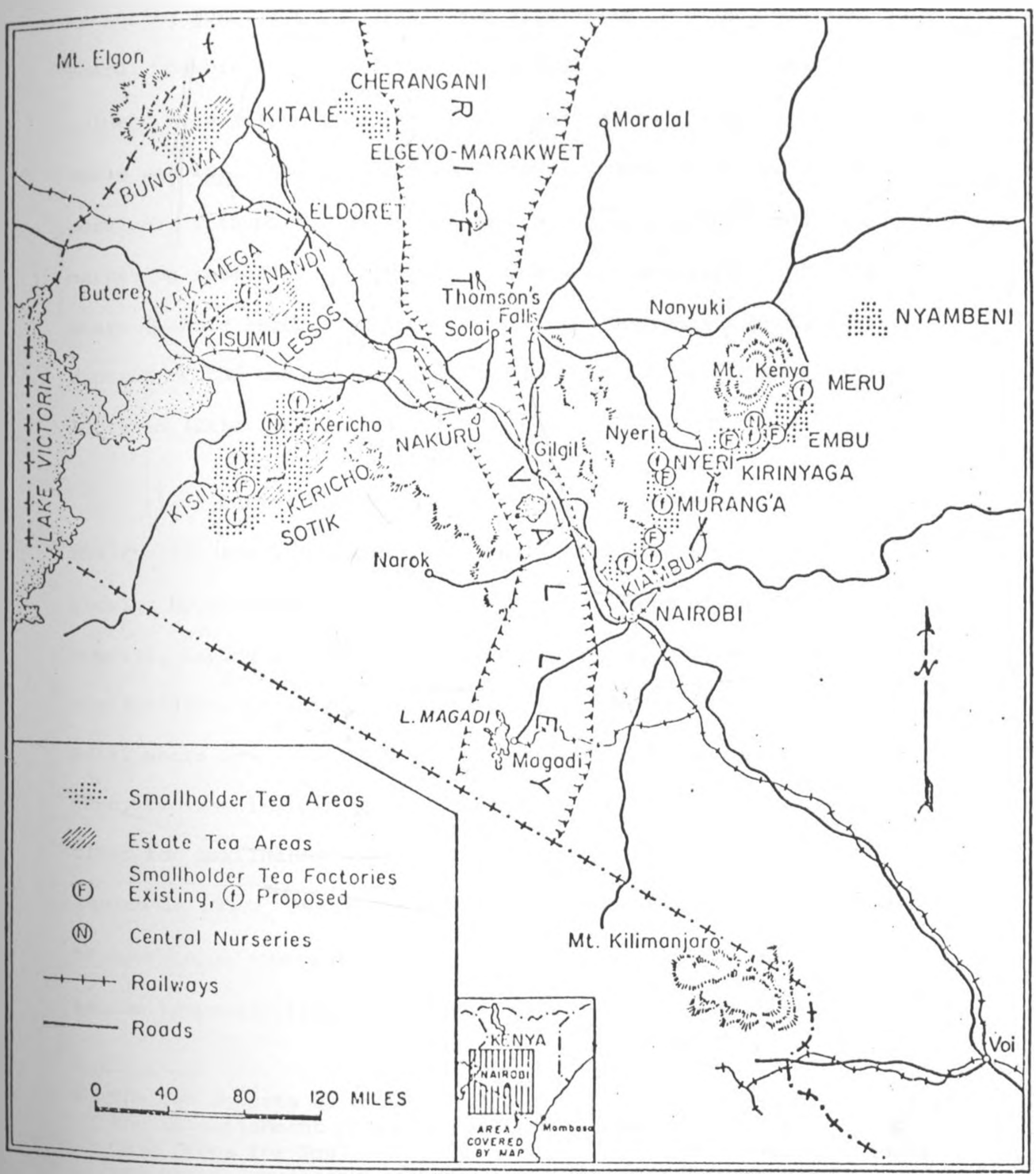
District	Potential Area '000 Ha
Kiambu	28.6
Muranga	49.2
Nyeri	21.1
Kirinyaga	16.7
Embu	14.4
Meru	44.0
Kericho	117.7
Kisii	155.3
Nandi	84.7
Kakamega	77.6
Marakwet	2.0
All Areas	611.3

Source: Brown 1966.

With such a vast potential and with the pilot projects which were run in Nyeri and Kericho since 1952 having proved successful, there was increasing attention to smallholder tea development.

FIGURE 1.1

ESTATE AND SMALLHOLDERS TEA GROWING AREAS IN KENYA



Source: Etherington 1973.

The first factory specifically for smallholder tea was completed in 1957 at Rigati in Nyeri District. The initial smallholder tea development was the responsibility of the Central Province African Grown Tea Marketing Board and the Nyanza and Rift Valley Province Tea Marketing Board. Gamble recognised that successful production of tea by smallholders necessitated complementary organisation of inputs of a large scale nature. This was evident in nursery management, extension services, transportation, processing and provision of credit and marketing research. Backyard planting was discouraged right from the start (Gamble 1956). In fact, Etherington contends rightly that the success of the tea project rests on the careful way in which it was nurtured (Etherington 1973).

During the period the Marketing Boards were concerned with smallholder tea development, the whole extension service for tea growing by smallholders was under the Department of Agriculture. However, having recognised the great potential of tea growing by smallholders, and having studied the problems of smallholder tea in Asia, where low production standards were a constant source of concern, two working parties were set up to make appropriate recommendations for smallholder tea development, the reports of which were presented in 1959.[1] Plans were made to establish a parastatal organisation to operate on commercial lines free from political influences and to assume responsibility for all the services which a smallholder tea

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1 The two reports were 'Report of the Working Party Set up to Consider the Establishment of an Authority to Promote the Development of Cash Crops for Smallholders' and the 'Report of the Working Party set up to Consider the Financial Implications of the Proposed Authority'.

producer cannot supply himself. The organisation set up in 1960 was initially called the Special Crops Development Authority (SCDA). The SCDA took over the responsibility of the earlier Tea Marketing Boards in the two regions. Technical personnel were at first to be taken from the extension staff of the Ministry of Agriculture but later the Authority was to be guaranteed complete independence. In addition, the services rendered by the Authority had to be paid for by the grower in the form of a cess, so that no subsidies in the form of free services would flow into the project. The detailed report contained comprehensive plans which formed the basis for all operations in the early years.

From the start, the SCDA had two plans in hand and began by obtaining finance from the International Development Association (IDA) and the Commonwealth Development Corporative (CDC) for the plans. The first plan (1960-67) aimed to bring smallholder hectarage up from 600 ha to 4250 ha in 1965 and the second plan (1964-70) to raise the hectarage to 10,000 ha by 1969 (Sullivan 1972). Both plans were completed well ahead of schedule and the estimate contained in the original Swynnerton plan, which seemed so impossible at the time, was in fact exceeded by a factor of more than two.

In 1964, SCDA changed its name to the Kenya Tea Development Authority (KTDA), since the authority dealt solely with smallholder tea development. The smallholder tea development is now so much connected to the KTDA that the next section considers the role of the KTDA in smallholder tea. Its organisation and historical details

are well documented in the annual reports.[1] The Organisational Chart is presented in Appendix 1.

1.2 The Role of the KTDA in Smallholder Tea Production

The primary objective of the KTDA was to promote and foster the growing of tea by Africans in Kenya. The KTDA provides external economies to smallholders and its functions may be divided into three areas: Field Development, Leaf Collection and Inspection and Head Office (KTDA 1972).

In Field Development, the KTDA is responsible for: management of tea nurseries and mother bushes for vegetative propagation; sale and distribution of planting material (originally stumps from seed but since 1967 vegetatively propagated cuttings) to growers; supervision of planting and field cultivation; training of growers; issuing of planting licences to the growers; maintenance of planting records; and liaison with government and the local authorities regarding construction and maintenance of tea roads.

In the leaf collection and inspection area, the role of the authority is the inspection and carrying of green leaf from growers to the factory, arrangement for processing, payment to the growers for leaf purchase, establishment of buying centres and establishment of factories and leaf bases.

In the Head Office, they plan and arrange for the processing of finances for field and factory development, technical and administrative

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1 For instance see KTDA 1966/67.

direction and the control of overall activities in the smallholder tea areas. In addition, they control the management of tea factories, keeping accounts and records for growers and the authority itself, liaison with the tea committees and the Boards and advances of credit to growers after raising international loans on commercial terms.

Apart from the road construction and housing by officers of the KTDA in the field[1], the whole complex of the tea development under the authority's auspices is designed to be a self-contained entity. The smallholders are encouraged to buy shares in the factory which eventually is supposed to become theirs when the loans for its construction have been repaid. Etherington (1973) describes the KTDA as an 'all powerful autocratic organisation' which is 'both monopolist and monopsonist'. It was originally the only source of planting material[2] and a major source of credit. It is the only channel through which the farmers can sell their leaf. Moreover, it has powers to prosecute any abuser of its rules (KTDA 1972).

The rapid expansion of acreage since the authority started operation is a measure of its success. Table 1.2 gives the expansion of tea in terms of total area, production and respective proportions contributed by smallholders and the number of smallholders per year, from 1959 to 1976. By 1976, under 10 per cent of the total potential area had been planted with tea (KTDA 1972). This leaves a large potential for further development.

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1 These are done by the government.

2 Now farmers may use their own bushes to get cuttings for vegetative propagation.

TABLE 1.2

TOTAL TEA AREAS, PRODUCTION AND NUMBER OF SMALL SCALE GROWERS BETWEEN 1959-1976

Year	Area '000 Ha			Production '000 Tonnes*			No. of Small Scale Growers
	Total	Smallholder	% of Total	Total	Smallholder	% of Total	
1959	15.3	0.6	3.9	12.7	n.a.	-	n.a.
1960	15.9	1.0	6.3	13.8	n.a.	-	6199
1961	17.4	1.4	8.0	12.7	0.1	0.7	9062
1962	19.8	2.5	12.6	16.4	0.2	1.4	14,397
1963	21.4	3.4	15.9	18.1	0.3	1.7	18,278
1964	22.8	4.3	18.9	20.2	0.6	3.0	19,775
1965	24.5	5.1	20.8	19.8	1.2	6.1	22,343
1966	27.2	6.5	23.9	25.4	1.8	7.1	26,693
1967	30.1	9.3	30.9	22.8	1.6	7.0	32,599
1968	33.5	12.2	36.4	29.8	3.9	13.1	37,953
1969	36.5	14.7	40.3	36.0	5.8	16.1	42,596
1970	40.3	18.0	44.7	41.0	8.6	20.9	48,443
1971	43.4	20.5	47.2	36.3	8.1	22.3	53,400
1972	50.0	24.9	49.8	53.3	n.a.	n.a.	66,897
1973	56.0	32.0	57.1	56.6	n.a.	n.a.	79,314
1974	58.0	34.0	58.6	53.4	n.a.	n.a.	90,135
1975	61.1[a]	37.2[a]	60.9	56.7	n.a.	n.a.	n.a.
1976	64.0[a]	40.0[a]	62.5	60.0	n.a.	n.a.	n.a.

Notes: a Estimated
n.a. Not available
* Production data refers to made tea.

Sources:

Area and production	1959-71	-	Etherington (1973)
	1972-74	-	FAO (1975)
			Lele (1975)
Production	1972-76	-	Ministry of Finance and Planning (1976)
No. of Small Scale Growers	1960-70	-	Sullivan (1972)
	1971-74	-	Lele (1975)

1.3 The Importance of Smallholder Tea Production

(a) Provision of Employment in the Rural Areas

There is increasing recognition that the traditional role of agriculture (of releasing labour to the rest of the economy) is for the time being in Kenya and in fact in most other less developed countries (LDCs) subordinate to that of holding labour until it can be accommodated elsewhere. The employment role of the rural sector of the economy is crucial at the moment. This is intensified by the fact that about 90 per cent of Kenya's population lives in the rural areas (Mbithi 1974), the growth rate of rural population being about 3.3 per cent per annum and the absorption capacity of the other sectors being very low (Etherington 1965). The government's awareness of the dynamics of unemployment caused by the soaring population growth, disappointing rate of employment creation, ever increasing number of school leavers and continuing influx of people from the countryside into the urban areas, caused the invitation in 1972 to the International Labour Organisation (ILO) to send a team of experts to advise the government on how to remedy the situation. The report (ILO 1972) made a number of far reaching recommendations, among which was the recognition that smallholder tea had a great potential for increasing rural employment. Kenya's Third Development Plan (1974-78) in fact stresses the employment generation aspect of the rural areas and promotion of small scale enterprise.

Tea offers employment in three ways:

(1) for family labour;

(2) for hired labour; and

(3) in factory and other KTDA services for tea development.

McArthur (1966) estimated labour requirements for five agricultural activities in Nyeri District and tea turned out to have the highest labour requirement of annual labour input per hectare (Table 1.3). We may therefore say that the potential contribution of tea cultivation in providing opportunities for the unemployed is high.

TABLE 1.3

ANNUAL LABOUR INPUT PER HECTARE FOR FIVE ACTIVITIES IN SMALL FARMS IN NYERI DISTRICT

Activity:	Tea	Coffee	Pineapple	Pyrethrum	Cattle
Workhours Per Ha	1877	1666	1287	1179	585

Source: MacArthur (1966)

Because of the relatively high labour demand per annum, smallholder tea production was originally restricted to only about 0.80 acres by the KTDA because it was to be a family enterprise where labour for cultivation was to come from the family itself. However, now it turns out that thousands of non-growers who otherwise would have been less fully employed are employed in the tea areas, either on a permanent or part-time basis. Moreover, the services KTDA gives to smallholders need personnel. For instance, by 1971 about 1300 people worked for the KTDA; of these 723 were in the field development sector and 535 in the leaf collection service, but by 1980, it

is projected the figures will be 856 and 1877 respectively[1] (KTDA 1972).

(b) Backward and Forward Linkages with Other Sectors of the Economy

The scheme has provided forward linkages with transport, machinery and the construction industries created indirectly in the industrial sector and backward linkages in the rural areas created by the need for sisal bags and baskets made by the rural people for leaf handling. It should be noted that by 1970, the KTDA had established 12 factories and the target by 1985/86 is 52 factories, with each factory having an annual capacity to process 1.1 million kilograms of processed tea, and the factories being located conveniently for all tea growers, i.e. in the rural areas.

(c) Rural Infrastructure

Since the tea project began, there has been tremendous improvement in rural infrastructure in the tea areas, in terms of roads, electricity, water supply and telephones and radio communications connected to the factories in the rural areas. Tea road development, undertaken by the government to facilitate leaf collection has been singularly remarkable. By 1968, 1450 kilometres of tea collection and factory access roads had been completed, about 322 kilometres of which was all weather gravel road (phase II programme).

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1 Indeed, this level of employment gave rise to serious concern that too many of the best extension officers were being drawn into this one crop (Sullivan 1972).

After the phase II program, the third phase covering 975 km at an estimated cost of K£5,250,000 was initiated and this was to be completed after 1974. The object in the third phase was to construct roads to new tea areas, to improve the bitumen standard of a few important factory access roads and to bituminise steep gradients (over 12 per cent) both on the phase II and phase III tea collection roads. Each grower is about one kilometre from the nearest leaf collecting centre. The responsibility of the grower for his tea ends only after the tea has been delivered and accepted by a KTDA official.

New trading centres have also grown following the construction or improvement of tea roads (Le Breton 1971). Also raising dairy cattle has been encouraged largely due to the good roads, because in addition to a common production environment, tea and milk share the requirement of swift delivery from farm gate to factory. The new roads mean that milk can now be delivered to the processing creameries quickly and without too much jolting.

(d) Rise in Farm Income and Income Distribution

Tea offers a substantial and in many cases the sole source of cash income to the smallholder, and therefore appeals to him greatly. It is a good source of regular income, likened again to milk, for tea plucking in these areas goes on throughout the year. It has an economic life of at least 50 years and there are not many disease problems in Kenya. The regular income enables the farmer to afford to pay school fees and his hired labour without having to resort to credit to tide him over (Sullivan 1972). These are advantages not

given by annual crops or other perennial crops. The bonus given to the smallholder at the end of the year may be used for investments, like the dairy enterprise or an expansion of tea planting. In fact, mostly tea has given farmers the opportunity to have a higher income than previously, considering the unique soil requirement for tea (that is acid soils). Moreover, the crop enables the farmers to diversify their enterprises which, again, is desirable.

Emphasis is now placed on encouraging farmers in the tea areas, who previously could not afford to raise the required 40 per cent of the loan given by the KTDA to plant tea (KTDA 1972). New growers are now required to contribute only Kshs. 20 to the KTDA before qualifying for full credit (given in kind). This has been considered sufficient to give the grower a sense of involvement in the project. A major contribution is, of course, made by the grower in the form of labour, which from a cash point of view goes unpaid for three years. The KTDA credit, which has a period of grace of three years, is recovered by a cess of 5 cents/kg of green leaf delivered. These conditions imply that almost every farmer in the tea areas has a chance to participate in the project which suggests some degree of equitable income distribution.

(e) Increased Exports and Export Earnings

The boom period in Kenya between 1976-77, when earnings from coffee and tea (as Kenya's principal exports) had turned around economic performance with a record surplus of K£35.8 million in balance of payments as compared with deficits of K£21.7 million in 1974 and K£17.8 million in 1975 (New African Development 1978) is

remarkable. Estimates for 1977-78 were that the surplus would be still higher. While coffee still dominates the economy, tea, the second major export crop, continues to increase in total production and export earnings because of the rapidly expanding smallholder tea sector.[1] Table 1.4 gives the relative importance of tea as an export crop from 1960 to 1975, with coffee as a comparison. Tea is expected to outplace coffee as a major export by the 1980s.[2] This is because all the planted acreage of coffee is practically mature while no further planting is permitted (because of the International Coffee Agreement). In the case of tea, as new growers enter into the industry and old growers expand their tea plantings, the new plantings from the smallholders will increase production further. This means that there will be no heavy reliance on one export crop and such diversification of export crops itself is encouraging.

Kenya's tea accounts for only a small percentage (6.5 per cent in 1974)[3] of total world tea exports. This means that she can expand her tea exports without significantly upsetting world prices for tea. With emphasis on quality production (smallholders sometimes get higher prices than the tea estates) as shown in Table 1.5, the country should be able to enjoy high prices for her tea especially with the increased demand for tea (a possible reflection of high coffee prices). The high price for tea since 1974 is shown in Figure 1.2 representing tea prices at the London Auction. The emphasis on quality

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1 Estate expansion is negligible (see Table 1.2).

2 See Ministry of Finance and Economic Planning 1974, p.238.

3 FAO 1974, p.256 .

TABLE 1.4

THE VALUE OF TOTAL EXPORTS AND THE PROPORTIONS TAKEN BY TEA AND COFFEE

Year	Total Exports KŁ'000	Value for Tea KŁ'000	% of Total	
			Tea	Coffee
1960	35,191	4411	12.5	29.2
1961	35,326	4004	11.3	30.2
1962	37,913	5189	13.7	27.9
1963	43,832	5665	12.9	25.1
1964	47,115	6066	12.9	32.7
1965	47,173	6085	12.9	29.9
1966	58,073	8714	15.0	32.3
1967	53,303	7396	13.9	29.4
1968	57,795	10,041	17.4	22.2
1969	63,332	11,271	17.8	26.6
1970	71,606	12,704	17.7	31.1
1971	73,185	11,855	16.2	26.8
1972	90,590	16,396	18.1	27.3
1973	122,636	16,923	13.8	29.2
1974	162,946	19,391	11.9	23.6
1975	168,812	22,958	13.6	20.9

Source: Ministry of Finance and Economic Planning 1976.
Sullivan 1972.

TABLE 1.5

A COMPARISON BETWEEN AVERAGE TEA EXPORT PRICES FOR KENYA AND THE KTDA

Year	Kenya Price Kshs per lb	Year	KTDA Price Kshs per lb
1964	3.3	1963/64	4.1
1965	3.5	1964/65	4.3
1966	3.5	1965/66	4.2
1967	3.6	1966/67	4.1
1968	3.3	1967/68	3.4
1969	3.1	1968/69	3.0
1970	3.3	1969/70	3.1
1971	3.2	1970/71	n.a.
1972	3.2	1971/72	n.a.
1973	3.0	1972/73	n.a.
1974	3.6	1973/74	n.a.
1975	4.0	1974/75	n.a.

Sources: Export prices for Kenya: Ministry of Finance and Economic Planning 1971, 1976.

Export prices for the KTDA: Sullivan 1972.

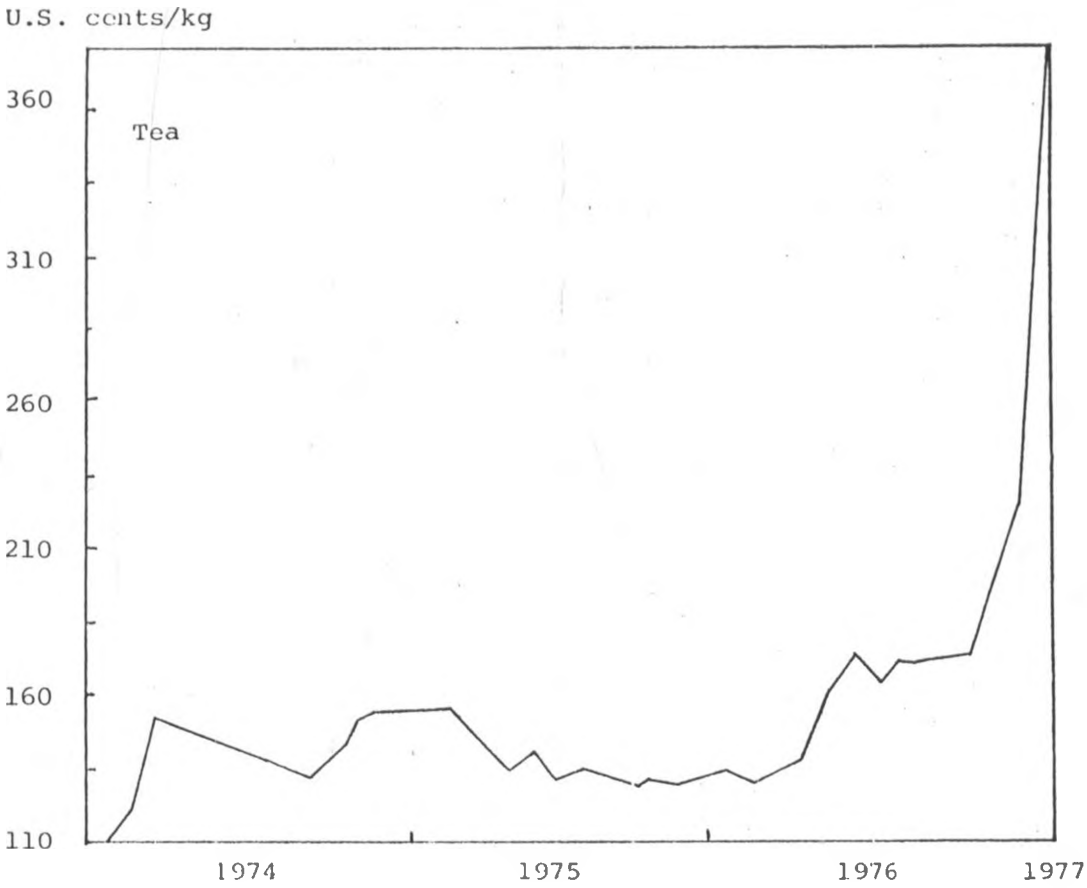
of tea produced in Kenya is reflected by the higher than average tea prices Kenya has enjoyed since 1966 (Figure 1.3) at the London Auction, her major tea market.

