Farmer-Trainer Extension Approach in Agroforestry: An Application of Cost Benefit Analysis in Selected Project Sites in Kenya

By

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DECLARATION

This thesis is my original work and has not been presented for award of a degree in any other university.

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This work has been submitted with our approval as supervisors

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ABSTRACT

Agroforestry can improve productivity in many ways. This includes increased output of tree products, improved yields of associated crops, reduction of cropping systems input and increased labour efficiency. Though ready access to appropriate technology can better the lives of the resource poor farmer, the adoption rates of recommended technologies has not been as high as would be expected. The challenge therefore has been to look for extension alternatives that embrace a defined methodology for participatory learning, and mobilize local creativity, energy, knowledge and experience in the search for context-specific solutions, which capitalize on diversity.

The Farmer-trainer extension approach is based on group training of identified farmers who have the scope and skills to become trainers of other farmers on agroforestry techniques. Their existing skills are improved through on-the-job farmer and extension staff joint training workshops. The farmer-trainers are then encouraged to train their neighbour farmers the skills acquired and hence make them farmer-followers through adopting recommended technologies and also taking up training of other farmers. It is envisaged that this would create a multiplier effect improving and expanding the practice of agroforestry innovations thereby improving the adoption rates.

The overall objective of this study is to establish the viability of the Farmer-trainer extension approach in terms of influencing adoption of agroforestry innovations, and more specifically the adoption of high value trees and the impact, if any this has had on the farmers. This would be achieved through determination of the usage of the taught agroforestry innovation; the economic returns of the innovation and a comparison with other on-farm enterprises; an assessment of the cost of training one farmer to the level of being a farmer-trainer; determination of factors affecting the performance of farmer-trainers; the average conversion of farmer-followers by farmer-trainers; farmers assessment of the approach; calculation of the cost benefit ratio and Net Present Value of the farmer-trainer approach; and exploration of the policy implication of the study.

A multistage purposive sampling procedure with stratified random selection was used to select farmers for the survey in the study areas. In the study, primary and secondary data were collected where primary data consisted mainly of Participatory Rural Appraisal (PRA), group discussions and interviews, observations and empirical field measurements. Four sites were selected for the study and these were Embu, Kisumu, Migori and Keiyo districts.

The results thus attained show that the Farmer-trainer extension approach is a viable concept of dissemination and results are generated within a short time. The study shows Embu district has the highest establishment of improved mangoes. This was the crop used for economic evaluation given that it was adopted in all the study sites. In the economic evaluation the study showed a positive return to investment of nine years given a discount rate of 18%. The study also illustrates factors that influence the performance of the farmers in the approach, whereby availability of a tree nursery, location of the study sites, gender, and farm size, were found to be of great significance to the performance of the farmer-trainer. In comparison to other farm enterprises, the study shows an increasing role of tree crops within the farming system. The study also explores policy implications of the farmer-trainer approach especially in research, extension, marketing and credit provision.

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Acronyms

CBA: Cost Benefit Analysis
CBO: Community Based Organizations
CVM: Contingent Valuation Method
FAO: Food and Agriculture Organization
FTE: Farmer Trainer Extension
GTZ: Gesellschaft Fuer Technische Zusammenarbeit (German Technical Cooperation)
ICRAF: International Centre for Research in Agroforestry
IRR: Internal Rate of Return
ITFSP: Integration of Tree crops Into Farming Systems Project
NGO: Non-Governmental Organization
NPV: Net Present Value
PRA: Participatory Rural Appraisal
SPSS: Statistical Package for Social Sciences
T& V: Training and Visit System
UNEP: United Nations Environment Programme
WTA: Willingness To Accept
WTP: Willingness To Pay

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CHAPTER ONE

INTRODUCTION

1.1 Background to the problem

Ever since the dawn of agricultural extension in the mid-18th century, when the British colonial power, through the agency of the governor, systematically promoted potato farming to combat famine in Ireland (Baver et al., 1998), various extension systems have been practiced all over the world, with varying levels of success and failure. There is scarcely a country in the world today that does not have at least its own formal agricultural extension service. Most of these systems were based on the top-down conception, but experience gained in behavioural sciences such as sociology and psychology, eventually led to the development of situation functional approach, that is still valid today for the adoption of new practices. The approach relies on individual's behaviour, understood to be the result of the individual's analysis of a subjectively perceived situation (Albrecht, 1991). Farmers have subjective preferences for technology characteristics (Ashby and Sperling, 1992; Ashby et al., 1989). Adoption or rejection of technologies by farmers may reflect rational decision-making based upon farmers perceptions of the appropriateness, or inappropriateness, of the characteristics of the technologies under investigation (Akiniwumi and Zinnah, 1993). This implies that extension measures proposed must match that specific situation if they are to be successful.

The training and visit system of extension (T&V) was developed by Benor (Benor and Harrison, 1977) who linked it to the "Green Revolution" in India. The Green Revolution brought significant increases in yields to parts of Asia through the introduction of high yielding varieties (HYV) of wheat and rice for irrigated farming. These successes rested on innovations from which all farmers benefited, uniform growing conditions, strict management of extension services and the availability of the requisite inputs. In Taiwan, various extension approaches have been used to promote the adoption of agriculture and home improvement practices. However individual contacts of farmer associations, contacts with neighbours and extension clubs were identified in a study as the most important channels or effective methods through which adult farmers obtain information for adoption of improved practices (Bruce and Shankariah, 1981).

In his foreword to the first edition of the account of the T&V system, Robert McNamara, the then president of the World Bank commented, "The costs of the systems were relatively low, results were within sight, and the farmers were acquiring confidence and satisfaction in their work… The system also contributes towards other investments in agriculture realizing their potential (Benor and Harrison, 1977).

The optimism that mirrored the inception of the T&V system did not persist for long, more so when the system was adopted in various countries of sub-Saharan Africa. The transfer of the T&V system to the rain fed farming areas, where fundamentally different production systems predominate and local conditions vary extremely widely, resulted in major complications and failures. The controversy regarding T&V within the extension community, as stated by a World Bank report, is largely because of perceived rigidity of the extension structure and a focus on procedure rather than on increasing the relevance of technological messages to farmers (World Bank, 1989:9).

The Kenyan situation in regard to the T&V system has been such that extension officers dealt mainly with major food crops, cash crops, and also areas such as fertilizer application and crop protection through use of chemicals. The system's rigidity did not leave room for adjusting to other emerging challenges and neither did it allow room for some specific areas of production such as the tree crop sub-sector and agroforestry in general. A subsectoral study conducted by GTZ on the state of the art of high value trees in Kenya (GTZ/ITFSP, 1995) revealed that there was an acute shortage of improved germplasm of high value fruits, nuts, and timber trees for both subsistence production and income generation at the farm level in all districts in the country. The study further revealed that there was insufficient information on tree species and suitable varieties available to farmers and extension staff. Both groups were found to have insufficient knowledge and skills in tree propagation, and management. The main challenge therefore in the development of tree crop sub-sector support structure was to develop and organize cost effective, sustainable extension approaches for practical skill development of tree propagation, management as well as for processing and marketing tree products. Organization of a decentralized and demand driven germplasm production and distribution system was essential as well as achieving improved cooperation and networking at different levels among farmers and extension staff, for the new approach.

Hayward (1989) lays out four main principles for improving extension systems: situation specificity; economic sustainability; systems flexibility; and participation. The development of the dissemination approach that involved collaboration between GTZ/ITFSP, the Ministry of Agriculture and Rural Development, and the Forestry Department, together with extension staff of various NGOS adopted the principles advocated by Hayward (1989) and this developed into the Farmer-train-Farmer extension approach. This has been in existence formally in six districts of Nyanza province, and three districts of Eastern province for the last five years. The approach has also been tried in other countries of Africa such as Tanzania, and Malawi.

The Farmer- train-Farmer extension approach is based on group training of identified farmers who have the scope and skills to become trainers of other farmers on agroforestry techniques. Their existing skills are improved through on-the-job farmer and extension staff joint workshops. The extension agents at divisional and district levels provide the farmers with the necessary facilitation. The farmer-trainers are then encouraged to train their neighbour farmers the skills acquired and hence make them farmer-followers. It is envisaged that this would create a multiplier effect improving and expanding the practice of agroforestry innovations thereby improving the adoption rates.

1.2 Problem statement

The study sites are characterized by limited agricultural enterprise choices due to various factors such as small farm sizes, the agro-ecological zoning of larger portions of the area falling under zones 3, 4, and 5, and farmers who are mainly small scale with limited access to capital and therefore invest very little in terms of inputs. The farmers' limited farm management skills especially in improved farming methods, maintains the farming at subsistence level and this subjects them to various risks that include: unpredictable weather patterns since they can not invest in irrigation due to the costs involved; soil erosion and reduced biodiversity due to overexploitation of particular flora, without regeneration and which perpetuates a vicious cycle of shortages, for example, over dependence on particular trees for fuelwood resulting in disappearance of the tree species within the areas and the resultant land degradation as a result of loss of soil cover. All these factors point to the need for better farming technologies that take into account the area specific situations and the prevalent indigenous farming systems. The expectation therefore is that the target farmers would mostly adapt and adopt technology that gears towards solving these situation specific problems. Agroforestry has been envisaged for these farmers.

Agroforestry has been perceived as viable cost effective and sustainable systems that have the potential in terms of productivity, sustainability and adaptability (Nair, 1993). Agroforestry approaches can improve productivity in many ways, which include increased output of tree products, improved yields of associated crops, reduction of cropping systems inputs and increased labour efficiency. In terms of sustainability, agroforestry can achieve and indefinitely maintain conservation and fertility goals through conservation of the production potential due to the beneficial effects of woody perennials on soils.

Despite the fact that ready access to appropriate technology can improve the lives of the resource poor farmers, through better and more sustainable production of goods to meet their basic needs especially with the current demands for increased food production as a result of increasing population pressures, the adoption rates of these technologies have not been as high as would be expected. The challenge therefore has been to look at extension alternatives that embrace a defined methodology for participatory learning that mobilizes local creativity, knowledge and experience in the search for context-specific solutions. This is on the premise that farmers are the ultimate experts in capturing opportunities and sustaining resources (Roling and Groot, 1998). The question is, does the farmer-trainer training extension approach meet this challenge?

1.3 Research Questions

The following questions were used in acquiring the data to address the stated objectives:

1. What are the factors associated with adoption of agroforestry technologies, and to what extent has the Farmer trainer training extension approach succeeded in influencing the farmer's attitude towards agroforestry practices.

2. What are the attributes of an effective farmer trainer, and what are the costs involved in training a farmer to be a farmer- trainer.

3. What are the overall benefits to the farm household that engages in agroforestry practices and what proportion do tree crops contribute to household income in comparison to other farm enterprises?

1.4 Objectives

1.4.1 Overall Objective

The overall objective of this study is to establish the viability of the farmer-trainer extension approach in terms of influencing adoption of agroforestry innovations, more specifically the adoption of high value trees. This is achieved through conducting a Cost Benefit Analysis of the approach and assessing it's impact.

1.4.2 Specific objectives

Based on the general objective, the specific objectives of the stare:

1. To determine the usage of the taught agroforestry innovations and hence the average conversion of farmers to farmer-followers.
2. To determine the economic returns of the agroforestry innovations in comparison with other on-farm enterprises, and evaluate the Benefit Cost ratio of the farmer trainer training approach.
3. To deduce the policy implications of the study with reference to extension and agricultural policy.

1.5 Research hypotheses

1. Tree crops have the capacity to play a significant role in income contribution to a farming system.
2. The farmer-trainer training approach contributes to better understanding of agroforestry innovations and consequently more widespread adoption by the small-scale farmers.
3. The earlier the break-even point is reached in the cost benefit analysis of the farmer trainer training approach, the higher the adoption rates by the small scale farmers.

1.6 Significance of the study

The study recognized the fact that there is no generally accepted approach to disseminating technologies in various disciplines. In light of this, it evaluates the farmer-trainer extension approach as a recommendation for improving the adoption rate of agroforestry technologies. This evaluation is done, through an analysis of on-farm activities and perceived changes in the farmers' living standards as a result of adoption of the technologies disseminated. It also reflects on farmers' assessment of agroforestry technology dissemination approaches, with the view to developing a more relevant extension approach for the study areas.

1.7 Scope of the study

The study entails an economic and financial analysis of rural households in the project areas and also outside the project areas for comparative purposes. The economic analysis involves the assessment of the returns at farm level of the various farm enterprises in practice.

An assessment of the adoption levels of various agroforestry practices is undertaken and treated as an indicator of perceived benefits of the agroforestry practices from the farmer's point of view.

The study mainly involves an ex-ante analysis with the assumption that results accrued and suggestions given could apply to the other areas of the two provinces that had not been covered by the study.

The determination of interest rates in the study was a constraint due to the prevailing elasticity's in interest rates over the study period. As such the financial analysis carried out involved a sensitivity analysis of the various scenarios possible given different interest rates. The study's aim is to generate reliable ex-post data on which to base ex-ante analysis.

The method of study requires the use of participatory research methods, which was time consuming. The other limitation was the fact that some non-market costs and benefits were difficult or costly to quantify and thus has not included in the Internal Rate of Return (IRR) or Net Present Value (NPV) calculations.

1.8 Justification of the study

Despite large investments, often through foreign funds, agricultural productivity has not kept pace with demographic growth and future food production is endangered. Public agricultural extension services are criticized for not matching the task and for being too expensive at a time of increasing austerity (Kidd et al., 1998). The remedy therefore lies in a kind of knowledge system approach which should be based on the principle that the potential for future growth, especially in agriculture is in making better use of the local knowledge chiefly by exploiting synergies with more effective coordination and communication between groups involved via networks and dialogue.The exchanges of knowledge will also apply within the target groups, as "most farmers get most of their information from other farmers"(Jiggins et al 1997)

Therefore an assessment of the farmer-train-Farmer extension approach is with a view of improving the system, promoting it and recommending its institutionalization and integration into the extension policies as a viable and effective system for dissemination of agroforestry innovations for wider application at national level and in the African continent as a whole.

The area of the study was chosen so as to reflect various social, cultural and economic activities of the inhabitants and in so doing be able to reflect various circumstances that would be if necessary replicated in other areas of similar characteristics in future. These areas are characterized by limited enterprise choice whereby, Kisumu and Migori districts engage mainly in fishing and sugarcane production as the main income contributor to the household, Keiyo farmers are mainly livestock rearing, while in Embu district coffee, tea and tobacco are the main source of income to farmers depending on their agro ecological zones. This has made the farmers in these areas vulnerable to factors that may affect their overall income, be it low productivity as a result of climate change or market fluctuations. The farming situation in the study areas called for alternative enterprises to boost income at the household level since the aforementioned enterprises were facing various constraints leading to poor pricing of the produce. Tree crops were considered an added income prospect that clearly suited the climatic conditions for these areas. To achieve the adoption of the desired technologies effective extension service is required and hence the testing and implementation of the FTE given the acknowledged limitations of the dissemination approach in place.

1.9 Definition of operational terms

The following terms may be used for non-market valuation of benefits and costs involved with dissemination of technologies through the farmer-trainer extension approach.

Hedonic pricing method: This is a method of non-market valuation which assumes that the value of goods / services is determined by the advantages and disadvantages the characteristics of that goods /services give to the user. Differences in value are the result of differences in characteristics. It is assumed that the price of a property is determined by the number of property -describing variables, the number of neighbourhood variables, the number of accessible/countable variables and environmental variables (Pearce and Markandya, 1988)

Contingent valuation method (CVM): There are two variants of CVM: the first one measures what people are willing to pay (WTP) for various quantities/qualities of environmental good and services; the second one measures the willingness to accept (WTA) i.e. to what extent are people willing to accept a decline in the quantity/quality of **an environmental good /service.**

Option value: This is the value attached to the resource by potential users, who are not sure whether they will use the resource in the future. The value can be considered as an insurance premium in view of the uncertainty of supply.

Quasi-option value: Here the demand is uncertain: potential users are willing to attach a value to a resource in order to preserve the option of use. The decision on use is delayed until more information is available.

Bequest value: An individual may want future generations to use the environmental good/service, hence he/she may attach a specific value based on this fact.

Externalities: This is also termed ('spill-over,' 'third-party' or 'external') effects. It refers to any impacts favourable or unfavourable which one activity may impose on other people and activities elsewhere in the economy without the appropriate payment for it within the normal markets operation (Wesonga, 1989). Externalities normally arise when individual(s) in the course of rendering or consuming some service for which payment is received (made), coincidentally also renders service or disservice to other persons for which payment cannot be exacted from the benefited parties or compensation enforced on behalf of the injured parties.

CHAPTER TWO

REVIEW OF THE LITERATURE

Agroforestry: Research and Extension

Agroforestry is concerned with the collective land-use system in which woody perennials (trees, shrubs, etc.) are grown in association with herbaceous plants (crops, pastures) or livestock, in spatial arrangement, rotation, or both. There are usually both ecological and economic interactions between the trees and other components of the system (Lundgren, 1982). The institutionalization of this approach came as a response to global concern over diminishing forest resources on which most of the local people depend for their livelihood. As Ford Foundation (1998) observes, *"The plight of tropical forests has caused intense international concern during the past two decades. Attention has focused chiefly on resource degradation, declining biodiversity and effects of decreasing forest resources on the global climate. Less international attention has been devoted to the implication of diminishing forest resources for local people who depend on forests for their livelihoods although national governments in many countries have developed programs that address the twin concern of poverty and environment".*

Agroforestry as a land use system has great potential to contribute substantially to the uplifting of the impoverished farming communities that comprise 60-80% of populations in developing countries (FAO, 1987a). However, for reasons that are not very well understood, the adoption and application of new or improved agroforestry systems are not as widespread as policy planners and rural development strategists would wish, hence its potential is not fully realized nor do the rural poor receive benefits that improved Agroforestry systems can offer (MacDicken, and Vergara 1990).

The disparity pointed out above on agroforestry research formulation and the implementation by the ultimate users of the innovations could best be addressed through looking at the basis on which current ongoing research in agroforestry is formulated. According to Raintree (1983), FAO (1985) and Wiersurm (1985), agroforestry technology research can best be based on the three main principles of:

a) Adopting a problem solving approach rather than a conventional technology development and diffusion approach.

b) Concentrating on the development of incremental changes in the existing land use systems.

c) Opting for diversified systems and multipurpose trees.

The two aspects that are concerned with research and dissemination should give special attention to the role of the farm households and local community groups as decision makers on land use (Rocheleau, 1987).

In developing agroforestry implementation tools, much attention should be given to measures that should stimulate private households to practice agroforestry either individually or as interest groups. This aspect is borne out by Wyatt-Smith (1979) pointing out that little can be achieved in rural areas unless people understand what is being proposed, support it and are personally involved. This opinion is also shared by many other scientists dealing with agroforestry (Raintree, 1982; Baker, 1983)

The dissemination processes

Adoption has been defined at different levels (Feder et al., 1982). At individual farmers level, adoption is considered as the degree of use of a new technology in a long-run equilibrium when the farmer has full information about the technology and its' potential. At the aggregate level, adoption is measured by the rate of spread of a specific new technology within a given geographical area or within a given population.

