Country Report

SUSTAINABILITY OF SMALLHOLDER TEA GROWING IN KENYA

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ABSTRACT

Although tea was introduced in Kenya in 1903, Africans (natives) were barred from growing the crop until after independence in 1963 when the legislation was repealed. Africans started growing tea under the smallholder tea growing scheme which developed very rapidly. In Kenya, the smallholder tea sector, managed by the Kenya Tea Development Agency Ltd (KTDA), own over 80% land under tea producing over 60% made tea (mt) in Kenya. The Kenya tea is grown in prime lands capable of producing over 6000 kg mt per hectare per year under good cropping weather. However, smallholder teas yield on the average less than 2000 kg mt per hectare per year due to use of inappropriate agronomic and cultural practices resulting from low adaptation and adoption of developed and recommended research technologies. For sustainable smallholder tea sector, it is necessary that tea production technologies developed through extensive research are disseminated and adopted in the tea sector. This can be achieved through an effective and knowledgeable extension service. Smallholders need to plant elite varieties with high yield and quality potentials using correct planting spacing and should prune at the correct pruning height using proper implements. Gappy tea fields need infilling soon after pruning. Fertilizer application is mandatory in tea production and use of NPK fertilizers is recommended in Kenya. KTDA should continue availing the fertilizer on credit and on time. A mechanism is needed to ensure farmers are enrolled for the fertilizer facility and obtained fertilizers are applied on tea, not competing crops. The high smallholder tea quality is partly attributed to fine plucking standard in the sector. The plucking of two leaves and a bud standard should be maintained to sustain the quality. Also effective control of weeds, pests and diseases or management systems are necessary for high and quality tea production. Factory capacity problems should be addressed so that the green leaf production does not exceed processing capacity and vice versa. There is need for good road network and vehicles to ensure that harvested leaf arrives in the factory in good condition even during rainy seasons. Sustainable green tea leaf production requires that farmers are paid adequately and on time to enable them to tend the crop. Regular reviews of green leaf payment and use of correct payment modules ensure sustaining tea production. However, smallholder tea sector is faced with challenges in rising costs of production, especially labour and energy costs. Since tea consumption world wide is not rising as fast as production, the smallholder tea sector needs to intensify tea marketing, market research and product diversification.

Introduction

Tea was first introduced into Kenya on experimental basis in 1903, but commercial tea planting started in 1924 (Owuor 1999). Africans were initially barred from the crop, but in the mid 1950's growing tea by Africans was

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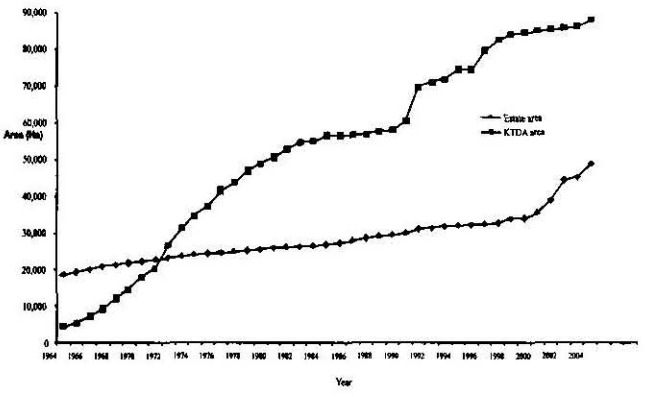
allowed and after Kenya attained political independence in 1963, the legislation barring Africans from growing tea was repealed. The native Africans immediately took up the initiative and commenced massive tea planting programmes, leading to a rapid growth of the tea industry in Kenya (Fig1). Tea production rose from 18.1 thousand metric tonnes in 1963 to 324 thousand metric tonnes made tea in 2004, largely due to the expansion in the smallholder sector. During the same period the smallholder tea production rose from 0.6 to 192 thousand metric tonnes. Kenya is now a leading world exporter of black tea.

Kenya tea industry comprises the estate and the smallholder sectors. The estates comprise the trans-nationals and local farmers whose holdings are generally over 50 ha. The smallholders are indigenous farmers whose average tea enterprise is about 0.27 ha. Up to 2000 smallholders were licensed to grow tea by the Kenya Tea Development Authority (KTDA), but now operate as free entities with the Kenya Tea Development Agency Limited (KTDA) as their commercial managing agent. The farms are owned as family units in which the individual farmer is the risk-taking manager.

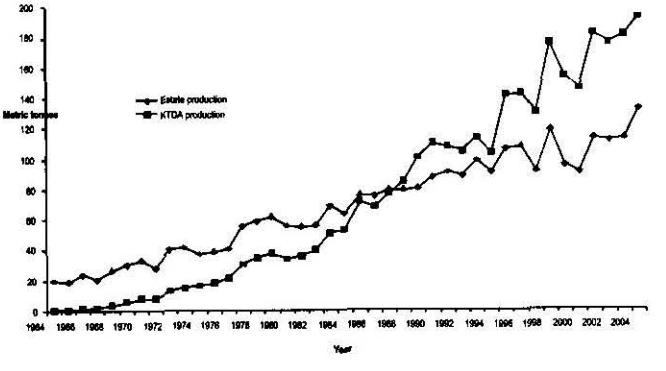
Kenya smallholder tea sector is considered the largest and one of the most successful smallholder schemes in the world (Lamb and Muller 1982), with over 447,617 growers operating 45 factories and producing 192 thousand metric tonnes of made tea by 2004 (Anon. 1963-2005). The smallholder tea areas are in the East and West of the Great Rift Valley on the foothills of Abardares and Kenya mountains in the East of the Rift Valley and the Mau ranges, Nandi, Kisii and Kakamega Hills in the West of the Rift Valley KTDA is acknowledged as a successful institution in smallholder, rural development and public sector enterprise, both of which in Africa are fraught with difficulties and disappointing performance (Lamb & Muller 1982). Although the

Fig. 1: Area under tea in different sectors of Kenya



area under tea in the smallholder sector has been higher than that in the estates sector since 1972 (Fig. 1) and total tea production by the sector surpassed that of the estates in 1988 (Fig. 2) productivity in the estates sector has always been higher than in the smallholder sector (Fig. 3). This is despite the fact that the estates host most of the pioneer plantations established using unimproved seedling tea (Wachira 2002a). The smallholders on the other hand, cultivate high yielding relatively young clonal teas capable of yielding much higher. By 2004, the productivity levels of 2,189 and 2,707 kg made tea per hectare were realised in the smallholders and estates, respectively.

Fig. 2: Tea production by different sectors

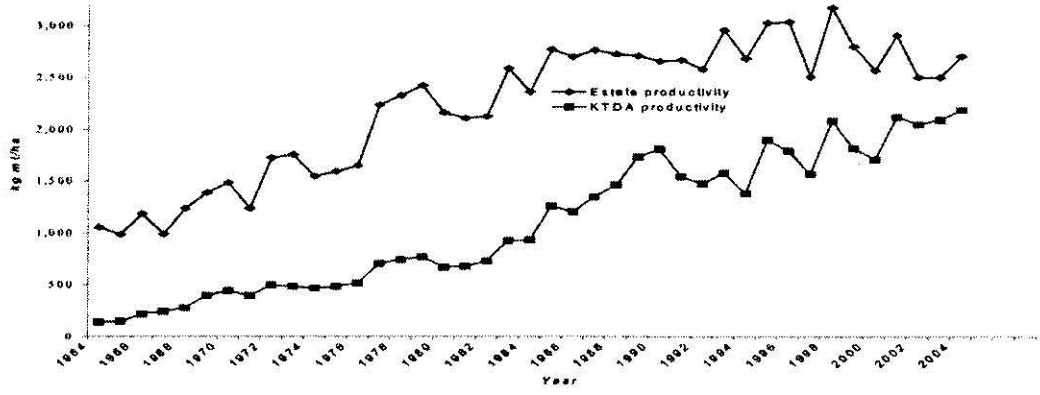


The smallholder tea sector in Kenya has gone through several phases of successful development. In the initial establishment phase, it had recorded phenomenal growth. This was

followed by a phase of rapid expansion and diversification into processing and marketing (Etherington 1973). Phase three consolidated the technical gains by striving to achieve economic optimum and high returns when expansion is much slower and the external environment less certain (Schluter 1984). The uncertain and continued low prices of tea (Fig. 4) and increased production costs imply that although the future may rely on tea quality, product diversification or value addition, it is more promising to get more profits by improving economic efficiency in production.