1.4 Source of Data and Area Studied

The data used in this study came from a survey carried out by Dr D.M. Etherington in 1965/66 on 48 smallholder tea farms in Kericho and Kisii. The farms selected were the result of a three-stage sampling process. First three of the twelve districts in which tea is grown were

FIGURE 1.2

INTERNATIONAL TEA PRICES AT THE LONDON AUCTION

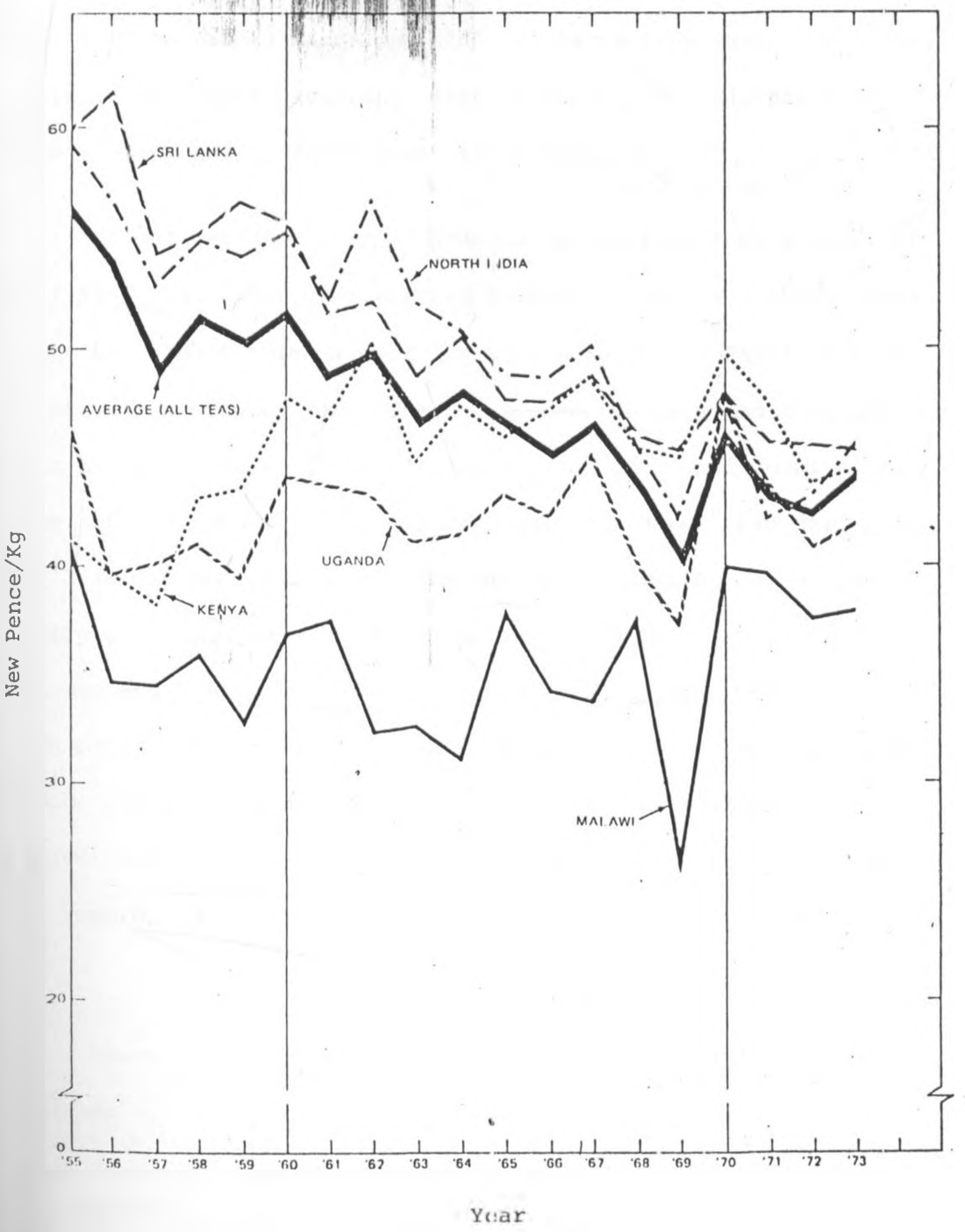


Source: FAO 1976/77, p.2 .

FIGURE 1.3

ANNUAL AVERAGE TEA PRICES FOR SELECTED COUNTRIES AT LONDON AUCTIONS, 1955-1973

(New Pence per Kilogram)



Source: IBRD 1975, p.159.

selected[1] (see Figure-1.1). Second, within each of the two districts considered in this study, two buying centres were selected randomly from a population of 30 tea buying centres. From each buying centre a random selection was made of 12 farms, this forming the third stage of sampling. In effect, Kericho had 24 farms included, 12 farms from Buret Division and 12 farms from Konoin Division; Kisii similarly had 24 farms, 12 farms from Nyamira and 12 farms from Kitutu Division

It was because of the degree of detail required (especially on labour) that the number of farms was limited to 48. For these farms, visits were to be made twice a week for one whole year. Thirteen hours of daylight were accounted for. The hours spent on farm and non-farm activities by each member of the farm family and each individual hired worker was noted. The labour inputs were summarised per farm per week.. There are 7 labour categories: family labour (consisting of farmer, other family adult men, women, children) and hired labour (consisting of men, women and children). The activities covered included tea, other cash crops, food crops, livestock, household, overhead, off farm work and the number of hours of illness. The way the weekly labour summary sheet was constructed is given in Appendix 2. The daily labour input was recorded but only the sub totals per week were punched onto cards.

There was a wide range of other information collected. This included:

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1 In addition to Kisii and Kericho, Kiambu was also selected. These are some of the major tea growing districts, but are ecologically different, which enabled comparison in the earlier study (Etherington 1973).

(1) farm sizes, ages of the family members and other particulars of the farm;

(2) harvesting and farm receipts and expenses;

(3) livestock numbers; and

(4) tea bushes and years they were planted.

In this study, I have addressed myself to labour input data on various activities, and in addition the tea bushes of various ages, to fully analyse smallholder tea production. Considering that the weekly labour summary is available for a whole year, the number of observations even for 12 farms would be 624, considering only a Division. However, it would be convenient for computational reasons to take monthly observations on labour inputs to give 144 observations for every 12 farms. With such a number of observations, we are unlikely to lack degrees of freedom in our analysis.

The randomly drawn sample included in the 48 farms is surprisingly heterogeneous even though it includes only those who grow tea. In the sample are local teachers, both junior and senior civil servants, those with no off farm income and even a student at the University! The individual size of farms varies from 2.6 to 17 ha in Kericho with an average of 8 ha per farm while in Kisii the range is between 0.8 and 21 ha with the average being 3.6 ha per farm.[1]

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1 Only one farm in Kisii had the extreme size of 21 ha. The rest were, in fact, below 4 ha in size. The area under tea, fixed by the number of stumps planted, varied between 0.2 and 0.7 ha.

1.5 Some Limitations of the Data Used

A major limitation of the summarised data as they stand is that leisure was considered as a residual, after accounting for all other activities. There was a limit of 2 digits to the number of hours per week on an activity by each category of labour. In effect, where there were two or more women or many children in a farm, the leisure activity of the labour category had more than 99 hours, exceeding the limit of 2 digits. In that event, the leisure activity for the various categories was omitted in the summary altogether. A second limitation is that the labour data, although detailed for one year, could not enable the examination of the reallocation of labour over the years between the various enterprises. This needs a longer time series data.

1.6 Justification for the Study and Objectives

The importance of smallholder tea has already been discussed. The scope for its expansion has also been considered. The importance of the crop therefore calls for a study of one of the major explanatory variables for output, i.e. labour input. It is known that even after tea has been introduced, smallholders do not restrict their activities only to tea. In effect, specialisation in tea is non-existent in small farms and how labour is allocated to other activities is therefore of importance.

The objectives of the study arise from the above observations. They include:

(1) To examine how labour is allocated among the farm and non-farm activities of the family farm across the year. This is important

in that in the event of expansion of tea holdings in the farm, there is a danger of creating labour bottlenecks for tea operations. The seasonality of labour inputs in various activities is to be studied. The distribution of labour input in the activities will reflect the impact tea has had on time allocation in tea areas, although it would have been more revealing if we had time series data on labour inputs to establish what activities the current labour was occupied with previously, before the introduction of tea. The labour absorption aspect of tea production in the rural areas will also be considered.

(2) To examine the correlation between labour inputs in farm and non-farm activities and other variables, like farm size, hired and family labour, tea plot sizes (determined by the number of bushes) etc. The hypothesis that as the prosperity of Kenya's smallholders rises they quickly substitute hired labour for their own family labour, implying that the income elasticity of demand for hired labour is high, will be examined. It may not be income only that determines the level of hired labour.

(3) To find out how labour is related to tea yields in small farms. This will be revisiting the analysis of Etherington (1973). In his analysis, he assumes there is a fixed factor proportion for tea production, i.e. that capital inputs in the form of tea bushes and labour inputs are perfectly complementary and verge on a Leontief input-output kind of production function with no possibility of substitution. He hypothesises that labour input in tea production is jointly determined by output[1], and by other inputs and therefore drops

---

1 Here, output refers to the amount and the density of the available two leaves and a bud on tea bushes.

it out of the production function for yield estimates. The present study attempts to relax this assumption in the belief that at the margin we may expect some room for substitution of factors such that farmers with fewer bushes, for instance, may take more effort in collecting the last '2 leaves and a bud' available from the tea bushes.

1.7 The Framework of the Study

After this introduction, the next chapter reviews some of the literature connected with rural labour supplies and absorption and their implications for rural and overall development. The third chapter examines the demand and supply situation of labour in the small farms using the survey evidence. Factors affecting the demand and supply of labour, the allocation of labour between the various activities and the correlation of the activities are examined. The fourth chapter relates directly to the production function analysis for smallholder tea. Here, the complications of deriving a suitable production function for tea are discussed and an attempt is made to estimate a production function which may allow for some substitution between labour and capital in the form of tea bushes. The fifth chapter presents the results of the proposed production function and discusses the results. The final chapter gives the conclusions of the study and draws inferences for policy.

CHAPTER 2

SOME THEORETICAL MODELS ON LABOUR USE IN AGRICULTURE

This chapter discusses some of the theoretical models on the use and productivity of agricultural labour. The models are based on one or more of the following assumptions:

(a) the supply of agricultural labour to the industrial sector is unlimited;

(b) withdrawal of a part of the labour force would have no significant effect on total agricultural output;

(c) the marginal product of labour in the agricultural sector in LDCs is very low or practically zero;

(d) in isolated communities where land is still substantial, there is a concealed agricultural labour surplus because such communities produce for their own consumption and little else. The idle hours in such communities, it is assumed, can be made use of in more productive enterprises;

(e) the time available for the rural people is divided between agricultural work and leisure.

The aim of this review is to indicate how some models, if used indiscriminately, may not be very useful in promoting rural development which is very desirable in countries such as Kenya,

while some models may be acceptable. The chapter starts with a discussion of the above issues and ends with a note on 'new home economics' - an area which represents a beginning to a new line of inquiry into the household behaviour as regards time allocation, among others.

2.1 The Lewis-Fei-Ranis Model of Development

This is one of the most popular employment models relating specifically to the LDCs. It was formulated by Lewis (1954) and extended by Ranis and Fei (1961). In the model, the underdeveloped economy is characterised by duality, i.e. (i) a traditional agricultural subsistence sector with low productivity and surplus labour, and (ii) a high productive modern urban industrial sector. The rural workers are surplus to the extent that they add little to agricultural output. In effect, the marginal productivity of labour in agriculture is forced to zero by population pressure on land and increasing output is not possible with existing techniques. Some of the labour could be transferred to the urban manufacturing sector with little or no loss of agricultural supply ceteris paribus.[1] Morever, the transferred lot were assumed to be willing to work at a fixed urban wage rate somewhat higher (30 per cent) than their average real incomes in rural areas. The coexistence of positive wage with zero marginal product in agriculture is explained by the fact that, due to institutional factors, rural labour is paid according to average

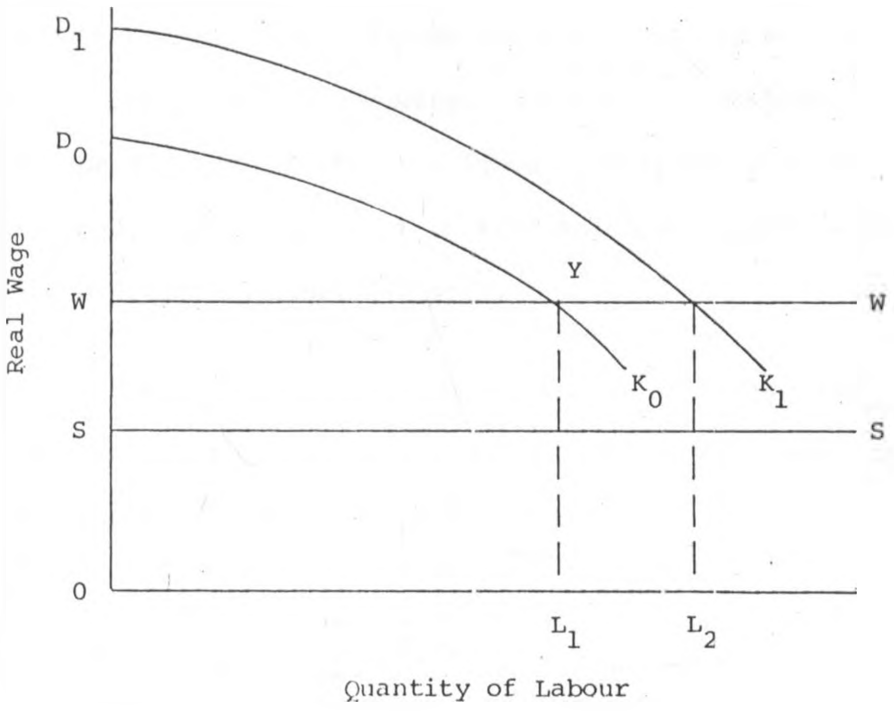
---

1 Some authors have relaxed the assumption of ceteris paribus and insisted that the remaining workers must work harder (Pepelasis and Yotopoulos 1962; Sen 1966).

product, not marginal product. Figure 2.1 illustrates the model as postulated by Lewis (1954).

FIGURE 2.1

ILLUSTRATION OF LEWIS' MODEL



The vertical axis represents the real wage, equal in a competitive economy to the marginal product of labour, and the horizontal axis represents the quantity of labour. OS is the subsistence wage, or institutional wage, determined by the average product of labour. OW is the constant urban wage fixed 30 per cent above the subsistence wage.

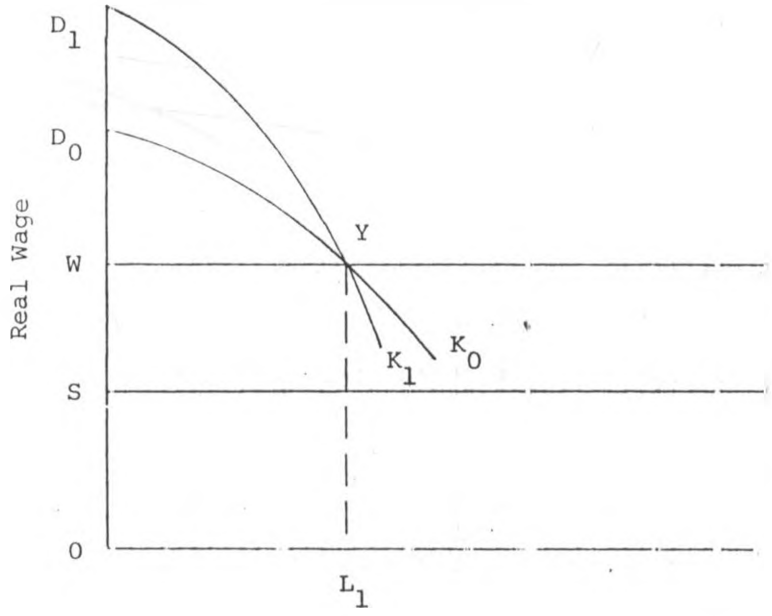
Given fixed capital K_0 initially, the demand curve for labour is determined by the labour's declining marginal product and

is shown by D_0K_0. Because of the profit maximisation tendency of the industrial sector, the point where marginal product and wage are equal is the level at which labour is used. Thus, OL_1 of labour is employed. Total output would be OD_0YL_1 of which $OWYL_1$ would be wages and WD_0Y would be profits. Development was to ensue by the industrialists reinvesting all their profits and continuing to absorb more labour. Thus, with higher capital K_1, in the next stage OL_2 of labour is absorbed in industry. The process continues until all cheap labour is absorbed when the labour supply curve becomes positively sloped, i.e. phase II of the Fei and Ranis model, when the terms of trade turn against industry.

Lewis was silent on what would happen if the capitalist reinvested the profits in more labour saving capital equipment. Figure 2.2 illustrates what could possibly happen in that case.

FIGURE 2.2

ILLUSTRATION OF REINVESTMENT BY CAPITALISTS
IN LABOUR SAVING TECHNIQUES OF PRODUCTION



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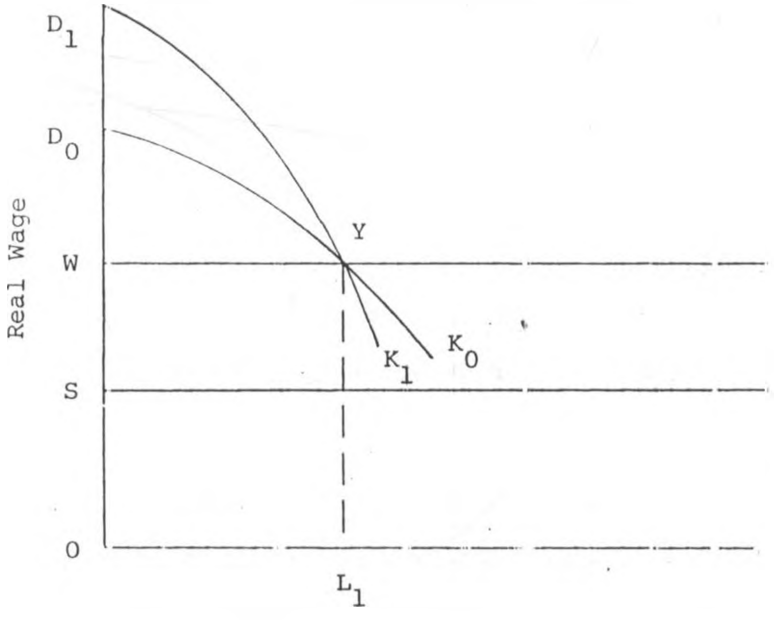

In Figure 2.2, D_1K_1 has a greater slope than D_0K_0 reflecting the fact that additional capital stock K_1-K_0 is of more labour saving variety than originally. In that event, only OL_1 is employed and there is no additional labour absorbed even with higher profits. Intermediate cases between these two extremes could also be illustrated.

The fact that industrialists may have no difficulty in recruiting a labour force may have inspired the idea of unlimited supplies of labour from agriculture. However, this may not be because the labour supply curve is horizontal. The employers may pay more than the supply price for labour. For instance, industrial wages may be forced upward by minimum wage legislation, trade union pressure, employers' efforts to retain skilled personnel in a firm, or other institutional forces and, in this case, their movement over time does not necessarily say much about labour supply conditions or labour productivity in agriculture.

The agricultural sector is largely ignored in the Lewis model and is treated only as a reservoir of labour. Ranis and Fei (1961; 1964) emphasised the structural interdependence of the agricultural and non-agricultural sectors. However, they assume zero marginal and non-agricultural sectors. However, they assumed zero marginal product in agriculture and called some part of labour 'redundant' and an agricultural worker is employed full time for only a few months in the year, he should still be considered at least partly redundant because of his idleness during the rest of the year. What is, however, apparent is that such workers cannot be withdrawn permanently without reducing agricultural output and, even if they are withdrawn, they are transferred back and forth between industry and agriculture: the

cost involved in such transfers may not be negligible. In fact, we shall see how in the area under study, there is a range of activities which may be performed by the rural people. If there is efficient work-sharing within the family there may be no redundancy. Alternatively, if the last manhour of labour input is considered, marginal productivity could be zero if (and only if) over a certain range, increased hours of work had zero disutility or leisure had zero value or the people are saturated with leisure as Striglitz (1969) puts it. This is very unlikely to occur.

There is also increasing recognition that the modern urban sector has a very limited capacity to absorb labour, hence the existence of open unemployment and a rapidly growing, low productivity 'informal'[1] sector in urban areas. Thus, ways of making the agricultural sector absorb labour are desirable. Todaro (1969) and Harris and Todaro (1970) assuming an institutionally determined wage rate in the urban area, and a wage determined by labour supply and demand in rural areas (a direct reversal of the Lewis-Fei-Ranis model), demonstrate that increasing urban employment itself is unlikely to reduce urban unemployment because of the nature of migration from the rural areas.[2] They establish that the rate of migration depends not only on the rural-urban wage differential but on the probability of getting a job in the urban area, which is a function of the rate

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1 The informal sector activities involve petty trades, street hawkers, shoeshine boys and other groups underemployed on the streets of big towns. Of course, some of these are economically efficient and profit making, but certainly not all could be considered productive.

2 A detailed study of the rural-urban migration in Kenya using the Todaro model is presented in Doran (1975).

of urban unemployment. Thus, an increase in urban employment by one worker is likely to induce an influx of more than one migrant, as the Tripartite agreement of 1964 in Kenya showed.[1] Considering that 90 per cent of the population live in the rural area and the low rate of increase of urban jobs, the logical implication then is that employment must be created in rural areas. This is possible especially in an open economy where increased production can easily be exported so that agriculture's terms of trade do not worsen as would be the case in a closed economy. Such exports would earn foreign exchange which may be used for further development of the rural area. It is in this area that smallholder tea contributes to the overall development of the country, because of the big capacity of tea production to absorb labour.

Neither Lewis nor Fei and Ranis claim universal validity for their models, but several studies show that even in the areas explicitly referred to by them to hold true for their models, transference of some part of labour is not possible without reducing output (Schultz 1966; Sen 1966). This may be because the seasonal nature of agriculture was not considered in the Lewis-Fei-Ranis model. If seasonality is considered, one can perceive output falling if, for instance, more acreage cannot be prepared for timely planting of crops due to lack of labour.

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1 The Tripartite agreement involved the government, private employers and trade unions. The private employers and the government agreed to increase the number of employees on their payroll by 15% at once on condition that trade unions agreed to accept a wage moratorium. This acted like a magnet attracting new workers to the urban labour market, thus replenishing the pool of urban unemployed.

Jorgenson (1961) refutes the idea of zero marginal productivity in agriculture and argues for a positive marginal productivity but with emphasis on structural interdependence in the dual economy. He shows that the transfer of labour from agriculture will in itself require an increase in agricultural productivity, which may arise from technological innovations in agriculture; thus great attention is being given to agricultural development for overall economic development.

Reynolds (1975), in a review on the agricultural labour surplus literature, cautions about the possible confusion that exists between labourers or manhours of labour applied. He asserts that labour surplus does not exist in the form Ranis and Fei put it because the marginal productivity of manhours worked must be positive for most work has disutility, but that a surplus may exist in the Lewis sense due to the overpricing of industrial labour. However, it should be noted that, because of the high price of labour given in the industrial sector, the employers undertake to introduce labour saving techniques in their production (see Figure 2.2) with the result that the absorption of labour from the rural area is very low.

2.2 On the Question of Disguised Unemployment

The term 'disguised unemployment' was coined by Robinson (1936) to refer to workers with a low rather than zero marginal product. It applied to workers in developed countries who were laid off from industries suffering from a lack of demand for their products and were prepared to be absorbed in inferior

occupations. It was later adopted to apply to areas with 'zero marginal product' of agricultural labour and where a portion of the labour force can be removed without reducing output ceteris paribus. Many authors[1] have attempted to explain the existence of disguised unemployment, some of which have been considered in the last section. However, Schultz (1956; 1964) has given empirical evidence from Latin America and India (areas where Lewis' model was to apply) showing that removal of part of the labour from agriculture ceteris paribus results in a decline in output. Viner (1957, p.18) argues that even if other factors of production are held constant, it may be possible to obtain some addition to output of a crop:

> 'by using additional labour in a more careful selection and planting of seed, more intensive weeding, cultivation, thinning and mulching, more painstaking harvesting, gleaning and cleaning of the crop.'

The evidence from Africa in general is that the marginal productivity of labour in agriculture is positive (Helleiner 1975, p.28). It is the peak season labour which is the operative constraint in the farming system, and many studies have shown this.[2] In effect, it is not meaningful to generalise that marginal product is zero throughout the year for this is known to vary across the year. The seasonally surplus labour which the casual observer assumes is a permanent phenomenon can be and is mobilised in a

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1 The literature on this issue is enormous. A good survey of the discussion and a fairly complete bibliography on it can be found in Kao et al. (1964), Sen (1966) and Wellisz (1968).

2 See, for example, Heyer (1971), de Wilde (1967), Byerlee and Eicher (1972), Cleave (1974).

variety of ways as will be indicated in the next chapter. In fact, the slackness may be well-deserved after a season of hard work (e.g. after planting, weeding or harvesting).