Emphasis on farmers as adopters of innovations should be an important element of the dissemination process, where without them as participants in development, planning, and as recipients and adopters of technologies, the extension process cannot be successful. The farmer's perception is different from that of the scientist. Farmers and scientists have different experimental and observation styles (Bentley, 1993). Rocheleau (1994) states that farmers use their own experience as experiments.

Other constraints that may have led to poor adoption levels could be due to policy issues that do not favour agroforestry. Government bodies almost invariably cling to the classical forestry concept of perpetual dedication of these lands to long term large scale and industrial oriented forestry and continue to regard agricultural-forestry crop integration as completely incompatible with and alien to accepted forestry practice. Furthermore, they believe that farmer's participation in forestry development is neither suited nor needed and they reinforce this view by depriving farmers of forestland tenure and equitable share in forests benefits

(Baver et al., 1998). Policy and institutional support for agroforestry will play a key role in adoption technologies at the farm level.

As noted by Wood (1988), another major element to be considered in formulating a strategy for promoting agroforestry is the identification of proper institutional arrangements. This element concerns the role of public organizations and regulations on agroforestry development, and should be directed at identifying measures, which ensure that the farmer are not constrained by the rigidity in public institutions to adopt Agroforestry practices. In this respect much will depend on the institutional and organizational framework within which agroforestry development has to proceed. Examples of such interventions include the formation of local High Value Tree crop marketing and producer associations and the adjustment of land and tree tenure arrangements in such a way that tree crop planters reap full long term benefits of investments in Agroforestry, support of locally grown fruits and other products as opposed to imports. These measures are necessary to support local organizations by having suitable institutional arrangements at national level. Experience from past forestry and agricultural development programmes indicate that institutional support for programme implementation is as important as the biological performance of the promoted technologies.

The experience to date in agroforestry is no exception in recent years it has become apparent that agroforestry implementation in many countries is hampered by a lack of supportive policies and institutions concerning equitable land tenure legislation, adequate research and extension, market support and development, and credit availability (Chew, 1989; Mercer and

Soussan, 1992). The traditional Malthusian belief of rising population and decreasing land assets do not in themselves explain the low productivity and sectoral related environmental degradation that is endemic in developing countries agriculture. Major obstacles to the evolution of a more efficient agricultural sector appear to be more of an institutional nature. This has important ramifications for agroforestry dissemination.

For the promotion of agroforestry, efforts should be undertaken to better utilize the existing traditional practices and to stimulate further adoption of new agroforestry practices. The efforts should take as a basic principle that agroforestry development should be directed at the creation of a diversified system of land use, which is adapted to locally specific environment, socio-economic and land use conditions. In this, the farmer trainer training extension approach does provide a likely and practicable solution. From a four-year experience it appears that farmer-to-farmer training of 'Self-selected '(those who seek training) is effective once there is a critical number of adopters (Fujisaka, 1993).

A comparative study of the Training and Visit and the Farmer-Trainer Training extension approach reveals various divergent basic principles. The central principles of the T&V system as are based on the surmision that strict observance by extension staff of set training and visit schedules is essential, followed by extensive regulation of procedures within the organization, and the standardization of recommendations, reducing them to "core messages". The aim of intervention is technology transfer: dissemination of innovative farming practices and the target group is individual farmers through contact groups. The introduction of innovation is "Top-down" from researcher via extension to the user. The organizational characteristics of the promotion agency involves action planning at senior level and the decision making process is also "Top-down".

For organizations working on the T&V system principles, the problems of their target groups are easily solved only if the situation on the ground is simple and homogenous and fit into the system. The reality of the matter on the ground, however, is that there exists varying environmental conditions and differing resource levels available in rural households which create a high socio-economic heterogeneity at local level with a multitude of coexisting farming and household systems. This makes it clear that the T&V system cannot achieve the desired results where the organizational environment is extremely heterogeneous, complex and dynamic. Unfortunately this is the type of environment typical of the African farming systems, where rain fed agriculture predominates and the quantity and the distribution of rainfall vary extremely. As a result, farm and household decisions must constantly be adjusted to changing conditions. Standardized extension advice such as that supplied under the T&V system is therefore rarely suited to solving the specific problem at hand.

The very nature of the T&V system in terms of its bureaucratic principles and the top-down decision-making and standardized procedure make it less responsive in the African context. In order to address the dynamic and heterogeneous nature of Africa's rain fed farming systems, the T&V approach would need to be turned upside down by moving away from extension as the systematic, large-scale dissemination of innovation within preplanned annual schedules, to a process of supporting local people to resolve specific problems (Albrecht , 1991).

The Farmer-Trainer training approach is based on four principles: farmer first, training for skill development, demands driven and group oriented. The farmer first principle is based on the assumption that there are always farmers who have above average skills, knowledge and talents for different farm enterprises. These farmers can more effectively be enabled and motivated to improve and provide their skills and know-how in training other farmers. Hence, farmer specialists have been selected according to their interest and available skills in tree crop production and are trained to become farmer-trainers (Eckert, 1999).

The training for skill development developed by GTZ/ITFSP involves an on-the-job training approach for the identified farmers jointly with the facilitating officers. This joint training sets into motion the complementary relationship between the farmer-trainers and the extension staff. A sequence of practical training sessions in nurseries and orchards has been conducted according to the production cycle of the trees. These trainings aim to get skilful and knowledgeable farmers and service providers who can improve the tree crop enterprises in their communities and locations.

The farmer-trainer training approach involves the farmers in the decision-making process and hence their felt needs and their indigenous knowledge is considered adequately. Other factors considered in the approach are the socio-economic circumstances of the small-scale farmers, and the gaps in research on the economic potential of trees on farm (Eckert, 1999). Through a farmer-backed monitoring and evaluation feedback system the farmers' ideas and situation is taken into consideration, and the pace of the various activities are determined by the farmers themselves.

Economic analysis and impact indicators

Measurement of the net economic benefits from changes in resource allocation is referred to as cost-benefit analysis (CBA). Schmidt (1989) points out that CBA is much like a consumer information system. This system neither tells consumers what to do nor what they should want. However, it does tell them which products will perform in selected ways and at what costs. This information helps consumers in making wise decisions.

The CBA model is built on the welfare foundations of economics and seeks to quantify and present the net social benefit or cost from the society's view rather than that of the individual or the enterprise. In contrast, a financial appraisal of an investment gives a comprehensive picture of economic advantages and disadvantages to the individual or to the enterprise. However it does not take into account effects of such a project on the community (Reddy, 1979). In a wider sense, welfare economics is concerned with the formulation of criteria allowing those who make decisions to distinguish between activities, programmes, or projects that would benefit the larger society and those decisions that would be to its detriment. An activity enhances a society's welfare if it results in a net increase in the value of the goods and services generated through the economy; the value of which is measured by the willingness of the people to pay for those goods and services (Anderson, 1977).

The primary objective of CBA is to help in determining both the size of government agency budgets or the number and type of projects that are to be undertaken. The determining criterion used to evaluate the merits of proposed projects is the ratio of benefits to costs or the magnitude of the net present value. Generally, the higher the ratio or the higher the net present value, the greater the possibility a proposed project had of being well received (Mckean, 1958).

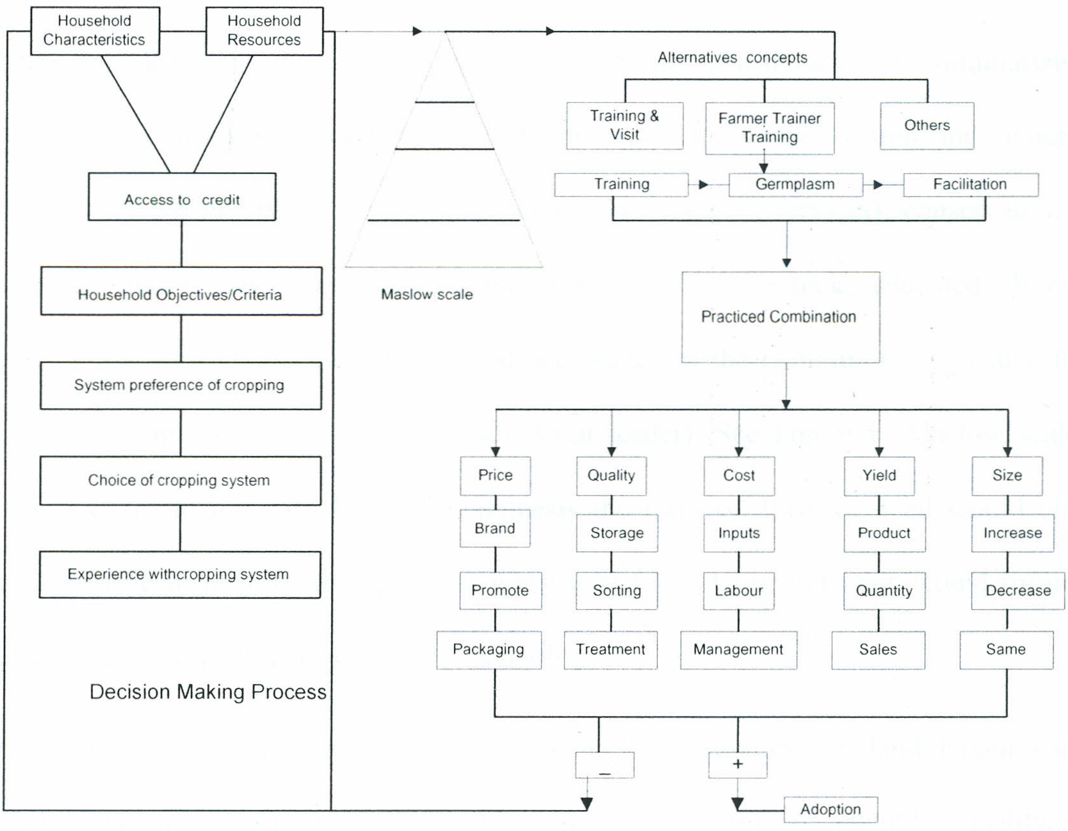
The choice of cost-benefit analysis as outlined by Scherr et al. (1991) is due to the fact that it: can provide guidelines for whether money or other resources should be used for a given investment; permits selection of the most profitable of several defined alternatives; maximizes return to given resources; takes account of uneven streams of costs and benefits; allows partition of response (e.g. green manure now vs. later); can be done with data derived from farm budgeting or bio-economic models.

The choice of the cost-benefit analysis tool in this study is guided by the fact that the economic analysis of agroforestry practices needs to take into account dynamic processes that are changing the agricultural economy, processes such as long-term trends in relative prices, land availability, population densities, market access, and household consumption patterns.

The Conceptual Framework

In conducting an economic evaluation of any technology or concept, it is imperative that it begins with an understanding of its potential relevance, impact and implications at the household/farming systems level. Effective evaluation will entail a clear understanding of objectives and priorities of those who are responsible for making decisions. The translation of these objectives into appropriate verifiable indicators provides the basic guidelines for data collection, analysis and interpretation of results with relevant methods, tools and time frames.

Figure 2.1: A conceptual framework for smallholder decision-making processes in respect to adoption of cropping systems



Source: An adaption from Management capacities in relation to environment (Carin et al, 1998)

A farming system in the tropical and subtropical regions of the world usually comprises the household, production systems (crop, livestock, trees, etc.), and other activities on-and off-farm (Collinson 1987). The household subsystem provides purpose and organization to the multiple production subsystems, specifically on decisions related to establishing priorities, allocating resources, managing production, implementing activities, and utilizing and distributing outputs of the system. Furthermore it is the household, which organizes and manages all relationships of the farming systems with the external environment. Thus the household is the basic unit of social organization, production, and consumption (Ellis, 1988).

The first step would be to understand the goals, objectives, and priorities of the household. Herein goals deal with physical and psychological needs, and these can be summarized as security of basic needs (i.e., food, shelter and clothing), generation of income and favourable cash flow (to pay for production inputs, school fees medical services), conservation and increase of the resource base (e.g., land, infrastructure, livestock, educated children), recreation and leisure, and recognition and acceptance in the community (e.g., nice farm, good house, contribution to village causes, local leader). See Figure 1 (Maslow scale of human needs). In line with Maslow hypothesis the farmers' level of need would play a significant role in priority setting at the household level. Ultimately this would influence their adopting or rejecting an advocated technology.

In order to achieve its objectives the household employs resources (i.e., land, labour, capital and management). Each resource can be described in terms of quantity, quality, and suitability, which depend on location, timing, and/or source e.g., any plot of land is not the same in terms of how and when it can be used. The quantity and quality of labour depend on the member of the household performing the tasks that are influenced by traditional customs regarding gender/age duties. Capital includes investments (i.e., infrastructure, equipment, tools, animals) and operational capital (i.e., cash in hand, savings, off-farm employment).

Differences in economic results are usually attributed to differences in the management of the farmer, (Boehlje and Eidman, 1984; Carin et al., 1998). Management capacity can be seen as a separate fourth factor of production, in addition to the traditional factors land, labour and capital (Case and Johnston, 1953; Carin et al., 1998). Management is the ability to make informed decisions, to monitor and evaluate success or failures, and to learn from such experience. This capacity may be correlated with age, education, experience, as well as other attributes and objectives of the manager.

For resource-limited farming systems as characterized by smallholder farms, production enterprises crops, livestock, trees, processing activities, and off-farm employment, are managed in a mixed and interactive manner. The mixture is such because the household has to diversify, spread the risks, and use scarce resources in the most rewarding options to achieve it's multiple priorities. This makes enterprise analysis difficult, and as such it is essential to understand how farmers organize, allocate resources, and manage all their activities to begin to define an appropriate framework for economic analysis.

The farmer-trainer extension approach (FTE) on dissemination has the main purpose of influencing the management process at the household level, in a way that the manager(s) gets the most benefit out of the inputs of production, as well as introducing other technologies that are deemed appropriate for the farmers. The success of the FTE on dissemination would therefore be best gauged through evaluation of the production process, and decisions made and implemented on adoption of the proposed technologies. A positive outturn would therefore hasten the adoption of the technologies and hence validate the dissemination approach. A negative outturn would reflect on either the technology involved or the dissemination approach, and where the technology is confirmed to have definite benefits, and then the approach would have to be re-examined so as to guarantee the desired improvement in management of the farming systems, and which would consequently result in some positive impacts. There are two major paradigms for explaining adoption decisions found in literature: Innovation–diffusion, and the economic constraints paradigms. The innovation-diffusion model, following the work of Rogers holds that access to information about an innovation is the key factor determining adoption decisions (Rogers, 1962; Agarwal, 1983; Akinwumi, 1993). The economic constraints model (Aikens et al., 1975; Akinwumi, 1993) contends that economic constraints reflected in asymmetrical distribution patterns of resource endowments are the major determinants of observed adoption behaviour. Lack of access to capital (Havens and Flinn, 1976; Akinwumi, 1993) or land (Yapa and Mayfield, 1978) could significantly constrain adoption decisions.

The choice of which dissemination concept would most likely succeed in improving the well being of the farmers would not only first and foremost encompass the household decision making process, but would also be a factor of the level of need of the farmers as could be adduced using the Maslow scale. The felt needs of the household would affect the farmers' priorities and be a major factor on adoption criteria. If a farmer was at subsistence level of production, it would be difficult for him/her to invest in a cropping system that promised future benefits without considering what to survive on presently. The costs involved in the various extension approaches vis-avis the number of farmers reached and those who adopt would be weighed against the outputs at the plot level, farming systems and at the project level.

Analysis of the FTE was made possible through an investigation of its activities and the consequent effect it has on the farmers in terms of influencing their management for profit maximization, at the farm level. An overall, positive outturn, coupled with an improved reach of the farmers, would validate the extension approach in the study.

CHAPTER THREE

DESCRIPTION OF THE STUDY AREA

3.1 Introduction

The study includes the following areas situated in three of the eight provinces of Kenya namely: Kisumu, and Migori districts both situated in Nyanza, Embu district in Eastern and Keiyo district in Rift Valley. These sites were picked among a list of areas where the farmer trainer extension activities were carried out.

Figure 3.1: Map of Kenya Showing District boundaries.

3.2 A historical perspective of the FTE in the study areas

3.2.1 Constraints of the tree crop subsector

The farmer-trainer extension approach was tried in a number of sites in the study areas among other areas as result of a felt need within the tree crop subsector (GTZ/ITFSP, 1995). Some of the constraints identified in the study areas prior to the implementation of the FTE included an acute shortage of germplasm of high value fruits, nuts and timber trees, insufficient information on trees and suitable varieties for farmers and extension staff, insufficient knowledge and skills in tree propagation and management and inadequate extension approaches which mainly emphasized on the provision of information rather than knowledge and skills. Another constraint among those already stated was farmers' limited access to markets and market information.

The project areas were also characterized by over dependence on a few limited enterprises. Kisumu and Migori districts were highly dependent on the production of sugarcane and rice growing for those within the Kano plains. These enterprises were by the Mid 90s experiencing very poor pricing due to the influx of imported sugar and other problems affecting the sugar industry. These factors seriously undermined the income generation potential for the farmers in these areas given their limited choices.

The Embu farmers on the other hand heavily relied on coffee and tea production, though this also depended on the agro-ecological zones. In higher potential areas, dairy was also an important source of income. The lower altitude areas of Embu mainly Runyenjes and Kieni divisions had a poor rainfall regime which made it less attractive for rainfed farming. In some parts of the district tobacco was a good source of income while in other areas the farmers totally existed at subsistence level relying on food crops maize and beans for sustenance. This made them vulnerable to uncertainties associated with the weather, whereby in times of drought the farmers would depend on relief food from the government and other organisations to survive. Keiyo district farmers were mainly livestock farmers but poor livestock prices since the collapse of organised livestock marketing in the mid 80s made them look for alternative means of income generation.

3.2.2 Steps of the farmer-trainer implementation

The first step involved in the farmer-trainer extension is the creation of awareness for both the farmers and the extension staff in the field. Then there is training on farmer selection for facilitators who can either be the extension workers or other community development agents. Farmer selection involves selection of farmers with an interest on tree crop propagation and who have a good standing within the community, and can therefore be useful in influencing other farmers to adopt recommended technologies. After the selection of the farmer-trainers, an on–the job training is conducted for the selected farmers and for extension staff on various aspects of tree crop propagation. Interest group formation is then initiated. After training, the farmers are then encouraged to create awareness amongst their fellow farmers on tree crops and subsequent trainings by the farmer-trainers ensues, with planned in house retraining of the farmer-trainers on topics that they find difficult. Regular planning and evaluation meetings are conducted with the extension staff facilitating these meetings.