The development of smallholder tea sector has resulted in the redistribution of wealth by the creation of new productive capacity in many parts of the country. It is providing meaningful, year round employment to over 447,000 farmers on their own farm; regular wage employment to farmers' relatives in modern, but rural tea factories, collection and transport networks and has been injecting millions of cash flow into rural areas where alternative opportunities are few. Sustaining tea production in the smallholder tea sector therefore should top the government's development agenda.

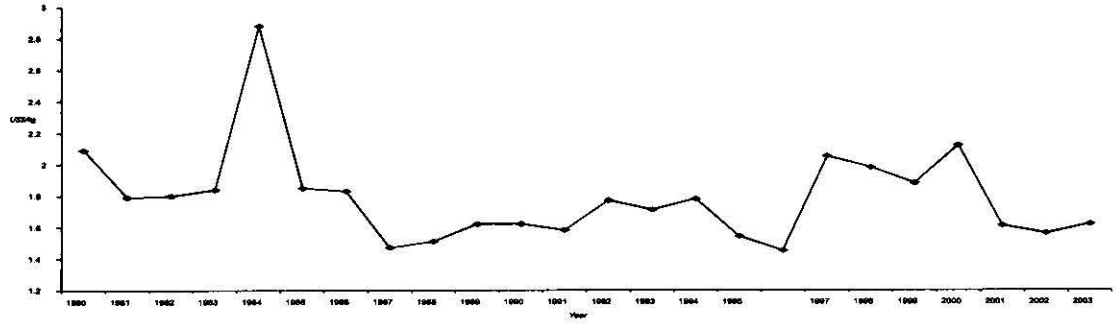
Figure 3: Tea production per hectare in different sectors



The need for improving efficiency and productivity

Tea in Kenya is planted in prime lands with very good soils and climate (Othieno 1991). It is hence pertinent to maximize its productivity. Although the target of the Kenya Government is to produce 350 thousand metric tonnes made tea per annum by the year 2008 (Anon. 2001), since most of the suitable land for tea expansion is limited, the increase should come from increased productivity of the existing tea farms and/or plantations. If the productivity of the smallholder tea increases to about 2500 kg per ha per year, this projection would be realized without the need to allocate more land to planting tea, which if done, results in replacement of food crop.

Fig. 4: Mean tea price (US$/kg) over period (Anon. 1964-2005)



Organisation and working of KTDA, labour use in tea and gender relations

The smallholder tea sector was established with the hope that family units would manage their farms (M'Imwere 1999). Indeed, most of the decisions on the smallholder tea farms are made by the key members of the family unit - husband and wife (Owuor *et al.* 2005; Kavoi *et al.* 2003). The main use of labour in tea production is in harvesting. But tea production in the smallholder sector has grown to an extent that in most farms the family alone cannot cope with the crop. Since child labour is also illegal in Kenya, most smallholders use hired labour in their farms. Although most smallholder tea farmers used male and female workers, there are some farms hiring females only, as they are easier to control. Women therefore play a vital role in tea production in Kenya. Like hired labour, females are also the dominant source of family labour. The data put together show that most smallholder tea is produced by women; therefore they have a significant role in sustainable smallholder tea production.

Gender relations also affect smallholder tea production negatively and lead to low productivity and neglected tea fields (Sorensen and von Bulow 1990). Tensions arise as a result of conflicts over the control of proceeds of tea sales, as the smallholder controls the labour of the household members only to the extent that they also benefit from production. As women make up large part of the labour force in smallholder tea schemes (Owuor *et al.* 2005; Kavoi *et al.* 2003), it is vital to consider gender in relation to extension service, transfer of skills, choice of technology and effects of subsistence crops (Lamb and Muller 1982; Sorensen and von Bulow 1990).The smallholders are unwilling to subdivide the tea holdings to their children past high school age despite the children doing most of the work on the farms. This acts as a disincentive for them to work on tea farms. There is need to develop a proper rewarding system for the family labour and to attract the younger generations into tea production.

In districts where there are few alternatives to tea, labour use efficiency is high (Kavoi *et al.* 2000). Farmers without alternative enterprises allocate most of their labour to tea enterprise. Studies are needed to be carried out to determine the competitiveness of tea relative to the other competing farm enterprises so that farmers are advised correctly on the most economic agricultural activities.

Establishment and expansion of tea

The tea crop requires specific soil characteristics to grow and produce economic yields (Othieno 1991a). Although an area may be gazetted as suitable for tea cultivation, there will always be pockets within the gazetted areas not suitable for growing tea due to poor soil texture, high pH, water logging and very steep slopes. New potential tea growing areas need to be holistically evaluated to avoid cultivating the crop in non-optimal lands. Since smallholder areas under tea are relatively small per farmer (M'Imwere 1999), poor choice of a site can lead to total crop failure or very slow and expensive tea establishment.

The smallholder teas are planted and established in areas receiving adequate rainfall in most years. Total rainfall *per se* is not as useful in tea production as its distribution. For sustainable tea production, there should be a minimum of 120 to 150 mm rainfall per month (Othieno 1991a). Smallholder tea should therefore be restricted to areas receiving adequate rainfall and good distribution as it has been established that productivity varies with agro-ecological zones (Owuor *et al.* 2001). Squire *et al.* (1993) and Obaga *et al.* (1988) had also reported yield decrease of 200 to 300 kg made tea per ha with a rise in altitude of 100 m.

Role of research and extension service in sustained development of small holder tea

Dissemination and adoption of research findings

Since independence in 1963, the Kenyan agricultural sector has undergone major structural and technological changes. Some of these changes have been in the form of institutional arrangements related to the land tenure system and creation of marketing and regulatory institutions such as the KTDA, Tea Board of Kenya, and Coffee Board of Kenya. Other changes are related to subdivision of land and a shift from subsistence to cash crop oriented farming by smallholders as in tea, coffee, and sugar cane. Considerable changes related to use of intermediate chemical and biological factors of production, such as fertilizers, improved seeds and germplasm, and machinery have also been evident.

Unlike most academic research, tea research in Kenya is highly integrated into the industry. The industry is directly involved in funding and strengthening most of its research activities through cess payments by farmers, which is administered by the Tea Board of Kenya. Tea scientists do not operate in isolation in producing results but concentrate on solving practical and technical problems arising within the industry. Due to this relationship, the estate sector of the Kenya tea industry has undergone improvement in productivity unparalleled to any other tea producing countries. However, productivity in the smallholder sector of the industry remains relatively low (Fig 3).

An assessment of technology transfer and adoption levels in smallholder tea sector (Owuor *et al.* 2005) revealed that the knowledge and the application level of various agronomic recommendations were relatively low for both farmers and extension staff. Front line extension staff do not have the correct research information for most of the tea agronomic practices. Thus, the knowledge and the technological gap between research and tea farmers in the smallholder tea sector have had a depressing impact on tea production. To sustain tea production in the smallholder sector, the knowledge gap between researchers and farmers must be bridged.