2.3 On the Question of Land and Labour Utilisation: Fisk's Model

The idea that there may be concealed resources in the subsistence sector, which may be brought to full use given the necessary incentives, was developed by Fisk (1962)[1] with observations from Papua New Guinean isolated communities. The model actually tries to explain how there may be a possible transition from pure subsistence to the monetary economy in the rural area where land is still substantial and applied labour, while very productive, could be induced to produce more.

Figure 2.3 illustrates what is involved in Fisk's model. It represents production possibilities of a production unit of whatever size in subsistence agriculture with constant (but substantial) supply of land, constant technology, and constant application of capital per man. There is one output, 'subsistence produce', shown on the vertical axis. Curve OT shows production possibilities with varying inputs of labour. The social and demographic characteristics of the population (e.g. age and sex structure) are taken as given but determine a number of factors, all of which are functions of total population (N).

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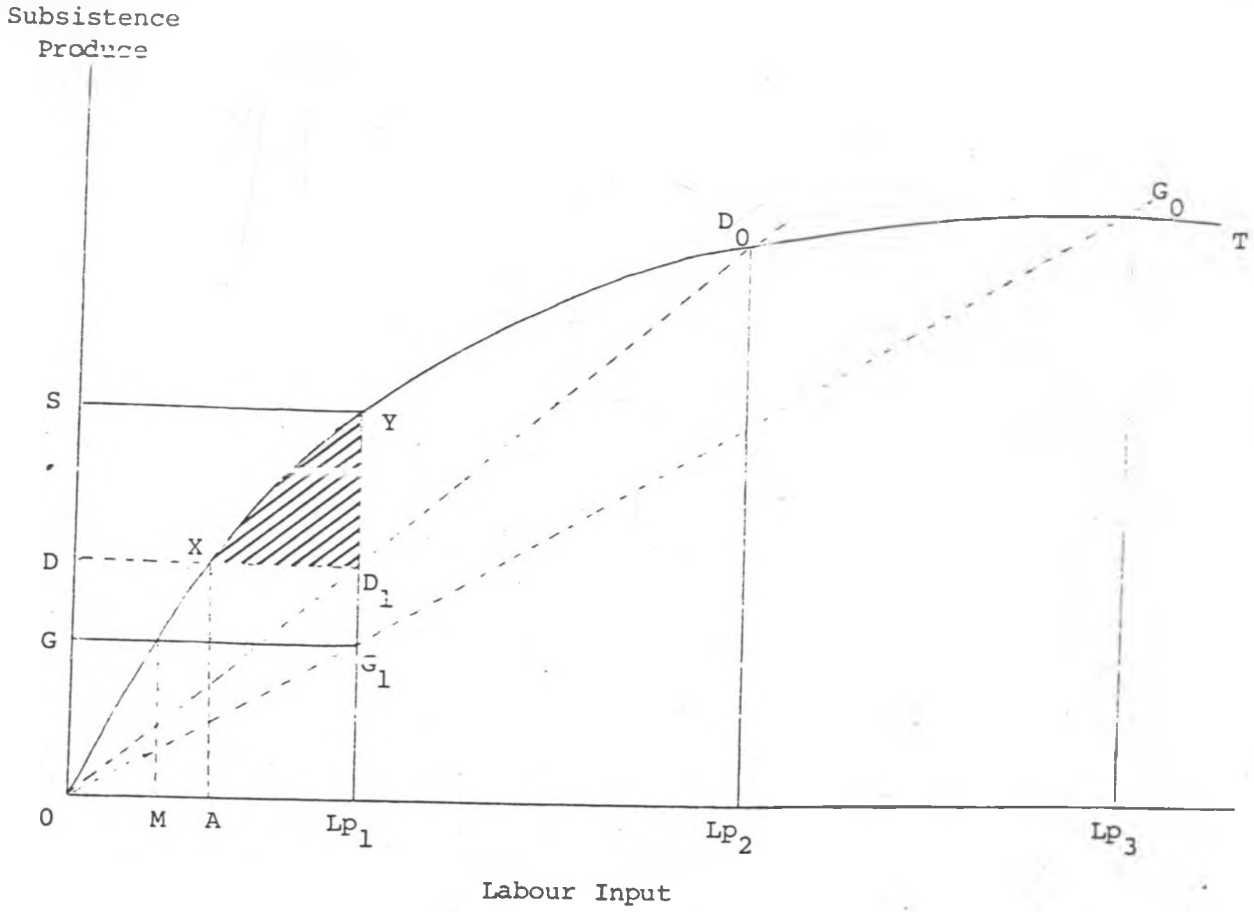
1 The model has since then been extended by Fisk and Shand (1969), Fisk (1971; 1975), Shand (1965), Nakajima (1969). A similar model was used by Helleiner (1966) in Nigeria to explain labour and land surpluses which can be mobilised for production.

FIGURE 2.3

ILLUSTRATION OF FISK'S MODEL



Initially, the labour potentially available for productive work is OLp_1 and is a function of N. This labour input gives potential subsistence produce OS. However, there may be a physiologically and socially determined ceiling to the amount of such produce which can be consumed with satisfaction (given some limit on the possible individual demand for subsistence, mainly starchy staple, foods). In effect, there is a ceiling beyond which consumption of further produce gives negative satisfaction and is also a function of N, represented by DD_1 in Figure 2.3. The radial OD_0 passing through D_1 shows the ceiling for any level of labour potential because of the direct relationship between Lp and N. Subsistence producers rationally may not produce to the level S by exploiting all the potential supply of labour, but produce only up to D using the lower level of labour input OA. With this, they may live in 'subsistence affluence'.[1] The balance available, ALp_1, comprises a surplus which may be used either for enjoyment as additional leisure or for investment or for production of surplus of up to DS of subsistence-type produce for sale in the market sector. Thus, when Lp_1 is used, OXA represents the produce for subsistence consumption and XYD_1 (shaded) represents the produce for monetary enterprises.

There is also a physiologically determined level of consumption, G, below which the nutrition of the population would be inadequate to sustain the potential supply of labour at Lp_1.

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1 This is a term coined by Fisk because it is assumed the subsistence producers have all that they need since only few external goods and services may be available or known to them.

This level of 'grinding' poverty is the minimum below which starvation sets in and Malthusian checks start to operate. OM represents the minimum input of labour necessary to maintain the population at its working strength. It may not be voluntarily held but may be forced on a community by, for instance, compulsory withdrawal of the quantity MLp_1 of the population for other tasks. In fact, the OM situation represents a critical shortage of labour and therefore innovations such as cash crop production cannot succeed, while the OLp_1 situation is likely to provide the extra labour needed for cash crop production in addition to subsistence, given the necessary incentives and organisation.

The radial OG_0, passing through G_1 traces the minimum demand ceiling for each level of population.

As population increases, the potential labour supply (Lp) increases but D and G also move upwards. Given a constant structure of the population and constant land supply, with existing techniques, soon the labour potential produces all the requirements without any surplus labour left; such is the condition at Lp_2. Similarly, the level of grinding poverty for all the population is reached at Lp_3 and here methods must be found to raise the total product curve if Malthusian checks are not to ensue.

Fisk's model is similar in many respects to the limited aspiration model given by Mellor (1963). The key assumptions of the limited aspiration model are that the marginal utility of added goods and services income drops substantially once subsistence is met and that the productivity of labour is such that incomes commonly range

around the subsistence level. The meaning of these assumptions is that if the subsistence farmers are to produce goods other than for subsistence, e.g. cash crop production, a wide range of goods and services must be made available to them at reasonable prices to increase the utility for the cash they may obtain from increased production. This is similar to giving them incentives to produce more by applying more labour if possible. In effect, the appearance of limited aspirations is not only to be explained by attaching high utility to leisure relative to material goods per se.

The source of labour which can be used for cash crop production in areas where land is not limiting may therefore be theorised by Fisk's model.[1] What is needed if such labour is available (e.g. ΔLp_1 in Figure 2.3), is to give the population adequate incentives by way of making available external goods and services to increase the utility for money, as has been pointed out, and improving infrastructure to increase the awareness of the population of the profitability of other enterprises apart from subsistence production. Myint's vent for surplus model (Myint 1964) suggests that with good organisation and incentives, cash crop production for export can successfully be introduced to capture the idle hours found in Fisk's model.

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1 However, the assumption of allocating time to either producing food (and providing shelter and clothing) or having leisure has been seriously questioned by Jones (1969). Jones contends that there are some other very important economic activities (e.g. crafts, attending development meetings and other non-farm activities) performed by those communities that are lumped together as leisure and which effectively may reduce the man-hours available for monetary enterprise. It is recognised that food satisfies only one need and since there are always other demands to fill there is no need for involuntary idleness.

It was difficult to test whether the labour used in smallholder tea farms in the area studied was previously idle or not, because only cross-sectional data was available, but the fact that production of tea is undertaken only after subsistence requirements have been met was evident in all the farms in the sample. It is also worth noting that the smallholders are very enthusiastic about tea growing due to the good organisation and incentives given to them by the KTDA and the committee members from their own areas. This is evidenced by the fact that initially the demand for planting material by the smallholders often exceeded the available supply in the KTDA central nurseries. However, since the introduction of propagation of tea from vegetative cuttings in 1967, individual farmers can now prepare their own planting material at their nurseries with KTDA supervision.

2.4 The New Home Economics and Labour Use

The labour-leisure dichotomy models applied in most rural employment models have come under question from some modern studies (Ishikawa 1975, Hymer and Resnick 1969, Gronau 1976a, Jones 1969). The question arises due to the lack of attention given to non-farm activities. Some of these activities, as we shall see in the next chapter, are essential for the survival of rural households. In effect, the time allocation studies pioneered by Becker (1965) and recently extended by Gronau (1976a) may give insights as to the behaviour of rural households with regards to labour utilisation.

According to 'New Household Economics'[1] a household is viewed as an economic unit (both producer and consumer) which maximises its welfare subject to time and income constraints (full income constraint) through the optimal use of its total resources in consumption-oriented as well as production-oriented activities. Welfare is assumed to be a function of commodities plus bundles of satisfaction or abstract goods (Z goods) which are produced using market goods and time as productive inputs. Thus, market goods are not themselves the agents that carry utility, but rather are inputs in a process which, together with time, generate commodities which yield satisfaction. Full income is incorporated as the constraint to utility maximisation, not merely wage income. Full income refers to either the value of household income produced by non-labour earning assets (e.g. butcheries, houses for rent, or rented land) plus the values of the time of household members utilised in the production of home goods or the sum of the quantities of each household good times the shadow price of each good, i.e.:

$$\text{Full Income} = \overset{*}{Y} + \Sigma t_{ij} w_{ij} = \Sigma Z_i \pi_i$$

where $\overset{*}{Y}$ = non-labour income

t_{ij} = j'th member's time in producing Z_i goods

w_j = wage rate of j'th member

Z_i = i'th good produced

π_i = shadow price of Z_i good

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1 A full exposition on 'New Household Economics' can be found in Schultz (1974), Evenson (1976; 1977), Becker (1965).

In the new home economics, 24 hours per day of each individual are accounted for. Rather than divide the available time into two, the time is divided into three major areas. Home production time, market production time, and leisure time. The allocation of time of a household[1] then is one of the means the household uses to maximise utility and it reflects the choice of household goods (Z goods). The choice is influenced by factors exogenous to the household, e.g. wages, market good prices, non-labour income and fixed production factors like the environment.

This new approach recognises that to describe the non-income earning time of women in the rural areas as leisure, for instance, is very misleading. Inducing women to increase work outside the home does not necessarily mean increasing their contribution to family welfare or reducing their leisure, although increasing their efficiency in home production may mean more time available for other activities ceteris paribus. As such, the women who spend their time in home production activities are given the status of producing more in line with their real contribution to family welfare. There may also be a revelation of whether the poor, to the observer, works harder than the richer or not; or who is the family's breadwinner (Gronau 1976b).

Only few empirical studies have been done on LDCs, using the new home economics model of time allocation (e.g. Quizon 1977,

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1 Households also allocate time resources among their members resulting in specialisation of roles within the family. For instance, husbands and wives are influenced by each other's tastes, wages and efficiency levels in different activities.

Evenson 1978). However, although data collection for such a study is very involved (i.e. accounting for 24 hours per day and recording time allocated to each Z good) this new approach to household behaviour certainly shows a great promise of unravelling many truths about households. This particular model could not be used for analysing labour utilisation in the tea farms in this study because data was only collected for thirteen hours of each day so that many aspects of home production and leisure time would have been omitted.

CHAPTER 3

LABOUR UTILISATION ON THE TEA FARMS

This chapter explores the use of labour in the survey farms. In particular it investigates which activities demand the time available and the possible sources of additional labour that can be used for production of cash crops. The competing demand for time of family labour, the factors affecting the demand and potential supply of labour, the labour profile across the year and the correlation between various activities in the area are examined.

3.1 Competing Demand for Time of Family Labour

In rural households in particular, there are so many diverse tasks to be performed at any one time. Thus, apart from market production and leisure which are normally given prominence in existing development literature, the activities are so many and heterogeneous that Hymer and Resnick (1969) and New Household Economics (discussed in the last chapter) have clustered them as Z goods. An attempt is made here to examine the activities which compete for the available time of the household members in the area under study but they may not be exhaustive.

3.1.1 The Farm Activities other than Tea Production

The area under study is generally classified as an agriculturally high potential area because both rainfall amount and

reliability are good, though bimodal (see Figure 3.2 for Kericho rainfall distribution). Other than tea, which was introduced only in the mid-1950s on smallholder farms, a number of agricultural activities are carried on. These include:

(a) food crop production;

(b) livestock keeping;

(c) growing of some other cash crops; and

(d) processing and marketing of the farm products.

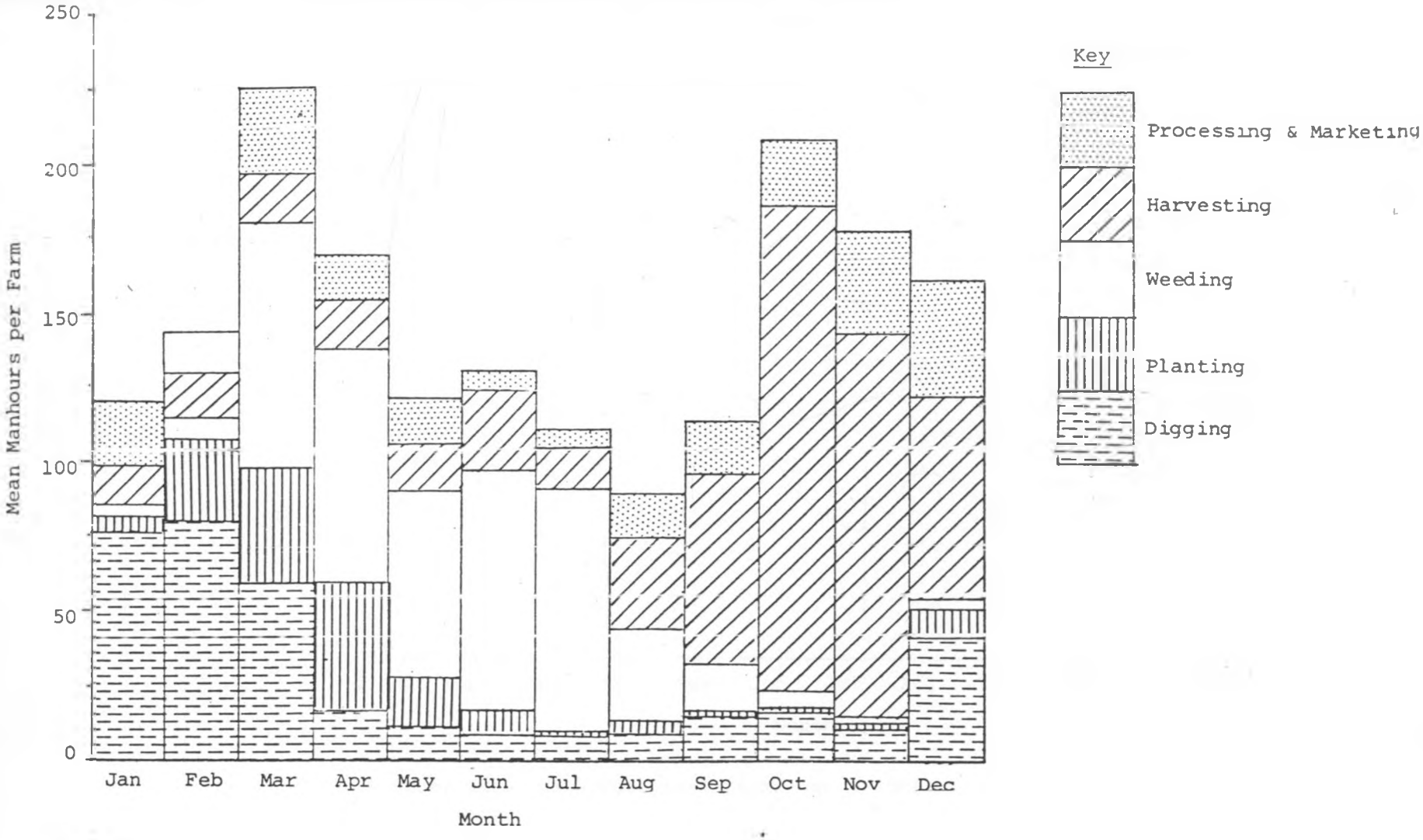
(a) Food Crop Production

The cultivation of food crops is undertaken by every household in the area. The major food crop is maize, but others include 'wimbi' or finger millet, beans, various kinds of vegetables, and sometimes bananas. Every household tries to be as self sufficient as possible in food production because of the unreliable market for food crops. In fact, if any activity is in conflict with food crop production in the area, time would rather be allocated to the food crop. De Wilde et al. (1967) notes that one major feature in African agricultural systems is that failure to provide food for one's family and to meet an obligation to a kinsman if need arises is regarded as a source of shame. This area is no exception in this regard.

Food crop production has an inherent seasonality of labour input. Figure 3.1 depicts the labour profile (both hired and family labour) for food crop production. Seedbed preparation for maize, the major subsistence crop, has to be done before the

FIGURE 3.1

MEAN MANHOURS USED PER FARM FOR FOOD CROP ACTIVITY

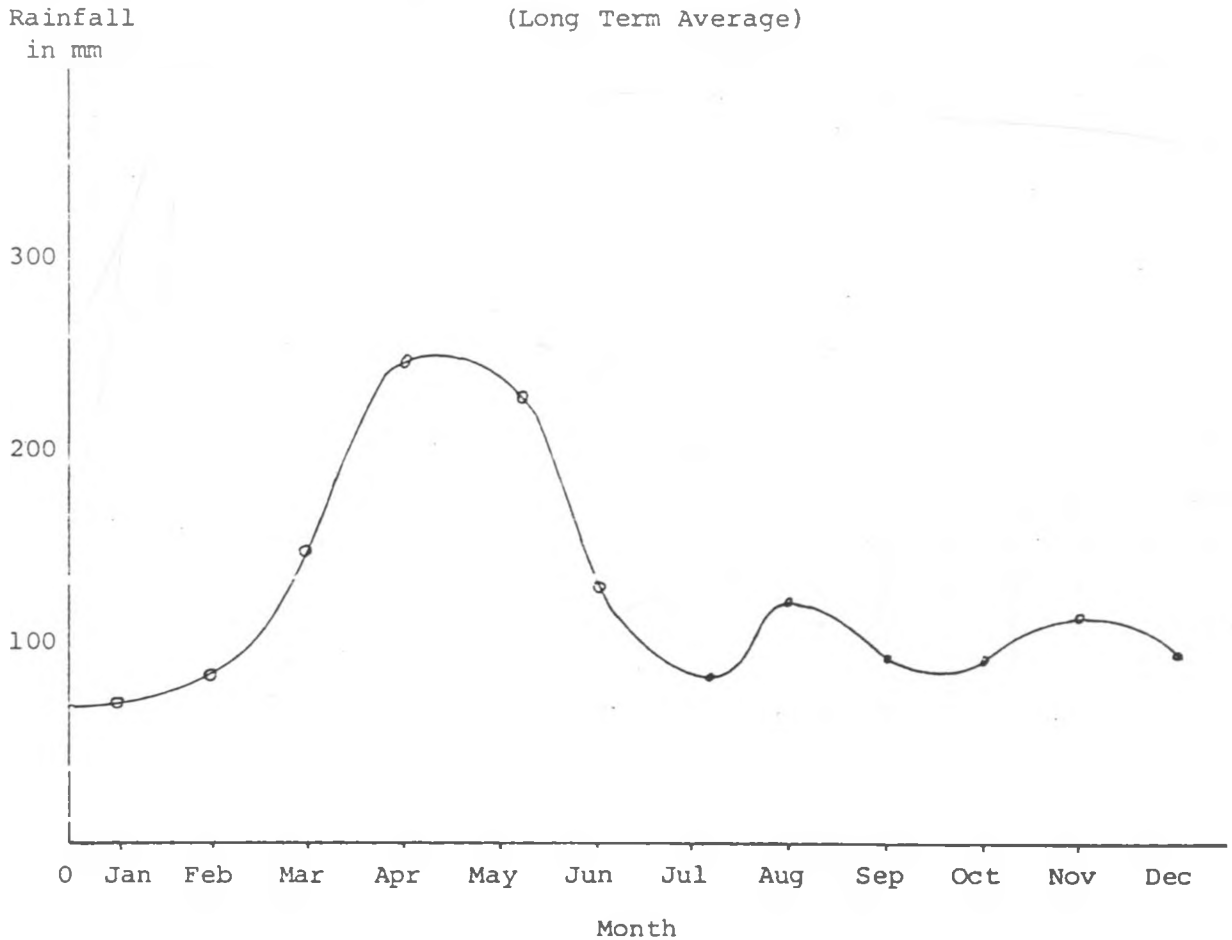


Source: Survey Data.

FIGURE 3.2

RAINFALL DISTRIBUTION FOR KERICHO; LITEIN MISSION

(Long Term Average)



Source: E.A. Meteorological Department, 1968.

beginning of the long rains in March (Fig. 3.2) if planting is to be on time and consequent yields are to be good. It has been shown that if planting takes place well after the onset of the rains, the maize yields drop considerably (Allan 1971). Soon after planting, weeding has to be done and if this is done late, yields again drop. After weeding, there may be a slack period and at harvesting time, towards the end of the year (exact time depending on the seed variety used) another peak season occurs. However, throughout the time the crops are in the field, they must be protected against pests like monkeys and birds. If birds are not scared from finger millet fields the harvest may be very poor. Also, during the short rain which begins around September, some quick maturing crops like beans or some vegetables might be planted. Comparing Figures 3.1 and 3.2 reveals the close relationship between labour profile in food production and rainfall distribution.

(b) Livestock Activity

The inhabitants of the area (especially the Kipsigis) are traditionally pastoralists. This implies that great importance is attached to cattle ownership. In fact, all the 48 farms surveyed had some cattle and each household had milk from its own cattle. In any one month, an average of between 13 and 17 per cent of labour used per farm was taken up by livestock activity. Although originally the number of cattle owned was more important than the quality, there is an increased realisation of the benefits of keeping good quality cattle and hence an increasing demand for exotic cattle for milk production. The dairy enterprise is very lucrative now with

good veterinary services, good prices for milk and good roads to facilitate quick transportation of milk for processing. Most of the cattle herding is, however, still done by children, although during school hours child labour for cattle herding may be unavailable and hence fencing of the land to divide the plots into paddocks for grazing has become common.

(c) Other Cash Crops

In this area, cash crops other than tea can also be grown, providing competition for the available labour. The crops include coffee, pyrethrum, wattle trees and passion fruit. However, it should be noted that in soils where tea thrives best, only a limited variety of other crops could grow because of the acidity of such soils (pH 4.5-5.5). Also, it should be pointed out that the crops used as food crops may be sold, especially if they are in excess supply relative to the household needs. These include maize, especially in Kericho, and bananas in Kisii.

After establishment, these other perennial cash crops have largely seasonal labour demands especially for harvesting of the desirable products. Between 5 and 11 per cent of the labour used per farm per month in Kisii was taken by other cash crops (the wide variation signifying the seasonal demand) but during the time of the survey, the Kericho farmers had negligible time spent on crops included in the other cash crop category for most of the farmers had not cultivated them. As will be seen, the seasonal demand for harvest labour in these other perennial crops is in direct contrast to tea, which has a more even labour profile after establishment.