3.2.3 FTE activities undertaken in the study areas

The farmer-trainer extension activities were started at varying times in the study areas. Activities in Kisumu and Migori were started in 1996, while they were started in 1997 in Embu district. Activities in Keiyo district were started in 1998. All the activities followed the described steps of the FTE but with some noticeable differences in terms of the funding and the persons involved. In Kisumu and Migori, the extension service was fully involved from the inception of the project. At the beginning all the financial requirements i.e. in terms of provision of improved germplasm and training were met by the project. Embu district activities were started as a result of the project being approached by some farmers who had an interest in tree crop production. Here, funding especially for improved germplasm was done more on a cost-sharing basis. The facilitation for FTE activities was more farmer organisation based and the extension service only came in when called upon on specific activities requested by the farmers. The FTE activities in Keiyo district were through a farmer organisation that used to work through a church development organisation that also sourced funds from other donor organizations. In Keiyo district the farmers also contributed to meeting some of the expenses incurred in the FTE process.

3.3 Choice of the survey areas

Among factors considered in the choice of the study sites were the diverse cultural backgrounds of the farmers within the different sites that could reflect on their response to the technological interventions. This would be an important factor to be considered when introducing FTE in new areas.

The nearness of a farm to a major market outlet or a large town could also be an incentive to a farmer. It would therefore influence his/her decision on whether to adopt a recommended technology or not.

The time that the dissemination approach has been in operation in the various project sites could reflect on the progress made and constraints experienced as the FTE process progressed.

The project period, proximity to major markets, cultural and socio-economic factors were considered in the choice of the study site (Table 3.1). These factors were considered to possibly have an effect on the implementation of the FTE. Note that Embu district is nearest to Nairobi and hence has an advantage when looking at the current export markets.

Table 3.1:Factors considered in the choice of study areas

Factors	*Area (Districts)*			
	Kisumu	Migori	Embu	Keiyo
Cultural/socio-economic Background	Mainly fishing	Subsistence farming	Mixed farming	Livestock
Project period (in Years)	6	6	4	2
Proximity to major market (Km)	Kisumu (10)	Kisumu (100)	Nairobi (90)	Eldoret (50)

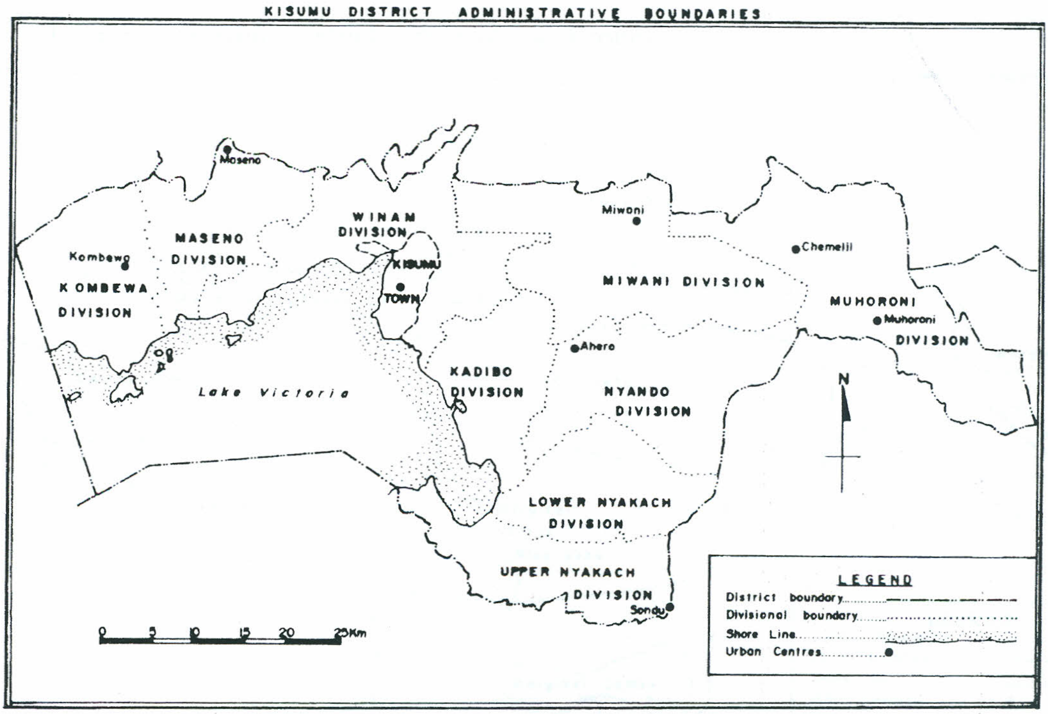
3.4 Descriptions of the study sites

3.4.1 Kisumu District

A) Geographical and ecological conditions

This is one of the twelve districts forming Nyanza province, and is bordered by Homa Bay district to the south, Vihiga district to the northwest and Siaya district to the west. It lies within Longitudes 33^0 20'E and 35^0 20'south and Latitudes 0^0 50'South (Kisumu district development Plan[KDDP], 1996).The district covers a total area of 2660 $Km^2$of which 567 Km^2 is covered with water. Kisumu has since been split into Nyando and Kisumu districts, but for the study purpose the larger Kisumu was picked as the reference area since the farmer trainer extension continued to operate with the named areas still as one district.

Figure 3.2: Kisumu district administrative boundaries



As shown in Figure 3.2, Kisumu district is divided into eight administrative divisions, fifty-one locations and one hundred and fifty eight sub-locations. The divisions are Winam, Maseno, Nyando, Muhoroni, Lower Nyakach, Kadibo, Miwani and Upper Nyakach.The divisional headquarters are fairly accessible in terms of telecommunications and the road network (KDDP, 1996).

Figure 3.3:Kisumu district agro-ecological zones

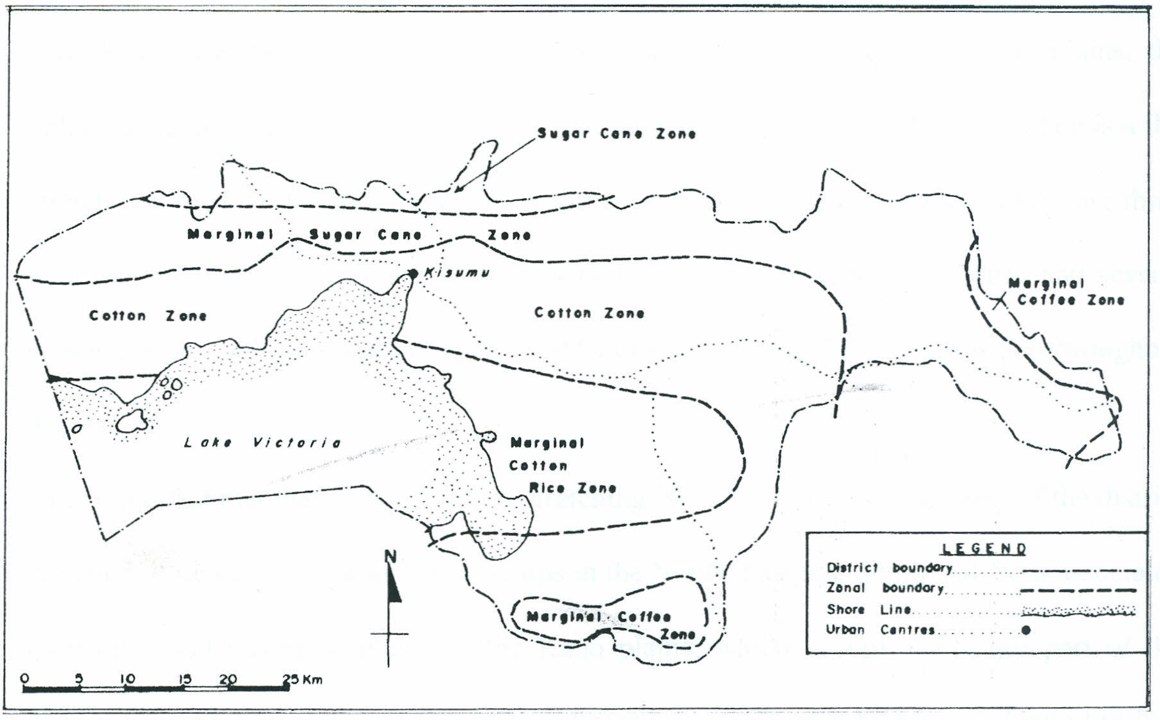


Figure 3.3 shows the agro-ecological zones within the districts and which consist of:

- Lower Midland(LM1): This zone covers an area of 149sq.km of Maseno division and $6km^2$ of Muhoroni/Miwani divisions
- Lower Midland2 (LM2): This zone covers Maseno, Muhoroni and Miwani divisions. Crops grown here are sugarcane, cotton and rice. Sugarcane can support sugar milling and jaggery and molasses industries
- Lower Midland 3(LM3): The zone covers Kadibo, Nyando and Winam divisions. It supports cotton growing of Kadibo and Winam divisions
- Lower Midland 4(LM4) This covers an area of 185 km^2

- Upper Midland (UM3) The zone supports growing of coffee, tea (at a small scale) and covers all divisions except Winam

The district can be divided into three topographical zones namely the Kano plains, the upland areas of Nyabondo plateau and the midland areas of Maseno. The Kano plain is a flat stretch bordered to the north and east by the escarpment of the Rift Valley. There are three major rivers flowing into Lake Victoria namely the Nyando, Kibos and Miriu and several seasonal rivers, which serve between 25-30% of the total population with water throughout the year.

Due to the fact that there is a rift valley stretching West-East, the physiography of the district is varied; it ranges from pronounced scarps in the North, East and South and from associated footslopes and piedmont plains to the Kano plains, which occupy the major part of the district Here plain soils on former lake sediments occur, having high to moderate fertility, but subject to waterlogging. In the western part of the plain, these soils are associated with swampy areas where soils are mottled. They have a variable fertility and also show waterlogging. On the slightly higher topography, on piedmont plains, alluvial soils of moderate to low fertility with some drainage problems are dominant (Jaetzold, 1983). Above the plains, upland soils with variable topsoil and moderate to low fertility are found. In the far Northwestern area are the soils of the rocky southern Kakamega uplands, which are soils of low fertility underlain by murram or rock within 80cm of the surface. Along the Winam Gulf, soils on lakeside beach ridges can be found which are variable fertile and partly waterlogging.

The area has two rainy seasons, with the long rains occurring in April/May while the short rains occur in August /September. During the short rains the average annual rainfall ranges between 450mm and 600mm. Their reliability is low and the rains are distributed over a long period, making cultivation of second crops in the year difficult. In the recent past floods in some parts of the district has become very common. The district has an average annual rainfall of about 1,400mm although the amount varies with altitude.

B) Population profile

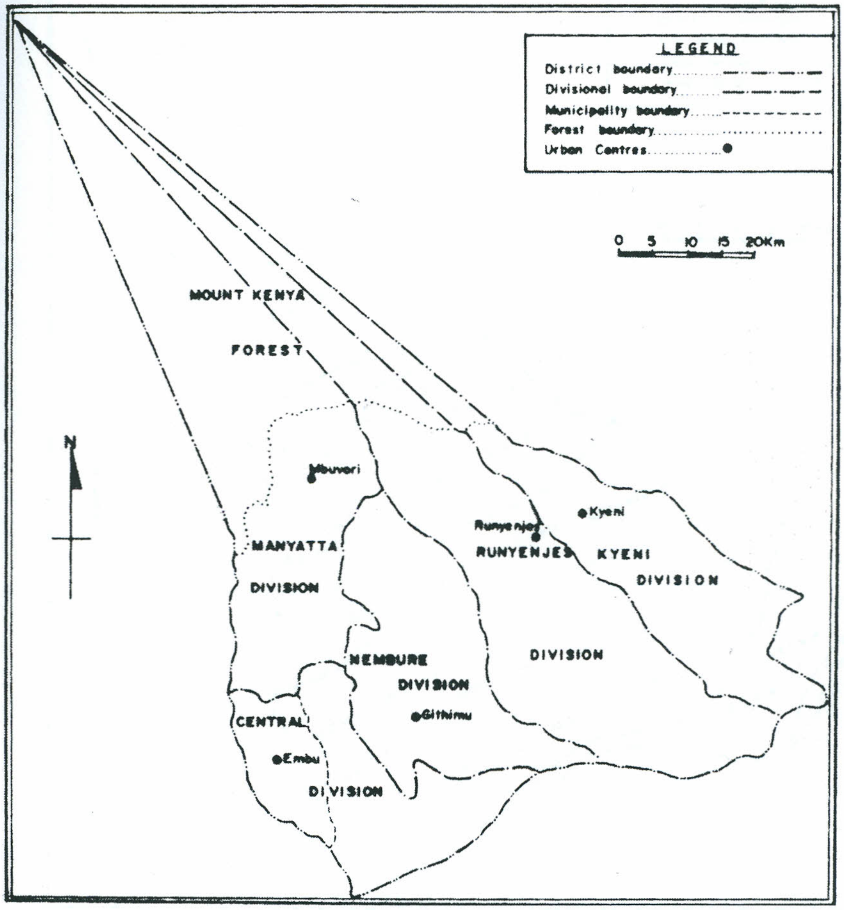
According to the 1999 population census, the district has a total population of 500,000 comprising of 243,000 males and 257,000 females growing at an annual rate of 2.3 per cent (1999 population and housing census: Ministry of Finance and Planning, 2000).

3.4.2 Embu District

A) Geographical and ecological conditions

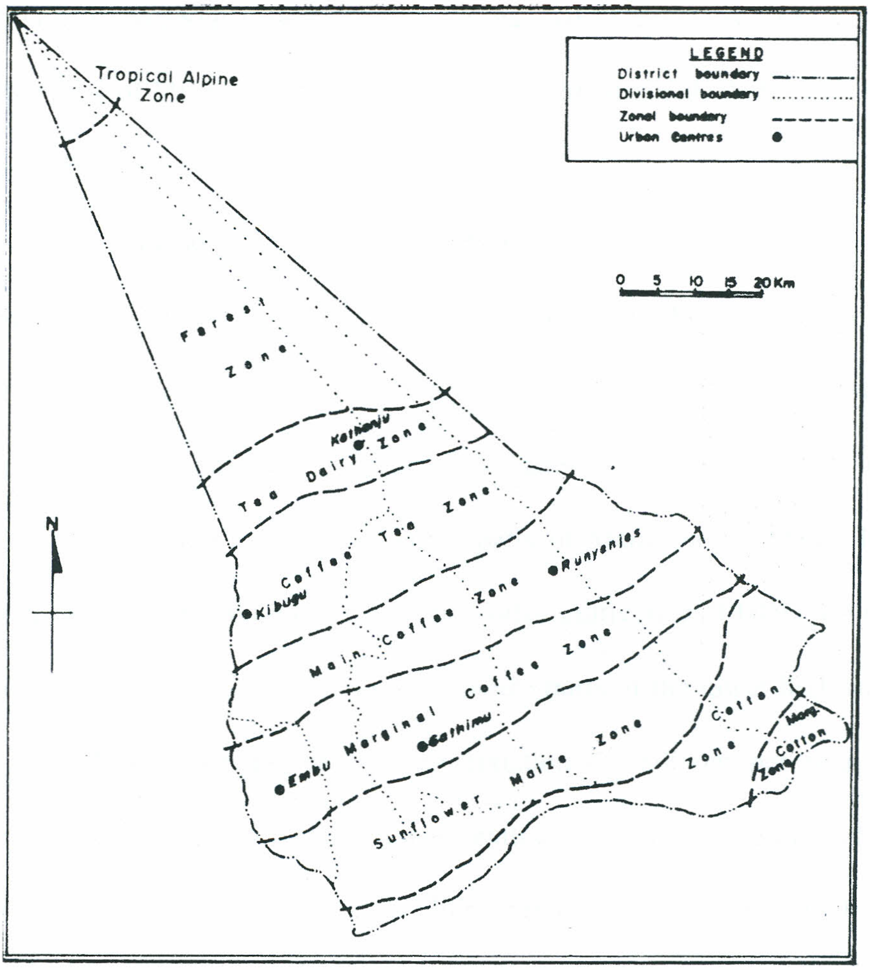
Embu District, is located in the central highlands on the southeastern slopes of Mt. Kenya at $0^0$30'S, $37^0$30'E and an altitude of 1480M. The total annual rainfall is 1200mm to 1500 mm received in two distinct rainy seasons; the long rains (mid March to June) with an average precipitation of 650mm and the short rains (mid October to December) with an average rainfall of 450mm. The average monthly maximum temperature is 25^0C and the minimum is 14^0C. The long-term monthly average is 19.4^0C (Mugendi, 1997).

Figure 3.4: Embu district administrative boundaries



Embu is one of the twelve districts that make up Eastern Province. It is bordered by Mbeere district to the east and southeast, Kirinyaga district to the west, and Tharaka Nithi district to the north. It occupies a total area of 708 Km^2, which as Figure 3.4 shows is divided into five administrative divisions (Embu district development plan, 1996).

Figure 3.5:Embu district agro-ecological zones



Embu district shows the typical agro-ecological profile of the windward side of Mt. Kenya, from the cold and wet upper zones to the hot and dry zones leading to the Tana River Basin. The average annual rainfall reflects this contrast: more than 2200 mm at 2500 meters above sea level to less than 650mm near the Tana River at 700 meters above sea level. (Jaetzold, 1983). The altitude of Embu district ranges between 900m to 4500m above sea level. The highlands are found in areas whose altitude range from about 1500 to 4500 meters at the foot of Mt. Kenya and covers parts of Manyatta, Kyeni and Runyenjes divisions. The midlands dominate most areas of Nembure and Central divisions and the altitudinal range is from 1200 meters to about 1500 meters above sea level (Embu District Development Plan, 1996). At the peak of Mt. Kenya, the soils are imperfectly drained, shallow to moderately deep, and reddish brown in colour.

The upper highlands are so wet and steep that forestry is the best land use. The forest reserve zone is characterized by humid andosols, which is well drained, very deep, dark brown, clay loam to clay with a thick humid top soil. They then gradually evolve into volcanic foot ridges that have soils developed on basic igneous rocks. These soils include ando-humid nitosols with humid andosols found in parts of Manyatta, Nembure, Runyejes and Kyeni divisions. They are suitable for tea and coffee cultivation (EDDP, 1996). In these areas of upper high lands, the upper and north eastern parts of the lower highland zones of and also the Tea –Dairy zone the average precipitation is 1800mm per year. In comparison the livestock-millet zones are characterized with an annual average rainfall of 650-800mm and this therefore limits the kind of agricultural enterprise that could be undertaken profitably.