Tea researchers have developed several technological packages which are available to the Kenya tea industry (Othieno 1988). The low productivity in the smallholder tea sector is possibly due to the fact that the improved production technology packages not reaching the individual farmers or that though available, the technologies are not being adopted by the farmers in the sector (Owuor *et al.* 2005). It is necessary to ensure that the technology reaches the farmers and factors leading to low adoption unveiled and corrected.

The Kenyan farming community has in general understood the benefits of adopting new and/or innovative technologies and farming practices provided that the cost/return relationships are favourable. However, it is the Kenyan large-scale tea farmers/estates that have largely benefited from the use of the tea production technologies (Othieno 1981). The small-scale farmers lag behind in adoption of improved practices. Sustainable and improved tea production in Kenya requires that effective mechanisms for transfer of developed technologies be put in place. Currently the information is disseminated to the growers through seminars, symposia, courses, publications such as annual reports, journals, participatory farmer demonstrations and advisory (extension) visits. These methods may be inappropriate to transfer the packages to the sector.

One factor possibly responsible for poor diffusion of tea production technologies to the smallholder sector is the low level of education of the target farmers. Majority of the smallholders have a low level of formal education (Owuor *et al.* 2005). The above outlined methods for transferring technologies may have been inappropriate for technology diffusion in the smallholders sector. It is necessary that the technologies are disseminated to the smallholders

through more appropriate methods especially using on farm courses based on practical and participatory demonstrations. This situation is likely to change in future as younger and better-educated farmers are gradually replacing the older farmers. There should be a concerted effort to replace the lowly educated extension staff with better-trained and well-equipped staff. A policy should be effected that ensures only staff with relevant training are assigned extension duties if higher tea productivity and production is to be achieved and sustained.

The success in the adoption of the improved technologies is largely dependent on the effectiveness of extension. Although the extension staff make several visits to farmers, many are not visited because, the ratio of frontline extension staff to smallholder tea farmers is too low (Table 1). The ratio of extension staff to farmers needs regular review to ensure farmers access to production technologies.

Table 1: Statistics of tea areas, number of extension staff, tea growers and productivity* during the 1997/98 financial year**

East of Rift				
District	Area under tea (Ha)	Number of Extension staff+	Number of growers	Mean production kg mt/ha)++
Kiambu	6,809	48	18,769	2,517
Murang'a II	5,836	37	19,673	3,163
Murang'a III	5,326	35	21,318	2,899
Nyeri	6,314	46	24,271	2,366
Kirinyaga	5,480	27	17,112	3,217
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Embu	3,447	24	12,657	2,317
Tharaka/Nithi	1,380	13	5,491	2,694
Meru	4,378	28	14,968	1,335
Nyambene	3,300	12	13,070	1,861
West of Rift				
Kericho	8,145	25	19,558	1,534
Bomet	6,747	43	21,102	1,775
Nyamira	9,500	41	47,500	2,045
Kisii	7,297	48	46,154	1,517
Nandi	2,490	20	6,820	1,028
Kitale	736	7	1,012	810
Vihiga	1,698	16	9,449	1,284
Kakamega	511	8	2,408	1,018
Olenguruone	1,013	1	1,346	404
Total	80,407	479	302,698	2,101

*Based on total green leaf production and using a factor of 0.225 (Anon 2002) to convert green leaf into made tea. **Source KTDA Statistical data; +Tea officers plus assistant tea officers and technical assistants. ++This figure excludes Nyayo Tea Zones Development Corporation areas.

Most smallholders have never attended any formal course on tea production apart from public meetings, called "barazas" (Owuor *et al.* 2005), which are attended mostly by the owners of the farms. The persons attending the meetings never pass the information learnt to the farm workers. Whenever the extension staff visit the farms, they usually meet the owner of the farm and not the operators. The new knowledge gained by the owners of the farms is not imparted to the farm operators. The training techniques need to be revised so that the correct personnel are trained to ensure that the technologies reach the intended groups who can effect change in production patterns.

Very few tea smallholders are aware that they contribute money towards research and development (Owuor *et al.* 2005). They imagine that the research technologies that are being developed for the Kenya tea industry are being financed by the government or by some donors. The farmers will surely seek the advanced knowledge if they are made aware that they are financing research and development and it is not coming free.

Role of extension in sustaining tea production

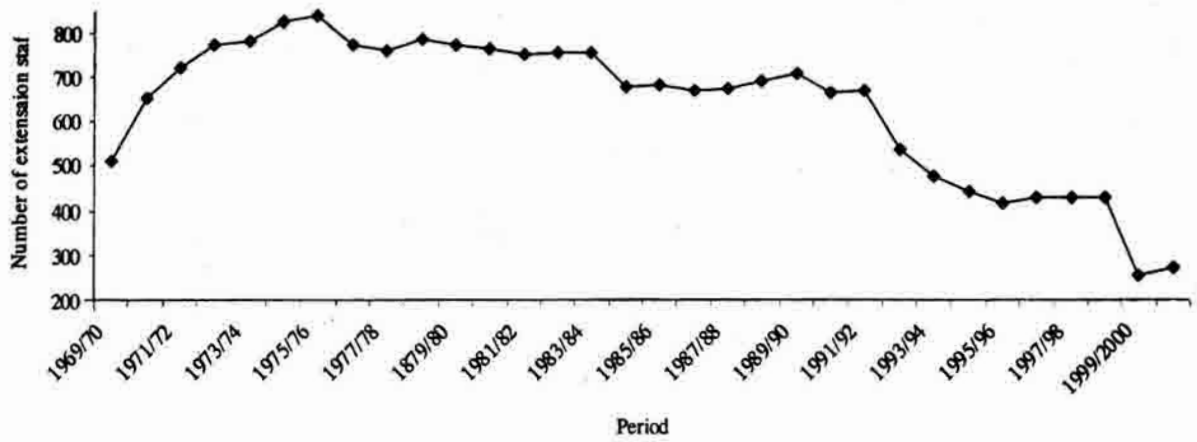
Extension programs are not worth the name if there are no profitable agronomic innovations to extend or if innovations that exist are of doubtful or marginal profitability (Anthony *et al.* 1979). Extension emphasis in tropical Africa has tended to be uneven due to the disparity of farmers over a wide area and the poor road system. For the extension program to have an impact it has to have strong mobile staff, well instructed in a limited number of farm activities and with profitable innovations to extend. To sustain smallholder tea production, the extension staff should be well trained, capable of searching, retaining and transferring agronomic recommendations to the intended users adequately.

All new research findings can only be delivered to farmers through an adequately staffed, qualified and motivated extension service that can also provide feedback for further research. Pandey and Anderson (1990) point out that a new technology is generally useful only if farmers adopt it. Poor knowledge transfer between research and extension and/or extension and farmers is a major limiting factor in developing new technology.

The number of the smallholders increased very fast leading to a scenario in which researchers found it impossible to pass on the technological information directly to every smallholder. The weakness was noted and KTDA created its own technology transfer system with the help of the Kenya government (Fig. 5). All the staff were initially employees of the Ministry of Agriculture and Rural Development seconded to KTDA, but from the year 2000 the extension staff became employees of the KTDA factory companies. Initially, there was a build up of extension personnel. However, since 1974/75 the number of extension staff has been declining while the number of farmers continually increased. There have been too many farmers for one extension officer to look after.

The smallholder-extension staff variable influenced tea yields negatively. This is because the area under tea and the total tea production have been increasing, but the number of extension staff has been declining due to the frozen employment in the various government sectors. Again, it was suspected that the extension staff of the smallholder sector were not being used efficiently since they were employees of Ministry of Agriculture seconded to KTDA. Their supervision and/or discipline were therefore initially difficult to maintain as they owed allegiance/loyalty to the ministry rather than KTDA. The recent decision to transfer them to KTDA may alleviate the problem. KTDA has to employ extension staff to make them more accountable to the farmers and that the staff be better trained and well equipped to undertake the extension duties.