(d) Processing and Marketing of Farm Produce

After harvesting of the crops, they must be processed at home either for storage or marketing and if processing is not done carefully, post-harvest losses may be large. Thus, maize and finger millet are normally sun-dried and sometimes shelled before storage. Drying involves taking the produce outside from a shelter each day for sun-drying and returning it to the shelter before the usual afternoon rain wets it or before nightfall.[1] This, therefore, takes a considerable amount of time. In the case of other cash crops such as coffee, passion fruit and pyrethrum, after harvesting the product must be delivered to either a co-operative or a processing factory which may be a considerable distance from the farm and hence more time is taken going to and from the place of delivery.

3.1.2 Household Activity

Domestic work is a major activity which is often taken for granted. The work involves preparation of food, fetching water and firewood, cleaning the compound, attending to children and washing clothing. Most of the domestic work is done by women and children. In fact, if domestic work is taken into account when considering time allocation by rural households, it is apparent that women are fully employed. Pudsey (1967) in a study of smallholder tea producers in Toro District in Uganda reached the conclusion that if domestic work is considered, women are over-employed. In the area

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1 It is proverbial in the survey areas that during most of the year the rain starts falling at 4 p.m. and stops at 7 p.m.

under study, an average of between 20 and 28 per cent of labour used in each farm per month is taken by household work indicating that it is a very time consuming activity. Since household work involves such activities as fetching firewood, water, and even purchasing food from the market, the distance factor becomes very important as far as time expenditure is concerned. In fact, a considerable amount of time is used walking from the home to a water point, to a firewood collecting place, or to a market place. In effect, improving the general infrastructure is one area where higher efficiency in household work could be attained.

3.1.3 Some Other Non-Farm and Overhead Activities

Even in a typically rural household, not all activities are farm production activities, although the boundary between farm and non-farm activities may be arbitrary and non-farm activities may facilitate enhanced agricultural production. Heyer (1968) established that in 14 holdings in Masii location in Machakos District, the relationship of work hours on the land to other work was 1:1.7, thus 'other work' was more time consuming than field work. The category considered as non-farm and overhead activities in this study includes paid employment[1], own commercial businesses like stores, butcheries, various forms of crafts, building and repairing own houses, general supervision and attending development meetings. Thus, treating household activity separately from non-farm activity

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1 The figures for paid employment include casual paid employment but not full time off-farm jobs. It is also to be pointed out that there was a data limit for any labour category of 99 hours per week in the summary forms.

in each farm, over 20 per cent of labour used in any one month per farm in this area is for off-farm work and overhead activity. If household activity is combined with non-farm work, all non-farm activities may be just as important as farm activities in terms of time allocation because, as we have seen, up to about 28 per cent of time used per month is taken by household activity.

The labour used across the year per farm and the percentage taken by each activity including tea (discussed in the next sub-section) is shown in Tables 3.1 and 3.2 for Kericho and Kisii respectively. Figures 3.3 and 3.4 show the average manhours derived from the respective tables. It is noticeable that the month of July shows unusually low activity. This may be due to possible enumerator bias for the survey began in July and this indicates their initial inexperience with recording data. We should recall that the farm sizes in Kericho and Kisii are different with an average farm size in Kericho being 19.7 acres (8.0 ha) and that in Kisii 9.0 acres (3.6 ha). It is therefore surprising that the profiles of labour use shown in Figures 3.3 and 3.4 should be similar. This may be due to the approximately similar number of family members over seven years old living in each farm in each of the districts.[1] The average for Kericho was 5.1 members and that for Kisii was 5.8 members per farm.[2] The similar labour profiles (Figures 3.3 and 3.4) contrast to the tea profiles (Figures 3.5 and

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1 A person over seven years old was considered able to contribute in some form of work. The lower age limit is especially useful in such work as scaring birds from crop fields.

2 It should be noted that the society here is polygamous and it is not uncommon for one to have more than two wives.

TABLE 3.2

THE PROPORTIONAL ALLOCATION OF WORK TIME PER MONTH IN KISII

(%)

Activity \ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tea	14	11	16	21	13	13	17	16	14	12	10	11
Other Cash Crops	7	6	6	7	7	5	11	10	10	9	5	8
Food Crops	22	19	18	13	14	12	17	15	8	13	19	20
Livestock	11	12	12	15	15	17	13	11	12	12	12	13
Overhead	2	2	3	2	3	4	5	6	4	2	1	1
Household	21	23	22	22	22	25	23	24	25	23	23	23
Illness	5	4	3	2	5	4	6	5	6	9	9	5
Off-Farm	18	23	20	18	21	20	8	13	21	20	21	19
All Activities[1]	100	100	100	100	100	100	100	100	100	100	100	100
Mean (All Activities) (Manhours)	852	720	822	740	730	869	436	750	721	937	782	1106

1 Excludes leisure.

Source: Survey data.

FIGURE 3.3

PROFILE OF LABOUR USED PER FARM PER MONTH IN KERICHO

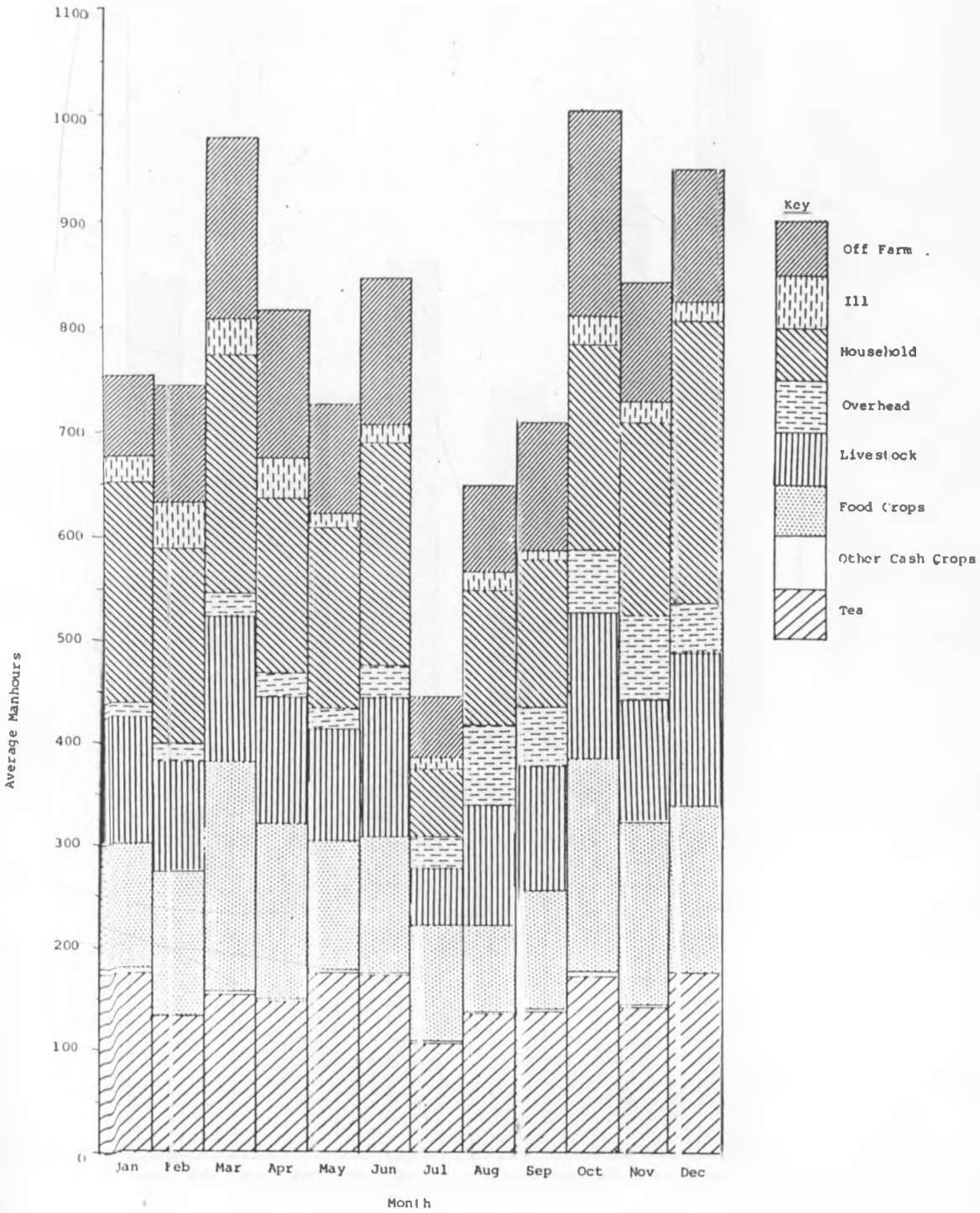
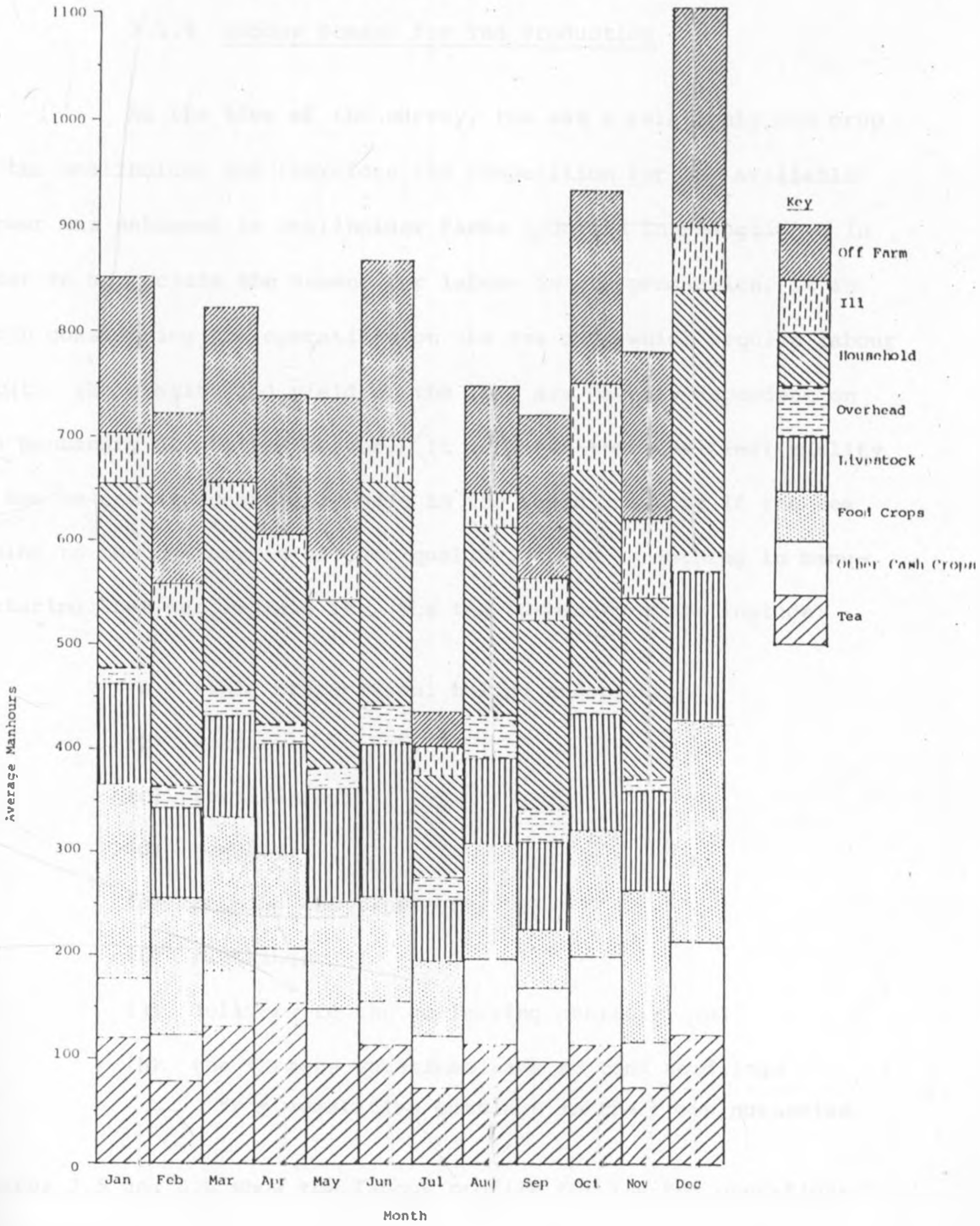


FIGURE 3.4

PROFILE OF LABOUR USED PER FARM PER MONTH IN KISII



3.6) where the difference in size of tea operations is clearly related to the amount of labour used.

3.1.4 Labour Demand for Tea Production

At the time of the survey, tea was a relatively new crop to the smallholder and therefore the competition for the available labour was enhanced in smallholder farms upon its introduction. In order to appreciate the demand for labour in tea production, it is worth considering the operations on the tea crop which require labour input. The quality and yield of the leaf are heavily dependent on the husbandry of the tea grower. It is known that the final quality of tea we use is essentially made in the field, because if the tea coming to the factory is of poor quality, there is nothing in manufacturing that can improve it. The tea husbandry steps[1] include:

(a) field preparation, holing and planting;

(b) weeding;

(c) fertilising;

(d) pegging;

(e) pruning and tipping;

(f) plucking;

(g) delivery to the collecting centres; and

(h) the farmers sometimes have to tend seedlings from vegetative cuttings in their own nurseries.

Figures 3.5 and 3.6 show the labour profile for the tea operations.

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1 The discussion of tea as a plant is contained in Eden (1965) and KTDA instructions for some of the operations is in Etherington (1973, Appendix 1).

FIGURE 3.5

LABOUR PROFILE OF TEA OPERATIONS ON KERICHO FARMS: AVERAGE MANHOURS PER MONTH

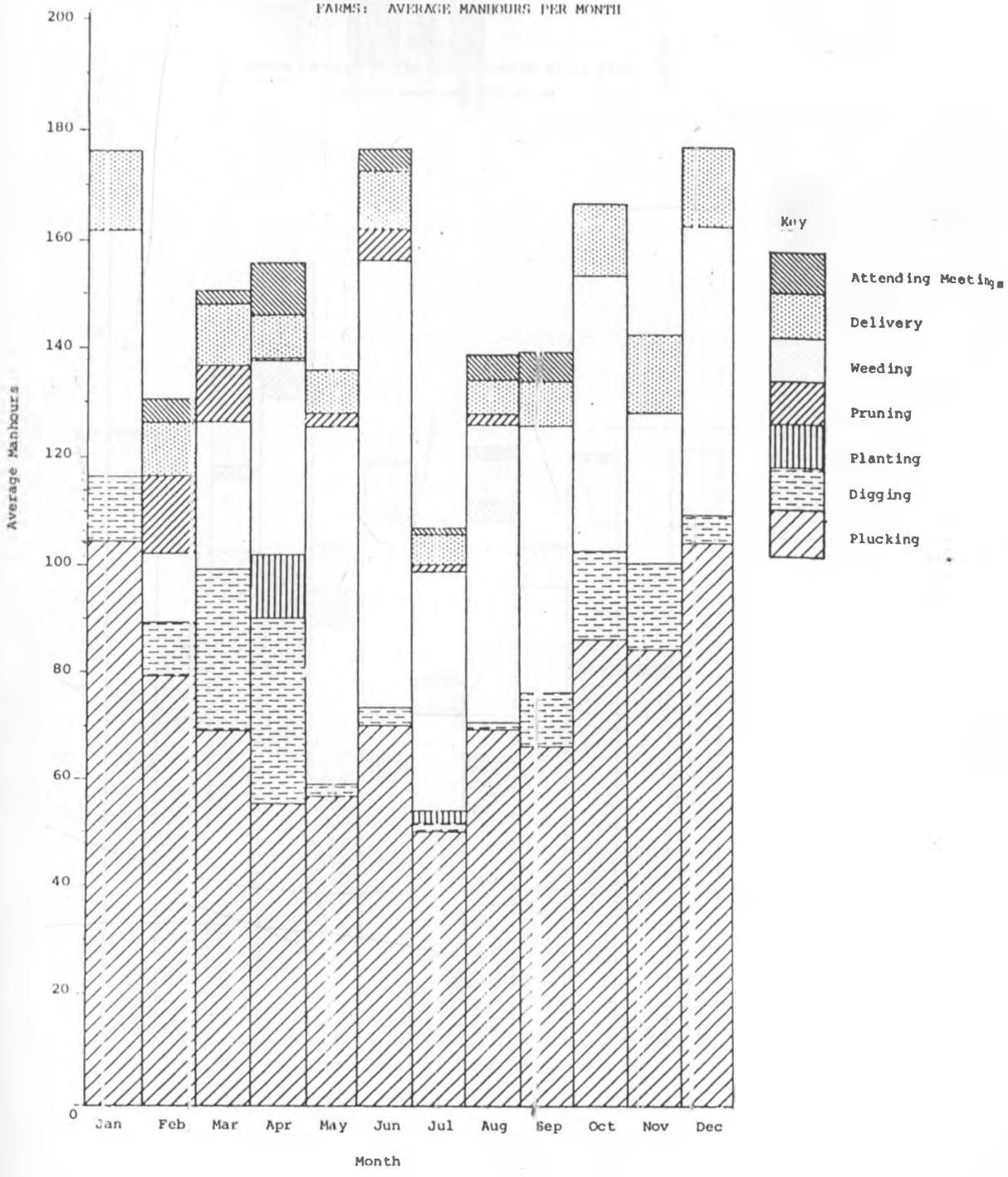
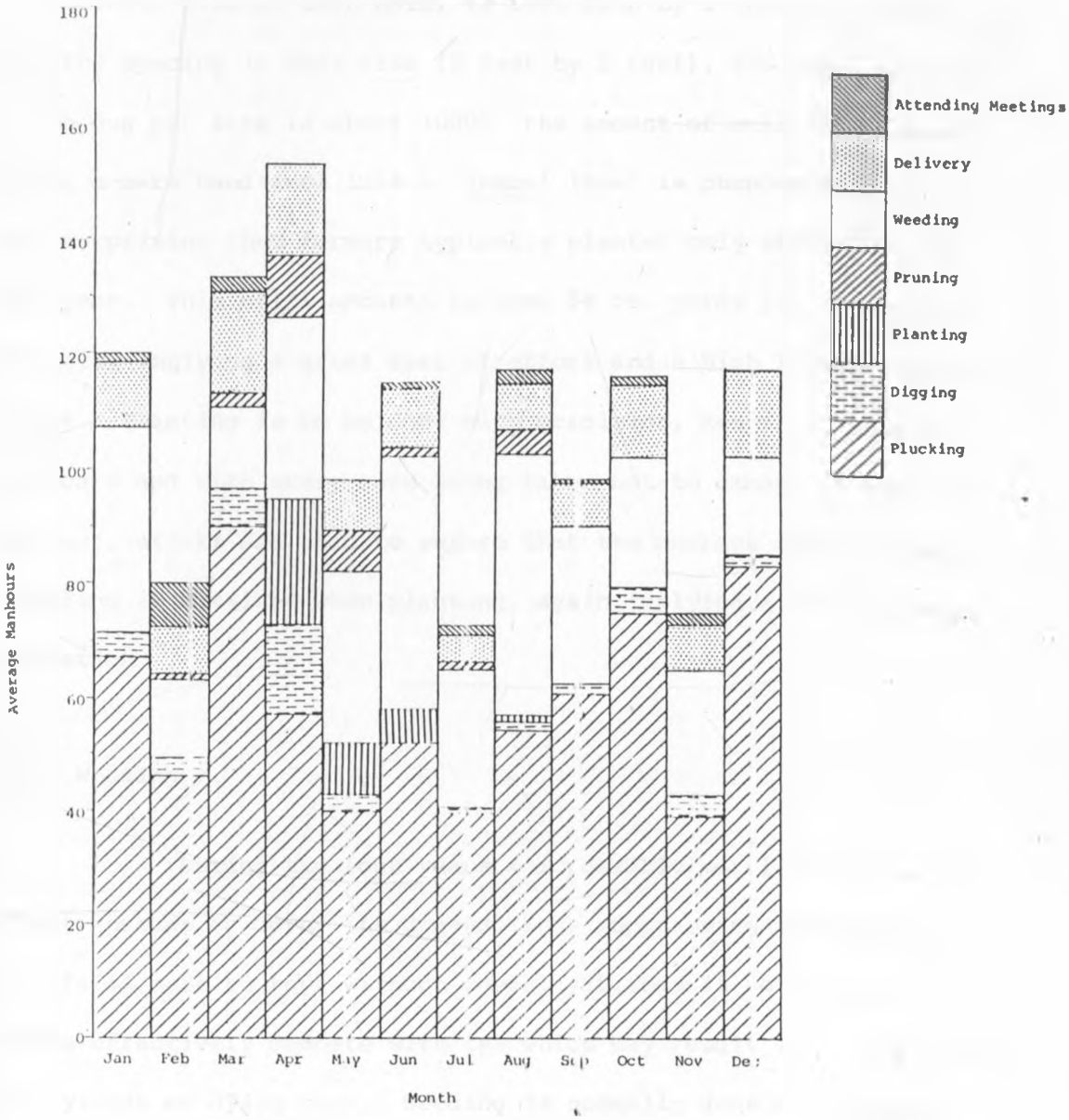


FIGURE 3.6
LABOUR PROFILE OF TEA OPERATIONS ON KISII FARMS
AVERAGE MANHOURS PER MONTH



(a) Field Preparation, Holing and Planting

The field must be well cultivated with all old roots, stumps and weeds removed. Holing is to be done 2 months before the actual planting to allow enough weathering. Considering the recommended size of each hole, (2 feet deep by 1 foot by 1 foot) and the spacing in this area (5 feet by 3 feet), the number of holes to be dug per acre is about 3000; the amount of soil to be removed using a mere hand tool like a '_jembe_' (hoe) is phenomenal. It is not surprising that farmers typically planted only about 1/3 acre per year. This still amounts to some 74 cu. yards (56 cu. metres) of soil, implying a great deal of effort and a high level of labour input. Planting is to be done with precision, keeping to rows or contours and with every care being taken not to damage the tap root. In fact, sticks are used to ensure that the correct depth for each seedling is attained when planting, again implying a time consuming operation.

(b) Weeding

During the four years (or possibly more) before the tea plant spreads to cover the ground (thus suppressing the weeds) the tea field must be kept without weeds. If this is not done, the weeds effectively compete with tea which may result in the tea giving low yields or dying back. Weeding is normally done with a _jembe_ and with much care, because if some part of the root is damaged by the hoe, _Armillaria_ root infection is possible and this kills the tea plant.

As the tea plant spreads laterally with each successive pruning and covers the ground, weeding is gradually eliminated except for the few months immediately after pruning when weeds again have a chance to grow. As is shown in Figures 3.5 and 3.6, weeding took a considerable amount of time which is not surprising as all the farms had some young tea, that is, in the age group less than five years.

(c) Fertilising

Since it is the leaf that is harvested, nitrogen fertiliser to promote leaf growth would certainly be essential, especially for tea over 5 years of age. Thus, the absence of any data on this might be considered surprising and, indeed, disturbing. However, at the time of the survey, no farmers were applying fertiliser (other than at planting time) because the KTDA felt itself unable to make any recommendations on the basis of the experimental results of the fertiliser trials of the Tea Research Institute. In 1970, that is after this survey data was collected, fertiliser recommendations were issued based on foliar leaf analysis. Subsequent studies indicated that farmers were applying about 50 per cent of the recommended levels of fertiliser.

(d) Pegging

'Pegging' of the branches of young tea plants is meant to improve the lateral spread of the tea plant and is desirable since the ground is covered earlier by the tea bushes to suppress the weeds

and also the frame from which the available leaves are to be plucked becomes more spread out than can be achieved simply by pruning. This ensures higher yields. The practice was, however, initiated after the survey period.

(e) Pruning and Tipping

Pruning is the periodic removal of branches of the tea plant to suppress the natural upward growth of the primary branches so that the plucking table is at a manageable height and also to stimulate new growth by removing unproductive or diseased wood.[1] Pruning is recommended to be done every 3 years after establishment. It is a skilled activity which may necessitate the use of hired labour for the operation.

Tipping, which is a form of light pruning, is done more often and is an essential operation for forming a good plucking table parallel to the slope of the ground. Tipping and the removal of dormant buds or banjhi[2] should be undertaken as a maintenance operation at the same time as plucking. A plucking 'table' infers a good height (usually 1 metre from the ground) to facilitate easy identification of the new young buds for harvesting. Both of the operations ensure a good frame formation which is desirable for a high rate of plucking and therefore a high yield.

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1 Tea trees, if not pruned to the flat table required by the industry, may grow up to 50 feet in height. Some natural tea trees are kept by estates and tea research institutes for the production of seed.