Embu district relies heavily on surface water resources for its water requirements, since there are several permanent rivers and streams, which flow along numerous valleys that traverse the landscape. Most of these rivers and streams have a substantial discharge throughout the year and could therefore be important for setting up irrigation schemes. The district is drained by four major rivers, namely Thuci, Kii, Rupingazi and Ena, all of which flow in a south –eastern direction. The forests occupy an area of about 22264 hectares, representing 30 per cent of the districts total area. The forests have a natural vegetation cover consisting of various valuable tree species (EDDP, 1996)

B) Population profile

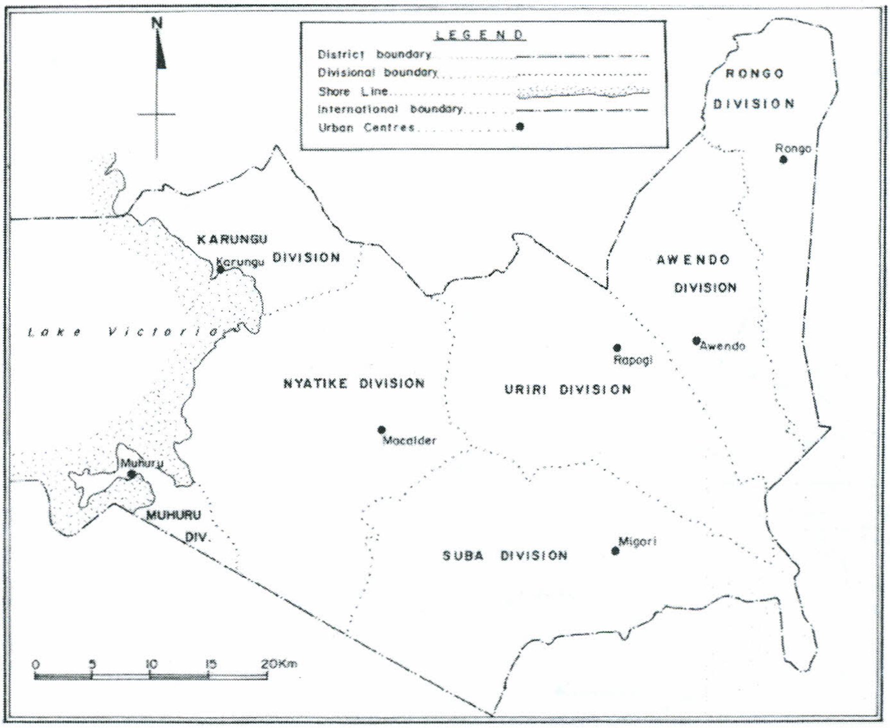
According to the 1999 population census, the district had a total population of 277,000 and this comprised of 136,000 males and 141, 000 females.

3.4.3 Migori District

A) Geographical and ecological conditions

Migori district is located between latitudes 0^0 24"and 0^0 40" South and longitudes 34^0 and 34^0 50" East. To the north it borders Homa bay district, to the East is Kisii and Transmara districts while its southern boundaries are shared with Kuria, Transmara and the Republic of Tanzania. Suba district and Lake Victoria are on its western boundaries (Migori district Development Plan, 1996). The total area of the district is 2,505 Km^2 including 475 Km^2 of lake Victoria.

Figure: 3.6:Migori district administrative boundaries



As shown in Figure 3.6 district is divided into eight administrative divisions. Nyatike division is the largest (502Km^2) followed by Uriri (379Km^2) and Suba-west (283Km^2). The smallest divisions are Karungu (136Km^2) and Muhuru (47 Km^2).

Figure 3.7:Migori district agro-ecological zones

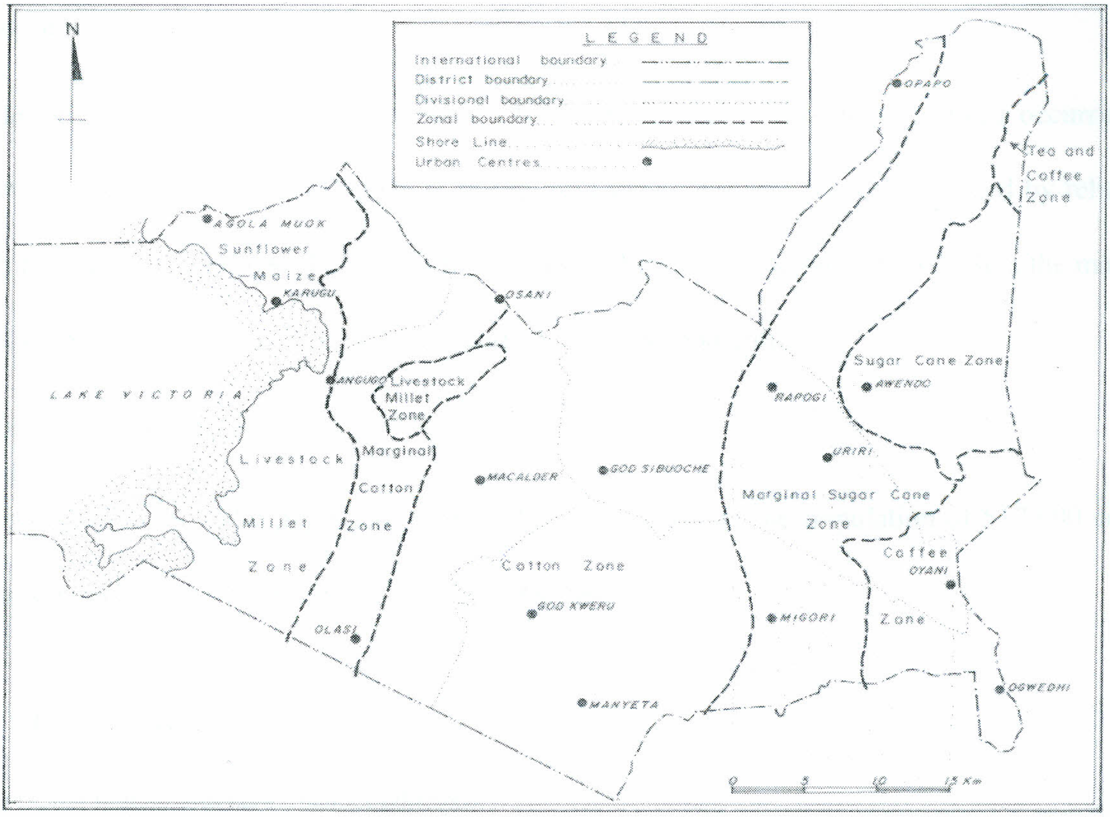


Figure 3.7 illustrates the two main ago-ecological zones in the district are the Upper midland and the Lower midland. The Upper midland zone comprises Suba West and East, Uriri, Rongo and Awendo divisions. The rest of the district falls under five classifications of Lower midland zone.

The altitude ranges from 1,135 meters at the shores of Lake Victoria in Muhuru, Nyatike and Karungu divisions to 1700 meters with several undulating hills and plains stretching 20 to 70 Km along the lake shore. The main rivers are the Kuja, Migori, and Riana. Other rivers are the Ongoche, Oyani and Sare. These rivers do not facilitate transportation because of falls and cataracts. They can support irrigation but at their lower reaches they often cause flooding.

Rainfall varies, ranging from 700mm to 1800mm annually, with the long rains occurring between March and May. Climate is of the mild inland equatorial type, modified by relief, altitude and proximity to the lake. It favours the cultivation of sugar cane, which is the main industrial crop, tobacco, cotton, maize and a variety of food crops.

B) Population profile

According to the 1999 population census, the district had a total population of 517,000 and this comprised of 248,000 males and 269, 000 females.

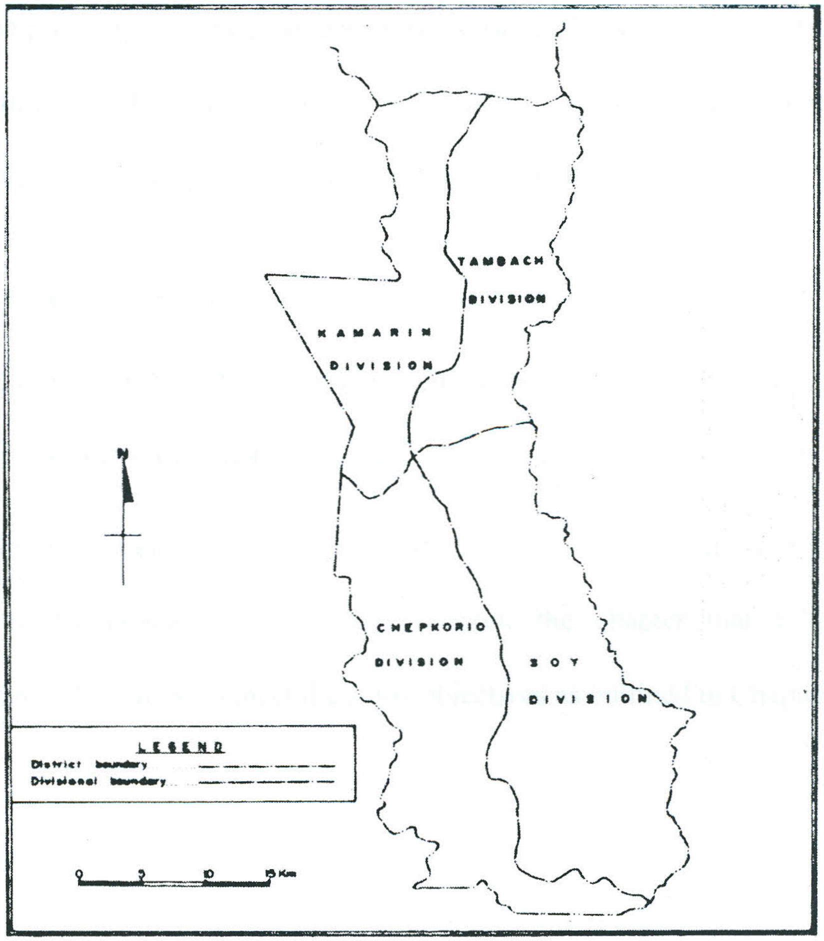
3.4.4 Keiyo District

A) Geographical and ecological conditions

Keiyo district is one of the 17 districts that comprise the Rift Valley province. The district was carved out of the former Elgeyo Marakwet district in 1994.It extends from latitude 0^0 10'North and Longitude $35^0$25'to 35^0 45' East. (Keiyo district development plan 1996).It is bordered by Marakwet district to the North, Uasin gishu district to the West, Baringo district to the East and Koibatek district to the South East.

The district as shown in Figure3.8 is divided into four administrative divisions. Soy division is the largest (489Km^2) followed by Chepkorio (409m^2). Tambach (281Km^2) and Kamariny (277Km^2) follow in that order (Keiyo District Development Plan, 1996)

Figure 3.8:Keiyo District administrative boundaries



Keiyo district can be divided into three main topographical zones, which run parallel to each other in a north-south direction. These include the Highland plateau, the Elgeyo Escarpment, and the Kerio Valley. The highland Plateau rises gradually from an altitude of 2400 meters above sea level on the Chebiemit Hills in the north to 2700 meters above sea level on the Metikei ridges in the south. The main water divide runs along the escarpment. East of the divide is the Kerio catchment area which drains into Lake Turkana. West of the divide is the

Lake basin which drains into Lake Victoria. The main rivers are Kerio, Torok and Kimwarer.

The prevailing farming system in the Kerio Valley is a mixture of agriculture and livestock with an emphasis on extensive livestock rearing. Individual farmers cultivate plots in the valley as well as the escarpment and in the highlands.

B) Population profile

According to the 1999 population census, the district had a total population of 143,865 and this comprised of 71,147 males and 72,718 females.

After the brief outlook of the study areas in terms of the physical features and socio-economic characteristics in this chapter, the chapter that follows defines the study methodology used to meet the study objectives as outlined in Chapter one.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.1 Introduction

This section defines the path used for identifying important economic criteria in assessing agroforestry technologies, among which were those that could only be identified by understanding the principles of farmer decision making in the study area. Another objective in this section is to assess the strengths and weaknesses of the different economic methods for evaluating these criteria.

4.2 Nature and sources of data

The purpose of this study is to determine the viability of the farmer-trainer extension approach to dissemination in terms of adoption potential and economic viability within the different farming systems in Kenya. In the study, primary and secondary data were collected. Primary data consisted mainly of Participatory Rural Appraisal (PRA) i.e. group discussions and interviews, observations and empirical field measurements. The secondary sources of data consisted of published information, which included project reports, journals, theses, and dissertations. Also textbooks on specialized topics, bibliographies, abstracts, working papers, and encyclopedias were consulted. In order to obtain these secondary data various institutions were visited, libraries, Central Bureau of Statistics, government offices, NGO's and others through the Internet.

4.3 Methods of data collection

A Multistage purposive sampling procedure with stratified random selection was used to select farmers for the survey in the study areas. The use of simple random sampling to select samples from within each stratum is called stratified random sampling. This type of stratified sample is collected the same way as a simple random sample, except that the choice of site for the fieldwork is made separately and independently in each stratum (Lee-Ann, and Martin, 1997).

A list of farmers in each study area was obtained from the district horticultural officers detailing the farmers who had undergone farmer-trainer training. This was collated with the list availed from the project reports. Another list of farmers trained by other farmers (farmer-followers) was made during the interviews, thus constituting a different stratum.

At least 20 farmer-trainers and 20 farmer-followers were selected from each of the study sites in Embu, Migori, and Kisumu.

Table4.1: Presentation of the sample size

Respondents	Study sites			
	Kisumu	Migori	Embu	Keiyo
Total Number of farmer-Trainers	61	66	50	48
Sampled farmer-trainers	22	20	20	18
Total number of farmer-followers (estimate)	1120	726	590	358
Sampled farmer-followers	27	22	26	18
Total number of farmers sampled	49	42	47	36

In Keiyo district 18 farmer-trainers and 18 farmer-followers (adopters) were selected and interviewed (Table4.1). The lower numbers of those interviewed in Keiyo district are explained by the fact that the FTE period was shorter hence a lower number of farmers trained.

A total sample of 174 farmers was obtained for the economic analysis. In addition, a further 76 farms were surveyed for information on improved tree crops established, with Embu having the largest number (53). This was necessary to increase data validity and reliability, given the higher than expected fruit tree establishment figures recorded at the initial interview for Embu.

The stratified random sampling design was most suitable as it took into account the different levels of the farmer-trainer training, hence able to sample both the farmer-trainers and the farmer-followers. The preparatory phases of the study involved introductory visits in the study areas to inform the agricultural staff about the study. The first visit was also used in collating the farmer-trainer list with the local agricultural staff and that from the project. The second visit was used to sample farmers from the list and testing the questionnaire. Finally, farmers were interviewed in the 4 districts over a 6-month period between 2000 and 2001.

Apart from the direct interviews, participatory rural appraisal methods were used in collecting basic data on agriculture in the different farming systems in the study areas. This included key biophysical (nature of soils, cropping systems, crop protection, rainfall patterns and importance of trees), and socioeconomic (farm sizes, tenure arrangements, marketing, enterprise contribution to income levels, labour availability) data.

4.3.1 Participatory Rural appraisal

The participatory rural appraisals conducted in the study sites not only provided basic data on agriculture but also the farmers perception of production constraints and opportunities. In the group meetings the data collection tools applied included; seasonal calendars, seasonal price calendars; historical profiles and timelines. During the individual farm visits the tools used were farm walks, farm maps, and a structured questionnaire. In order to validate the information collected during the group and individual farmer meetings, empirical field measurements were also carried out.

Group Meetings

The meetings were conducted using the PRA approach instruments as advocated by Odour-Noah et al (1992). The meetings were arranged in Ciamanda Anglican Church in Kyeni division for Embu district, Cheptebo African Inland Church in Soy division of Keiyo district, Farmer Training Centre Ahero for Kisumu district and Maranatha Training and Vocational Centre for Migori district. In each study site three group meetings were conducted. The initial group meetings were for basic data collection while latter meetings were used as follow up. The mean attendance for these meetings was 45 farmers.

Seasonal calendar: The calendar was developed to show crop sequences (land preparation to post harvest handling) and labour demand for men, women and children throughout the annual cycle. Farmers discussed seasonal and tree calendars for various crops and trees on their farms, its implication on labour availability and wages for hired labour. Farmers were also required to identify different tree species on their farms and ranked them in order of importance. From the tree species, farmers were also able to identify attributes that they valued most. The farmers were also able to enumerate constraints in agroforestry production. A questionnaire guide is presented in appendix 11.

Seasonal price calendar: This represented a result of discussion of marketing of crops and tree production throughout the annual cycle. This information was invaluable in increasing reliability and accuracy of price and market data.

Historical profiles: This led to the understanding of changes in farming systems, and the use of trees and their products in different areas. It also revealed effects of policy changes on their household decision making processes.

Farm Visits

The main instruments in use were farm walks, farm maps and discussion with farmers using a structured questionnaire (Appendix I). The farm visits were conducted using a PRA approach as applied by Nagel (1992). At the farm level the respondents were mostly heads of households or where not applicable (i.e. farmer-trainer or follower not household head), the household head was present and took part in the discussion. The initial step was general introduction, the purpose of the visit and the planned visit. This would be followed by a discussion on the main farm activities and their location within the farm.

Farm walk: The researcher asked the farmer to show him around the farm after the introductory discussion. During the farm walk discussions on various enterprises took place. On reaching specific plots on the farm, the farmer explained the area in terms of size, situation of the planted crops, inputs used, previous history of the crop if planted before, expected harvest as well as sale prices. Discussion on livestock if present also took place taking into account issues such as the pedigree, feeds and productivity.

Farm map: This was drawn (example annex III) and comprised a sketch representation of the farmhouse and the locations of different plots. The farmers drew and identified resource flows at the location and to other subsystems such as crops and livestock.

Interviews

The study population comprised of farmers involved in farmer-trainer extension approach in agroforestry and was subjected to the same questionnaire (appendix I) in all the study sites. A total of 174 farmers were interviewed and their farm surveyed in terms of adoption of high value tree crops. Another set of questionnaire (Appendix IV) was used for key informants interviewed and these included, district agriculture extension officers, local chiefs, teachers, traders of inputs and farmers with interest and knowledge in tree cropping practices. All the people interviewed provided information on tree cropping and dissemination of technologies in their respective fields of understanding.

The qualitative data obtained was used in confirming field measurements and statements from the farmers in the discussions at the individual and group levels. On the other hand, the agricultural officers interviewed provided information on agricultural production practices in their respective areas of work, marketing, general biophysical information and their perspective on agriculture extension constraints and opportunities.

Empirical Field Measurements

On the sites observed during the farm walk, slope lengths and steepness were measured with tape and slope meter. The area covered with woodlots was also enumerated. The tree crops established were physically counted and their ages determined and recorded. Where possible (in areas where the survey was done during harvesting period), harvesting was done and production of fruits per tree recorded.

4.4 Data analysis

The SPSS computer programme was used to enter and analyze pre-coded data. Descriptive statistics were applied to summarize the data. The study analyzed the data under the following major sections:

i. The number of farmers practicing agroforestry technologies as a result of training through the farmer-trainer training approach,
ii. Economic returns of the practice and that of other farm enterprises,
iii. Logit analysis of factors influencing performance of a farmer-trainer, and
iv. Costs incurred in the farmer trainer training approach.

4.4.1 Model of analysis

The economic analysis framework used in the study is cost benefit analysis. A hypothesis was accepted or rejected based on three investment criteria; the net present value, the cost benefit ratio and the internal rate of return. An option with a positive net present value was considered to be economically beneficial.

Due to the elasticity of interest rates and the frequent price changes in the economy it was deemed necessary to conduct a sensitivity analysis to assess the effect of changes in key parameters such as input-output coefficients, the discount rate, or prices of inputs and outputs.