Figure 5: Growth of extension staff in smallholder tea sector since 1969/70 up to 1999/2000



Elite varieties and genetic resource use efficiency

Remarkable achievements have been made in the development of improved tea clones and appropriate production technologies. Several clones capable of yielding over 5000 kg made tea per hectare per year under good management have been developed and commercialized. Some of these clones have yielded as much as 11,000 kg made tea per hectare per year under commercial production systems (Oyamo 1992). These yield levels are some of the highest in the world and are in the magnitude of four times the average tea yields in Kenya. The selection of clonal plants for superior yield and black tea quality has contributed immensely to increased production capacity. About 47 clones selected by the TRFK for consistent superiority in black tea quality and yield have been extensively planted by the smallholders and it is claimed that the high quality of black tea produced by Kenyan growers is partly due to these improved clonal germplasm. By 1999, the smallholder tea sector was 80 percent clonal with one clone TRFK 6/8 constituting close to 60 percent of this. However, in keeping with good agricultural practices, the TRFK has been encouraging growers to cultivate diverse and disparate clonal germplasm in order to access greater genetic diversity at the farm level and thus create a buffer against the attendant risks associated with mono-cropping (Wachira, 2002a).

Like in all agribusinesses, tea farming continues to be shaped by the ever changing abiotic factors such as weather and climate and co-evolving biotic (disease and pest) factors. All these factors continue to have a substantial impact on tea production now and in the future. Changes in weather pattern particularly the increasing frequency and intensity of drought incidences pose more challenges to farmers. New diseases and pests or severity of existing ones may continue to increase and are bound to continue posing a threat to sustainable tea production. A case in point is that of *Hypoxylon* wood rot that is now increasingly becoming a major disease of tea particularly in the small-scale sector. These challenges will require integrated approach to mitigate their deleterious effects. More than ever before, farmers will have to harness the rich and invaluable genetic resource at their disposal to not only improve on their productivity but continue to sustain it. It is recognised fact that genetic diversity is an invaluable resource; it is threatened by extensive cultivation of high yielding clones. Tea farmers in Kenya have to conserve genetic variation in their farms both for

posterity and also as a method of mitigating some of aforementioned threats. In this regard, the policy of cultivating mixed clones is encouraged.

Kenya's tea germplasm remains predominantly of the Assam type (*Camellia sinensis* var. *assamica*) and although appreciably diverse, the variability cannot be regarded as sufficiently broad since most of the commercial clones cultivated by the smallholders are genealogically related (Wachira *et al.*. 1995; 1997; 2001). This poses two problems. Firstly, the current assortment of clones are closely related, and this is risky in the event of unprecedented outbreaks of existing or new pests and diseases. Secondly, it imposes certain limitations on future breeding and variety development. The choice of disparate parents is a critical prerequisite for the realization of genetic advance and it is also necessary to avoid inbreeding and narrowing of the genetic base in advanced breeding generations under high selection pressure. Accordingly, appropriate national strategies have been undertaken to broaden and maintain sufficiently large genetic base in Kenyan tea gardens. These have included further introductions of genetic resources based on mutually negotiated germplasm exchange agreements.

Future tea improvement and clonal selection strategies

A more integrated approach with emphasis on quality and consolidation of yield gains already realized and buffering of existing clones against adverse biotic and abiotic factors is envisaged in future. This approach, coupled with site-matching of potential clones through appropriate multi-locational adaptability trials (Wachira *et al.* 2002) and the development and adoption of the agronomic recommendations and appropriate manufacturing technologies should enhance quality, guarantee higher productivity and fetch premium prices for Kenyan tea. Expected breakthrough and accrued benefits will, however, be sustained through the application of the traditional and biotechnological approaches complementarily in tea-breeding programme (Hackett *et al.*. 2000; Wachira 2002b). Tea breeding should also target the development of varieties with high functional components such as specific catechins, flavanols, anthocyanins, theanine, ??carotene, caffeine, theobromine and other chemicals. Tea consumer is becoming more discerning and is demanding tea products that have specific chemical components, taste or flavour. It is possible for Kenya to tap some of these niche markets through development of appropriate varieties which have very specific biochemical profiles like low or totally caffeine free tea. Though it can be achieved through conventional breeding by wide crossing, but it takes time. Biotechnology through the RNAi (RNA interference) technologies can give faster results.

Field practices in small grower holdings. Plant spacing and land preparation

The bush population in smallholder holdings is generally low (Owuor *et al.* 2005; Kavoi *et al.* 2002b). Many smallholdings planted before the year 2000 do not have the 8611 plants per hectare originally recommended. The currently recommended density is 13,448 plants per hectare. Even most of the newly planted fields do not have the recommended density. The smallholder tea fields have many vacancies. It is important that infilling is carried out urgently as vacancies in the field translate to under use of the land resource. In some tea growing districts, the mean number of tea plants recorded from the farmers' records was higher than what it should have been (Owuor *et al.* 2005; Kavoi *et al.* 2002b). This may be due to farmers using closer plant spacing than the 1.52 x 0.91 m recommended by KTDA. Closer planting leads to higher tea production per unit area (Wanyoko and Owuor 1995) and reduces cost of production as tea plants cover the ground

faster, reducing weeding costs and soil erosion. There is need to review the planting density in the smallholder tea sector. The smallholders should be encouraged to plant at higher density.

The fast expansion of the smallholder tea sector was made possible with availability of planting materials. Farmers who planted tea at the initial stages used seedling materials from either the KTDA nurseries or estates. However, raising plants from seeds takes too long: up to three years from seed propagation to field planting (Othieno 1981). The plants from seeds are not improved or pre-selected for any agronomic trait and are highly heterogeneous. It, therefore, became necessary to avail methods to obtain superior plants. This culminated in the development of appropriate and cost effective vegetative propagation methods (Othieno 1981). The methods were simplified for the smallholders to use. Indeed, the fast expansion of smallholder tea sector in Kenya was made possible by the easy availability of the vegetatively propagated plants which take only between nine and eighteen months in the nursery. With vegetative propagation, it became possible to develop plants with desirable characteristics like high yield and quality. The smallholder tea sector in Kenya has consistently been producing high quality tea due to the use of high quality cultivars (Othieno 1981). Most importantly, vegetative propagation near the catchment areas removed the burden of the smallholder transporting heavy plants over long distance (Kavoi *et al.* 2001a). Farmers need to be encouraged to learn nursery techniques to propagate their own planting materials.

For successful establishment, tea planting should be done after the field is well prepared and during the correct season, namely the rainy season, to ensure high rate of survival and fast establishment. Planting pits should be 15 to 20 cm deeper than the length of the sleeves and double the sleeve diameter. For a standard sleeve of 25 cm length and 6.25 cm diameter used in the smallholder sector, the pits should be 40 cm deep and 25 cm in diameter. During planting a fertilizer rich in phosphorous must be used to ensure the young tea plants develop good root system and start growing vigorously. Usually 30 gm of single super phosphate or DAP is mixed with the soil removed from the pit before planting. Many smallholders do not use fertilizer for planting tea as majority of the smallholders planting tea for the first time are not registered with KTDA and do not have fertilizer credit facility. For fast tea establishment, efforts should be made to ensure that fertilizer for use in the planting hole is made available to all farmers, and especially new farmers.