2 Banjhi is the technical term for the dormant shoots.

(f) Plucking

This involves picking 'two leaves and a bud' (fine plucking) from the tea bushes. Once the tea bush starts bearing (at about 3 years after planting), plucking becomes the major operation requiring labour (see Figures 3.5 and 3.6). It requires some skill (acquired by experience) for only fine plucking is encouraged. Coarse plucking (picking more than 2 leaves and a bud) is strongly discouraged since the extra leaves, while increasing quantity, temporarily drastically decrease quality. The plucking round, or frequency of plucking, is very important. Too short a round (e.g. less than five days) results in the tea bush becoming twiggy with yields being adversely affected while too long a round (e.g. usually more than two weeks) is underplucking and may result in considerable loss of leaf and the bushes losing shape. Underplucking may be caused by either negligence or if the competition for the available labour is very intense with preference being given to activities other than tea. In the event of underplucking, the plucked material appears 'leggy' with a high proportion of stalk and the bud normally becomes hard. This would tend to decrease the quality of tea. In fact, unless caution is taken in plucking the leaves, the plant gets damaged and gives lower yields in the future. Commonly, plucking is done once every week to ten days (depending on the season) and this goes on throughout the year as Figures 3.5 and 3.6 show. This explains the evenness of labour demand by tea once it is established. Imposed on this generally even monthly requirement, are the seasonal 'flush' periods following the rains, particularly the short rains which are followed by warmer growing

conditions than the period following the long rains. Some unevenness may also be due to the use of calendar months in getting the profiles shown in the figures.

(g) Delivery to the Collecting Centres

After the green leaf has been plucked, it must be delivered within at least 4 hours to the buying centre, where it may be rejected by the KTDA official if it is deemed to be of poor quality. Poor quality may be due to:

(1) coarse plucking, in which case the person delivering the tea may be advised to remove the extra leaves in order for delivery to be accepted;

(2) crushed leaves in the containers, which happens when the plucking baskets are poor (i.e. badly aerated) or if the leaves are not loosely packed. Such crushed leaves will start uncontrolled fermentation before reaching the factory which is undesirable and therefore the leaves must be rejected.

Strict inspection standards ensure that the pluckers take every care to do fine plucking in the field and deliver the tea to the buying centre in an uncrushed form, otherwise the delivery is rejected and the whole day's work would have been wasted.

The distance from the farm to the buying centres may be up to 3 miles but the scheduling of collecting days is so arranged by KTDA that if a farmer is unable to pluck on the day of collection at the nearest (normally not more than 1 mile) buying centre's

scheduled day, he may pluck his tea on another day and deliver it to a farther centre provided he reaches there by 2 p.m. when all the leaves collected are taken to the factory by truck. This indicates that in tea production, there is some degree of flexibility and the harvesting, although time consuming, is not necessarily on a strictly daily basis (as in rubber or in dairying) and can be postponed a couple of days if necessary to fit in with other farm operations. In effect, the timeliness is not a strict and rigid requirement outside of the general requirement of a good length of plucking round. Another good feature of tea is that the harvesting operation can be done by all members of the family at the same time and this provides some social togetherness, where family members can discuss and even sing while actually working (i.e. combining work with pleasure).

(h) Raising Own Planting Material

Since 1967, the time of the introduction of propagation of tea from cuttings on smallholdings, the tea grower has been able to raise his cuttings from recommended clones and propagate them in his own nursery rather than depending on a central nursery. This has necessitated a high level of skill and increased labour input for farmers wishing to fill the vacancies left in the field or for those who want to expand their tea acreage.

All the above operations on tea imply that once tea has been introduced on a farm it effectively competes for the available time. To get good yields, the farmers need to follow the recommendations. However, in tea production, after the high labour input for

field preparation and planting, there is a time lag (other than weeding) before harvesting starts. The harvesting operation being flexible in time requirements, however, should enable the farmers to fit it conveniently to their schedules.

3.1.5 Leisure Activity and the Need for Rest

Rural household members have often been accused of having too much leisure, or rather they prefer leisure to higher incomes from agricultural work (Berg 1961). Leisure time effectively competes for the time available for productive activities. However, if we examine the uses to which non-agricultural time is put, we may come to the conclusion that not all such time is actually devoted to leisure per se. We have seen, above, the range of activities other than agricultural work that goes on in the rural area. The time may be used inefficiently, but we cannot generalise it as leisure time. The traditional labour-leisure models appear to have been based on the fact that rural households after satisfying their subsistence needs either work in the wage market or resort to leisure, and since market activities may be few it would be assumed leisure takes most of the time. This generalisation cannot hold if non-farm work is considered. The non-farm work provides occupations for the rural people in the absence of any other productive activity. Other studies use the criterion of an 8-hour work period per day such that, if work is done in the field for say 5 hours, the remainder of the time signifies unemployment.[1] Norman (1968) quoted in Iswell

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1 For difficulties encountered in measuring unemployment in LDCs, see Turnham (1971).

(1973) cautions against the criterion of work period per day in measuring unemployment and suggests that as far as labour is concerned, it would appear realistic to expect male adults to work not much more than 5 hours per day in the conditions of Tropical Africa, where disutility of any further work quickly outweighs any utility. Yudelman et al. (1971) point out that if there is leisure at all in these areas, that would be leisure well-deserved for during peak periods (especially harvesting food crop time as is shown in Figure 3.1), the peasants overwork, spending most of the daylight hours (not merely 8 hours) working. Furthermore, the amount of time spent working also depends on the arduousness and the urgency of the task. It may be questioned whether any apparent idleness in these areas is not the farmer's due, just as weekends are to their urban fellows.

Jones (1969) and Raynaud (1970) have argued that there are some activities called leisure in peasant communities which in western societies are not considered as such. These activities include attending local meetings, where disputes may be settled and some social and economic values learnt and even traditional healing ceremonies. The peasant societies have their own ways of adjusting to the seasonal rhythm of labour demand (as evidenced in the preceding section). In fact, small farmers hardly have leisure if there is an urgent task needing attention, especially if timeliness of an operation is known to be crucial in determining the resulting yield. The time used in leisure was not available in the data used

except as a residual[1]. However, the above facts need observing in studies related to labour use in peasant communities.

3.2 Factors Affecting the Demand for Labour

The factors affecting the demand for labour include:

(1) the seasonality of various activities;

(2) the effective demand for the products produced;

(3) the production technique employed;

(4) the availability of other factors such as land and other capital.

3.2.1 The Seasonality of Various Activities

The reason for peak seasons occurring is that some tasks such as planting, weeding and harvesting must be done at particular seasons of the year. Delays generally cause loss in yields (Heyer 1968; Allan 1971). This can be due to technical reasons, e.g. the rainfall distributional pattern and the biological requirements of crops and animals, or it may be due to the organisational set up.

We have discussed how the labour profile for food production is related to rainfall distribution and from Figure 3.1 there are two peaks of labour used per year. Other crops like coffee demand a high labour input at harvest time for the berries

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1 The residuals obtained for some categories of labour, like where family women numbered more than one or where there were many children, often exceeded 99 hours/week and therefore could not be punched onto the cards.

must be picked when ripe if they are not to get spoilt. Similarly, during the tea planting period, the labour requirement may be very high. However, other activities like tea plucking, herding of cattle, and milking have a more even labour requirement throughout the year. The even distribution of labour for such activities helps to keep the farmers occupied with agricultural work in periods which otherwise could be taken up by slackness or non-farm activities. For the activities which are characterised by peak labour demands, as food crops in March (seedbed preparation and planting), an extra manhour of labour input would yield a considerable increase in total product either because of more timely completion of the work or because a larger area of crop would be cultivated. From Figures 3.3 and 3.4, we notice that there is a relatively slack period in the middle of the year. During such a slack period, it is possible that the marginal product of an extra hour of labour in food crop production for instance may be low but not zero unless the work performed has no disutility at all. Because of the seasonality of some of the operations, it is now recognised that the marginal product across the year varies (Upton 1976). There is in fact no single meaningful value for the marginal product or opportunity cost of a manhour which applies throughout the year.

3.2.2 The Effective Demand for the Products Produced

The data reveal that more time is spent on the activities whose products are likely to have higher demand. Looking at Tables 3.1 and 3.2, we see that food crop production, tea production and household activities dominate the activities performed in terms of

the proportion of total time used in both areas. It may be rationalised that the farmers have to satisfy their subsistence needs, and here, it is important to notice that livestock activity also has a relatively high proportion of labour used since milk is a major subsistence food. The household services are important since they provide a high utility to the members. Tea being a highly valued cash crop sold through an excellent marketing channel, with an even labour requirement throughout the year, has also been readily accepted. The relative ease of obtaining labour to work on it demonstrates this.

In some instances, especially in Kericho, off-farm work is extremely important because of the nearness of the farms to the Kericho tea estates, where the household members may find work. For remote areas, such work can only be done on a full-time basis because of the legal conditions of employment and the distances (typically over ten miles) which make bicycle commuting difficult.

3.2.3 The Production Technique Employed

The farmers who use only hand tools with no help from mechanised equipment require more labour in order to prepare a reasonable acreage for planting. On the other hand, the few farmers who own or hire bullocks or tractors for land preparation[1] may require less labour at planting time but certainly would require more labour at weeding and harvesting time.

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1 Of the farmers surveyed, no farmer owned a tractor but a number of Kericho farms had ox drawn ploughs.

3.2.4 Availability of Other Factors such as Land and Other Capital

Farm size and total labour use were found to be significantly positively correlated (see Tables 3.5 and 3.6 in Section 3.6), implying that the larger farms require more labour since mechanisation was minimal. Moreover, activities such as plucking can hardly be mechanised economically in this area and therefore reliance must be on hand labour: the greater the tea acreage the more the labour used to work on it.

3.3 Sources of Labour Supply in the Smallholder Farms

It is often assumed that the labour supply in agriculture is abundant. Lewis (1954) conceptualising the implication of this assumption developed the two-sector model we have reviewed in Chapter 2, where the labour supply from the agricultural sector to the industrial sector is unlimited. This may not always be true. Because of the seasonality of some activities, labour often limits the carrying out of activities like preparing a large seedbed, planting in time, or even weeding all the crops in the fields. The labour used in the area comes from:

(a) the family - the core of labour supply;

(b) hired labour, which may be casual or permanent.

If subsistence production is maintained with existing technology (i.e. the supply of labour for subsistence production is taken as given) it is useful to examine the possible sources of labour which can be used for either increasing the production of existing

crops or producing new cash crops. It is possible to conceptualise 5 sources of labour (Jones 1968). We may find labour

(1) which has no opportunity elsewhere;

(2) released from non-farm economic activities or inefficiently employed;

(3) available due to seasonal slacks, climate permitting;

(4) released from poor health or nutrition;

(5) voluntarily unemployed or labour giving up part of their leisure time.

In practice, all the 5 categories of labour sources probably contribute to the labour available for further production. The relative importance of each, however, is worth considering although the time series data necessary for testing the relevance of some of them in these areas is lacking in this single year study.

The first category seems to have contributed much to tea production and there is more scope for drawing on it. After the introduction of tea, the enthusiasm with which its production was taken up in smallholdings possibly demonstrates that once the opportunity for growing this high-valued crop existed, there was an existing supply of labour which hitherto had no job opportunities elsewhere. The scope for employing more labour with no opportunities elsewhere is evident because of the lack of jobs for the rising population in general and school leavers in particular (ILO 1972).

Labour released from non-farm economic activities or labour inefficiently employed can be used if the opportunity exists for a more efficient and productive enterprise. In this case, labour

would simply shift its allocation from the less productive to the more productive enterprise. This reallocation can be tested if time series data on the labour input for various enterprises exist. There is also a possibility that some slack periods which exist in off-farm or annual crop activities may be used for agricultural work with a more even demand for labour.

If the nutritional and health standards are low with consequent chronic illness, improving nutritional and health facilities may help to release more labour for productive work. In the area under study, using tea output and number of hours of illness as an example to test the relationship, it was found that they are inversely correlated, implying that with fewer hours of illness, tea output could be increased (see Tables 3.5 and 3.6). If these levels of illness are habitual then it might be argued that those with less illness plant more tea because with more tea bushes more output is obtained.

Releasing labour from part of leisure or labour voluntarily unemployed may be difficult to effect because this category is in fact difficult to distinguish, considering that part of the apparent idleness may arise from biological need for rest. Also, the price to be paid for labour voluntarily unemployed may be so high that the smallholders may not be able to hire them at a profit.

3.4 Factors Affecting Labour Supply in Smallholder Farms

The factors which affect the labour supply for small farms include:

(a) family size, the participation of the family labour force and community organisation;

(b) the mobility of labour between farm and non-farm jobs and between agricultural regions;

(c) specialisation of task by sex or age groups;

(d) nutritional constraints and illness; and finally

(e) the involvement in schooling, attitudes to agricultural work and rural-urban migration.

(a) Family Size, Participation of the Family Labour Force and Community Organisation

The number of people of working age living in the farm and participating in farm work determines the availability of family labour. The family members include the farmer, his wife (wives), sons and daughters. As has been noted, the average number of family members per farm was 5.1 and 5.8 for Kericho and Kisii respectively. In addition, there are local community organisations or arrangements where labour is pooled for work in alternative farms on a reciprocal basis without cash payment.

(b) Mobility of Labour Between Farm and Non-Farm Jobs and Between Agricultural Regions

Off-farm commitments prevent family members from contributing directly to agricultural work for they are absent. However, sometimes people may leave off-farm jobs for some period (especially peak periods) to work on the farms. If there is a high mobility between farm and non-farm work, then labour may readily be available for farm work in case of need.

The idea that farmers with smaller farms who may have excess labour should let the excess labour be hired in neighbouring larger farms could be contemplated. However, in this area, hired men normally come from the neighbouring districts rather than from the neighbouring farms because of the cultural barriers attached to hiring a relative for payment and the loss of prestige resulting from working for a neighbour. In effect, any surplus men look for employment in another region, mobility of the workers between the neighbouring farms being very low. In the case of women, there is normally the possibility of being hired in the neighbourhood for tea plucking. This is particularly convenient for them for after plucking tea, they can do their own domestic work. In fact, any low mobility of workers within a region may be explained by the fact that peak seasons occur for both larger and smaller farmers simultaneously because of similar climatic regimes. It is only because tea has a flexible time requirement for plucking that farmers could hire labour from the neighbourhood. In addition, where a particular farmer has a specific skill, e.g. in ploughing with oxen, pruning tea or carpentry, then hiring labour from within the region is possible. The fact that the use of hired labour was common in the tea farms necessitates its discussion in the next section (Section 3.5).

(c) Specialisation of Task by Sex or Age Groups

Labour sources may not be perfectly substitutable. For instance, in their area, domestic chores are the traditional

responsibility of women[1] and children. It is also known that previously food crops also were to be tended by women while cash crops were the responsibility of men. Of the time spent in milking in Kericho District, women provided 80 per cent of the time, men and children providing 13 per cent and 7 per cent respectively. This may indicate the original specialisation by sex in milking.

The survey evidence shows that now both men and women work on tea and even food crops. The fact that some men have left for employment in the towns and estates forces the women to take care of the '<u>shambas</u>'. A study done by Mook (1976) in Vihiga Division, Kakamega District, shows that 38 per cent of the households studied were headed by women. Of necessity, these women take farm management decisions and should not be neglected in any agricultural extension efforts. The original specialisation of duties by sex seems to be breaking down. Lele (1975) points out that innovations meant to lighten domestic work may release women for other work. These innovations may include improving water supplies, by reducing the distance to be walked in fetching water and improving rural infrastructures to facilitate quick transportation to and from market. In areas where strict specialisation of duties is still observed, certainly the supply of labour for various activities would be limited.

Age also influences the supply of labour for various tasks. For instance, children are responsible for scaring birds and

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1 Indeed, 88 per cent of total household work was provided by women in Kericho, children and men providing 9 and 3 per cent respectively.

monkeys and herding cattle. In the event that they go to school, the supply of labour for these activities would be limited.

(d) Nutritional Constraints and Illness

The capacity for individual physical effort is normally reduced by undernourishment and there may be a reduction in the length of day worked, especially during the physically arduous cultivation operations. This can only be conceptualised since undernourishment was not measured as such. However, there were periods of illness which reduced the labour supply. For instance, Tables 3.1 and 3.2 show that between 2 and 6 per cent of available hours for work per month were taken by illness. Therefore, there was some scope for reducing the numbers of hours of illness (especially for men) to increase the labour supply for the various activities.[1] However, acknowledging that some 'illness' relates to pregnancy, these levels of illness are certainly not excessive.

(e) Schooling, Attitudes to Agricultural Work and Rural-Urban Migration

Those who go to school effectively become unavailable for agricultural work during school times. Moreover, with the kind of education geared for 'white collar jobs' some people tend to consider that agricultural work is for the uneducated, neglecting the fact that some forms of education may mean unemployment in

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1 Of the total time of illness per year in Kericho, for instance, 62 per cent was women's illness, 29 per cent men's illness and 9 per cent children's illness.

non-agricultural sectors.[1] Thus, the attitudes to agricultural work have been rather negative with those educated tending to have great illusions as to the scope for and tasks required in non-agricultural work. This has been one of the causes of migration from the rural areas because those who have got any formal education beyond primary school consider themselves to have a higher probability of getting a job in the urban areas (see Todaro 1969) and strive for the few places available there. In fact, parents are known to discourage their children from agricultural work. Gwyer (1973) quotes some parents as telling their children:

> 'We have tilled this soil over since time immemorial; we are still poor as ever; if you want to live as poor as we do, stay with us and enjoy our poverty', and
>
> 'Because the land we have is small, your only source of livelihood is the education you are being equipped with because there is no more land to be inherited.' (Gwyer, 1973, p.395).

These attitudes necessarily reduce the potential family labour supply for farm work. They also reduce the potential hired labour supply because work in the farms for wages ranks very low in the occupational prestige scale of the community, hence mobility of labour between farms is low. Moreover, since the length of time taken for formal education is normally long, and the fact that school leavers tend to be less equipped with productive agricultural

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1. For a more detailed discussion of attitudes and relevance of the educational system see Hopcraft (1974).

knowledge the 'educated' lot may be the ones in the category of the voluntarily unemployed in the rural areas and the openly unemployed in the towns. The 'back to the land' policy could work very well in areas which still have more land for use as in Kericho if the education was equipping the school leavers with some agricultural knowledge.

3.5 The Extent of Labour Hiring in Smallholder Tea Farms

Of the 48 farms, only 3 farms had no hired labour. This means that hiring labour is common in the tea farms although the extent of hiring the labour differs for Kericho and Kisii.

Tables 3.3 and 3.4 compare for each activity the proportion of hired labour to total labour (family plus hired) used in performing the activity per month for Kericho and Kisii respectively. In Kericho, more than 45 per cent of labour used in tea per month was hired. The other categories which used considerable amounts of hired labour in Kericho are food crops and overhead activities. This emphasises the fact that once permanent (i.e. full-time residential) labour was hired, they could be used for other activities and not restricted only to one activity. Overhead activities often require specialised skills which necessitate hired labour.

The Kisii farmers on the other hand tend to rely more on family labour and hire relatively less labour, as a comparison between Tables 3.3 and 3.4 shows. Two reasons may be advanced for the difference in the extent of hiring labour. One is that the Kisii farms are relatively smaller (3.6 ha compared with 8 ha in

Kericho) and as is shown in Table 3.5, there seems to be a positive correlation between farm size and hired labour. Another reason may be that most Kericho tea estates offer ready off-farm jobs for Kericho farmers who have therefore to use more hired labour. This is shown by the fact that in Kericho, the average hours worked by a farmer in tea production is 301 hours which is relatively lower compared to the Kisii value of 303 hours. Kericho District had an average farm population of working age of 5.1 compared with 5.8 in Kisii. This difference in farm population, while not large, could also explain the relatively higher level of hired labour in Kericho.

Even on Kisii farms, tea and overhead activities had a relatively high proportion of hired labour compared with other activities. This may lead to the conclusion that tea may actually be responsible for creating opportunities for hired labour in the tea areas. Considering that non-unionised labour is still cheap, farmers with tea plots find it still pays to hire labour, for the hired labour also work on other operations. In fact, it is sometimes alleged that some hired labour comes to work in smallholder tea farms to gain experience in tea plucking and then takes off to the estates for full-time employment. However, considering the strict discipline required on the estates, there is really not much competition between estate and smallholder farms for hired labour because, although the estate provides many facilities for its workers, the permanent labourer feels more secure in the smallholdings where he may be given a small plot for cultivating his own subsistence food in addition to his wage, thus inducing him to stay. The part-time labourer has the opportunity to work at will, having time off to perform his own activities.

TABLE 3.3

PERCENTAGE OF LABOUR HIRED FOR EACH ACTIVITY PER FARM PER MONTH IN KERICHO

Activity \ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tea	52	54	60	49	53	59	53	45	52	56	59	49
Other Cash Crops	0	0	0	27	0	89	0	13	0	72	100	0
Food Crops	34	42	31	27	22	28	34	14	28	37	24	26
Livestock	3	4	6	4	17	20	7	4	6	8	12	8
Household	2	1	0	0	0	1	0	1	2	1	1	4
Overhead	37	38	34	17	33	47	33	42	26	35	45	31
Off-Farm	4	1	1	1	1	1	1	1	1	2	1	2

TABLE 3.4

PERCENTAGE OF LABOUR HIRED FOR EACH ACTIVITY PER FARM PER MONTH IN KISII

Activity \ Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tea	25	28	28	26	33	34	29	24	33	30	19	21
Other Cash Crops	6	17	13	5	22	13	3	8	6	8	7	4
Food Crops	6	9	16	4	13	22	8	6	8	7	9	11
Livestock	3	3	4	2	4	6	2	0	3	2	3	1
Household	0	1	1	0	1	1	2	1	0	0	1	1
Overhead	32	36	24	25	44	19	7	9	21	20	19	4
Off-Farm	2	4	0	0	0	1	0	0	0	0	.1	1

There has been an argument as to why the smallholder tea farmers should hire labour at all, given the small tea acreages they have. Some have argued that rural farmers have a high income elasticity of demand for hired labour (De Wilde 1971), meaning that if their income increases by some proportion (e.g. due to tea receipts) they employ proportionately more labour to do the arduous work. This may be true in some cases but cannot be generalised. During peak seasons, hired labour may be needed to help complete certain tasks in time, this having no direct causal relation to increased income. Moreover, there are some skilled tasks like pruning which may require hired labour anyway. One other important reason is that it is hard to find the original KTDA model tea farm, where only farmers without off-farm occupations plant tea. The farmers who have off-farm jobs in teaching or the civil service or on estates of necessity have to hire labour. In addition, it is also known that the peasant societies have a high propensity to share (Cumper 1963). Thus, those who are in wage employment, e.g. sons and daughters of peasants, transfer part of their income to the rural areas and this is often invested in improved housing, fencing, and planting tea, all of which either immediately or in due course lead to an increased demand for hired labour.

3.6 The Correlation Between the Various Activities

Tables 3.5 and 3.6 show the matrix of the Pearson correlation coefficients[1] between the various pairs of variables. Some

1 The Pearson correlations are zero-order correlations because no controls for the influence of other variables are made. The coefficients indicate the strength of relationship between two variables, i.e. the goodness of fit of a linear regression line to the data.