Projects' evaluation indicators:

- Internal Rate of Return (IRR)
- Net Present Value (NPV)
- Benefit- Cost Ratio

The net present value model used is:

NPV=PVB-PVC, where:

NPV= Net present value

PVB= Present value of benefits

PVC= Present value of costs

$$PVB = B_0 + \frac{B_1}{(1+r)} + \ldots + \frac{B_n}{(1+r)^n}$$

$$PVC = C_0 - \frac{C_1}{(1+r)} + \ldots + \frac{C_n}{(1+r)^n}$$

Where:

B_0= Benefits at year 0; B_1= Benefits at year 1; B_n= Benefits at year n

C_0= Costs at year 0; C_1= Costs at year 1; C_n= Costs at year n

r= discount rate

Assumptions:

The benefits accruing to the farmer-trainer extension approach will not only include the number of farmer-followers adopting the technology but also a summation of their joint benefits derived from the agroforestry technology taught and practiced. This would amplify the multiplier effect nature of the FTE approach.

Measures used in cost -benefit analysis:

1.The cost-benefit ratio: This refers to the ratio of the sum of discounted Benefits to the sum of discounted Costs

The Benefit- cost ratio can be defined as:

$$\text{B-C Ratio} = \frac{\sum^{n}_{t=0} b_t(1+r)^t}{\sum^{n}_{t=0} c_t\,(1+r)^t}$$

Where:

b_t = the benefits accruing in year t; c_t = the cost accruing in year t

n = the number of periods; r = discount rate

t = time period

The project is considered acceptable if the Benefit Cost ratio is greater than one.

2.Internal Rate of Return: This is the discount rate that makes the net present value equal zero.

The internal rate of return can be defined as:

$$NPV = \sum^{n}_{t=0} \frac{b_t - c_t}{(1+r)^t} = 0$$

A project is acceptable if its internal rate of return exceeds some specified interest or discount rate, which is decided by the prevailing commercial cost of capital, and as specified by the sensitivity analysis presenting prevailing discount rates over the project period.

3.The Net Present Value: refers to the difference between the present values of benefits with that of the present value of costs.

It is defined as:

$$NPV = \Sigma^{n}_{t=0} \frac{b_t - c_t}{(1+r)^t}$$

Economic criteria are not the only determinants controlling public investment projects. Other factors such as national security, personnel or political interests of involved policy makers may play a part in project related decisions. The Benefit-cost analysis is a basic technique of economic appraisal. It involves summing up of all the benefits and project costs to society, and discounting them to reflect the opportunity cost of invested funds. Social costs are intended to represent the true opportunity cost of inputs and outputs to the farmers, or society in general. In order to achieve this analysis, a description of the farmers involved, inputs and outputs of the farming systems is imperative.

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 Introduction

This chapter describes the results obtained from the study. It is a synthesis of information gathered from the target sources mentioned in chapter three which describes the methodology of the study. The bulk of the information originated from responses given by farmers during the survey and in personal observations made during field visits. It also includes secondary information garnered from literature. The chapter starts by defining the general characteristics of the farmers within the study areas; a section on the adoption process follows, where an analysis of the adoption of the taught technologies through the FTE is described and factors affecting the performance of the farmer-trainers determined. An assessment of the economic returns of agroforestry innovations in comparison with other on-farm enterprises and the evaluation of the Cost Benefit Analysis of the FTE is also described and finally policy implications of the study findings on the FTE process is discussed.

5.2 General farmer characteristics

This section describes the general farmer characteristics in the study area. In the study area, a total of 174 households were visited. This included 42 households in Migori, 36 households in Keiyo, 49 households in Kisumu and 47 in Embu districts.

In the assessment of the farm household systems of the study sites, the variables family size, farm size, cultivated area and family labour were described. Table 5.1 shows the farm household characteristics in terms of the family size, contribution of the family to farm labour, the farm size and the area under cultivation.

Table 5.1:Farm Household Systems of Migori, Kisumu, Keiyo, and Embu Districts

	Migori (n = 42)		Kisumu (n = 49)		Keiyo (n = 36)		Embu (n = 47)		Total (N = 174)	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Family size	9.7	6.7	8.4	4.9	5.7	2.3	8.6	3.4	8.22	4.9
Farm Size (acres)	6.5	6.4	5.7	4.5	7.2	6.4	5.1	3.0	6.1	5.2
Cultivated area (acres)	4.0	3.9	4.3	3.4	2.6	2.5	3.5	2.5	3.9	3.2
Family Labour*	4.9	4.7	3.9	1.9	3.6	2.5	3.5	1.7	3.9	2.9

Std = Standard Deviation

Family Labour* :One unit of family labour is equivalent to six-hour day of work done by family member.

The mean family size is nearly the same for Kisumu and Embu districts and differs very little from the total study area mean. Keiyo district has a lower mean family size than the other districts, while Migori had a much higher family size mean than the other areas.

The differences in the mean farm size in the four districts was about one acre and mean farm sizes ranged from 5 acres in Embu to 7 acres in Keiyo as the higher scale. Area under cultivation was much lower than the mean farm size of the total study area, while mean area under cultivation showed a variation of 0.6 acres for Migori, Kisumu and Embu. Keiyo district reflected a rather low area under cultivation considering that it had the largest mean farm size. This could be attributed to the fact that the farmers within this region were more biased towards livestock farming than crop production. The differences in contribution of the family to farm labour was marginal, though Migori had the highest family labour input by 4.9 units and Embu the lowest by 3.5 units.

The following individual tables representing farmer characteristic categories namely, type of household, age of household head, education level of household head, and land ownership are structured in such a way that the frequencies which are in percentage, are as per particular district i.e. Migori (n = 42), Kisumu (n = 49), Keiyo (n = 36), Embu (n = 47). It also shows the frequencies of a specific attribute category based on the total study sample of the four districts i.e. (N = 174).

Table 5.2: Type of farm households

Household type	Migori (%)	Kisumu (%)	Keiyo (%)	Embu (%)	Total (%)
WH no husband	7.1	4.1	0	12.8	6.3
WH absent husband	2.4	8.2	2.8	6.4	5.2
MH monogamous	54.8	55.1	77.8	68.1	63.2
MH polygamous	33.3	20.4	5.6	10.6	17.8
MH widower	0	0	5.6	2.1	1.7
MH single	2.4	12.2	8.3	0	5.7

WH: Woman headed household

MH: Male headed household

The most prevalent household type in the total study area and also within the districts is that of a male head that is monogamous. Table 5.2 shows that polygamous families are second in the total study area having 17.8% of the total household types. They also come second in Kisumu with 20.4% and Migori with 33.3% of their respective district totals, while they come third in Embu (10.6%) and Keiyo (5.6%) districts. These results have implications on resources sharing and division of labour especially in Kisumu and Migori where some families choose to jointly farm amongst the different wives and their children. For others resources are subdivided amongst the wives and these subunits operate almost independently. There are more single men participating in the farmer-trainer extension in Kisumu and Keiyo than in the other districts and this could be attributed to their gaining access to land at an early stage (for those who are single due to age) and therefore are able to make decisions on what to farm.

The age factor in the performance of the farmer-trainers and hence the implementation of the FTE was generally considered important by the project implementers. Table 5.3 illustrates the age groups amongst the household heads interviewed.

Table 5.3: Age group categories of household heads

Age group categories	Migori (%)	Kisumu (%)	Keiyo (%)	Embu (%)	Total (%)
YA (16-30) years old	14.3	24.5	44.4	4.3	20.7
MA (31-50) years old	47.6	40.8	44.4	38.3	42.5
OA (>51) years old	38.1	34.7	11.1	57.4	36.8

YA: Young age
MA: Middle age
OA: Old age

The middle age group is the largest, both for the total sample area and also within the individual districts. The young age group is the lowest based on the total sample and also the districts', apart from Keiyo's where it ranks first together with the middle age group. This situation needs to be analyzed further as to why the young generation involved with the farmer-trainer extension are fewer in most of the study districts and to the contrary the reasons for such a high number in Keiyo district. Such reasons for this phenomenon could possibly depend on the traditional land tenure arrangement, or cultural view of farming as an activity such that the younger generation in Keiyo may be free to plant tree crops before being allocated their portions of land by their parents and still be able to reap the benefits of the tree crops even if probably allocated different land portions from where the tree crops are established.

The level of education among the farming community was considered crucial in accelerating the level of adoption through making the farmer-trainers more effective through their better ability to understand issues easily and for the farmer adopters' quicker understanding of the advocated technologies. Table 5.4 below shows that more than fifty percent of the household heads had less than eight years of formal education while only about ten percent of them had more than thirteen years of formal education.

Table 5.4: Education level categories of household head:

Education level	Migori (%)	Kisumu (%)	Keiyo (%)	Embu (%)	Total (%)
Basic	50.0	44.9	44.4	74.5	54.0
Secondary	38.1	46.9	44.4	17.0	36.2
Post secondary	11.9	8.2	11.1	8.5	9.8

Basic: This stands for less than 8 years of formal education

Secondary: refers to more than 8 years but less than 13years of formal education

Post Secondary: refers to 13 years and above of formal education.

Land ownership was considered very important in the establishment of perennials such as tree crops whose benefits are not always in the short term. The frequencies as shown in Table 5.5 on number of households that bought their own land is the highest though with a slight margin over households that acquired their land through inheritance and this observation applies within three of the districts apart from Embu district whose bulk of the land is through inheritance.

Table5.5: Land ownership and tenure arrangement of households

Land ownership	Migori (%)	Kisumu (%)	Keiyo (%)	Embu (%)	Total (%)
Own land	50.0	36.7	44.4	21.3	37.4
Ancestral/family land	45.2	42.9	33.3	63.8	35.8
Leased land	0.0	2.0	0.0	2.1	12.6
> Than one category	4.8	18.4	22.2	12.8	14.4

Own land: This refers to land bought directly by the household head and is usually with a free hold Title deed.

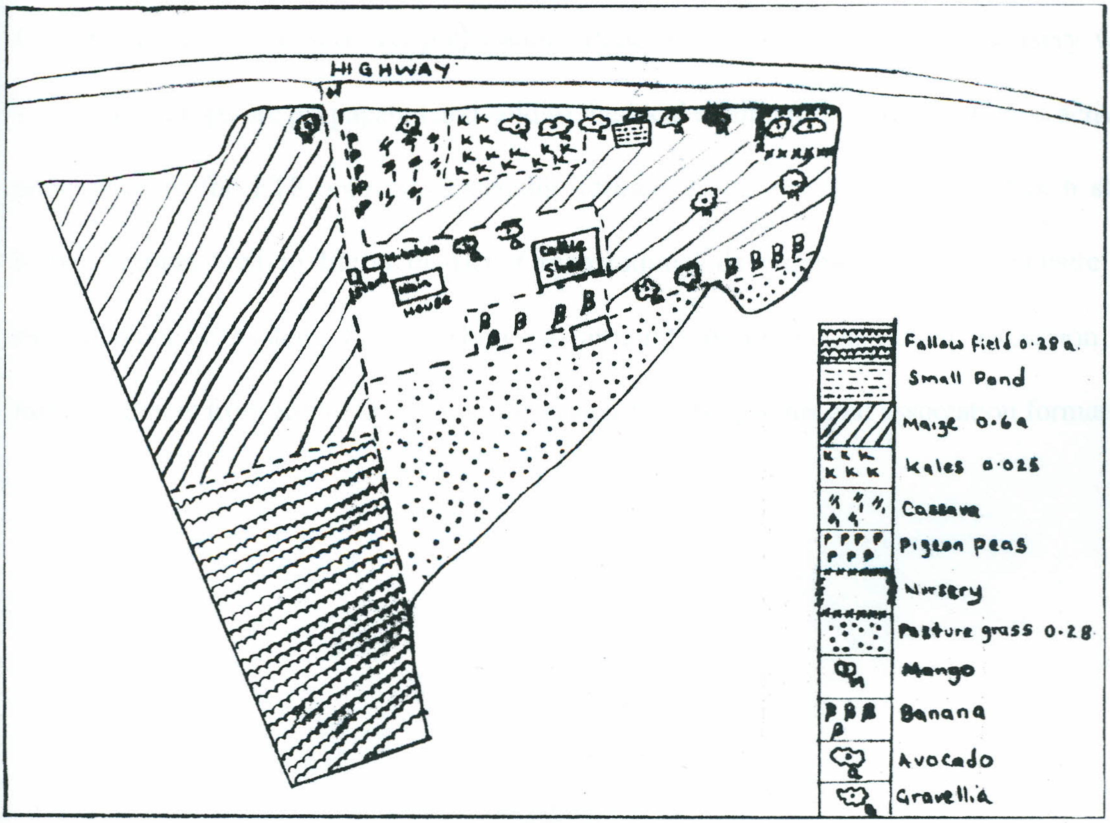
Ancestral/Family land: Refers to land inherited from the parents, and may have a free hold title or in the process of demarcation for eventual provision of the Title deed (usually on a 99 years lease arrangement).

Leased land: Implies land leased usually from a neighbour and charged per season

> Than one category: Refers to some farmers who have several pieces of land falling under the above-mentioned categories.

There are a significant percentage of farmers who have more than one piece of land with different ownership arrangement. There are some who have leased extra land but this is mainly used to grow food crops such as maize and beans, also vegetables. This is the case in Embu, Migori and Keiyo districts while Kisumu district most of the leased land was being used in Sugarcane and Rice production.

Figure 5.1: Farm Sketch as drawn by a farmer-trainer in Kisumu district.



As illustrated in Figure 5.1 a typical small-scale farm is characterized enterprise mix geared towards minimizing risks and ensuring that food is available in the household throughout the year.

The next section shows photographs depicting various activities undertaken in the FTE approach. Plate 1 shows a farmer trainer from Kisumu demonstrating to fellow farmers techniques of tree crop propagation through topworking technique. Plate 2 shows a farmer-adopter from Migori with a Van Dyke mango tree variety with fruits. Note the short height of the tree and which makes harvesting easy. Plate 3 shows an orchard in Keiyo District and where the fruit tree established is in a very rocky area. Plate 4 illustrates a training sessions for farmer-trainers on seedbed preparation. Plate 5 shows a farmer group nursery where various tree crops are propagated and sold to the local community. Farmers' tour is activities undertaken in the FTE approach to enable farmers learn from each other. Plate 6 shows Keiyo farmers visit to Embu district. Organizational development is a prerequisite of a sustainable FTE system. Plate 7 shows a farmer from Embu district in discussion with farmer-trainers from Keiyo District on the issue of farmer groups and association formation.

Plate 1: Farmer-trainer demonstrating top working techniques

Plate 2: Farmer-adopter with Van dyke mango varieties

Plate 3: Farmer-adopter in Keiyo District

Plate 4: Farmer-trainer training on seedbed preparation

Plate 5: Farmer-trainer meeting in a group nursery

Plate 6:Keiyo Farmer-trainers' tour to Embu

Plate7: Embu farmer-trainer exchanging views with others in Keiyo

5.3 The adoption process

Introduction

The adoption process section of this chapter explores the extent of adoption of the taught innovations amongst the farming community in the study areas. It also describes the conversion of farmers to farmer-trainers and farmer-followers in the FTE approach. The section concludes with a logit analysis for the determination of the factors that influence the performance of the farmer-trainers.

5.3.1: Determination of the usage of the advocated agroforestry innovations and hence the average conversion of farmers to be farmer-followers.

In order to assess the effectiveness of the Farmer-Trainer Extension approach, an analysis of the farmer-trainer network and spread effect was made for the four study sites. This was in the quest for the determination of the impact of farmer-trainer extension approach (FTE) on adoption of improved tree crop technologies and awareness creation. The spread effect of the farmer-trainer network if present would have a great influence on the sustainability of the FTE approach through the multiplier effect generated. Table 5.8 illustrates farmer participation in the FTE approach.

Within the four study districts, there is a gradual increase in the number of farmer trainers. The new farmer trainers comprise of farmer adopters who not only adopt the technologies taught by the farmer trainers but also assist the farmer trainers in the training of other farmers and continue to do so until they are considered active enough to be included in the farmer trainer planning meetings, assigned tasks like those of the original farmer trainers, and also included in the project sponsored retraining exercises and progress report writing.

Table 5.8: Farmer participation in the FTE approach

Indicators	1997	1998	1999
Migori			
Farmer-trainers	25	49	66
New Farmer-trainers participants	16	18	10
Inactive Farmer-trainers (dropped out)	2	1	0
Total farmer-adopters participation	246	385	726
General farmers (awareness creation)	1968	2310	2175
Embu			
Farmer-trainers	26	35	50
New Farmer-trainers participants	12	20	7
Inactive Farmer-trainers (dropped out)	3	5	1
Total farmer-adopters participation	228	366	590
General farmers (awareness creation)	970	1890	2470
Kisumu			
Farmer trainers	26	41	61
New Farmer-trainers participants	16	24	21
Inactive Farmer-trainers (dropped out)	1	4	2
Total farmer-adopters participation	475	827	1120
General farmers (awareness creation)	1425	2481	1770
Year	**1998**	**1999**	**2000**
Keiyo			
Farmer trainers	24	36	48
New Farmer-trainers participants	12	12	7
Inactive Farmer-trainers (dropped out)	0	0	0
Total farmer-adopters participation	75	117	353
General farmers (awareness creation)	300	585	1918

The new farmer-trainers are drawn out of the farmer-followers constituting farmers who have shown a lot of self-initiative in awareness creation and tree crop propagation. The farmer- trainers do this selection themselves. From the table, Kisumu has the highest level of farmer- adopters followed by Migori then Embu and finally Keiyo. The number of adopters does not in itself signify the extent of adoption because planting of a single improved tree crop was taken as adopting just as planting of large numbers of improved varieties. Keiyo's lower numbers could be attributed to a large extent on the shorter project period since the adoption picks up impressively in the third year.

5.3.2: Factors associated with effectiveness of the farmer-trainer in influencing the adoption of Agroforestry production decisions.

A number of studies have been carried out to relate farmers' adoption of new technologies to various socio-economic factors (Feder et al., 1985; Nowak and Korsching, 1982; Mwangi, 1992; Elias, 1997; Akinwumi, 1996). Some earlier studies used correlation analysis to examine the factors affecting adoption decisions of farmers but these studies provided no information on the quantitative importance of the explanatory variables, policy makers could therefore not appreciate the significance of these factors (Sureshwaran et al., 1996). Correlation analysis is still useful though, in directing on variables that need be looked at more rigorously.

There are various possible models for this analysis, this include linear probability models, least squares regression models with limited dependent variables (Tobit) and binary choice models such as probit and logit. The logit model is based on the following relationship:

$$P_i = F(X_j'b) = \frac{1}{(1 + \exp(-X_j'b))}$$

where, P_i is the probability that the farmer is an effective performer as per the farmer-trainer extension approach index, and is dependent on a vector of variables, X_j and a vector of unknown parameters *b*.

A logit model was considered appropriate in this analysis. This is due to the fact that the response factors considered were dichotomous dependent variables. In our case we are considering whether the farmer-trainer is effective or not, as defined by the performance index concept. Based on the studies already done on adoption, a conceptual framework model was established to explain the effects of the socio-economic factors on the effectiveness of the farmer-trainers in influencing adoption of agroforestry technologies.