In the establishment phase of tea, there is a period when financial returns may depend on the speed and efficiency with which the young tea plants are brought into bearing. The best method of bringing tea into bearing should therefore result in rapid economic returns of an even stand of healthy bushes attaining their optimum yield potential as soon as possible and sustaining it. The lower part of the branch system of the bush will form a permanent frame that will remain largely unaltered throughout the life of the bush or until the bush is down pruned for rejuvenation. The frame must therefore have a low, strong and spreading branch system. A method of bringing tea into bearing which enables early plucking may first seem satisfactory, but will prove poor in the long run if it restricts root development or encourages dispropornate root-shoot ratio making the plants susceptible to drought. It also results in narrow frame covering the ground slowly and low yields. Operations designed to help the plant form permanent branch system from the time the plants are in the nursery to the time they are tipped-in to form a plucking table are collectively called "bringing into bearing". Young tea can be brought into bearing by pruning or pegging. When bringing into bearing by pruning, the shoots are first pruned at 15 cm. This should

be done when the plants are 30 cm tall. Most farmers start bringing their tea into bearing late. This delays the cropping. However, delayed pruning ensures plants to develop deeper root system enabling them to withstand drought better.

Pruning and infilling period

The plucking table rises at a rate of about 20 cm per year (Mwakha 1997) reaching a height of 120 to 150 cm after three to four years from prune, which is too high for efficient plucking. It then becomes necessary to prune the bushes; this is normally done at 45 cm to 70 cm. Each time the pruning height is increased by five cm above the previous pruning cut. After reaching the 70 cm pruning height, it is again brought down to 45 cm. The common type of pruning in the smallholder sector is to cut across using pruning knives. The prunings are left *in situ* to return nutrients, reduce soil erosion and conserve moisture as the prunings also act as mulch.

Many smallholders prune at the end of three years as recommended, though some prune after four years. Since plucking has been intensified and many farmers now pluck on ten-eleven day rounds, longer pruning cycle is justifiable as frequent plucking reduces rate of table rise. There are farmers who prune when the plucking tables have not reached even 50 cm just because it is three years since last prune. This needs to be avoided.

Most of the time pruning heights are not measured in the smallholder sector. Many farmers never prune themselves, but use hired pruners who are not supervised in most cases. These workers generally prune the tea plants at very low heights, sometimes below the formative pruning height at which the plucking table was established. They do so to ensure that only few branches are to be cut, facilitating fast completion of the task.

Low pruning below the formative prune has several disadvantages: the tea plants take a long time to come to plucking. Such pruning reduces yields (Kaptich 1985) as it reduces area of the plucking table. Low pruned fields take long to cover the ground, thus raising costs of weeding. Low prune causing large wounds make it easier for *Hypoxylon serpens* to infect the tea bushes (Otieno 1997). Many smallholder farms have heavy *Hypoxylon* wood rot making the future survival of tea uncertain. Pluckers have to bend most of the time to harvest such low pruned tea. This tires them much faster reducing their productivity. In the long run, this constant bending while plucking causes backache to the pluckers. Low pruning therefore hurts both the tea plant and the farmers and must be avoided.

Most smallholders use pruning knives to prune as recommended. Some of the smallholders use inappropriate implements such as 'pangas' to prune tea. The use of pangas is claimed to make pruning faster. But pangas usually split tea stems making the wounds even larger/bigger and the plant more predisposed to *Hypoxylon* wood rot. Maintaining a uniform pruning height is difficult to achieve with the use of this implement. Farmers should prune correctly and use appropriate implements. Most farmers leave the prunings in the field, which should be encouraged.

As a result of diseases, pests and other natural calamities, some plants die creating large vacancies. It is possible to infill during the year of prune; some farmers infill every year one or two. It is unlikely that such in-fills survive. Most farmers do not infill their farms. Since no other crop can grow viably in these vacancies, it implies that large areas of prime land are being under-utilised as no crop is grown on them. There should be a continuous infilling programme after every pruning to increase tea production of fields.

Fertilizers and manures

Tea under regular plucking has to get nutrients supplemented in the form of fertiliz-

ers and/or manures to continue to give high yields. In the smallholder sector, the recommended fertilizer (Othieno 1988) has been NPKS 25:5:5:5 although more recently there have been some variations in the formula. The fertilizer is supplied by KTDA on credit. Most farmers use the fertilizers in tea, but there are farmers who do not apply fertilizers. These farmers are either not applying to get fertilizers from KTDA on credit or sell whatever they receive to their neighbours or divert the fertilizers to other farm enterprises.

The fertilizer use per unit area varies, but this follows the same pattern as productivity such that farmers applying correct amounts of fertilizers realise higher production per bush. KTDA must continue to supply fertilizers to farmers and address problems associated with fertilizer use. Distribution of fertilizer to the farmers on time is a problem. Farmers should receive fertilizers on time for application when the rains come. Late application of the fertilizer after the rainy season does not benefit tea production during the season.

Some farmers believe that the amount of fertilizers they obtain on credit is not adequate and purchase additional fertilizer from the market or their neighbours. Many farmers apply higher rates of fertilizer than recommended. Use of higher rates of nitrogen than recommended raises the cost of production without reasonable economic benefits (Owuor and Othieno 1996; Owuor and Wanyoko 1996), reduces black tea quality (Owuor *et al.* 1997; 2000) and causes other soil management problems. Farmers need to be pursuaded to use correct amounts of fertilizers to boost their production. Some smallholders use organic manures, the common type being derived from cattle, goats, pigs manure and maize stalks. There is nothing wrong in the use of the organic manure provided it supplies the necessary nutrients and is used at the correct rates.

Fertilizer use is technically efficient in some districts and some agro-ecological zones (Owuor *et al.* 2002). Extension services on fertilizer use need to be intensified in Lower Highland zone where at present it is not technically efficient. Lower Highland zone is a traditionally tea-growing zone in Kenya. Improving fertilizer use efficiency in this zone would improve green leaf production. It is necessary to develop fertilizer recommendations suitable for particular areas, as present blanket fertilizer recommendation may not be appropriate.

Fertilizer is used efficiently in some districts particularly in the Upper Midland zones (Kavoi *et al.* 2000; Owuor *et al.* 2002). The main reason for efficient fertilizer use in the Upper Midland I zone could be that farmers are within very warm zone where growth and response to fertilizers are higher. The rainfall is relatively lower in the Upper Midland zone than in Lower Highland zone and the temperatures are higher. Farmers, therefore produce more green leaf by the fertilizer input. The relatively low rainfall in the Upper Midland 1 zone is adequate for economic tea growing. Fertilizer experiments should be set on the basis of agro-ecological zones so as to come up with precise recommendations for each zone. Fertilizer use efficiency is lower in the East than the West of the Rift Valley (Owuor *et al.* 2002). Fertilizer use campaigns should be intensified to achieve a uniform efficiency in all tea growing districts.

East of Rift Valley produces more tea per hectare than the west of Rift Valley. The differences can be accounted for by differences in soils, climate, cultural attitudes and different levels of input utilization. For high yielding tea, growers are advised to study yield/fertilizer relationship under the prevailing ecological and cultural practices. Generally, the recommended fertilizer rates in Kenya range between 100 and 250 kg nitrogen per hectare per year depending on yield performance of a field (Othieno 1988). KTDA/TRFK fertilizer demonstration plots at divisional level in all tea growing areas have shown that NPK(S) 25:5:5 (5) or NPK 20:10:10 fertilizer rates of up to 150 kg nitro-

gen per hectare per year are profitable (Othieno *et al.* 1984).

Many farmers are applying the fertilizer below optimal levels for various reasons. First, farmers may be ignorant of the recommended level of fertilizers to maximize profits. Secondly, farmers may not be getting adequate quantity of fertilizer from KTDA. Thirdly, fertilizer supply may not be timely. Fourthly, farmers may be diverting fertilizer meant for tea to other enterprises. Finally, the goals and objectives of some farmers may not necessarily be to maximize profits. These areas need further investigation to establish the causes of inefficient use of fertilizer in tea production. The KTDA should ensure that farmers get the correct amount of fertilizer on time. Similarly, a thorough campaign should be mounted in all smallholder areas to sensitise farmers through on-farm demonstrations and educational seminars on benefits of fertilizer use on tea.