TABLE 3.5

THE MATRIX OF PEARSON CORRELATION COEFFICIENTS FOR VARIOUS PAIRS OF VARIABLES FOR KERICHO

Variables	(Initial)	TEA	OCC	FCR	LVS	HSH	ILL	OFM	FMS	OTP	TACR	TOTL	THL
Tea Labour (mannours)	TEA	1											
Other Cash Crops "	OCC	-.06	1										
Food Crops "	FCR	-.12*	.14	1									
Livestock "	LVS	-.09	.10	.41***	1								
Household "	HSH	-.10*	.05	.48***	.44***	1							
Illness "	ILL	-.11**	-.01	-.12*	.11*	.18***	1						
Off-Farm "	OFM	-.15**	.09	.23***	.37***	.32***	.05	1					
Farm Size (Acres)	FMS	-.03	.01	.39***	-.57***	.33***	.18***	.15**	1				
Tea Output (lbs)	OTP	.67***	-.04	-.17**	-.21***	.05	-.11*	-.19***	-.17**	1			
Tea Acreage (Acres)	TACR	.63***	-.01	-.10	-.02	-.04	-.14*	-.11*	.14**	.70***	1		
Total Labour (Manhours)	TOTL	.20***	.12	.69***	.64***	.79***	.29***	.57***	.51***	.13**	.10*	1	
Hired Labour "	THL	.59***	.03	.13**	.08	-.05	.02	.07	.20**	.41***	.50***	.30***	1

* Significant at the 5 per cent level
** Significant at the 1 per cent level
*** Significant at the 0.1 per cent level
Number of observations = 288

TABLE 3.6

THE MATRIX OF PEARSON CORRELATION COEFFICIENTS FOR VARIOUS PAIRS OF VARIABLES FOR KISII

Variables	(Initial)	TEA	OCC	FCR	LVS	HSH	ILL	OFM	FMS	OTP	TACR	TOTL	THL
Tea Labour (Manhours)	TEA	1											
Other Cash Crops "	OCC	-.25***	1										
Food Crops "	FCR	.06	.37***	1									
Livestock "	LVS	.18***	-.15**	.15**	1								
Household "	HSH	.01	.44***	.56***	-.36***	1							
Illness "	ILL	-.09	.11*	-.02	.08	-.003	1						
Off-Farm "	OFM	-.14***	-.02	.003	-.11*	-.14**	-.08	1					
Farm Size (Acres)	FMS	-.03	.47***	.42***	.15**	.46***	.04	.02	1				
Tea Output (lbs)	OTP	.76***	-.29***	.08	.17**	-.04	-.12*	-.11*	-.06	1			
Tea Acreage (Acres)	TACR	.68***	-.40***	.02	.20***	-.04	.02	-.12*	-.10*	.74***	1		
Total Labour (Manhours)	TOTL	.18***	.43***	.67***	.38***	.78***	.23***	.41***	.46***	.13**	.18**	1	
Hired Labour "	THL	.41***	-.18***	.01	.32***	.08	.04	0	.04	.36***	.44***	.20***	1

* Significant at the 5 per cent level
** Significant at the 1 per cent level
*** Significant at the 0.1 per cent level
Number of observations = 288

of the correlations have been referred to in the preceeding sections and only relationships connected with tea production are emphasised here.

In some cases, the signs and the statistical level of significance of the coefficients differ in the two districts but in some cases both signs and even significance are similar. This may be indicative of the danger of any generalisation across the two areas. The statistical test for testing the difference is given in the next chapter.

It was found that tea labour is inversely and significantly correlated to food crops, household activities, illness and off-farm work in Kericho, while in Kisii the inverse relationship holds between tea labour and other cash crops and tea labour and off-farm work. In both areas, output of tea is significantly inversely correlated with illness and off-farm work. The former would be expected, but the latter could be explained by the fact that farmers who rely almost entirely on hired labour (with little supervision because of their absence) for tea production tend to get relatively less output. Other inverse relationships exist between output and food crops, livestock activity and farm size for Kericho, and for Kisii between tea output and other cash crops. The inverse relationship between farm size and tea output for Kericho may imply that in Kericho, the smaller the farm the more the output, which is an interesting result. It may be argued that smaller farmers plant relatively more tea.

As expected, there is a positive correlation coefficient between tea labour and tea acreage, total labour and hired labour in both districts. Only in Kisii is there a positive correlation between tea labour or tea output and livestock activity. The reason here is that the Kisii farmers tended to invest both in exotic dairy cattle and tea during the survey period. Also expectedly tea acreage is positively correlated to tea labour, farm size and tea output. The whole row of total labour shows significant positive correlations with all the respective variables.

A close examination of the tables indicates that the signs of the coefficients between tea labour with respective variables and tea output with respective variables for each area are similar. For instance, taking Table 3.5, the coefficient between tea labour and food crop is -0.12 (at 5 per cent significance) and the coefficient between tea output and food crop is -0.17 (at 1per cent significance). For Table 3.6, the correlation between tea labour and livestock is 0.18 and output and livestock is 0.17 (both at 1 per cent level of significance). This may imply that output and tea labour themselves are highly correlated and, in fact, is 0.67 for Kericho and 0.76 for Kisii (both at 0.1 per cent level of significance). The next chapter examines more closely the role of tea labour in the analysis of tea production because tea labour considered in Tables 3.5 and 3.6 consists of all the labour input in all tea operations, some of which may have no direct relevance to the current tea output.

CHAPTER 4

THE ANALYSIS OF TEA PRODUCTION

This chapter essentially revisits the analysis done by Etherington (1973) to predict yields in smallholder tea farms.[1] The reason for this revisit was outlined in Chapter 1 and will become clearer in this chapter.

4.1 The Production Function for Tea

Before starting to estimate any production function, we are to make several choices as to which will be estimated and how. As outlined by Grilichen (1957; 1963), Heady and Dillon (1961) and Yotopoulos (1967), several considerations are crucial to the economic specification of a production function for, if they are not considered, the consequent bias will not make the function reflect the true structure in an analytical economic sense of the production process. These considerations include:

(1) The inclusion of variables relevant to the production process; whether they are to be aggregated or not and if so how, or in which form the variables are to be included. The omission of relevant input variables will tend to overestimate one or more of the coefficients of the included ones if the omitted variables are

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1 The reasons for having accurate predictions of yield in smallholder farms include proper factory phasing, general planning of smallholder tea expansion programmes, extension, good scheduling of loan repayments and are discussed fully in Etherington (1973).

positively correlated with the included ones. The converse holds in the case of a negative correlation between the omitted and the included variables;

(2) the algebraic form of the production function;

(3) the economic and physical logic of the production function;

(4) the proper choice of the technique for estimating the coefficients of the production function; and

(5) the economic implication of the functional form chosen.

In the analysis that follows, all these considerations are taken into account.

4.1.1 Tea Production Variables

The variables which may explain the output of tea have been identified by Etherington (1973) and may be represented in a general production function as:

$$Q_{it} = F(X_{kit}, L_{jit}, S_i, D_i, C_{it}, M_{it}, M_{it-1}, \ldots M_{it-n}) \qquad (4.1)$$

where

Q_{it} = output of green leaf in pounds from farm i delivered to the buying centre in time t

X_{kit} = number of tea bushes of age k on farm i in time t

L_{jit} = number of hours of labour by various categories (j) in farm i in time t

S_i = the land input in farm i

C_{it} = the microclimate on farm i in time t

$M_{it}, M_{it-1}, \ldots M_{it-n}$ = the present and past management of the tea bushes

t = time (may be month or year)

(a) The Number of Bushes of Various Ages (X_{kit})

The tea bushes where the desirable product grows represent the capital investment by a farmer once he decides to grow tea. Without the bushes, there can be no output. Each tea bush has the usual logistic growth curve and it has been shown that maturity is attained between 9-10 years in this area. The tea bushes in any one farm may be of different ages, hence yields differ (before maturity). If the yield coefficient of each 'age group' of the bushes (vintage) is known, a 'mature'[1] bush equivalent can be obtained by weighting, as will be shown in Section 4.1.5.

(b) Labour Input (L_{jit})

The labour used in plucking tea is an important variable determining output as defined above. Without labour, there can be no output. Labour used in other operations such as planting, weeding or pruning relate largely to establishment and maintenance and may be captured by the management variable. Etherington (1973) has made two assumptions about the labour input to justify that the labour input in plucking can be left out of the production function explaining tea output in smallholder farms. The assumptions are:

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1 'Mature' here will be a relative term referring to the bushes aged 7 years; tea bushes attain maturity between 9-10 years.

(1) if capital (tea bushes) is properly specified, it occurs in a fixed proportion with labour. This means that other inputs perfectly explain tea output and would also explain labour input equally well since the amount of tea leaves available on the bushes 'call forth a certain labour input'. Thus the direction of causation is such that output determines labour;

(2) labour is not a binding constraint in the area because plucking rounds are conveniently spaced (plucking is done once per week to 10 days) throughout the year. Moreover, hiring of non-union labour is relatively cheap (compared with the legal minimum wages on estates).

These two assumptions are the major reasons for revisiting the analysis and we turn to them in the next section (4.1.2).

(c) Distance of Farms from Tea Buying Centres (D_i)

This is unlikely to be a binding constraint since no farm is likely to be more than one mile from a buying centre.

(d) Land Input (S_i)

The area of land occupied by tea is fixed by the spacing recommendation to all farmers within the area. However, the quality of land may vary but this may be minimised by considering sample farms whose soils are similar, being in the same region.

(e) Microclimate (C_{it})

Here again, variability within a small area is likely to be small. There may be monthly variations, especially in rainfall amounts, but it is noteworthy that the tea areas receive rainfall every month except for short droughts which occur once every five years in which case moisture would be a limiting factor.

(f) Management (M_{it}, M_{it-1}, ... M_{it-n})

The tea production process involves 'point input multipoint output'. This means that the establishment period is crucial to good frame formation and consequent yields. Reversal of the results of initial bad practices is unlikely. Management may be judged by the results of its decision (Timmer 1970) and therefore if we assume each farm to have an effect on the resulting output we would be incorporating the management effect of the farm as such in explaining output.

4.1.2 The Model Specification Problem

The assumptions of fixed proportions between labour and capital should mean that there is a high degree of complementarity between them. The argument was that, provided labour was not a binding constraint, the use of a linear production function excluding labour was a valid procedure. However, it is likely that with a rapid expansion of smallholder tea, labour may become a binding constraint. Moreover, the relative cost of labour (compared with tea prices) may

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enhance the constraint of labour[1]. This calls for the re-examination of the role of labour in tea production.

In trying to integrate labour into a production function for tea, one is faced with a chicken and egg problem, with the weighting system for alternative categories of labour. It is no good assuming that children or women for instance would be working at half the capacity of men simply on the basis of work rates in studies elsewhere on other crops. On some tea estates women are the best pluckers, on others men are the best. Furthermore, here there is the added complication of the use of both family and hired labour. There is no *a priori* reason why their productivity should be the same - they are presumably faced with rather different opportunity costs.

Two procedures may be used to overcome the weighting problem:

(1) to assume that hourly wage rates reflect the marginal productivity of the labour category[2];

(2) if the degree of multicollinearity or complementarity between labour and the capital stock of tea bushes is as great as was hypothesised by Etherington, one could as far as statistical analysis

---

1 The labour constraint may also arise to the reallocation of the available labour to other activities like food crops (or dairy enterprise products) whose prices have risen continually compared with the internationally determined tea prices which, until 1976/77 (the recent boom), have been relatively low. Moreover, there may be a constraint caused indirectly because the KTDA trucks collecting the leaves from buying centres leave the factory by 2 o'clock thus restricting the plucking period to about five hours/day.

2 This was the technique used by the Farm Economic Survey Unit in Nyeri District in the 1960s.

is concerned, have two independent regressions to explain output, i.e.:

$$\text{(i)} \quad Q_{it} = \beta_o + \beta_{oi} + \beta_{oot} + \sum_{k=3}^{7} \beta_k X_{kit} + U_{it} \qquad (4.2a)^1$$

$$\text{(ii)} \quad Q_{it} = \alpha_o + \sum_{j=1}^{6} \alpha_j L_{jit} + e_{it} \qquad (4.3)$$

where

β_o and α_o = the respective intercept terms

β_{oi} and β_{oot} = the farm effect and the year effect respectively included implicitly as dummy variables

β_k and α_j = the marginal physical products of bushes of age k and labour category j respectively

U_{it} and e_{it} = the respective error terms

Equation (4.2a) was reformulated to have yield (output/tea bush) as the dependent variable instead of output by dividing the equation by $(\sum_{k=3}^{7} X_{kit})$. Thus we have:

$$Y_{it} = \beta_{oi} + \Sigma\beta'_k P_{kit} + u_{it} \qquad (4.2b)^2$$

where

Y_{it} = total yield achieved by farm i in year t

β'_{oi} = the farm effect coefficient

β'_k = the 'ratio coefficient' showing the contribution of total yield derived from the proportion of bushes aged k years

---

1 Equations (4.2a) and (4.2b) (below) were estimated on the basis of annual data; the conversion to monthly data is discussed later in this chapter.

2 The overall intercept term and year effect coefficients are omitted in the equation for reasons of exposition. The intermediate steps before (4.2b) are discussed fully in Etherington (1973), pp.45-47.

P_{kit} = the proportion of bushes aged k years in farm i in year t

u_{it} = the error term

This was done because in the form (4.2a) the intercept, the farm and the year effects are additive in a lump sum fashion and a farmer could get output without bushes! Furthermore, the error term was likely to be heteroscedastistic in its distribution. After such reformulation it can be shown that β_{oi} becomes multiplicative when we multiply back through equation (4.2b) by $(\sum_{k=3}^{7} X_{kit})$. We get:

$$Q_{it} = \sum_{k=3}^{7} (\beta'_{oi} + \beta'_{k}) X_{kit} = \sum_{k=3}^{7} \beta_{ki} X_{kit} \qquad (4.2c)$$

where the β'_{oi} and β'_{k} are to be distinguished from the β_{oi} and β_{k} in (4.2a) and the error term is left out.

The results obtained using (4.2b) will be used in this study to get the 'mature' bush equivalents. The explanatory power was good: $\bar{R}^2 = 0.75$.

Similarly, we could run a regression for the linear equation (4.3) above, not necessarily for any supposed explanatory powers, but to give an appropriate weighting system to use in adding up different types of labour to get single values for labour input. This may reverse the supposed direction of causation $L = f(Q)$ where L is total labour requirement and Q is total output. However, we may assume that, if we use OLS technique for estimation and the resulting coefficients of the various labour categories are highly significant and the coefficient of multiple determination (R^2) is high, then the errors resulting from such reversal would be

small.[1] The regression was run for Kericho and Kisii Districts separately because the Chow test (Section 4.1.3) proved them not to be homogeneous. The results were as given in Tables 4.1 and 4.2 for Kericho and Kisii respectively.[2]

The dependent variable, Q_{it}, is output measured in pounds of green leaf, hence the coefficients of the labour categories represent the work rates in pounds of green leaf plucked per hour.

4.1.3 Tests of Homogeneity Between the Two Districts and the Two Divisions in Terms of Labour Use in Tea Production

It has been suggested that it is more appropriate to pool sample farms in a way that will avoid large variations in microclimate and soil quality in the pooled data. Our sample farms come from the two neighbouring districts of Kericho and Kisii with two divisions per district. The ethnic group in Kericho is largely the Kipsigis, while that in Kisii is largely the Abagusi. Before pooling the data, therefore, we need to test for homogeneity between the samples.

Use is made of the test developed by Chow (1960). Having shown that the R^2 obtained in the regressions type:

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1 For consistent and unbiased results in using OLS, the assumption of the error term (e) being normally distributed with zero expectation and constant variance, no serial correlation of the error terms and no severe multicollinearity of the independent variables were held.

2 The results are slightly different from the values given by Etherington (1973, p.106) because he used annual figures and treated both districts together. When the data was pooled his results were duplicated.

TABLE 4.1

THE LINEAR REGRESSION RESULTS FOR KERICHO:

PARTIAL CORRELATION COEFFICIENTS

Variable		Q_{it}	L_1	L_2	L_3	L_4	L_5	L_6
Output	Q_{it}	1						
Farmer	L_1	0.41	1					
Other Adult Family Men	L_2	0.19	0.05	1				
Family Women	L_3	0.41	0.45	0.16	1			
Family and Hired Children	L_4	0.11	0.25	0.10	0.12	1		
Hired Men	L_5	0.81	0.18	0.08	0.19	-0.14	1	
Hired Women	L_6	0.49	0.21	-0.05	0.16	-0.02	0.26	1

R^2 = 0.84

Adjusted R^2 = 0.83*

F = 238.5**

D-W test = 1.78[1]

Number of observations = 288

$$Q_{it} = 36.15 + 1.75L_1 + 1.66L_2 + 1.65L_3 + 1.75L_4 + 3.77L_5 + 4.33L_6$$

(0.36) (4.12) (3.66) (5.42) (6.08) (27.02) (9.95)***

*** The figures in brackets are the t-tests and are all highly significant except for the intercept term which is good lest we get output without applying labour.

** The F-statistics which indicate the goodness of fit are highly significant.

* The R^2 is adjusted for the number of observations and the included variables.

1 The D-W test shows there is no serial correlation, for the figure is above the upper limit value in the tabulated values.

TABLE 4.2

THE LINEAR REGRESSION RESULTS FOR KISII:

PARTIAL CORRELATION COEFFICIENTS

Variable		Q_{it}	L_1	L_2	L_3	L_4	L_5	L_6
Output	Q_{it}	1						
Farmer	L_1	0.66	1					
Other Adult Family Men	L_2	0.07	0.02	1				
Family Women	L_3	0.68	0.52	0.12	1			
Family and Hired Children	L_4	0.54	0.23	0.14	0.46	1		
Hired Men	L_5	0.43	0.20	-0.06	0.08	0.08	1	
Hired Women	L_6	0.43	0.10	-0.08	0.26	0.21	0.16	1

R^2 = 0.79

Adjusted R^2 = 0.79*

F = 178.9**

D-W test = 2.14[1]

Number of observations = 288

$$Q_{it} = 21.30 + 4.84L_1 + 1.27L_2 + 2.10L_3 + 2.29L_4 + 3.16L_5 + 2.75L_6$$

(0.24) (11.75) (0.98) (7.70) (7.95) (9.85) (8.07)***

*** The figures in brackets are t-tests and are all highly significant except for L_2; this may be because of the relatively few numbers of observations for this category and, in fact, the low proportion of hours used (Table 4.3 below) and the intercept term which is again good test we get some output without labour input.

** Highly significant.

* Adjusted for the degrees of freedom.

1 Shows no serial correlation.

$$Q_{im} = \alpha_0 + \sum_{j=1}^{6} \alpha_j L_{jim} + e_{im} \qquad (4.3a)$$

is high, where the notation is consistent with equation (4.3) and m refers to month m, we can use the procedure as set out by Johnston (1963) to perform the Chow test. The matrix equation is:

$$Y_1 = X_1\alpha_1 + Z_1\gamma_1 \qquad (4.4)$$

$$Y_2 = X_2\alpha_2 + Z_2\gamma_2 \qquad (4.5)$$

where the subscript indicates the sample number, Y = yield, X = the matrix from equation (4.3) but with the inclusion of a dummy variable for each month, and Z = matrix for farm effect dummies.

The order of the matrix is:

Matrix	Order
X_1	$M_1 \times (K_1+T_1)$
X_2	$M_2 \times (K_2+T_2)$
Z_1	$M_1 \times N_1$
Z_2	$M_2 \times N_2$

where

M = number of observations; 144 for division, 288 for district and 576 for the two districts

K = number of independent variables (i.e. 6)

T = number of months (12)

N = number of farms; 12 for division, 24 for district and 48 for the two districts

The hypothesis is that $\alpha_1 = \alpha_2 = \alpha$. This implies that the coefficient of the variables are similar in both districts/division and therefore the model can be represented as:

$$\begin{bmatrix} Y_1 \\ Y_2 \end{bmatrix} = \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} \alpha + \begin{bmatrix} Z_1 & \\ & Z_2 \end{bmatrix} \begin{bmatrix} \gamma_1 \\ \gamma_2 \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} \qquad (4.6)^1$$

Representing R_1 as the sum of squared residuals in equation (4.6) and R_2 as the sum of squared residuals in equation (4.4) plus the sum of squared residuals in equation (4.5):

$$F = \frac{(R_1 - R_2)/K+T}{R_2/(M_1 - N_1) + (M_2 - N_2) - 2(K+T)} \qquad (4.7)$$

The F-test results are given in Table 4.3.

TABLE 4.3

THE RESULTS OF THE F-TEST OF THE HYPOTHESIS OF HOMOGENEITY BETWEEN KERICHO AND KISII AND THE DIVISIONS WITHIN THEM

Division	District	Degrees of Freedom	F Ratio	$F_{.01}$	Hypothesis Not Rejected
Buret Konoin	} Kericho	19; 226	1.30 <	1.63	Yes
Kitutu Nyamira	} Kisii	19; 226	1.39 <	1.63	Yes
	Kericho Kisii }	19; 490	13.20 >	1.95	No

1 It is to be noted that the coefficients for farm effect dummies γ are kept separate, for each farm is unique to itself.

The hypothesis is that $\alpha_1 = \alpha_2 = \alpha$. This implies that the coefficient of the variables are similar in both districts/division and therefore the model can be represented as:

$$\begin{bmatrix} Y_1 \\ Y_2 \end{bmatrix} = \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} \alpha + \begin{bmatrix} Z_1 \\ Z_2 \end{bmatrix} \begin{bmatrix} \gamma_1 \\ \gamma_2 \end{bmatrix} + \begin{bmatrix} e_1 \\ e_2 \end{bmatrix} \qquad (4.6)^1$$

Representing R_1 as the sum of squared residuals in equation (4.6) and R_2 as the sum of squared residuals in equation (4.4) plus the sum of squared residuals in equation (4.5):

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	Kericho Kisii }	19; 490	13.20 >	1.95	No

1 It is to be noted that the coefficients for farm effect dummies γ are kept separate, for each farm is unique to itself.

The test statistically justifies the pooling of intra-district, but not inter-district, data.

4.1.4 Obtaining a Weighting System for Labour Input

From the regression results (given in Tables 4.1 and 4.2), we can get the marginal physical productivities ($\frac{\partial Q_i}{\partial L_j}$) or work rates with which we can work out the man-equivalents, i.e. the index of labour with respect to men. To do this, first we need the average labour input by each category per farm which is given in Table 4.4 for both Kericho and Kisii.

Calculation of the average marginal physical product for men and women is now possible using the information in Table 4.4. Thus for Kericho:

$$\text{Average MPP}_{\text{men}} = \frac{(12.19\times1.75)+(3.96\times1.66)+(28.77\times1.77)}{12.19+3.96+28.77} = 3.04 \text{ lbs/hr}$$

$$\text{Average MPP}_{\text{women}} = \frac{(21.91 \times 1.65) + (3.02 \times 4.33)}{21.91 + 3.02} = 1.97 \text{ lbs/hr}$$

$$\text{MPP}_{\text{children}} = 1.75 \text{ lbs/hr}$$

For Kisii:

$$\text{Average MPP}_{\text{men}} = \frac{(12.30 \times 4.84) + (9.36 \times 3.16)}{12.3 + 9.36} = 4.11 \text{ lbs/hr}$$

$$\text{Average MPP}_{\text{women}} = \frac{(23.39 \times 2.10) + (6.84 \times 2.75)}{23.39 + 6.84} = 2.25 \text{ lbs/hr}$$

$$\text{MPP}_{\text{children}} = 2.29 \text{ lbs/hr}$$

TABLE 4.4

THE AVERAGE LABOUR INPUT PER FARM PER MONTH, PROPORTION OF HOURS BY LABOUR CATEGORY AND THE MARGINAL PHYSICAL PRODUCTS (WORK RATES)

Labour Category	Kericho District			Kisii District		
	Average Hours per Farm per Month	Proportion of Hours in Plucking	Marginal Physical Product	Average Hours per Farm per Month	Proportion of Hours per Month	Marginal Physical Product
	Hours	%	lbs/hr	Hours	%	lbs/hr
Farmer	12.19	14.5	1.75	12.30	18.76	4.84
Other Family Men	3.96	4.7	1.66	1.08	1.65	not significant
Family Women	21.91	26.09	1.65	23.39	35.67	2.10
All Children	14.14	16.84	1.75	12.61	19.22	2.29
Hired Men	28.77	34.25	3.77	9.36	14.27	3.16
Hired Women	3.02	3.60	4.33	6.84	0.43	2.75

With these results, the appropriate indices normalised with respect to men are for:

Kericho - Men 1.00 Women 0.65 Children 0.57

Kisii - Men 1.00 Women 0.54 Children 0.56

These were the indices used to weight the various labour inputs to get single values for labour (L) used in each farm in tea plucking.

4.1.5 Obtaining the Weighting System for Capital Input ('Mature' Bush Equivalent)

The results obtained for the yield coefficients of the five vintages of bushes as contained in Etherington (1973, p.73) were used. Table 4.5 gives these coefficients.

Given the equation (4.2c), i.e.

$$Q_{it} = \Sigma\beta_{ki} X_{kit} + u_{it} \quad \text{where } u_{it} \text{ is the error term}$$

then

$$Q_{it} = \Sigma\beta_{k}.X_{kit} + U_{it} \qquad (4.8a)$$

where

$\beta_{k}.$ = the average yield coefficient for bushes aged k years

U_{it} = the new error term

Using equation (4.8a):

$$K^{*}_{it} = \hat{Q}_{it} = Q_{it} + U_{it} \qquad (4.8b)$$

where K^{*}_{it} is a measure of capital in terms of tea bushes in farm i weighted by the average yield in the best area in a district in time t.