The model to evaluate the farmers' performance in the FTE approach is derived through development of a performance index (PI), resulting from a summation of the difference between a farmer-trainer's mean number of farmer adopters trained and that of the group mean within a specific period. This is necessary since the farmer-trainers have joined the FTE approach at varying times, which also have to be taken into account. Hence individual farmer- trainers' performance indexes derived are not biased towards farmer-trainers with a longer experience in the FTE approach. The PI indexes are consequently arranged in ascending order and a median PI arrived at.

From the formulae the median of the performance indexes derived was considered the cut off point amongst the farmers. Those above the median were considered above sample average and therefore more effective than those below the median performance index.

The performance Index in this study is defined as follows:

$$PI = \frac{?_{i}^{n} \; (Y_i - M_i)}{n}$$

where; PI = Performance Index

Y_i = Actual number of farmers trained by a farmer-trainer in year (i)

M_i = The sample mean of the number of farmers trained in year (i)

(n) = The number of years since training as farmer-trainer.

$$\text{Performance} = b_0 + b_1\text{FAMHD} + b_2\text{GDER} + b_3\text{AGE} + b_4\text{FAMLB} + b_5\text{HLAB} + b_6\text{LBAV} + b_7\text{LADOWN1} + b_7\text{LADOWN2} + b_7\text{LADOWN3} + b_7\text{LADOWN4} + b_8\text{FRMSZ} + b_9\text{CAQRE} + b_{10}\text{TRENS} + b_{11}\text{EDUC} + b_{12}\text{LOCT} + b_{12}\text{LOCT1} + b_{12}\text{LOCT2} + b_{12}\text{LOCT3}$$

The selection of the variables was based on a priori assumption of their relevance in influencing the performance of the farmer-trainers. Some of the variables included in the logit regression model (Table 5.9) included farm household type, gender, age, hired labour, land ownership and location among others. Location as a variable encompassed many characteristics that were location specific such as socio-cultural factors.

Table 5.9: Definition of variables included in the logit regression model

Variable name	Description
PERFORM	1 if farmer is above median hence effective, 0 below median hence non effective
FAMHD	Farm household type, monogamous or polygamous
GDER	Gender whether farmer-trainer is male or female
AGE	Age group the farmer belonged youth, middle age, or old age
FAMLB	Contribution to labour by family members
HLAB	Use of hired labour: 1 for yes, 0 for no
LBAV	Labour availability when required: 1 for available, 0 for not available
LADOWN	Landownership whether bought by farmer, ancestral, leased, or more than one of the categories.
FRMSZ	Farm size measured in acres
CAQRE	Availability of credit facilities for the farmer: 1 if yes, 0 if no
TRENS	Presence of tree nursery in the farm: 1 if yes, 0 if otherwise
EDUC	Education level of farmer in number of years spent in formal school.
LOCT	Location of farmers' farm in respect to study sites whether in Migori, Kisumu, Keiyo or Embu

The Logit model required four iterations to generate the parameter estimates. The hypothesis tests are based on the Wald statistic, which has a Chi-squared distribution. The likelihood ratio index indicates that the logit model explains approximately 49 percent of the total variation in the dependent variable (Table 5.10). This is still reasonable for an analysis of cross-sectional data. The likelihood ratio test statistic exceeds the critical chi-square with 18 degrees of freedom at less than 0.00 level of significance. Hence the amount of variation explained by the model is significantly different from zero. Through classification of the predicted value of Farmer trainer effectiveness (denoted as PERFOM) as 1 if P_i =>0.5 and 0 otherwise another measure of goodness of fit is arrived at.

Table 5.10: Explanatory Statistics for the logit model

Statistic	Value
Sample size	174
Number of iterations	4
-2 log likelihood function	186.075
Goodness of fit	184.540
Chi-square statistic for significance of equation	51.819
Degrees of freedom for chi-square statistic	18
Significance level for chi-square statistic	0.0000
Correctly specified [a]	72.99%
Sensitivity [b]	77.78%
Specificity [c]	66.67%

[a] Based on a 50-50 probability classification scheme

[b] Correctly predicted performers based on a 50-50 classification scheme

[c] Correctly predicted non-performers based on a 50-50 classification scheme

The model correctly predicts 72.99 percent, of the observations as shown in Table 5.10. The sensitivity (correctly predicted performers) and the specificity (correctly predicted non-performers) of the logit model are 77.8 percent and 66.7 percent, respectively.

The results of the logistic regression (see Table 5.11) show a highly significant association between performance and the following factors: Presence of a tree nursery in the farm; Gender of the farmer-trainer; farm size; location of the farm household in terms of the study areas. The other factors e.g. age, education of the farmer-trainer, household type, land ownership, availability of hired labour contribution to farm labour by family members all proved top have no association with performance of the farmer-trainer.

Table 5.11: Results of logit regression

Variable	Coefficient	Standard error	Significance
Constant	4.7936	1.9915	.0161
FAMHD	1.2197	.7754	.1157
GDER	-1.0847	.4943	.0282**
AGE	-.2529	.2759	.3594
FAMLB	2.3304*		.3119
HLAB	-.3360	.4290	.4335
LBAV	.3662	.5393	.4971
LADOWN	8.3865*		.0784
FRMSZ	.5700	.2665	.0325**
CAQRE	-.0577	.5466	.9160
TRENS	-1.7783	.4030	.0000**
EDUC	.2753	.2988	.3568
LOCT	8.1180*		.0436**

*Wald coefficient

**Highly Significant varables

α=0.05

The presence of a tree nursery in the farm has a high significant (α=0.0000) association with the farmers' performance in influencing other farmers to adopt tree crop production. This could be attributed to the fact that adoption of the technology on offer requires improved germplasm that the farmer-trainers can immediately provide from their nursery to the farmers in training, if they do have nurseries. Since the tree crop seedlings are offered at a cost, the farmer-trainers become highly motivated when the farmers being trained agree to adopt and buy their seedlings.

Gender was found to be of significance in the performance (α=0.0282) but this was most probably due to the fact that selection of the farmer-trainers in some of the study sites e.g. Migori, Kisumu and to a lesser extent Keiyo had an obvious bias towards the males. The females were more likely to have a higher performance and this could be attributed to their better organizational ability (they tended to form groups more often) and spend more time within the farms.

The farm size was a factor indicated to influence performance (α=0.0325) where it is positively related to the size of the holding. The reasons as advanced by Feder et al., (1985) could be due to the fact that the size of the holding is a surrogate for a large number of other factors such as size of wealth, access to credit, capacity to bear risk, access to information among other factors.

Location of the farmer-trainers in the four districts under the study was also found to have significant association with performance (α=0.0436) of the farmer-trainers and even more than the farm size the location was a surrogate of a large number of other factors such as cultural /socio-economic background of the people in the different districts, presence or absence of a major market outlet and the period the project has been in operation within the study area.

5.4:Economic analysis

5.4.1: The economic returns of agroforestry innovations in comparison with other on-farm enterprises, and the Cost Benefit ratio of the farmer trainer extension approach.

Introduction

As it may take seven to fifteen years for trees to have significant ecological effects, it is necessary to consider both the level of farm output and the trends. Part A of the economic analysis section of this chapter is a comparison of the financial returns of tree crops and other crop production enterprises. This is followed by part B, which is an analysis of the benefits, accrued from the farmer-trainer extension approach, and its distribution among the community. An enumeration of the cost involved in the FTE follows as part C and the section will conclude with part D that explores the policy implications of the Farmer-trainer extension approach.

A) The financial returns of tree crops in comparison to other crop production enterprises within the farm household.

The study looked at the various household enterprise data over a period of five years for three areas namely Embu, Migori and Kisumu. This was mainly in crop production. Concise livestock information was unavailable and was therefore not included. Data for Keiyo district was based on one year only having been entered into the FTE approach later than the other study areas. From the data availed mean gross margins were calculated and this mainly involved calculation of the enterprise outputs less the direct costs, using Microsoft access program and the results are shown in Table 5.12.The production of food crops is steady within the districts other than during times of drought as shown in Table 5.12.The major food crops grown consist of maize, beans, sweet potatoes, sorghum, millet and cassava. Most food crops are consumed within the household, the farmers depend more on the horticultural, industrial and tree crops for cash. Horticultural produce mostly grown is tomatoes, onions, kales and cabbages. In all the study sites the major factor in income contribution to the household through horticultural enterprises is the market prices, which are seasonal and difficult to predict. The industrial crops involved include sugarcane and cotton for Kisumu and Migori, coffee and tobacco for Embu. The industrial crops contribution to farm income has been on a steady decline and this is attributed to poor prices being offered to the farmers by the industries concerned.

Table 5.12: Mean contribution to farm income of crop enterprises over 5-year period (Values in KSH)

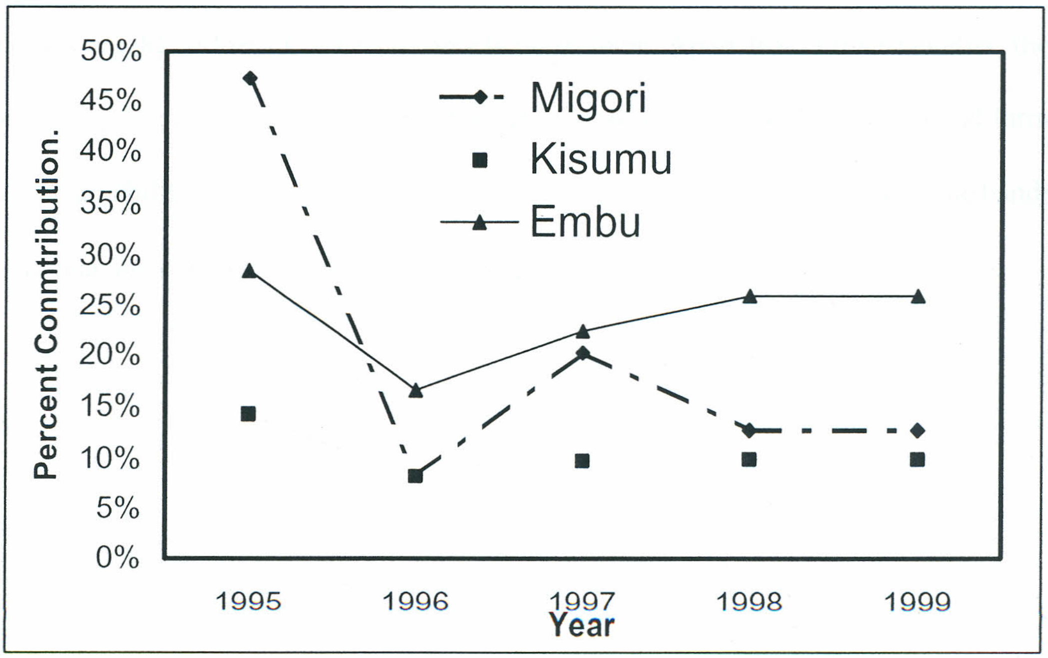
	1995	1996	1997	1998	1999
Food Crops					
Embu	5048	10935	7875	6825	6739
Kisumu	7930	20589	17472	13926	13222
Migori	7782	13093	13033	12367	12778
Horticultural Crops					
Embu	0	2805	2525	5700	2025
Kisumu	13200	19800	5925	18000	2025
Migori	2468	3362	1488	3500	3883
Tree Crops*					
Embu	5865	7724	7930	9650	15422
Kisumu	5152	5402	4771	5197	8309
Migori	17868	13047	8031	6889	4797
Industrial Crops					
Embu	9650	25122	17071	14903	14026
Kisumu	9650	25122	23825	14903	14026
Migori	9650	26875	17071	31216	28925

Tree Crops*: This excludes coffee and tea, which are classified under the industrial crops.
Ksh*: 78Ksh = 1US$

An illustration of the trend in contribution to mean farm income by tree crops in three of the study sites (Figure 5.1) confirms the direction of change in income from the enterprises over a 5-year period. This can also be achieved through simple linear regression of the data presented in Figure 5.1. In the illustration, Migori shows a big decline, which is attributed to the reduced income from citrus fruits as a result of the citrus greening disease, and the general drought over the same period. The effect was also experienced in Kisumu and Embu district though not to such a big extent.

Embu district shows a gradual increase of income through tree crops and these can be attributed to their efforts in improving their tree crop varieties and hence the value in the market.

Figure 5.2: Percentage mean contribution of tree crops to farm income over a five-year period



B) Benefits from the farmer-trainer extension approach.

The farmers trained under the FTE approach were expected to establish high quality tree crops that could also earn them income throw both the domestic and export markets. Data was collected on the farmer's establishment of tree crops within the study sites. This was a prerequisite in assessing the accruing and potential benefits of the technologies advocated through the FTE and from which an "Ex ante" and "Ex post" economic analyses was done by comparing the costs incurred versus benefits accrued. In the farmer-trainer training, farmers were encouraged to grow tree crops that they felt would best suit their needs. A large variety of tree species were established and whose benefits as perceived by the farmers are outlined in Table 5.13. From the table the total marked (Total*) represents the percentage total of farmers who viewed a particular impact aspect as beneficial to them. (Total number respondents. **) represents the total number of respondents per district who found that the technologies taught and practiced were beneficial to them. Apart from direct benefits, there are other intangible benefits of the farmer trainer extension, which include: improved farmer organizational ability, environmental awareness and good land management husbandry, good farm management and good record keeping.

Table 5.13:Farmers perceptions on impact of taught agroforestry technologies

Impact of Agroforestry Technologies	Migori	Kisumu	Keiyo	Embu	**Total***
Improved soil fertility	3.08	6.17	3.70	1.85	**14.8**
Provision of firewood	11.72	12.34	1.85	7.4	**33.3**
Provision of fodder	6.79	4.93	2.46	0.617	**14.8**
Provision of Timber	6.17	10.49	3.08	4.94	**24.7**
Income from sale of fruits	16.04	13.58	12.96	25.9	**68.48**
Prevention of soil erosion	4.32	0.617	0.617	2.46	**8.0**
Aesthetic i.e. beauty, shade	3.70	6.17	1.23	3.08	**14.2**
Total number respondents. **	40	43	34	45	**162**

From the table the biggest benefit accruing is that from the sale of fruits and this is in all the study districts. It is followed by provision of firewood in Migori, Kisumu, and Embu. Keiyo farmers consider agroforestry for soil fertility improvement more important. This fact can be attributed to the fact that there are still wide areas in the district especially in Soy division where the land is still community land and is not demarcated. This land has an abundance of trees and shrubs, which the community makes use of for firewood, whereas in the three aforementioned districts their land has been demarcated and utilized for cultivation. Firewood in such cases is expensive and valued more highly. Other beneficial aspects of agroforestry include prevention of soil erosion, provision of timber and trees for aesthetics. Some benefits would have their full ecological effects at the time of maturity of the trees. Participation in the farmer trainer extension transcended various age groups and farmer categories and this ensured that the benefits would encompass the whole community.

Embu district's preponderance in adoption of improved mango varieties as compared to the other districts, made it necessary to increase the survey sample in order to be clearer on whether the results represented the true situation of the adopters. The study also analyzed the mango varieties and the trend in production shows that there are some that are more preferred than others (Table 5.14). The Kent variety was much more popular due to the fact that it fetched a good price in the local markets while Tommy Atkins was second in preference due to its popularity in the export market. The values shown in Table 5.14 represent the number of improved mango varieties that were established and survived the year of establishment. From the table, the decline of establishment of improved mango varieties in Embu in 1999 was due to the drought that was experienced and which caused a high mortality of the planted seedlings.

Table 5.14: Tree improvement and the establishment of export quality mango varieties from 100 randomly sampled farmer adopters in Embu.

Mango Varieties	**1997**	**1998**	**1999**	**Total**
Kent	390	1100	745	2235
Van Dyke	100	207	170	477
Haden	50	156	100	306
Ngowe	93	150	50	293
Sensation	140	50	17	207
Parvin	0	10	17	27
Tommy Atkins	300	400	221	921
Apple	35	11	9	55
Total	**1108**	**2084**	**1329**	**4521**

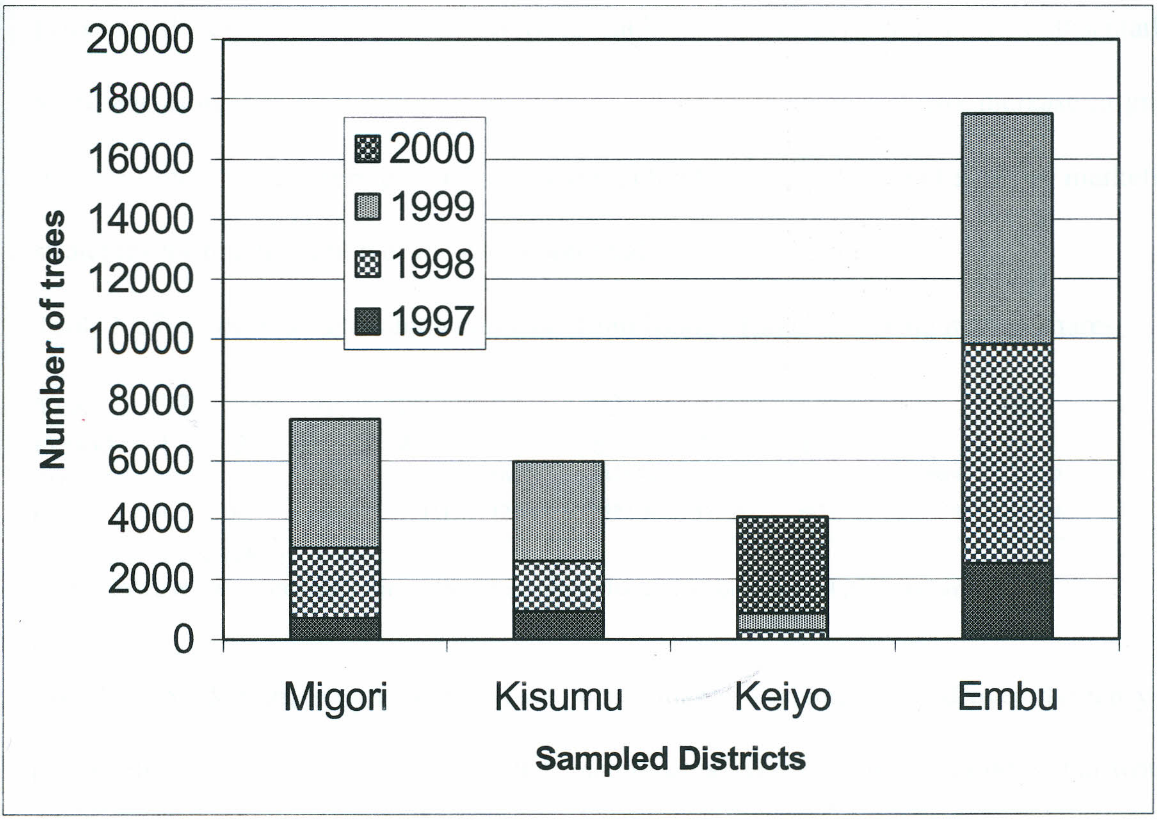
Data on some of the major tree crops grown amongst the respondents surveyed in Migori, Kisumu, and Keiyo districts is shown in Table 5.15. Migori had mangoes being more popular while more avocados were planted in Kisumu. Keiyo had more tissue culture bananas introduced during the period. Among non-fruit tree crops grown and which were popular was fodder, calliandra in Migori and luceana and calliandra in Kisumu. The levels of production of mangoes in Kisumu, Migori and Keiyo were not comparable with that of Embu, which was quite high. Kisumu experienced a very low production level of mangoes in the year 2000 which the farmer attributed to lack of readily available improved germplasm

Table 5.15: Tree improvement and the establishment of export quality varieties from 50 randomly sampled farmer-trainers in Migori, Keiyo and Kisumu Districts

Tree crop	1997	1998	1999	2000	Total
Migori district.					
Improved Mango	150	297	295	442	**1184**
Improved avocado	85	120	115	180	**500**
Oranges	25	14	18	20	**77**
Calliandra	67	134	63	178	**442**
Kisumu District					
Improved Mango	100	109	131	38	**378**
Improved avocado	189	182	159	116	**646**
Paw paws	0	25	20	15	**60**
Calliandra	150	306	265	232	**953**
Lucaena	85	180	87	38	**390**
Keiyo District					
Improved avocado	0	30	21	35	**86**
Paw paws	0	311	287	720	**86**
Banana	0	487	224	380	**1091**
Banana	0	151	98	149	**398**

Figure 5.2 illustrates the trend of mango establishment and survival over a three-year period under the FTE approach. The results show that there is a steady increase in the four study areas but among the districts, Embu has the highest establishment followed by Migori. Keiyo district started the FTE approach in 1998 and made a big increase in the third year possibly due to a big interest created among the farmers by the farmer trainers.