Weeds, pests, diseases and their control

Weeds in tea cause yield reduction as applied fertilizers mostly feed the weeds. It is therefore necessary that tea plantations are kept weed-free. Generally this is done manually by using "jembes" or hoes, or by using herbicides. Regular manual weeding destroys feeder roots of the plants impeding the ability of the plants to absorb nutrients from the soil (Othieno 1981). Although chemical weeding is recommended in tea, most smallholders resort to manual weeding. Educating farmers on benefit of chemical weeding is necessary.

There are several pests that attack tea in Kenya (Owuor *et al.* 2005). However, many tea farmers cannot identify tea pests. If pests invade farms, most farmers leave them to laws of nature for control. Some farmers believe that they can control pests by field management practices, while a few use pesticides. As pests are not widespread pesticides are not recommended in Kenya. If, however, there is a widespread pest out-break, proper control strategy must be put in place. The smallholders must inform TRFK for further advice and action. Indiscriminate use of pesticides leads to pesticide residue problems which render teas unfit for human consumption.

Several diseases attack Kenyan tea (Owuor *et al.* 2005). A majority of the farmers cannot identify diseases of tea. Without a proper knowledge of pests and diseases, farmers cannot control them. Farmers' education on identification and control of pests and diseases is urgently required. The lack of adequate knowledge on pests and diseases attacking tea is probably due to the fact that tea production in Kenya is relatively pest- and disease-free. The situation is however changing and for sustainable tea production, there is a need to train smallholders on identification of pests and diseases and their control.

Government policy on tea cultivation

The question of how efficiently farmers use resources in smallholder tea sector is of considerable interest. It is particularly important for low income countries since endowments of productive resources are frequently low. Nevertheless, there exists an urgent need for these countries to produce as much as possible within those scarce resources. The efficiency of farmer decision making can influence the design of development strategy in a country (Pachico 1980). If farmers are inefficient in the management of resources, then agricultural production can be raised by simply improving on the allocation of resources without having to develop new technologies, which are usually expensive. On the other hand, if new technologies are under utilised due to inefficient decision making, the gains are reduced from these technologies, both to the farmers and society as a whole. Inefficiency in resource use is one key factor reducing yields in the small scale tea sector (Owuor *et al.* 2005; Kavoi *et al.* 2002a; 2003). It is necessary that efficiency in resource use is enhanced for sustained

smallholder tea production.

Tea is a key player in the agro-industrial sector and is currently the leading foreign exchange earner accounting for 26 percent of Kenya's total export-earnings and four percent of GDP. The Kenya Government projects to achieve fast economic growth through rapid rural industrialisation and to reach industrialised state status by the year 2020. The industrial development projection is targeted mainly at the rural areas and can be attained if agricultural industries achieve high and efficient production to create more jobs, improve the living standards of Kenyans and increase export earnings. The smallholder tea sector is projected to play an important role in the realisation of the projection. To help the government of Kenya attain the development objectives and to realize 350 thousand metric tonnes of made tea by the year 2008 (Anon. 2001), the major increase in productivity can only be expected from the smallholder sector in the short run. Expectations are that the smallholder tea sector can attain the high production and productivity through putting emphasis on efficient use of strategic inputs such as high value elite varieties, fertilizers and intensive adoption of other improved production technologies (Anon. 1997).

Problems of factory capacity

The smallholder tea production has risen very fast both in terms of area (Fig. 1) and actual production (Fig. 2). The rise, however, has not been matched by concurrent expansion in black tea processing capacity. Consequently, during peak production period in April-June and October-December, many tea factories cannot cope with the quantity of leaf available. This is despite developing processing technique to cope with high leaf production (Owuor and Obanda 1997). Smallholders, therefore, suffer considerable wastage of leaf, high investment in production costs not withstanding. A mechanism should be put in place such that the extra leaf does not go wasted. One such mechanism is to have proper planning, so that green leaf production is matched with processing capacity.

When there is high production there are a lot of problems in factories due to congestion. Usually, withering troughs are overloaded; consequently, physical wither is not achieved. There is normally excessive use of heat reducing quality further (Obanda *et al.* 1997; Owuor and Obanda 1996) while raising costs of production. Also, high leaf production leads to delay in leaf delivery to factories, lowering quality (Owuor *et al.* 1990). During peak production periods, there is usually massive leaf mishandling and over-handling resulting in lower quality of black tea and poor prices. Lack/poor planning or uncoordinated factory expansion programmes cause heavy losses to the smallholders. For sustainable tea production there must be a policy of expanding leaf processing capacity.

Soil conservation

Most smallholder tea is planted in fields with more than 25 degree slopes. Such fields are prone to soil erosion if not properly managed. High vacancies in the smallholder tea fields lead to loss of top fertile soils. There is need for new planting in the smallholder tea sector to use contour planting techniques while planting on slopes. The land needs to be prepared in contour to reduce soil erosion. Also before the tea plants cover the ground, oats should be broadcast as soon as land preparation is complete. Napier grass should be planted every ten rows to further reduce soil erosion.

Tea growing policies

At present, there is no regulation of tea growing. Consequently, there are some smallholder plantations which factories will come to know about only when the owners start deliveries to factories. There is need for government regulation on tea expansion. This will ensure

that all green leaf produced is converted to some useful product and will reduce losses to farmers when the factories are congested. Regulations on tea growing shall ensure that country produces adequate quantity of leaf that does not cause over supply to factories leading to low and uneconomical tea prices. Also, such policies will help restricting smallholders to grow tea only in areas where tea will grow economically. But even within the suitable areas, control will help KTDA to correctly plan tea-processing capacity. Despite past controls, the processing capacities in most areas have remained behind leaf production for a long time (Owuor and Obanda 1997). However, if tea expansion is uncontrolled, there will be too much leaf for inadequate factory capacity or *vice versa*.

The robust population growth in tea areas coupled with escalating unemployment in the country translates into continued sub-division of tea farms to school-leavers who cannot get alternative employment outside agricultural sector. This scenario is an overt potential threat to the future of the smallholder tea production in Kenya and is a great concern to farmers, researchers and policy makers in the tea industry. In the past few years, incessant sub-division of tea farms has degenerated into what is termed as "uneconomic farm unit". Tea farmers sub-divide tea to their children in terms of the number of bushes and at times by tea farm acreage. This problem is so severe that sub-division to a tea farm of 500 bushes or below is not uncommon. For sustainable tea production, sub division of farms into uneconomic units should be discouraged.

Increasingly, it is being recognized that tea is a viable buffer crop for the management of forest borders as attested by the successful Nyayo Tea Zones Development Corporation and smallholder tea farms bordering forest zones. In areas where tea is cultivated it has positively contributed to environmental conservation. Tea forms a continuously transpiring canopy like the forest cover though its capacity for carbon sequestration has not yet been determined. It is nevertheless expected to be high because a large proportion of the dry weight of the harvested leaf is carbon and the crop is known to be an efficient sink which mops up carbon from the atmosphere. With its huge hectarage of tea plantations, Kenya should be able to accumulate substantial carbon credits and thereby get monetary compensation from the industrialized north as stipulated in the Kyoto Protocol. There is however need to carry out research on carbon sequestration in tea.

Leaf collection and commercial manufacture Plucking and leaf collection

Economic part of tea bush is the tender shoots which are harvested to process various tea beverages. Efficiency of harvesting the shoots can dictate whether a tea enterprise is profitable or not. If plucking is done at very long intervals, yields (Odhiambo 1988; Owuor *et al.* 1997) and quality (Owuor *et al.* 1997; 2000) decline. Plucking rounds in Kenya vary from seven to ten days during favourable growing seasons and twelve to fifteen days during dry or cold seasons. Most smallholders are plucking on ten or eleven day plucking rounds throughout the year. There are some smallholders who pluck at very long rounds, while there are others who pluck at very short intervals. Smallholders need to pluck at optimal rounds.