TABLE 4.5

THE AVERAGE YIELD COEFFICIENTS OF THE FIVE VINTAGES OF BUSHES

District	Division	β_3	β_4	β_5	β_6	β_7*
		Pounds of Green Leaf/Bush per Year				
Kericho	Buret	0.5001	0.7826	0.9287	1.4374	2.0176
	Konoin[1]	-	-	-	-	-
Kisii	Kitutu	0.6211	1.4889	2.0081	2.7265	2.8391
	Nyamira	0.4403	1.0100	0.9424	1.1445	1.3791

* Considered relatively mature.

1 The yield coefficients for Konoin in Kericho were not estimated because plantings of more than seven years (planted earlier than 1959) had no exact date of planting in the data set. For my purposes, the yields in Buret were generally observed to be higher than those in Konoin farms. I used the Buret β_7 and β_6 to weight all the Buret bushes and considered the resulting indices would apply to Konoin. The rationale for doing this is that the older tea bushes in Konoin would tend to have higher yields (age effect) than the younger tea bushes in Buret and this would offset the environmental effect in Buret.

Thus, the capital in farm i is not quite the same as explained output ($\hat{Q}_{it}$) (or actual output plus the error term) because K^*_{it} excludes the individual farm management effect. To obtain normalised K^*_{it} we normalise with respect to the division with the highest yield since such a weighting system takes out the environmental differences between divisions. This, then, measures the flow of services each farmer is getting from his stock of capital, i.e. tea bushes - excluding the flow due to differences in management measured by the farm effect coefficients (see equation (4.2b)). The normalised measure of capital which we shall use, K_{it}, is merely a linear transformation of K^*_{it}.

The results presented in Table 4.5 were based on annual data and there is a need to convert the annual capital flows into monthly flows if we are to integrate the capital and labour data sets, because labour input observations were on a monthly basis. Since the tea bushes had not attained maturity, it is reasonable to assume that they appreciated in value over the year Normalisation was done by dividing all the K^*_{it} by β_7 and then by β_6 (thus taking in the latter case tea bushes aged 6 years to be the 'oldest') for the respective districts. For Kericho, the Buret β_7 and β_6 were used, and for Kisii the Kitutu β_7 and β_6 were used to get the weights. The reason for dividing first by β_7 and then by β_6 was to enable the values of K^*_{it} at year 7 and year 6 to be obtained separately so that the monthly values could be obtained by interpolation (considering the appreciation of the capital) and adjusting for the periods within the year when there was pruning of some bushes and therefore no capital service flow from the pruned bushes in the two months immediately following.

Tables 4.6 and 4.7 give the weights used for getting the 'mature' bush equivalent taking as base the tea bushes aged 7 years and 6 years respectively.

TABLE 4.6

THE WEIGHTS USED IN GETTING THE 'MATURE' BUSH EQUIVALENT WITH BUSHES AGED 7 YEARS AS BASE

District	Division	β_3	β_4	β_5	β_6	β_7
Kericho	Buret	0.25	0.39	0.46	0.71	1.0
	Konoin	0.25	0.39	0.46	0.71	1.0
Kisii	Kitutu	0.22	0.52	0.71	0.96	1.0
	Nyamira	0.16	0.36	0.33	0.40	0.49

TABLE 4.7

THE WEIGHTS USED IN GETTING THE 'MATURE' BUSH EQUIVALENT WITH BUSHES AGED 6 YEARS AS BASE

District	Division	β_3	β_4	β_5	β_6
Kericho	Buret	0.35	0.54	0.65	1.0
	Konoin	0.35	0.54	0.65	1.0
Kisii	Kitutu	0.23	0.55	0.74	1.0
	Nyamira	0.16	0.37	0.35	0.42

4.1.6 In Search of a Suitable Production Function for Tea

Having obtained appropriate weights for both our heterogeneous capital stock (in the form of average yield coefficients for trees of different ages) and our heterogeneous labour input, we should be able to get single measures of the flow of capital (K) services and the flow of labour (L) services. If we have this information, it may be possible to estimate the parameters of either a Cobb-Douglas production function:

$$Q_{it} = A K^{\beta} L^{\alpha} \qquad (4.9)$$

where A, β and α are the parameters to be estimated, or the constant elasticity of substitution (CES) function:

$$Q_{it} = \gamma[\delta K^{-\rho} + (1 - \delta) L^{-\rho}]^{-1/\rho} \qquad (4.10)^{1}$$

where γ, δ, ρ are the parameters with the following restrictions:

$$\gamma > 0; \quad 0 \leq \delta < 1 \quad \text{and} \quad -1 < \rho < \infty$$

γ is the efficiency parameter similar to A in the Cobb-Douglas function, δ the distribution parameter and ρ the substitution parameter.

If the hypothesis that there is perfect complementarity between the inputs is correct, then the Cobb-Douglas production function, though

---

1 The way the function is specified signifies that it is linearly homogeneous (constant returns to scale), but this can be varied by making the power in the outer bracket equal to $-v/\rho$.

easy to estimate[1] is essentially ruled out because it restricts the elasticity of substitution between labour and capital to 1 regardless of the level of the inputs.

Using the CES production function, it can be shown that:

$$\sigma = \frac{1}{1 + \rho} \tag{4.11}$$

where σ is the elasticity of substitution, and ρ is the substitution parameter (Arrow et al., 1961).

In effect, σ is a constant whose magnitude depends on the substitution parameter ρ. Although the specification restricts the elasticity of substitution (σ) to constancy, it permits a much wider choice among alternative values of σ. By substituting values of ρ in (4.11) it is evident that if

$$\left.\begin{array}{lll} -1 < \rho < 0 & \text{then} & \sigma > 1 \\ \rho = 0 & \text{then} & \sigma = 1 \\ 0 < \rho < \infty & \text{then} & \sigma < 1 \end{array}\right\} \tag{4.12}$$

The limiting cases of the CES production function can give us three examples of the traditional production function. If $\rho = -1$, $\sigma = \infty$ and the production function is linear. If $\rho = \infty$, $\sigma = 0$ and the production takes on the Leontief input-output form with fixed factor proportions. Finally, if $\rho = 0$, then $\sigma = 1$ and we have the Cobb-Douglas production function.

---

1 The data transformations in the Cobb-Douglas functions are straightforward; the function becomes linear in the logarithms.

It may therefore be tempting to estimate the CES production function parameters to prove the hypothesis of perfect complementarity between labour and capital in smallholder tea production. However, before trying to estimate the parameters of CES in this case, a word of caution is necessary. We have obtained the capital input using weights of average yields for each area with year 7 and year 6 as bases and then interpolated to get the monthly capital input, i.e.:

$$K_{i7} = \Sigma \frac{\beta_{k.}}{\beta_7} X_{kit}$$

and $$K_{j6} = \Sigma \frac{\beta_{k.}}{\beta_6} X_{kit}$$

The resulting monthly values of capital (K_i) after interpolation are the linear transformation of tea bushes weighted by the average normalised yield coefficients, as explained in Sub-Section 4.1.5.

Similarly, we have obtained labour inputs using weights of the average marginal products for men to get the manhours:

$$L_i = \Sigma \frac{\alpha_j}{\alpha_j} L_{ji}$$

where α_1 is the Marginal Physical Product for men. However, the regression results from equation (4.3) have shown that the R^2 was high, so L_i is a linear transformation of explained output on farm i. Thus, our logic tells us that capital inputs in the form of tea bushes and labour inputs are highly complementary and verge on a Leontief fixed factor proportions situation as is shown in Figure 4.1.

FIGURE 4.1

PRODUCTION ISOQUANTS IN THE LEONTIEF INPUT-OUTPUT PRODUCTION FUNCTION

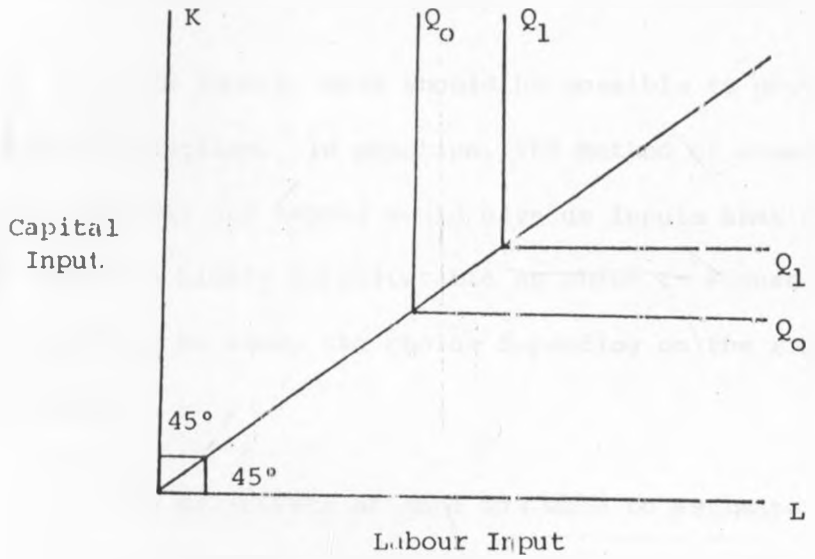
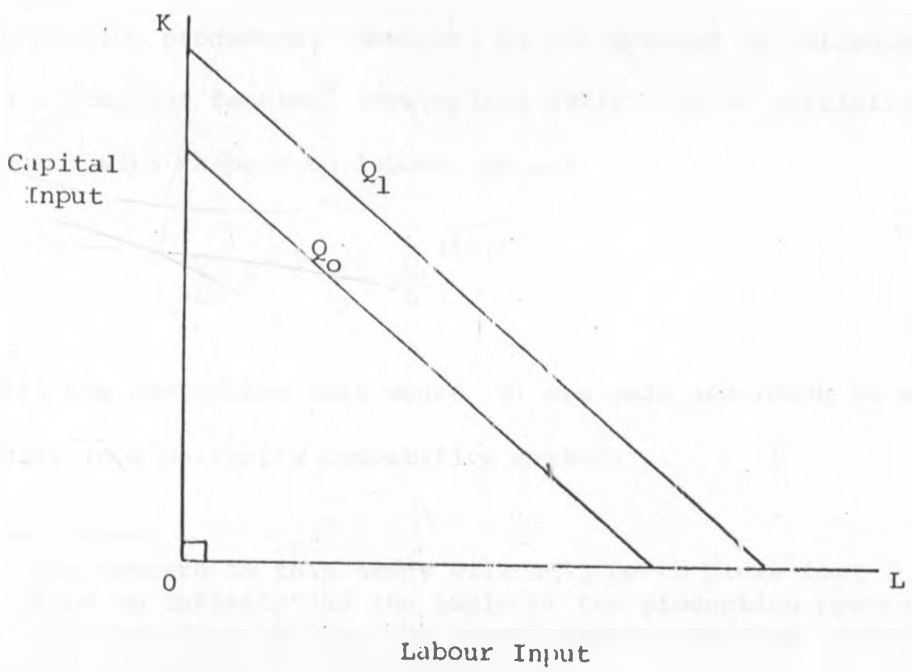


FIGURE 4.2

PRODUCTION ISOQUANTS IN THE CASE OF PERFECT SUBSTITUTION BETWEEN INPUTS



If this figure reflects the true situation, it would mean that there is no substitution between inputs for production takes place at the corners of the isoquants with fixed input porportions.

In theory, this should be possible to prove using the CES production function. In practice, the method of summing up heterogeneous capital and labour would give us inputs that are very similar and therefore highly substitutable as shown in Figure 4.2. Here, only one input may be used, the choice depending on the relative prices of the inputs.

A deliberate attempt was made to estimate the ρ parameter in the CES production function to establish that the way the indices were constructed, a case of an almost perfect substitution between the inputs would be the result.

Given equation (4.10), we see that it cannot be linearised in the logarithms as in the Cobb-Douglas case to enable us to use OLS estimation procedure. However, we can proceed to estimate the parameter in a stepwise fashion[1] (Heathfield 1971). If we partially differentiate (4.10) with respect to labour, we get:

$$\frac{\partial Q}{\partial L} = \frac{1 - \delta}{\gamma^{\rho}} \left(\frac{Q}{L}\right)^{(1+\rho)} \qquad (4.13)$$

With the assumption that wages (W) are paid according to marginal products in a perfectly competitive market:

---

1 The concern in this study will only be to prove that ρ does not tend to infinity (as the logic of the production process infers) and therefore it would be unnecessary to proceed to estimate other parameters in the function.

$$W = \frac{1-\delta}{\gamma^{\rho}} \left(\frac{Q}{L}\right)^{(1+\rho)} \qquad (4.14)$$

This can be linearised in the logarithmic form to get:

$$\text{Log } W = \log \frac{1-\delta}{\gamma^{\rho}} + 1+\rho \log \left(\frac{Q}{L}\right) \qquad (4.15)$$

From this we can get the estimate of $(1+\rho)$ from which ρ can be found. However, this particular way of estimation is usually used with time series data over a number of years. Here we had problems because the wage rate was constant[1] over the one year, with a monthly time series, and so regression using OLS procedure was impossible with constant W.

An alternative approach of estimating ρ using the factor shares method as used by Nichols (1966) and quoted by Morris and Saad (1977) was tried. Partially differentiating (4.10) with respect to L and then to K, we get:

$$\frac{\partial Q}{\partial L} = -\frac{\gamma}{\rho} \{\delta K^{-\rho} + (1-\delta) L^{-\rho}\}^{-(1+\frac{1}{\rho})} \{-\rho(1-\delta) L^{-(1+\rho)}\} \qquad (4.16)$$

$$\frac{\partial Q}{\partial K} = -\frac{\gamma}{\rho} \{\delta K^{-\rho} + (1-\delta) L^{-\rho}\}^{-(1+\frac{1}{\rho})} \{-\rho\delta K^{-(1+\rho)}\} \qquad (4.17)$$

Dividing (4.16) by (4.17) gives:

$$\frac{\frac{\partial Q}{\partial L}}{\frac{\partial Q}{\partial K}} = \frac{(1-\delta) L^{-(1+\rho)}}{\delta K^{-(1+\rho)}} \qquad (4.18)$$

---

1 The wage rate was according to the leaves plucked, but it normally worked out to be about 30 cts/hr.

With the assumption of perfectly competitive markets, we know that:

$$\frac{\partial Q}{\partial L} = W \qquad \text{and} \qquad \frac{\partial Q}{\partial K} = I$$

where I is the interest rate on capital.[1]

Therefore:

$$\frac{W}{I} = \frac{1 - \delta L^{-(1+\rho)}}{\delta K^{-(1+\rho)}} \tag{4.19}$$

The share of output going to labour is WL and that going to capital is KI. Therefore, from (4.19) we have:

$$\frac{WL}{KI} = \frac{(1-\delta)\ L^{-(1+\rho)}}{\delta K^{-(1+\rho)}}\frac{L}{K} = \frac{(1-\delta)}{\delta}\left(\frac{K}{L}\right)^{\rho}$$

or

$$\frac{WL}{KI} = \frac{(1-\delta)}{\delta}\left(\frac{K}{L}\right)^{\rho} \tag{4.20}$$

The value added approach was used in getting W rather than using the constant value. Thus, given that:

$$V = QP \tag{4.21}$$

where V is value added, Q is output in pounds, and P is price of output (40cts/lb), and:

$$LW + KI = V \tag{4.22}$$

$$LW = V - KI \tag{4.23}$$

$$W = \frac{V - KI}{L} \tag{4.24}$$

---

1 An interest rate of 8 per cent was used since the interest on loan from KTDA was 6.5 per cent for the first acreage planted but those expanding their tea holdings had to have loans from commercial banks whose interest rate was 9 per cent per annum.

The W from equation (4.24) was substituted in equation (4.20). Linearising (4.20) in the logarithm, we get:

$$\text{Log } \left(\frac{WL}{KI}\right) = \log \left(\frac{1-\delta}{\delta}\right) + \rho \log \left(\frac{K}{L}\right) \qquad (4.25)$$

The results of equation (4.25) were:

$$\text{Log } \left(\frac{WL}{KI}\right) = \underset{(2.27)}{6.08} - \underset{(59.7)}{0.97} \log \left(\frac{K}{L}\right)$$

Adjusted R^2 = 0.93

F-statistic = 3566.4

D-W test = 1.79 - showed no serial correlation.

The figures in brackets are the t-tests and they show the coefficients to be highly significant.

Substituting the value of ρ in equation (4.11) gives:

$$\sigma = \frac{1}{1 - 0.97} = 33$$

which proves that if we construct the indices of the inputs in the above manner, we are likely to get a high degree of substitution between capital and labour which is contrary to the logic of the production process (i.e. elasticity of substitution near zero).

To get δ:

Since $\text{Log } \frac{1 - \delta}{\delta} = 6.08$

$$\frac{1 - \delta}{\delta} = 10^{6.08}$$

$$1 = (10^{6.08})\delta + \delta$$

It is also evident that the value of δ would be negligible. However, we know that for a given elasticity of substitution and given factor proportions, the distribution of output between capital and labour is determined by the parameter δ in the CES case. Since the value calculated for σ above is logically highly suspect, the value obtained for δ in this case would consequently also be suspect.

The result leads us to question whether it may be better to have a functional form which estimates values of both K and h, because forming such single values gives us results which the logic of the production process does not support. The hypothesis is that while there is a high degree of complementarity between labour inputs and capital (tea bushes), at the margin there may be some substitution of harvesting labour for capital such that farmers with relatively fewer tea bushes may search out for every available '2 leaves and a bud' on the bushes. The converse may apply to the farm with relatively more tea.

It was for this reason that an attempt was made of fitting a production function formulated by Mukerji (1963) and used to analyse the productivity of qualified manpower by Sargan (1971).

4.1.7 The Mukerji Production Function

The Mukerji functional form may be represented as:

$$Q_{it} = A_o K_i^{\beta} \left(\sum_{j=1}^{n} \alpha_j L_{jit}^{\rho_j} \right)^{\beta_1} + u_{it} \qquad (4.26)$$

where

Q_{it} = quantity of tea leaves delivered in lbs by farmer i in month t

A_o = constant term

K_i = normalised capital (mature bush equivalents)

L_{jit} = labour category j used in farm i in month t

u_{it} = error term

β = parameter determining the magnitude of marginal product of capital

α_j = parameter determining the magnitude of the marginal product of labour category j

ρ_j = parameter which gives a measure of the substitution between the labour categories

a_1 = the overall labour elasticity

In $\log_e$, the function becomes:

$$\text{Log}_e Q_{it} = \log_e a_o + \beta \log_e K_i + a_1 \log_e \left(\sum_{j=1}^{n} \alpha_j L_{jit}^{\rho_j} \right) + u_{it} \qquad (4.27)$$

Thus, this functional form allows us to normalise capital but not labour inputs. In tea production, $\rho_j = 1$ in (4.26) and (4.27) for all j's, because there is perfect substitution between the labour categories. This is a reasonable assumption, for the categories considered are by age and sex but are all doing the same job - plucking tea. The next section considers the estimation of this function

4.2 Estimation of the Mukerji Production Function

An examination of (4.27) shows that we cannot use the OLS procedure to estimate the parameters of the function because a_1 and α_j cannot be uniquely determined. In effect, a non-linear least square estimation procedure has to be used.

There are special computer programs written to estimate the parameters of such functions, where the residual sum of squares is minimised by an iterative procedure. The program used ordinarily has a limitation of 90 observations but this can be modified so that more observations may be used. In effect, two trials were made with the Kericho observations[1]. First, only 84 observations (thus 7 farms each with 12 months observation) were used and, secondly, all the 288 observations for Kericho District. Five categories of labour were considered, i.e. family men, family women, children, hired men and hired women. Thus, other men were added to the farmer category to form family men because the former had relatively few observations in the data set. Thus the estimated equation was:

$$\text{Log}_e Q_{it} = \log_e a_o + \beta \log_e K_i + a_1 \log_e(\alpha_1 L_1 + \alpha_2 L_2 + \alpha_3 L_3 + \alpha_4 L_4 + \alpha_5 L_5) + u_{it} \quad (4.28)$$

where L_1 is family men, L_2 is family women, L_3 is children, L_4 is hired men and L_5 is hired women.

Estimation by iterative procedure requires starting values for the parameters to be estimated. Initially, the coefficients obtained from linear regression as given in Table 4.1 for the labour categories and the one obtained by regressing capital on output were used as starting values. With these starting values, convergence of the iteration was not possible. Better starting values were therefore

---

1 Only the Kericho data were used for the attempt in estimating the Mukerji function but the same procedure could be applied to the Kisii data.

formed for the first trial with 84 observations. Given the model in equation (4.28) and assuming a_1 to be 1, OLS estimation was done for:

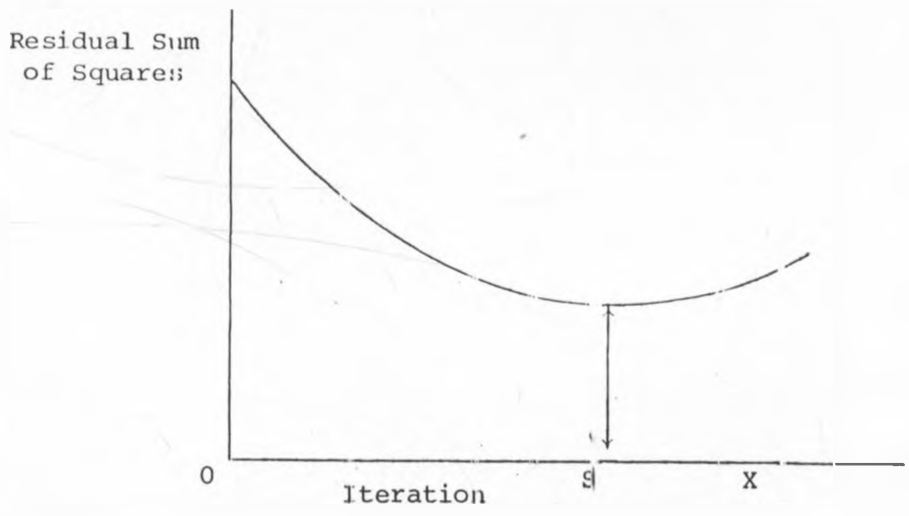
$$\text{Log}_e Q_{it} = \log_e a_o + \beta \log_e K + \alpha_1 L_1 + \alpha_2 I_2 + \alpha_3 L_3 + \alpha_4 L_4 + \alpha_5 L_5 + u_{it} \qquad (4.29)$$

where the L's refer to the $\log_e$ of the respective labour category.

The coefficients obtained in (4.29) were used as starting values except for α_5 in the first trial as is shown in the next chapter.[1] On each iteration, the values of the parameters would be given, the iterations terminating at a point where the resulting residual sum of squares (RSS) minimum (i.e. where the next iteration would give a higher RSS). Figure 4.3 shows an illustration of the way the iteration proceeds with the iteration terminating at S.

FIGURE 4.3

AN ILLUSTRATION OF THE ITERATIVE PROCEDURE TO MINIMISE THE RESIDUAL SUM OF SQUARES



1. A requirement in the estimation procedure was that one of the values of α be assigned an arbitrary value of 1.

The procedure would be valid if there are no local minima in the RSS. This was assumed to be the case.

The results of the estimated Mukerji function and their discussion form the next chapter.

CHAPTER 5

THE MUKERJI PRODUCTION FUNCTION RESULTS

Given the equation to be estimated:

$$\text{Log}_e Q_{it} = \log_e a_o + \beta \log_e K_i + a_1 \log_e(\alpha_1 L_1 + \alpha_2 L_2 + \alpha_3 L_3 + \alpha_4 L_4 + \alpha_5 L_5) + u_{it}$$

where

Q_{it} = the quantity of tea delivered by farmer i in month t

K_i = the weighted capital in terms of tea bushes

L_1-L_5 = the various labour categories as tabulated below

a_o, β, α_1-α_5, a_1 = the parameters to be estimated

u_{it} = the error term

The iteration results for the 84 observations considered in the first trial are shown in Table 5.1. For this trial, after the second iteration, the termination point was reached.

With the final results given in Table 5.1, ignoring L_5, we have:

$$\text{Log}_e Q_{it} = \underset{(2.97)}{5.00} - \underset{(-0.16)}{0.1395} \log_e K + \underset{(6.98)}{0.6002} \log_e (\underset{(1.55)}{0.11} L_1 + \underset{(1.77)}{0.20} L_2 + \underset{(1.00)}{0.02} L_3 + \underset{(2.41)}{0.37} L_4)$$

where the figures in brackets are the 't' tests and show that only the intercept term, the overall labour elasticity term a_1, and the coefficient for hired men category are statistically significant at the 1 per cent level. α_1 and α_2 are only significant at the 20 and 10 per cent levels respectively.