Figure 5.3:Total yearly establishment of improved Mangoes among the adopters* in the four study district



*: Derived from the means of mango trees established by the sample population

NB: Data not recorded in the study for Embu, Kisumu, and Migori for the year 2000.

Table 5.16: Projected Mango production and cost per tree over a ten year period

Years	**1**	**2**	**3**	**4**	**5**	**6**	**>10**
Yield	0	0	50	100-200	250-500	500-600	>1000
Cost*	15.6	15.6	50.5	50.5	50.5	50.5	50.5

Cost*:In Ksh based on the 1997 pricing. The cost is based on the average cost incurred by the established small-scale mango producers in the study area.

The expected annual revenue for the mango fruits based on the average production levels in the whole study area as per the yield projection shown in Table5.16, and the 1997 farm gate prices for the export market are presented in Table 5.17. The analysis assumes a 30% market share and compares with a 60% market share. The results show a steady increase in gross income from the fruit trees planted and also highlights the importance of superior marketing strategies for maximization of the profit potential.

Table 5.17: Expected Total annual revenue from Mango fruits at varying market shares

Year	97	98	99	00	01	02	03	04	05	06
Period	1	2	3	4	5	6	7	8	9	10
30%	0	0	8262	35722	86459	141139	211327	296089	378989	481572
60%	0	0	16524	71444	172918	282278	422657	592178	757978	963144

*: Revenue in US $ (KSH 78 per $).
Mango Price at farm gate export price (Ksh 8 per fruit) based on constant real price assumption

The 30% market share is a safety factor on the mango revenue accrued over the ten year period and which takes into account such factors as adverse climatic conditions that would reduce productivity, pest infestation that occasionally lowers the marketability of the fruits especially in the export market and the possibilities of a glut in the later years if farmer organizational development is not yet ready to improve on marketing and still rely on middle men for their marketing activities. This would be especially so if the current tree crop establishment continues at the current rate.

C) Costs involved in the Farmer-Trainer Extension approach

There are various costs involved in the setting up and implementation of the farmer trainers, some which are incurred by the farmer and others, which were incurred by the facilitators. Table 5.18 is a summary of the FTE activities undertaken in the years 1997,1998, 1999 and 2000 in the four study sites; corresponding direct costs for the training activities, motherblock establishment and follow up.

Table 5.18: Table of FTE activities and corresponding Costs* in the study sites

Facilitators costs	1997		1998		1999		
Migori	No.	Costs	No.	Costs	No.	Costs	Total
Training (Tree propagation &Planning)	2	83000	2	120000	2	120000	323000
Follow-up (Transport)	6	62000	3	43000	12	89000	203000
(Tools & equipment)	0	0	12	35100	9	23400	58500
Mother tree and scions	200	18000	200	18000	100	4500	40500
Kisumu							
Training (Tree propagation &Planning)	2	83000	2	120000	2	120000	323000
Follow-up (Transport)	6	62000	3	43000	12	89000	203000
(Tools & equipment)	0	0	12	35100	9	23400	58500
Mother tree and scions	200	18000	0	0	100	4500	22500
Embu							
Training (Tree propagation &Planning)	2	83000	2	98500	2	101000	282500
Follow-up (Transport)	6	49300	8	72200	5	54900	137200
(Tools & equipment)	0	0	12	35100	9	23400	58500
Mother tree and scions	100	19000	150	23320	160	13500	55820
Keiyo	1998		1999		2000		Total
Training (Tree propagation &Planning	2	43000	2	50000	2	30000	123000

Follow-up (Transport & farmer tour)	10	26000	5	276000	12	23000	325000
Mother tree and scions	200	18000	200	35100	100	4500	57600

Costs*: in Ksh (78Ksh=1U.S$)

The first training of farmer-trainers involved selection of farmers who were invited for an in house training lasting 3 days which involved an intensive on the job training in grafting techniques, nursery establishment and other agronomic aspects such as crop protection. The training involved both the farmers and extension staff. Other costs shown in Table 5.18 include costs of improved fruit tree seedlings that were supplied to the farmers in an effort to establish motherblock that would also be sources of scions to other farmers later. Scions were also provided to the farmers in the course of the years in order to improve the local fruit trees already in the farms through Topworking. Follow up involved the extension staff in their facilitative role and the ITFSP (project) team, which made field visits according to the plan of operation agreed to earlier on, with the farmer trainers during planning meetings. Retraining was also conducted according to demand and training was done on perceived problem areas.

Economic analysis results are presented in Tables5.19-5.21. Inflation is accounted for in the discount rate, which is pegged at 18%. The costs and prices used in the analysis use 1997 as the base year. The benefits accounted for in the analysis are primarily derived from the production of the improved mangoes. The reason for this is the fact that mango establishment was done in all the study areas and this presented the highest income option among the tree crops within these areas.

In Table 5.19 the costs are twofold whereby the costs at the farmers level are viewed as an externality at the facilitators level. The benefit and cost streams are represented over a ten-year period. The figures computed in the Table 5.19 represents the total number of mango trees established by the farmers through the FTE within a three year period in the four study areas as shown in Table5.14 and Table 5.15. The input costs per tree for the farmer constitutes the cost of propagation and inputs such as fertilizer, the cost of other agronomic practices such as pruning, fruit staking and crop protection. Note that after an initial increase in the cost per tree, by the sixth year of production cost evens out when desired canopy size is achieved and the annual cost thereof is the same, given base year prices. The economic analysis covers mango established in the study areas through the farmer trainer extension approach between 1997 and 2000. The net benefits are derived from the difference between the total operating costs, which include both the farmers' costs and the costs incurred by the project facilitators. The farmers' opportunity cost is based on the number of days spent on the farmer trainer activities and this is equated to the cost of manual labour in the community.

Table 5.19: Economic analysis of the Farmer Trainer Extension Approach

	1997	1998	1999	2000	2001	2002	2003	2004	2006	2007
	1	2	3	4	5	6	7	8	9	10
Benefits										
Income from mangoes	0	0	8262	35722	86459	141139	211327	296089	378989	481572
Variable Costs*										
1) Farmer costs										
Input cost of trees	839	3156	8227	14046	21192	22613	22613	22613	22613	22613
FT opportunity costs**	53	64	64	53						
2) Total operating costs	6119	9363	13406	9366						
Total cost (1+2)	7011	12583	21697	23435	21192	22613	22613	22613	22613	22613
Net Benefits	-7011	-12583	-13435	12287	65267	118526	188714	273476	356376	458959
Discount factor (18%)	.847	.718	.609	.516	.437	.370	.314	.266	.225	.191
NPV	-5938	-9034	-8181	6340	28522	43855	59256	72744	80184	87661
PV of benefit stream	0	0	5032	18433	37783	52221	66357	78760	85273	91980
PV of cost stream	5938	9034	13213	12092	9261	8367	7100	6015	5088	4319
B/C ratio										5.42

Variable Costs*:In US Dollars

FT opportunity costs**: Farmer-trainer opportunity cost in terms of labour units for days spent in training other farmers, at the rate of three days per adopter trained.

The analysis done in Ms Excel spreadsheet shows that after initial negative net present values for the first 3 years, positive net present values are attained in the year 2000 (Table 5.20) thereafter these increase tremendously with the increase in fruit production per tree.

Table 5.20: Summary of the economic analysis

	97	98	99	00	01	02	03	04	05	06	Total
NPV	-5938	-9034	-8181	6340	28522	43855	59256	72744	80184	87661	363590
PVB	0	0	5032	18433	37783	52221	66357	78760	85273	91980	435839
PVC	5938	9034	13213	12092	9261	8367	7100	6015	5088	4319	80427
B/C Ratio											5.42

NPV: Net Present Value PVB: Present Value of Benefit stream

PVC: Present value of cost stream B/C Ratio: Benefit Cost Ratio

Markets, inflation, and policies are often unpredictable to such an extent that predicting prices and consequent benefits with any certainty a few years in the future is difficult.

Table 5.21 shows various discount rates with their subsequent net present values. Though the discount rate is taken to be 18%, which is generally the lowest interest rate that the farmers could avail credit commercially by 1997. There is need for sensitivity analysis given the turbulence in interest rates.

Table 5.21: Sensitivity analyses for the FTEs' Total 10 year period.

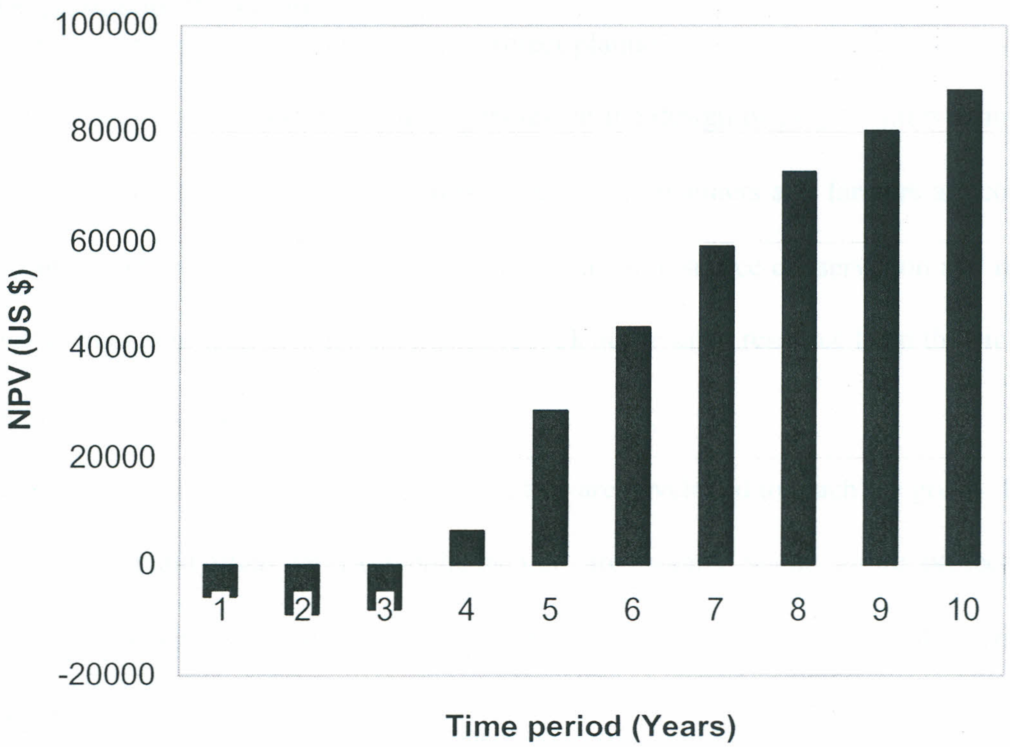
Discount Rates	0%	5%	10%	15%	18%	24%	30%
Total Net Present Value	1903612	1168818	734794	470192	363590	220819	138964

Figures in US Dollars at (Ksh 78)

The sensitivity analysis represented in the Table 5.21 shows that the project was highly viable since despite higher discount rates being used the net present value is still large. Note that at five percent discount rate the farmer adopters are able to earn the equivalent of half the project cost of 2.5Million U S Dollars within a ten-year period and this is a proof of the viability of the technology practiced.

Figure 5.3 shows the trend in net present values over time, where the first 3 years a negative NPV is attained since fruit production has not commenced yet. In the fourth year a positive NPV is attained and continue to increase in subsequent years, as fruit production increase.

Figure 5.4: Net present values over a ten-year time frame



The benefit cost analyses shows that the FTE approach is economically viable and more so noting that not all the benefits accruing were taken into account and that only the improved mango was considered. The production projection of the Mango tree is such that it will continue increasing it's production with age and does so for more than twenty years. The benefits from Mango production is therefore bound to improve especially if the market prices will remain stable based on the 1997 prices.

D) Discussion on Policy Implication

The perceptions of government officials, project planners as well as representatives of non-governmental organizations and donor agencies, in the design of project interventions often differ with those of the farmers. When perspectives of planners and farmers are compared, the former tend to look at forests and trees as means to resource conservation and reversing environmental degradation, whereas the latter look at the same resource from the view of the household's overall needs.

Farmers have clear visions, goals and actions that are developed to reach the goals. Planners on the other hand often develop policies that are usually vague, more protective and restrictive in nature. They adopt strategies that are inconsistent, at times contradicting each other (Malla, 2000).

Experience from past forestry and agricultural development programmes indicate that institutional support for programme implementation is as important as the biological performance of the promoted technologies. The experience in agroforestry to date is no exception. In recent years it has become apparent that agroforestry implementation in many countries is hampered by a lack of supportive policies and institutions concerning equitable land-tenure legislation, adequate research and extension, market support and development and credit availability (Chew, 1989;Mercer and Soussan 1992).

In order to explore the policy implications for the farmer-trainer extension approach in agroforestry, a situation analysis was conducted and a list of constrains affecting the adoption, implementation and use of agroforestry technologies were analyzed.

Table 5.22 shows the various constraints experienced by the farmers who felt that they were a major issue in then adoption and expansion of agroforestry technologies. The constraints are expressed as a percentage within particular districts and also as a percentage in the whole study area.

Table 5.22: Proportion of farmers expressed as a percentage facing various constraints in adoption and expansion of agroforestry.

Constraints of agroforestry	Embu	Keiyo	Kisumu	Migori	Total*
Unavailability of appropriate germplasm	8.5	16.7	14.3	7.1	11.5
Insufficient Knowledge on agroforestry	2.1	11.1	8.2	14.3	8.6
Lack of nursery tools and implements	4.3	0	0	23.8	6.9
No major problem experienced	0	2.8	8.2	14.3	6.3
Weather unpredictability (drought, floods)	48.9	16.7	24.5	9.5	25.9
Lack of credit facilities	12.8	13.9	4.1	9.5	9.8
Agroforestry being labour intensive	0	0	0	2.4	0.6
Pests and diseases	4.3	0	18.4	2.4	6.9
Shortage of land for expansion	0	0	2.0	0	0.6

Total*: Refers to the number of farmers expressed as a % experiencing it as a major constraint within the whole study areas (n=174) as compared to within particular districts.

From the table, the major constraint is weather unpredictability and more so with drought spells in Embu, Keiyo, and Migori while flooding was a major constraint in the Nyando plains of Kisumu. Unavailability of appropriate germplasm at the right time was also a very pertinent issue and in Keiyo district it tied in ranking with the weather unpredictability. Lack of credit facilities came in third in the list of priority issues, and this was followed by insufficient knowledge on agroforestry technologies. The little credit availed was mostly specific to particular cash crops such sugarcane, tobacco and coffee and was given in kind i.e. in terms of inputs. Pest and disease constraints, lack of nursery tools and implements were also noted as major issues though this could be related closely to aforementioned constraints of credit availability and insufficient knowledge.

From the above problem analyses the major policy and institutional constraints can be summarized to include: research and extension support; marketing, pricing and credit. The principal institutional constraints were in relation to: inadequate extension; little state financial assistance and limited affordable credit.

Research and Extension support

In order to analyze and improve on the Farmer-Trainer Extension approach it is important to examine the other extension methodologies particularly what has been in use, so as to set a basis for comparison.

The Training and Visit (T&V) system of extension that was first implemented in 1982 as a pilot project in Kericho district and then followed nationwide through the Kenya National

Extension Project (NEP) in 1983. An evaluation of the T&V system (Vishva and Robert, 1993) through a study of seven districts showed that financial commitments were as shown in Table 5.23.

Table 5.23:Resource allocations to extension

	Total for NEP period	Average annual for NEP Period	1982/83	Farm household per frontline extension worker	
	(Constant 1991 Thousand U.S Dollars)			1982/83	190/91
Allocations	7552	959	1170		
Emoluments	21665	2752	1602		
Total	29217	3,711	2,772	913	816

(An excerpt from "Evaluation of the Performance of T&V Extension in Kenya: World Bank Technical Paper Number 208, 1993 pg 50)

The table shows that the total commitments to extension in the seven districts under study increased from 2.77 million dollars in 1982/83 to an average of 3.71 million dollars a year in 1991 constant terms. This in comparison to the costs involved in the FTE approach is a very high figure (see Table 5.18). The T&V system also requires adequate extension staff in place to maintain an acceptable farmer to extension staff ratio.

Against a background of reduced government spending, reduction in extension staff through retrenchment, and reduced employment levels it is important to support other extension approaches that would ensure adoption of improved technologies at reasonably lower costs.

Table 5.24 shows the fact that most farmers involved in the FTE wanted an increase of practical training and regular joint follow-ups between farmer trainers and the extension staff.

Table 5.24:Percentrage responses on methods of FTE approach improvement

Methods of farmer-trainer improvement	Embu	Keiyo	Kisumu	Migori	Total*
Group formation	48.1	22.2	18.5	11.1	15.5
Supply of necessary training facilities	17.2	27.6	34.5	20.7	16.7
Increased practical training for the farmers	33.3	15.2	33.3	18.2	18.9
Motivation of farmer-trainers	0	16.7	16.7	66.7	6.9
Encouraging regular farm visits	20.0	33.3	13.3	33.3	8.6
Encourage regular joint follow ups	22.7	27.3	31.8	18.2	12.6
Expand training topics	31.6	10.5	31.6	26.3	10.9
Provide facilitation in terms i.e. transport	28.6	14.3	28.6	28.6	4.0
No changes required	20.0	10.0	40.0	30.0	5.7

Total*: Refers to the number of farmers expressed as a % suggesting specific FTE improvement method within the whole study areas (n=174) as compared to within particular districts.