For plucking to be efficient, it is necessary that the plucking table is kept flat and uniform. When the table is not uniform, plucking pace becomes slow as plucking becomes more difficult. Farmers find it difficult to keep set plucking standard and a lot of leaf that is ready for harvesting is left on the bush. Again it leads to farmers harvesting immature leaf. Pluckers should use plucking wands (long sticks) to ensure that the table is maintained. Most smallholders believe that use of a plucking wand slows down their speed and thereby plucker productivity. It is important to make the farm-

ers appreciate the benefits of using plucking wands.

Most of the smallholders start plucking between seven and eight a.m, and a few start plucking at six a.m. In some districts plucking in most farms ends by one p.m. This duration is too short for all leaf to be removed from the fields. Where farmers pluck for longer periods, the productivity per bush is higher than where plucking time is short. For farmers to have adequate time to harvest all the available leaf it is necessary that plucking is started early in the morning. Most farmers do not have adequate plucking time because the leaf collection lorry comes once a day and too early. Tea production is generally higher where leaf collection is done many times in a day.

The earliest most farmers deliver their leaf to buying centres is between ten a.m and noon. A large number of farmers deliver their leaf at any time of the day: there is no timing since the lorry comes only once a day at irregular times and farmers rush to buying centres whenever it arrives. Early delivery of leaf to buying centres where it is collected at least twice a day is beneficial as it helps factory personnel to handle and process leaf more efficiently; but most farmers can not deliver their leaf early as they need adequate time to pluck. Supervision of errant leaf clerks and streamlining the buying centres is urgently needed.

Arrangement of leaf buying centre committee setting a reasonable time of last leaf delivery brings order in the operation and should be encouraged. Short plucking time and early time for leaf delivery at buying centres are factors that reduce leaf productivity and production. Farmers need to be educated to start plucking early to give themselves extra harvesting time, while at the same time attempts should be made to ensure leaf is collected at least twice a day and that leaf clerks spend longer durations at the buying centres.

Sometimes farmers spend too long duration at the buying centres as the leaf clerk avoids buying too much leaf. A mechanism should be developed so that farmers avoid spending too much time at the buying centres as this denies them a chance to do other farm and personal duties. In most cases the poor leaf collection programme is due to the poor state of the roads. In the areas where the state of the roads is poor leaf collection programme is also poor. It is not possible to correct leaf collection problems without improving the state of the roads. Farmers now pay cess to improve and maintain the roads. Smallholder tea roads should therefore be maintained in good condition.

Commercial manufacture of black tea and its quality

Tea quality is a result of many variables including intrinsic high quality traits within the clone(s), the effect of growing conditions at different localities, agronomic practices and manufacturing technologies. Valuable information has been acquired from the past studies, but a need exists for adaptive research factory at commercial scale. The TRFK does not yet have such a facility but in conjunction with private tea concerns, it has up-scaled its technologies in commercial factories. This needs to be continued to generate improved and appropriate technologies applicable at a commercial scale.

Good image of tea as a beverage and increased tea consumption can only be achieved through production of good quality tea (Ellis and Cloughley 1981). Tea producers desiring to stay competitive in the market must improve their the quality of their produce. Most tea producing countries have been involved in production of technologies leading to making good quality tea. In Kenya, much research has gone into understanding how the process parameters and cultural practices affect black tea quality (Owuor 1996). For sustainable tea production in the smallholder tea sector of the Kenya, it is necessary that they apply and adopt improved

manufacturing technologies. Consumer demands continue to change with time, necessitating the intensification of research on the quality demands of the consumers. The smallholders of Kenya must strive to produce superior black teas to stay in the market.

Economics of small grower tea production

Tea prices vary in different districts depending upon prices realised at international markets. Areas that produce better quality black teas receive better prices (Owuor and Othieno 1996). Quality is an important determinant of the prices. Quality is affected by many factors and it is important that efforts are made to improve agronomic and processing techniques to ensure production of high quality teas.

Adequate and timely payment to the farmers is the key to the success of any agricultural enterprise. The farmers felt that the payment of Kshs 7.50 per kg green leaf in 1999/2000 as minimum guaranteed payment on monthly basis followed by a second payment ("bonus") after the tea has been sold to give a full value at the end of financial year was not adequate. Some farmers felt that the first (monthly) payment was too low to run their tea business. A monthly payment of Kshs 11 to 12 per kg green leaf was necessary. The rate of payment to farmers needs to be objectively worked out to enable the farmers to produce quality tea (Kavoi *et al.* 2000). Subsequently, the first payment has been adjusted to Kshs 9 and Kshs 10.50 in 2004 and 2006, respectively. The farmers need the second payment at the end of the financial year to help save money. Consequently the farmers want a payment mode with higher first (monthly) payment followed by second (bonus) payment at six-month interval.

Smallholder tea under the current system is economically viable as the tea enterprise is able to cover all the variable costs and has a positive return for depreciation, management and risk. The gross margin per hectare, per man-day and per bush can be assessed by comparison with that from other countries or competing enterprises. For instance, small-scale dairy keeping is one of the main competing enterprises in tea growing zones. The gross margin per man-day of an average dairy farm in Kiambu District in east of the Rift valley region is Kshs. 68.20 (Kilungo 1998). The average margin per man-day in tea in the east of the Rift valley is Kshs. 210.11. Hence, tea earns more return per man-day than the dairy enterprise. On the basis of this comparison, a decision can be made on how much labour to allocate to tea and dairy so as to maximize profits.

The break-even price of tea leaf for all farms in 1998/99 was approximately Kshs. 7.50. There was a significant gap between the computed break-even price and the monthly payment made for green leaf. The monthly payment of Kshs 6.00 per kg green leaf made in 1998/99 did not meet the recurrent costs of tea production. This price was adjusted to Kshs 7.50 per kg green leaf in the year 1999/2000 and thereafter but the adjustment was accompanied by rise in production costs. Thus this level of payment was still lower than break-even price. Frequent farm surveys should be done to determine tea production costs and returns. The break-even price computed from the surveys and subsequent tea enterprise analysis will enable policy makers in the industry to make price decisions based on facts. The subsequent first green leaf payment of Kshs 9 and Kshs 10.50 in 2004 and 2006, respectively, have been helpful. Adequate payment to the farmers will assist optimising inputs which in turn will improve yields.

The year-end "bonus" price of tea which lagged five years has a significant effect on tea production. If the "bonus" increases, tea production would increase five years later. Thus, even if farmers respond by planting new areas it takes up to three years for the plants to come to production, the response by way of green leaf supply is felt significantly in the fifth year.

This is longer than expected, possibly due to the new smallholder tea farmers being unable to get inputs, especially fertilizers on credit from KTDA until they are registered and start full scale tea production. Establishment of young tea is expensive in terms of land development, purchase or propagation of planting materials, planting, weeding, bringing into bearing and fertilizer application. Consequently, most new smallholders cannot afford regular weeding, bringing into bearing of the tea and fertilizer application to young tea. KTDA or the Government needs to work out a financing scheme for new tea farmers who have not started delivering leaf to factories. The level of knowledge of technologies used in planting and establishment of young tea plants among the new smallholders is also low. A mechanism of training new tea farmers in necessary.