TABLE 5.1

THE INITIAL AND FINAL VALUES OF THE PARAMETERS OF THE MUKERJI FUNCTION WITH 84 OBSERVATIONS

Variable	Parameter	Initial	Finish
	a_o	2.5000	5.00
Capital (K)	β	-0.3300	-0.1393
	a_1	1.0000	0.6002
Family Men (L_1)	α_1	0.0137	0.1130
Family Women (L_2)	α_2	0.0176	0.2034
Children (L_3)	α_3	0.0068	0.0206
Hired Men (L_4)	α_4	0.0230	0.3734
Hired Women (L_5)*	α_5	1.0000	1.0000
(RSS)		9.5532	9.2973

* After arbitrarily assigning the value of 1 to α_5 as required by the estimation procedure, it did not change from the initial value.

$R^2 = 0.73$

F-statistic = 34.0

D-W test = 1.21, showing the existence of serial correlation

Since the observations come from only seven farmers, each with 32 observations, there may be relatively fewer observations for some categories hence their non-significance statistically.

Transforming the results to natural numbers, we have:

$$Q_{it} = 148.42\ K^{-0.14}\ (0.11L_1 + 0.20L_2 + 0.02L_3 + 0.37L_4)^{0.60}$$

Supposing we consider only the statistically significant variable of hired men:

$$Q_{it} = a_o(\alpha_4 L_4)^{a_1} = 148.42\ (0.37L_4)^{0.60} \qquad (5.1)$$

Differentiating (5.1) with respect to L_4 gives us the marginal physical product for the hired men:

$$\frac{\partial Q}{\partial L_4} = \frac{a_1(a_o(\alpha_4 L_4)^{a_1})}{\alpha_4 \bar{L}_4} = \frac{a_1 \bar{Q}}{\alpha_4 \bar{L}_4} \qquad (5.2)$$

Taking the arithmetic means of Q and L_4, the value of:

$$\frac{a_1 \bar{Q}}{\alpha_4 \bar{L}_4} = \frac{0.6 \times 492.05}{0.37 \times 70.79} = 11.27 \text{ pounds}$$

and with geometric means for Q and L_4 the value becomes:

$$\frac{0.6 \times 408.18}{0.37 \times 26.83} = 24.71 \text{ pounds}$$

The marginal physical product values obtained are biased upwards, possibly because of the serial correlation. The results may be compared with the values obtained by linear regression of output simply on labour inputs using the same 84 observations (and with similar labour categories as in the non-linear regression). In the linear equation, the result was:

$$Q_{it} = 146.3 + 0.67L_1 + 2.88L_2 + 0.43L_3 + 3.40L_4$$
$$\qquad\quad (0.82) \quad (0.78) \quad (3.30) \quad (1.05) \quad (0.64)$$

where the figures in brackets are again the 't' tests and show the coefficients for L_4 and L_2 (i.e. hired men and family women respectively) to be highly significant.[1]

$R^2 = 0.60$

F-statistic = 32.5

D-W test = 1.01, showing serial correlation[2]

A comparison between the values obtained for the marginal physical product of hired labour in the linear equation (3.40 lbs) with that obtained in the non-linear equation reveal that the latter value is relatively higher due to greater bias in the estimation. We know that tea plucking is an individual affair and expect additive relationships between the various labour categories in contributing to output (as expressed in the linear equation) hence the bias in the

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1 This is in contrast to the result of the similar linear regression using 288 observations where all the coefficients were statistically highly significant (see Table 4.1). The relatively fewer observations may be the reason for the non-significance of the coefficients.

2 Similarly, there was no evidence of serial correlation in the linear regression with all the 288 observations (see Table 4.1).

estimated values for the marginal products for various categories in the linear equation form may be smaller.

The ranking of the marginal physical productivity in the linear equation form is, from highest to lowest, hired men, family women, family men and children such that, relative to hired men, the indices would be 1:0.72:0.21:0.1 respectively. However, the coefficients for family men and children were not statistically significant. In the case of the non-linear equation, although only the coefficient for hired men was statistically highly significant, taking the coefficients α_j as determinants of marginal physical products of the various labour categories, the order of ranking is similar to that in the linear form but the indices change. The indices with respect to hired men are now 1:0.54:0.30:0.07 for hired men, family women, family men and children respectively.

It was felt that these results were sufficiently encouraging to proceed with a trial using the pooled data for Kericho District involving all observations. In the second trial using all the 288 observations in Kericho District, the starting values used were obtained from the final values in Table 5.1. The values of the parameters in the initial and final iterations (iteration number 19) are given in Table 5.2.

With these results, again ignoring L_5, we have:

$$\underset{}{\text{Log}_e Q_{it}} = \underset{(-12.82)}{-8.90} + \underset{(7.18)}{0.74}\ \log_e K + \underset{(6.11)}{0.64}\ \log_e (\underset{(0.46)}{7775}L_1 + \underset{(0.59)}{981}L_2 + \underset{(0.47)}{5253}L_3 + \underset{(0.45)}{9790}L_4)$$

TABLE 5.2

THE INITIAL AND FINAL VALUES OF THE PARAMETERS OF THE MUKERJI FUNCTION WITH 288 OBSERVATIONS

Variable	Parameter	Initial	Finish
	a_c	5.0000	-8.9000
Capital (K)	β	-0.1393	0.7380
	a_1	0.6002	0.6300
Family Men (L_1)	α_1	0.1130	775.0700
Family Women (L_2)	α_2	0.2034	981.6000
Children (L_3)	α_3	0.0206	5253.9500
Hired Men (L_4)	α_4	0.3734	9790.1400
Hired Women (L_5)	α_5	1.0000	1.0000
(RSS)		2200.0	559.3900

where the figures in brackets are the 't' tests and show that only the intercept term, the coefficient for capital and the overall labour elasticity term a_1 are statistically significant (at 1 per cent). All the coefficients for the various labour categories are now not significant.

$R^2 = 0.77$

F-statistic = 157.7

D-W test = 1.66 and lies in the indecisive range

It should be pointed out that at the 20th iteration, there was a matrix inversion problem. This was probably due to the fact that α_1, α_2, α_3 and α_4 were tending to infinity apparently and yet they were statistically not significantly different from zero. This presents difficulties in interpreting these results. However, the coefficient for capital is now highly significant; the R^2 shows that the variables included in the specification explain 77 per cent of output; the F-statistic is highly significant.

Looking at the results, we see that the order of ranking of α_j's per se is hired men, family men, children and family women and the indices with respect to hired men being 1:0.79:0.54:0.01. Of course, this ranking must be treated with caution because the coefficients are statistically not significant. Comparing the results of non-linear regression with those of linear regression using the same data set, the ranking in terms of marginal physical productivity is hired men, children and family men tying, and family women (derived from Table 4.1) and the indices are 1:0.46:0.46:0.44 respectively.

It may be suggested that there were serious estimation problems probably due to the bias caused by the inclusion of variables which are highly complementary. We see that in the two trials it was not possible for both capital and labour inputs to have significant coefficients at the same trial. In his analysis, Etherington tried an iterative regression procedure to estimate tea yield curves with multiplicative farm effect 'management' variables (Etherington 1973, pp.48-51 and pp.74-77). The model was of the form:

$$\hat{Q}_{it} = \beta_{oi} \left(\sum_{k} \beta_k X_{kit} \right) \qquad (5.3)$$

where

$\hat{Q}_{it}$ = the tea output delivered by farm i in year t

β_{oi} = the multiplicative farm effect coefficient

β_k = the yield coefficient of tea bush aged k years

X_{kit} = the number of bushes aged k years in farm i in year t

It was found that the product of β_{oi} and β_k stabilised within a few iterations but that a 'see-saw' effect occurred between the two sets of parameters (β_{oi} and β_k). It should be observed that a similar 'see-saw' effect has taken place here between the overall intercept a_o and the labour productivity coefficients, α_j. Thus, from Table 5.2, we can demonstrate the 'see-saw' effect (see Table 5.3).

Furthermore, as a_o has gone down, the elasticity coefficient for capital (β) has gone up.

Clearly, the non-linear estimation technique tried here does not conclude with stable and meaningful results. It may well be

TABLE 5.3

THE 'SEE-SAW' EFFECT IN THE MUKERJI FUNCTION ESTIMATION

Parameter	Starting Value	Finishing Value
a_o	148.42	0.00013
$\bar{\alpha}_j$ (j = 1-4)	0.1776	5950
β	-0.14	0.74

that, since the data used were collected during periods of no labour constraint in plucking tea, incorporating the harvest labour in tea production as such is bound to give us biased results because the tea output in terms of the available '2 leaves and a bud' necessitated a certain amount of labour which was readily available. In effect, until harvest labour becomes a binding constraint to smallholder tea producers, it may not directly affect the quantity of tea delivered to the buying centres, thus implying a high degree of complementarity between labour and capital, that is, the stock of tea bushes.

CHAPTER 6

CONCLUSIONS AND SOME INFERENCES FOR POLICY

This study has tried to demonstrate the commitment by the smallholders in two Districts of Kenya to commercial production once the opportunity to do so has been made available to them. The opportunity arose after the removal of legal restrictions to cash crop production (before the mid-1950s) and the solution to some of the technical and economic difficulties inherent in small scale tea production. The farmers realising that tea production would enable them to obtain cash income were prepared to devote part of their land and labour to the crop. Where the family members had off-farm commitments, labour was hired to provide the necessary manpower. This showed the flexibility of the small farmers which allowed them to adjust to changes in order to grasp the new opportunities.

The pattern of introduction of the cash crop economy in the rural areas follows very closely the Myints 'Vent for Surplus' model (Myint 1964)or that theorised by Fisk where a concealed labour surplus or pockets of surplus labour in the rural area may be mobilised for increased production (either cash crop or subsistence crop) in places where there is still ample land, provided the incentives exist. The KTDA's role in providing the services the farmers cannot provide for themselves, in addition to good guidance, has been one of the reasons for the success of the smallholder tea scheme. In the cases where farmers are still reluctant to introduce tea, there may be sound reasons for their behaviour and this study has reviewed a new

procedure of economic analysis, 'new home economics', which tries to explain in a more comprehensive way the labour force participation rates of household members using assumptions other than the usual labour-leisure dichotomy models for rural households.

It is found that there is a marked seasonality in most of the agricultural activities, closely associated with the bimodal rainfall regime. However, after establishment, tea has a unique evenness of labour requirement. Thus, plucking is done once every week to ten days throughout the year and there is flexibility within this period as to the actual day a farmer may pluck tea. The farmers therefore find tea an appealing enterprise, for reasons of regular income (monthly) and the flexibility of the labour requirement. Household and livestock activities are also year-round activities. Because household activities (involving food preparation, firewood and water fetching) are mainly done by women and yet they also perform other farm work, it is evident that infrastructural development, which in part has been enhanced by the introduction of the smallholder tea project, may release more women-hours for productive farm work. Because of the good roads, milk can now be transported easily from the farm for processing and an increasing combination of tea and dairy enterprises in the farms is in evidence.

Most of the tea farms have hired labour, especially in Kericho where about 50 per cent of the labour used on tea is hired. However, the hired labourers also work on other activities like food crops where 30 per cent of the total labour is hired in the same Kericho farms. One may argue that the KTDA might have originally overestimated the family's labour supply to cope with the planted tea

since the earlier intention was to make smallholder tea a family enterprise with family labour only. What has happened in practice is that most of the tea farmers have off-farm jobs and have to hire labour. In Kisii, there is relatively less hired labour but the tea enterprise is found to use most of the hired labour. The size of the farms and the tea enterprise here is also considerably smaller than in Kericho.

There was no evidence of a labour constraint on tea production. This might have been because of the ease with which hired labour was mobilised for tea production (and hence other activities) from the neighbouring non-tea growing regions of Nyanza Province and also the use of labour which may have been less fully employed. The fact that in most farms there was hired labour points to the fact that tea production provides the necessity for hired labour if the previous economic activities before tea introduction in the farms are to be maintained. Such necessity for hiring labour need not be explained only in terms of the farmer having increased prosperity and therefore having leisure while employing labour to do farm work. It is important here to point out that if the labour is to be available for the farms both from within and without the regions (i.e. easily mobilised) then the attitudes of school leavers some of whom may not get non-farm jobs, must change. This may be done by some public reform measures on education right from the 'grass roots'.[1]

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1 This is more easily said that done, but it is the logical conclusion one arrives at because remaining without a job (migrating to the cities) means the marginal productivity is zero, which is a loss to the economy, given that farm work, and especially working on tea, has a positive marginal product of labour.

The correlation between the various activities shows some unexpected results which have been discussed in the text; one important result is the inverse relationship between off-farm work and tea output in both areas studied. The implication of this result is that heavy reliance on hired labour without adequate supervision by the farmer may lead to having less than optimal tea output.

The analysis of tea production indicates that the marginal productions of the various categories of harvest labour were rather low (about 4lbs of leaf/hr). This is in sharp contrast to the work rates in the tea estates where levels of about 10 lbs of leaf/hr are obtained per worker. One reason why the work rate in the smallholdings may have been low is that they were still in a period of learning the process[1] with the tea bushes not yet at full maturity. Another reason for lower work rates could be that there was no pressure on the time of those plucking (no labour constraint) and household members might have been mixing work with pleasure, for tea plucking provides a good environment for both working and chatting. One worthwhile area of investigation at the moment would be to find out whether the work rates have improved with greatly increased area and maturity of tea in these districts since the survey was conducted in 1965-66.

The attempt to incorporate harvest labour in the production function for tea was not successful. First, to prove that capital and labour were perfect complements according to the logic of the production process (and as hypothesised by Etherington (1973)) by using a CES production function was not possible. This was because the

1. No wonder there are claims that some hired workers after attaining plucking experience in smallholdings go to find jobs in the estates, this representing a high rate of turnover of smallholder hired labour.

method of forming indices of capital and labour so as to incorporate them as single values in such a production function pointed to the opposite of the logic of the production process. Thus, both capital and labour when regressed on output independently had high coefficients of determination (R^2). Forming indices of capital and labour by using the weighted capital of various ages and labour of various categories turned out to be like including two inputs which are identical (or perfect substitutes), the exact opposite of the logic of the production process.

To avoid the above dilemma, use was made of the Mukerji production function, which left the labour categories unnormalised and with the hypothesis that at the margin there may be some substitution between capital and labour (farmers with less tea bushes using slightly more hours to increase output). With this function there were severe problems of estimation probably due to the inclusion of variables which are highly complementary. In two separate trials (with different numbers of observations) either one or the other of the inputs was not statistically significant. The hypothesis of little possibility of substitution could not be rejected therefore in the light of the available data. It was concluded that the incorporation of harvest labour in the tea production function must therefore wait until there is a heavy constraint on the labour supply in smallholder tea farms. Before that, the tea production function may take the form of a fixed factor proportions relationship, such that if there is a certain amount of leaves to be plucked from the tea bushes, labour would readily be available to pluck it and deliver it to the buying centre. Any future study on the impact of a labour constraint on tea output should use data

modelled to test the hypothesis rather than to use the available data with no a priori hypothesis.

The implication of the above remarks on tea production is that, at the time of the survey, labour supply for tea production seemed to be no problem. In effect, larger farms could expand tea acreages or introduce tea gradually (i.e. planting only at least 1/3 of an acre per year because of the heavy labour input during the establishment period) without creating labour bottlenecks. This was because there was a possibility of hiring labour if family labour could not cope with the increased labour requirements. However, presumably there is a limit to the tea area a smallholder can effectively operate both in terms of the degree of specialisation warranted in such a cash crop and the likely constraints on hired labour. That is to say, that while there has been a phenomenal expansion of the area planted to smallholder tea in Kenya and while the area still represents only about 10 per cent of the potential land, the period of disequilibrium must eventually end with the opportunity cost of land and labour slowing down the rapid expansion. Already Kenya is the third largest tea exporter and it will soon no longer be the case that she can assume a perfectly elastic market for her product (Etherington 1973; Tyler 1976). Continued expansion is likely to be met with declining prices.

This study has not attempted any supply response study of smallholder tea because of the disequilibrium situation, where, despite the low existing prices for tea, the smallholders made the investment decisions to plant tea, a reflection of the effect of the removal of the legal restrictions imposed earlier. However, especially with the prevailing boom in the tea market, there is a possibility of undertaking

such a supply response study since we now know the planting-output relationship and we could incorporate the producer price into a function aimed at estimating the farmers' price responsiveness.

However, there are more significant issues at the micro level which well deserve investigation. The smallholders, to a large extent, are still in the transitional stage between subsistence production and specialisation in export production. In fact, although the credit availability has been made relatively easy by the KTDA in the tea areas, some farmers are still reluctant to either take the credit or involve themselves in tea production. A detailed study needs to be undertaken to understand the internal workings of the community, analysing the socio-economic factors responsible for different farmers' behaviour hence the different degrees of specialisation and market dependence on food production. Unfortunately, the present data set only included tea farmers. A sample including both the tea farmers and the non-tea farmers should be taken and aspects of 'new home economics' used to analyse the efficiency of their resource allocation and the relative rapidity of the adjustment to the new production environment. It may well be that the non-tea farmers are more efficient in their allocation of the available resources with the given technology. Be this as it may, what is so crucial in the tea areas is the rapidity of the change. It would be particularly interesting to examine the impact on income distribution and land holdings that the rapid acquisition of high value productive assets has had on the society. Substantial changes are likely to have occurred not only between families but within the family structure itself.

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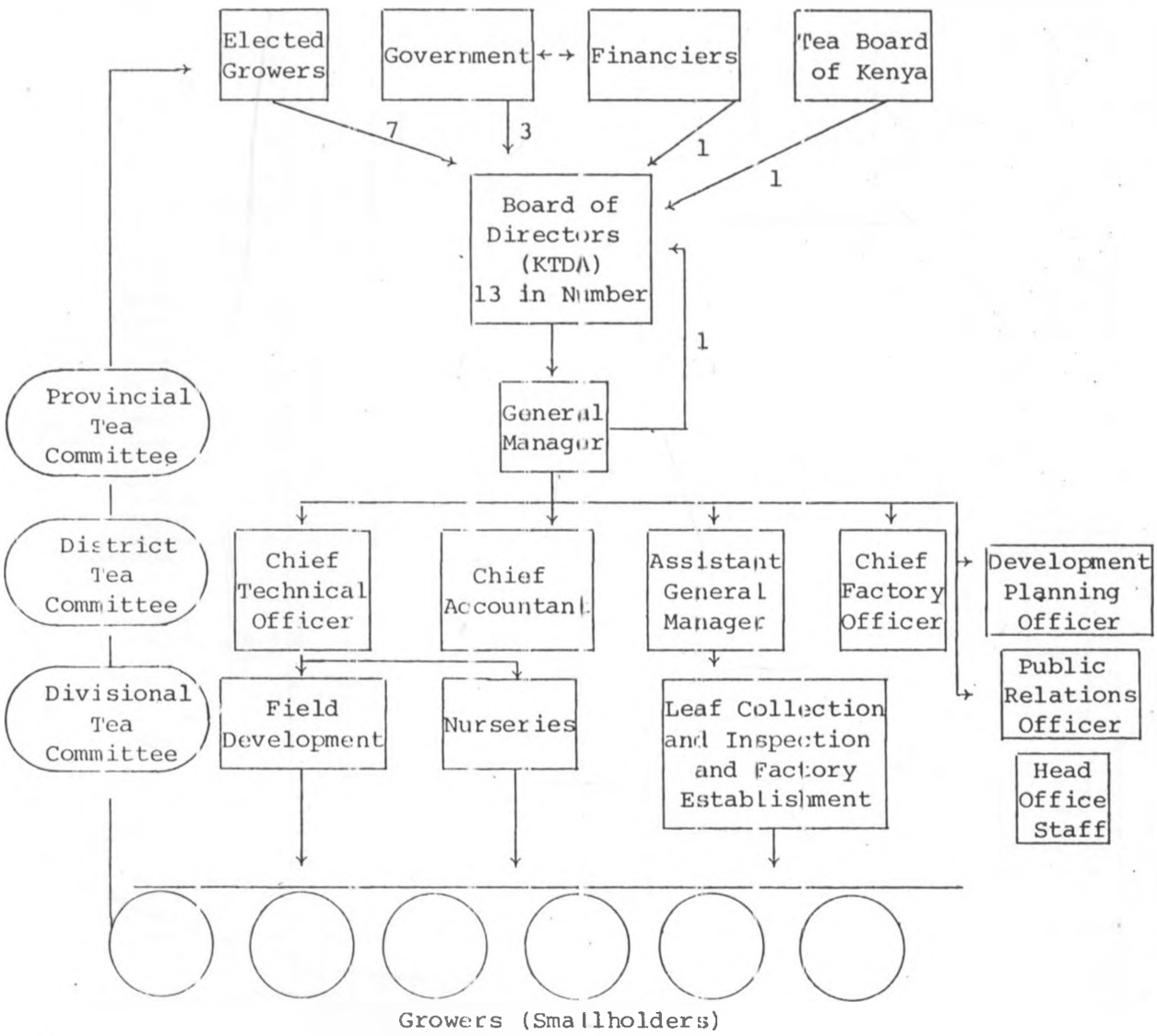
APPENDIX 1

ORGANISATION CHART OF THE KENYA TEA DEVELOPMENT AUTHORITY



Notes: (1) Three levels of hierarchy: the Board, the Management (appointed by the Board, and the tea growers. Everyone with responsibility in the hierarchy has his area of activity defined in writing down to the last detail.

(2) Provision of participation by the growers; note the elected growers form 7 out of the 13 members of the board. In effect the influence of politically oriented representatives on the board is reduced.

(3) The financiers include the International Development Association, the Commonwealth Development Corporation, and the Kreditanstalt fur Wiederaufbau.

Source: Blume (1970); KTDA (1972).

APPENDIX 2

LABOUR SUMMARY SHEET

FARM NO
WEEK NO

GROUP	ACTIVITY	OPERATION	CARD	COLUMN	FAMILY LABOUR: Farmer M/T	Farmer W/T	Farmer F S/S	Farmer Sub Tot	Men M/T	Men W/T	Men F S/S	Men Sub Tot	Women M/T	Women W/T	Women F S/S	Women Sub Tot	Children M/T	Children W/T	Children F S/S	Children Sub Tot	HIRED LABOUR: Men M/T	Men W/T	Men F S/S	Men Sub Tot	Women M/T	Women W/T	Women F S/S	Women Sub Tot	Children M/T	Children W/T	Children F S/S	Children Sub Tot
1	TEA	Plough/Digging	1	11-24																												
		Planting		25-38																												
		Weeding		39-52																												
		Pruning		53-66																												
		Harvesting		67-80																												
		Marketing	2	11-24																												
		Supervision		25-38																												
		Attnd Meetings		39-52																												
2	COFFEE OR PYRETHRUM	Digging		53-66																												
		Planting		67-80																												
		Weeding	3	11-24																												
		Harvesting		25-38																												
		Marketing		39-52																												
	WATTLE OR PASSIR	Digging		53-66																												
		Planting		67-80																												
	FRUIT	Weeding	4	11-24																												
		Harvesting		25-38																												
		Processing		39-52																												
		Marketing		53-66																												
3	MAIZE	Digging		67-80																												
		Planting	5	11-24																												
		Weeding		25-38																												
		Harvesting		39-52																												
		Processing		53-66																												
		Marketing		67-80																												
	MIMBI OR BEANS	Digging	6	11-24																												
		Planting		25-38																												
		Weeding		39-52																												
		Harvesting		53-66																												
		Processing		67-80																												
	VEGETABLE & BANANAS ETC.	Digging	7	11-24																												
		Planting		25-38																												
		Weeding		39-52																												
		Harvesting		53-66																												
		Marketing		67-80																												
4	ALL LIVE-STOCK	Milking	8	11-24																												
		Marketing		25-38																												
		Herding		39-52																												
5	CAPITAL OVERHEAD	Building		53-66																												
		Repairs		67-80																												
		Supervision	9	11-24																												
		Attnd Meetings		25-38																												
6	HOUSEHOLD	Domestic Chores		39-52																												
7	NOT WORK-ING	Restings		53-66																												
		Illness		67-80																												
8	OFF FARM WORK	Paid Employment	0	11-24																												
		Own Business		25-38																												
		Communal		39-52																												

Key:

Group	Activity	Group	Activity
1	Tea	5	Overhead
2	Other cash crops	6	Household
3	Food crop	7	Illness
4	Livestock	8	Off farm

* Not punched on to cards