Supply of necessary facilities for training was also an important factor in improvement of the approach. In Embu district where there is already a big production of fruits for the market, the farmers prioritized group and association formation very highly. Given the suggestions above it is necessary to link up the farmer trainers with the extension staff in areas of common interest so as to act complementarily in areas of mutual interest. It is also necessary to train extension staff on their modified role as facilitators and advisors. The aim is to encourage a demand driven extension where the farmers can request specifics from the extension service and even be ready to pay for the service.

Marketing, Pricing and Credit.

The information gathered so far shows that farmers need capital not only to improve and expand production of tree crops but also to improve on the organizational capacity in the FTE approach. The pertinent issue has been whether funds can be available and under what terms. Table 5.25 shows that very few of the farmers were able to get credit and those who did, say that it was very expensive for their production levels.

Table 5.25: Percentage of farmers with credit facilities

	Embu	Keiyo	Kisumu	Migori	Total*
Received credit	46.80	2.78	4.08	14.28	17.82
Had no credit facilities	53.2	97.22	95.92	85.72	82.18

Total*: Refers to the total number of farmers receiving credit within the whole study area (n = 174)

In order to commercialize effectively, a number of issues raised by the farmers need to be addressed and policy proposals put forward. There is need for group formation and possible associations that would look into marketing possibilities for the small-scale farmers; it should also look into aspects of credit facilities for the farmers at manageable interest rates. The experience so far with farmer cooperatives is that they succeed as long as they are small scale. Giant cooperatives have so far shown weaknesses in accountability and leadership which has led to many of them collapsing, leaving the farmer members feeling bitter and disillusioned. The suggestion would therefore be to form horticultural marketing associations under the private companies act that would make the elected directors more accountable to their members. They also would be required by law to declare a statement of the associations' accounts and to have annual general meetings. Quality is an important aspect for export of fruits and the association would assure a certain level of quality for the market through stringent crop protection guidelines for it's members. The associations thus formed would form the umbrella under which the FTE would operate and possibly even provide the funds needed in engaging the extension workers to facilitate the farmer-trainers in their activities. The ultimate goal would be to encourage the setting up of a national lobby body for agroforestry products and which would be charged with the responsibility of networking, standard setting and accessing export markets.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This study has provided useful information on the Farmer-Trainer Extension (FTE) approach in tree crops and agroforestry in general in four sites namely Migori and Kisumu districts of Nyanza province; Embu district in Eastern province and Keiyo district of Rift Valley province. The information has focused on the spread effect of the FTE approach and the adoption of high value tree crops and the factors affecting performance of the farmer-trainers. The economic impacts of the adopted technologies have also been documented.

6.2 Conclusion and recommendations

The farmer-trainers were able to initiate diffusion of high value tree crops through training their fellow farmers on skills in improved tree management. They also established where resources allowed, decentralized germplasm production and distribution systems that made available germplasm for farmers adopting the technology at a cost.

The multiplier effect of the farmer-trainer extension renders the approach sustainable more so if group formation and organizational development were initiated. This is due to the fact that farmer organizations are expected to take the initiative in determining the pace and direction of the development process and also demand from the facilitators such as the extension service and researchers the necessary information and training required.

The performance of the farmer-trainers was found to be location dependent. This therefore indicates that socio-economic, cultural factors and nearness to a major market would influence the adoption of the technologies and as such also influence the performance of the farmer- trainers. The policy process would therefore need to take into account the specificity attached to every location and the effects and ramifications of various policy instruments. Another factor that was found to influence performance of the farmer-trainer is the mode of selection of the farmer-trainers and initiation of the FTE process. Where the FTE set up was participatory, involving the farmers, the extension staff and the initiators of the project, success was more assured. The programme was also more likely to be sustainable.

The study showed that there was hardly any direct financial support to farmers through provision of credit whereas many of the issues raised by the farmers for expansion of agroforestry and improvement of the tree crops needed capital. The farmers who adopted the tree crops in their farms felt that the evident lack of capital restricted the scale of production and only expanded when extra income was available at the farm level. Other farmers charged grafted mango seedlings for their neighbours and charged them for the service. The policy recommendations would therefore involve either subsidies by the government on farm inputs or encouraging local finance institutions to finance farmer organizations that support the farmers at a lower interest rate, by lowering taxation of these institutions.

The study proved that a demand driven (in terms of felt needs) and farmer led extension (such as FTE) make desirable impact and lead to increased integration of tree crops into the farming systems. This is as a result of the fact that the farmers not only are able to get information as to why they should integrate the crops but also how they should do it. As a result of the perceived benefits, a demand for the technology is created at the farm level where the farmer trainers fill in by training their neighbour farmers skills in production of the tree crops.

The farmer-trainer extension approach needs to be addressed as a viable extension approach and policy. Institutional factors such as encouraging formation of farmer associations and strengthening existing ones by enabling them to provide credit and eventually extension services to their members. Another institutional factor needing support is the establishment of strong research-extension linkages that would involve the farmer-trainers in farm trials and germplasm bulking and distribution. This needs to be put in place to facilitate implementation of the approach by the extension service.

Through the FTE, areas with very few enterprise choices as a result of their climatic conditions are able to generate income at the farm level through propagation of high value tree crops that begin to yield within three years of propagation. The high value crops propagated are also drought tolerant to some extent and are able to produce in times when traditional food crops cannot. It is therefore important to expand the use of the approach in many of the semiarid areas, where it can produce early results.

The economic analysis done shows that production of high value tree crops such as mango is a very good opportunity for poverty alleviation. These may be produced in areas where both land use and economic choices are limiting. Appreciation of the potential of the FTE and its improvement and funding through the Ministry of Agriculture would be very advisable and a step towards a self sustaining extension service.

Formal credit is not available to the tree crop farmers. With rising input prices, credit becomes increasingly important to farmers. In collaboration with the government and other stakeholders, the formal credit system needs to address the credit problems faced by the small-scale farmers. This should include information about formal credit and procedures for obtaining it.

Farmer organization formation should not only be encouraged but the government and other stakeholders should formulate means of improving and supporting these organizations so that they can take the initiative in development and therefore make the process sustainable. The issue of gender balance in constituting the farmer-trainers is an aspect that could ensure successful implementation of the FTE.

It is evident from the study that a key factor in fostering tree crops is the establishment of highly decentralized nursery and seedling distribution system operated by the farmers that is responsive to their demands. This would need concerted efforts by the extension service in locating sources of good quality germplasm.

6.3 Suggested Areas for further Research

There is need for acquiring data on fuelwood consumption, tree stocks, yields, depletion rates and ecological conditions. This would enlighten people on the need and importance of tree crops integrated in the farming systems. There is also need for studies of the sociological, economic and tenurial factors that are likely to influence community's response to natural resource management programs and their choice of trees. The response towards various policies, economic and legal by the farmers in the area of natural resource management and agricultural development needs to be evaluated, and the resultant action taken documented. This would improve the policy formulation processes, making them more community sensitive and ultimately result in positive response towards conservation and development.

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APPENDIX 1:QUESTIONNIARE ON CBA

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QUESTIONNAIRE ON COST BENEFIT ANALYSIS OF THE FARMER TRAIN FARMER EXTENSION APPROACH: A STUDY OF AGROFORESTRY PRODUCTION SYTEMS AT SELECTED PROJECT SITES IN EASTERN AND NYANZA PROVINCES OF KENYA.

The purpose of this research is to evaluate the farmer-trainer extension approach in agroforestry in terms of its economic viability and impact, as reflected by the farmers practicing agroforestry and those adopting through the approach. The findings of this research may be of assistance to the policy makers, the small-scale farmers and other interested parties in rural development as they seek solutions to the reduction of poverty and the improvement of the general well being of the small-scale farmers.

The information is for academic purposes and will be treated in strict confidence. Kindly respond to all the questions by either ticking where appropriate or filling in the blank space where necessary. If the space given is not sufficient, kindly use a separate sheet of paper or turn the back of the appropriate page. Thanks in advance.

Enumerator ______________________________ Date of Interview ___________

District _________________________________ Location/village________________

1.Name of farmer____________________________

2.Household Type:

Woman headed, no husband	
Woman headed, married	
Male head, one wife	
Male head, polygamous	
Woman head husband away	
Male head widower	
Male head, not married	

3.Farmer interview:

Respondent	
Male	
Female	
Both	
Both separately	

4.Age:

16-20 years	
21-30 years	
31-40 years	
41-50 years	
51-60 years	
61 and above years	

5. Education level:

Nil	
Primary (1-4)	
Primary (5-8)	
Secondary (1-2)	
Secondary (3-4)	
Secondary (5--6)	
Post secondary training	
Diploma	
University	

6.How many members of your family work with you in the farm:____________

7.Number of family members:________________People

8.Number of children among them (Below 16 years of age) ______________Children

9.Do you employ hired labour?_______________

Permanent___________workers:_______Man-days/season___

Casual piecework_____workers:_______Man-days/season___

No hired labour

10.If hired labour, how do you pay hired workers?

Payment in cash _______________Ksh

Payment in kind________________

11.Are there always enough workers available?

Yes____ No____

If not, why?

1.____

____

2.____

____

12. Do you receive unpaid assistance from neighbours or friends for the production of your crops?

Yes____ No____

If yes, how many days per year?

_______________ Mandays/year

13.Farm size___________________________

14.Land Ownership:

Own land___________

Communal__________

Leased___________(At how much________From Whom_________

Family/Ancestral_______

15. Area currently cultivated:_______________

16.Farm enterprises:

1995

Enterprises	Farm area	Production	Yield

1996

Enterprise	Farm area	Production	Yield

1997

Enterprise	Farm area	Production	Yield

1998

Enterprise	Farm area	Production	Yield

1999

Enterprise	Farm area	Production	Yield

17. Do you use fertilizer?

Yes__________No_______

18. If yes what kind of fertilizer?

Fertilizer	Food crop	vegetable	Fruit trees	Timber trees	other
CAN					
DAP					
NPK					
UREA					
MANURE					
COMPOST					
GREEN MANURE					
Others					

19. If not, why not?

____

____

____

20.What are the prices for the fertilizers used?

Fertilizer	Price / unit(specified)
CAN	
NPK	
UREA	
MANURE	
COMPOST	
GREEN MANURE	
OTHER	

21.What is your source of seeds?

Farm_________________

From Out_____________

SEED TYPE	COST

22. Do you protect your crops against pests and diseases?

Yes_________No_________

23. If not, why not?

____

____

____

24.If yes what crop protection measures do you apply and how much would it cost?

Crop protection activity	Food crop	Fruit trees	vegetables	Timber	others

25. Do you obtain credit from any person or institution?

Yes_________ No ___________

26. If yes from where do you get it?

Source	**Interest payment**

27. What of the following types of trees do you grow in your farm? How many trees do you have from every type?

Fruit Trees		Fodder trees		Timber trees		Soil fertility/cons.		Medicinal trees		Other tree types	
Type	No.										

28. Do you have a nursery in your farm?

Yes___________ No___________

29. If yes is it group owned or is it individual?_____________

Item	output	cost

30. Have you grown any of the Agroforestry trees in your farm?

Yes________________No_________________________

31.If yes who informed you about it?

____

32. If no why not?

1.I have not been informed about it _______

2.I was informed by _______________________but could not because of________

____

____

33. Since you were informed about Agroforestry have you expanded production?

Previous year	Last year	This year

34.What are the financial returns per agroforestry practice

Agroforestry practice	Cost		Net income
	Labour man-days	others	

35.Have you trained other farmers on agroforestry techniques?

Yes___________No________________

36. If yes how many have you trained

Previous year	Last year	This year

37.What problems have you encountered with adopting agroforestry practices?

____

____

____

____

____

____

38.What problems have you encountered as a farmer training other farmers on agroforestry techniques?

____

____

____

____

____

____

39.Are you in position to expand area planted under agroforestry?

Yes__________No ______

40.If yes

Agroforestry practice	Area for expansion

41.If no Why?

(a) Shortage of land

(b) Have enough

(c) Question not answered

(d) Other(specify)____

____

42.In what year did you build your last house?____________________

43. Where did you obtain poles for the last house you constructed?

(a) From own farm
(b) Bought from neighbours
(c) Bought from market
(d) Given by neighbours/relatives
(e) Other (specify)____

____

44.Did you use any of the following for fuel over the past year?

Fuel type	yes	no	Reason: Scarcity	Other	Month used
Charcoal					
Cow dung					
Paraffin					
Firewood species (specify)					

45.How often do you collect fuelwood and who does?

Person	Busy period: Times/week	Hours/time	Slack period: Times/week	Hours/time
Female adult				
Female child				
Male child				
Other (Specify)				

46.Do you feed your animals with tree fodder?

Yes__________ No____________________

47.If yes,

Fodder tree	**Quantity**	**Cost if sold**	**Time period**

48.What are the major constraints to tree planting? (If more than one please rank)

Reason	Yes	No	Rank
Damage by termites			
Shortage of land			
Lack of seedlings/seeds			
Competition with crops			
None			
Lack of know how			

49.If you have been trained by your fellow farmer trainers what can be done to make them more effective?

____

____

____

____

50.How can the farmer trainers integrate more with the extension agents to make easier and better information exchange?

____

____

____

____

51.Has the agroforestry practices taught and practiced made an impact to your household? If yes how?

____

____

____

____

52.Farmers off farm activities:

Off farm activities	Husband	Wife	Other
None	0	0	0
Salaried	1	1	1
Business	2	2	2
Casual	3	3	3

Other (specify)____

____

53.General questions asked by the farmer.

____

____

____

____

54. General comments by the enumerator on respondent

____

____

____

____

55.What do you think is the income level of the farmer?

High _____

Low______

APPENDIX II: GROUP QUESTIONNAIRE

Agroforestry technologies provide multiple outputs and services to farmers and as well requires changes in the way farmers allocate labour and other inputs. Because of this complexity, it is unwise to launch studies to examine factors associated with adoption solely from a deductive perspective. (Franzel Steven et al 98)Workshops with the focus group will therefore be a valuable initial step in the study of the adoptability of Agroforestry technologies.

The main objective of the farmer workshops will be to help researchers through the: -

- Identification of important effects of technologies, both positive and negative.
- Identification of invisible effects (spill over effects) such as secondary effects on other farm enterprises.
- Identification of farmer's own variables used to evaluate the performance of technologies.
- Clarification of plot, household and larger scale constraints to adoption and impact of technologies.
- Public policies and institutions influence on the biophysical performance, profitability and acceptability of Agroforestry practices.
- Historical perspective of Agroforestry and production trends (hence creating a time lines to provide an opportunity to find out about past innovating and interventions and

their effects; to discover and enforce shared aspirations within a group; to establish support as people are usually pleased that others show an interest in their history.

I Assessment conducted in analyses of adoption potential of selected agroforestry practices.

Decision tree: Expansion of Agroforestry trees by farmer trainers.

Practi ce	Biophysical performance	Profitability		Acceptability						
		P. budget	Enterprise budget	R	Q	S	R	D	F	M

Where Under acceptability:

R_1-Resource budget

Q-Evaluation of quality of technology

S-Surveys of problems

R_2-Risk assessment

D-Decision tree

F-Farmer assessment surveys

M-Monitoring expansion

II. **Farm models comparing net returns to labour per year of farms practicing Agroforestry with other farm enterprises, and those that do not practice Agroforestry.**

Crop	Area (Ha)	Workdays/yr	Yield (Kg)	Net returns/yr

III. Problems that farmers faced in growing Agroforestry trees

Problems	Number and % of farmers having as main problem	Number and % of farmers mentioning problem	Number of farms where interviewers observed problems not mentioned by farmers

IV. Farmers mean ratings of species, using bao game on growth characteristics, intended uses and preference for future planting.

Species	Growth	Bio mass	Compatibility with crops	Fodder	Food	Firewood	%Farmers preferring, for future planting

V Chronology of Agroforestry and high value tree production in the areas.

VI A study of markets for fruits and other Agroforestry products and inputs to determine prices, demand and supply.

Products/markets	Local	Regional	National	Export
Fruits				
Agriculture crops				
Fuelwood				
Charcoal				
Medicines				
Pulpwood				
Fodder				
Sawed logs				
Poles				
Others				

APPENDIX IV:KEY INFORMANTS QUESTIONNAIRE

DISTRICT EXTENSION OFFICERS

DISSEMINATION OF HORTICULTURE / AGROFORESTRY PRACTICES

1. (i) What in your view has been the major bottleneck in the dissemination of horticultural / fruit tree technologies to the farming community within the District?

____

____

–

____

–

____

–

(ii) Could you rank these problems in order depending on what is most limiting.

____

____

–

____

–

____

–

2. According to your experience, can you evaluate the Farmer Train Farmer Approach in terms of the following:

(i) Cost-effectiveness (a) Very Good

(b) Good

(c) Poor

What are the reasons for your choice?

1)____

2)____

3)____

(ii) Sustainability (a) Very Good

(b) Good

(c) Poor

What are the reasons for your choice?

1)____

2)____

____

3)____

____

____

(iii) Ability to integrate with other dissemination technologies.

(a) Very Able

(b) Not Quite

(c) Impossible

What are the reasons for your choice?

1)____

____

____

2))____

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3)____

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3. How best would we be able to improve and institutionalize the Farmer Train Farmer Approach and thus make it more effective, in terms of: -
   (a) Training of Farmer trainers.
   (b) Facilitation of Extension agents
   (c) Follow-up of field activities.
   (d) Monitoring and Evaluation system

4. what criteria was used in selecting the project sites within your District?

   (a)____

   (b) ____

   (c) ____

   (d) ____

5. From your experience with the farmer trainers could you illustrate in a kind of analogy that shows the persistence and/or failure rate in recruitment and training of Farmer trainers. For example Trained 30, 5 dropped out. Why? after how long?

Number Trained	Number dropped out	Year	Time period

6. What are in your opinion the adoption rates for technologies in the following fields currently?

Field	**Adoption rate %**
(a) Horticulture / Vegetables	________________
(b) Horticulture / Tree crops	________________
(c) Coffee	________________
(d) Food Crops	________________

HORTICULTURAL MARKETING

1.What has been the trend in marketing over the last 3 years of the following commodities in terms of volumes traded and cash generated?

COMMODITY	VOLUME			PRICES		
Horticultural (Veg)	**1999**	**1998**	**1997**	**1999**	**1998**	**1997**

COMMODITY	VOLUME			PRICES		
Horticultural (Tree crops)	**1999**	**1998**	**1997**	**1999**	**1998**	**1997**

N.B -Rank from highest to lowest.

1.Who are the major exporters currently interested with horticultural commodities within Embu, and what commodities are they interested in?

EXPORTERS	COMMODITY

3. From your records what is the current production levels of the following fruit crops within the district.

CROP	**FARM AREA**	**PRODUCTION**
(a) Mangoes	________	________
(b) Bananas	________	________
(C) Papaws	________	________
(d) Avocadoes	________	________
(e) Passion	________	________
(f) Macadamia	________	________
[g] Others	________	________

4. What are the major bottlenecks experienced in fruit (tree crops) marketing. Rank them according to the most limiting.

5. According to you how best can these issues be addressed?

(a) At district level

(b) At Policy level