The quantity of green leaf supplied is highly responsive to tea price fluctuations both in the short and long run. Monthly payment is determined by KTDA. It is usually a sustainable proportion of price realisation based on the previous year's international price. It is possible to manipulate this variable depending on the international tea price trends in order to increase tea leaf output by smallholders. Policy makers in the smallholder sector should continuously consider the international tea price trends and fine tune the monthly green leaf payment in order to increase green leaf output in the sector. As monthly green leaf payment increases by one per cent the management of plucking, fertilizer application and others improves and the green leaf supply increases by 32.877 per cent in the following year. If the "bonus" increases by one per cent, more new farmers enter into tea production and those already in production expand the scale of operations and the supply of green leaf increases by 6.691 per cent five years later *Ceteris Paribus*. If the "bonus" decreases, new farmers have no incentive to plant tea and those already in production cannot expand their operations in the long run. The farmers respond to decreases in tea prices by neglecting the tea fields. It is noted that response of green leaf supply to better monthly payment is higher than response to second payment; more of green leaf payment should be made on monthly basis. This would have a higher impact on green leaf supply than year-end payment of bonuses.

The smallholders in Kenya are quite price efficient and hence economically rational in tea production (Kavoi *et al.* 2001b). Low tea output could be attributed to factors like lack of diffusion of adequate production technologies, inadequate extension, low monthly green leaf payment and inefficient use of fertilizers. Methods of overcoming these short falls need to be determined and implemented.

The number of bushes per hectare, fertilizer cost and labour wage positively and significantly influence tea farm profits. It means that there is room for farmers to optimise the use of the various inputs. The farms in the East of the Rift Valley are more profitable as they are more efficient in optimising inputs; the farms in the West of the Rift Valley are not as efficient. The farmers in the West of the Rift Valley need to improve on resource use efficiency in order to improve on their tea production.

Opportunities and challenges before small holding tea growers in Kenya

Production costs

World tea prices have continued to decline or stagnate over the years (Fig. 4), but the unit cost of production has continued to rise. The situation has worsened because of the ever increasing inflation in most tea producing countries. Thus the net returns to tea farmers continue to decline. Smallholders must seriously seek cheaper ways of production. In Kenya, the high cost factors are labour, energy and farm inputs.

Labour costs

Labour costs constitute a large component

in the smallholder production in Kenyan tea industry. In addition to harvesting by the family labour usually not costed, a growing number of farmers now use hired labour. Labour is thus becoming a significant expenditure of the smallholders. However, even for the smallholders using family labour, it is recognized that working on tea plantation has an opportunity cost. One area that the smallholder tea sector of the Kenya tea industry must address is management of labour costs.

It is not easy to estimate the field labour costs in the smallholder tea sector, but the labour costs incurred in the factories are easier to quantify accurately. During the monthly green leaf payment, it is necessary to workout rates that can facilitate the smallholders to remove all crop on the bush. If the farmers are unable to remove all ready shoots, there is overgrowth which translates into losses. Farmers need adequate monthly payment to organise harvesting of entire crop.

Energy costs

Energy costs constitute a large portion of the production expenditure in the tea factories. In Kenya, the estates factories use wood fuel as energy source while smallholder factories use furnace oil as fuel. The energy costs in the factories vary from about 15 percent total costs in the factories using wood fuel to about 35 to 40 percent for the factories using furnace oil. The cost is likely to increase as the furnace oil prices keep on increasing. As a result, some of the smallholder tea factories are converting to use wood particularly in areas close to natural forests. However, the Kenya government has outlawed the cutting of forest wood. Consequently, the factories are no longer able to obtain this resource. Despite this, the conversion of smallholder factories to use wood has extended even to factories further away from forests. These factories source their fire wood from the smallholders or any farmer able to supply the item from the neighbourhood. At present fire wood supplied is of variable calorific value and also the source is running out as it was not planned for. The future of the use of fire wood as a source of energy in the smallholder tea sector lies in proper planning.

Eucalyptus is most commonly used fire wood due to its fast growth and high calorific value. The smallholder should be encouraged to adopt an agro-forestry approach to tea farming to enable tea factories to attain self sufficiency in fire wood. This would earn the tea farmers additional income through direct payment and as a result of the reduced cost of production of tea.

Kenya is endowed with other possible, sustainable and environmentally friendly energy sources, such as sun shine and wind. Smallholder tea factories need to explore these alternate sources of energy.

Tea marketing, market research and product diversification

Tea is a health drink and there is need to spread this message which could form a plank to persuade more people to drink it within and outside the country. Increase in per capita tea consumption resulting from such promotions ultimately will benefit the Kenyan farmer through increased sales. Exploration of new markets for Kenyan tea is a challenge, which needs to be aggressively addressed, while maintaining the traditional markets.

Kenya produced only black tea in the past. Orthodox black tea was produced upto the early 1970s; with the advent of the tea bags, the country switched over to CTC black tea. Many black tea producers in the world have also switched over from orthodox to CTC black tea. Consequently, the market for CTC black teas seems to be saturated. The demand for orthodox black tea declined with the introduction of tea bags; still, there are markets which have traditionally consumed orthodox black tea, which has increasing demand.

Kenya black teas are believed to be plain

and that such teas sell better if they are processed by unorthodox methods. A comparison of aroma profiles of Kenya black CTC tea with black teas produced in different areas of the world showed that there are parts in Kenya, particularly in the smallholder tea areas that produce aromatic black teas comparable to those that are famous for flavoury black teas (Horita and Owuor 1987; Owuor *et al.* 1986a). The clonal teas are chiefly planted in the smallholder tea sector in Kenya and produce very flavoury black CTC teas (Owuor *et al.* 1988). The favourable aroma noted in the CTC black tea in Kenya can be enhanced by orthodox processing. It is necessary to diversify production of black tea in the smallholder sector to orthodox black teas.

There are other advantages associated with orthodox black teas. Several studies have shown the beneficial health aspects of flavanols (catechins) in tea. Generally, in orthodox black tea processing, there is less oxidation of the flavanols compared to CTC processing. Orthodox black teas, therefore, have a higher potential to confer beneficial health effects compared to CTC black teas. Thus, in the health conscious environment, orthodox teas have a higher potential to fetch better prices than CTC black teas.

About 95 percent of Kenya's tea is sold in very competitive world markets, with little and uncoordinated market advisory support on international trends. Most of the market research is restricted to individual companies in the large estate sector of the industry which are not supplying the information to the entire industry. There is need for establishment of coordinated market research for the Kenyan tea industry to constantly keep abreast of the changing world tea market trends.

The traditional markets to which smallholders sell their black teas continue to be saturated. There is need to process some of the leaf to produce different products. The smallholder tea sector in Kenya can be better sustained if some of the leaf being produced is channelled to making green tea, instant black tea, instant green tea and decaffeinated tea.

Owing to the documented health benefits of catechins, one area that has not been extensively exploited in tea production is the use of these products in health promotional activities. The smallholder tea sector can set up catechin extraction plants and market the products for their known health benefits. Indeed Kenyan tea growing areas are endowed with suitable conditions for producing very high amounts of catechins compared to areas further away from the equator (Owuor *et al.* 1986b).

Kenya continues to sell most of her tea in bulk; Kenyan teas are normally used to blend quality upwards for those low quality teas produced in some parts of the world. One way of ensuring smallholders improve in their earning from tea is to do value addition. This can be done by packaging tea into small packets that can reach the house-wives. The smallholder tea sector in Kenya can benefit enormously by value addition and exporting Kenya tea as a processed product. This would also create more employment to the rural Kenyans. In addition, this will make "pure" Kenya black teas to be available to consumers world over.

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Bringing together the latest research from leading experts, this book provides an indispensable reference on the health benefits of drinking tea. It examines the general health giving properties of tea before moving on to a detailed review of the evidence for the beneficial effects of tea on specific ailments including cancer, the common cold, renal disease, cardiovascular diseases, viral afflictions like Influenza and SARS, arthritis, lung and pulmonary ailments, aging, oral health, and dementia. The book concludes by challenging misconceptions of the effects of tea. For more information please visit ISTS website < WWW.teascience.org> under Publications — Books.

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