ASSESSMENT OF THE CONTRIBUTION OF AGROFORESTRY TO POVERTY ALLEVIATION IN LUSHOTO DISTRICT

BY

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ABSTRACT

This study was initiated to assess the contribution of agroforestry to poverty alleviation in Lushoto District, Tanga, Tanzania. A total of 134 respondents were involved from two wards Soni and Ubiri. Four villages two from each ward were surveyed. Data were collected using structured questionnaire, focused group discussion and through physical observation. Statistical Package for Social Science computer software package was the main tool employed in data analysis. In this regard distribution of responses, central tendency and dispersion, and multiple linear regression analyses were explored. Results indicate that two agroforestry systems namely agrosilvicultural systems and agrosilvopastoral systems were practiced mainly in the uplands. Statistically ($P \leq 0.05$), farmers practicing agroforestry had significantly higher contribution to the household's level of farm production and net income and thus poverty alleviation than those who were not practicing agroforestry. Given the average farm size of 3.1 ha, 2.3 cows and 9.2 chicken, the annual production for farmers practicing agroforestry was 425.9 kg for maize, beans 225.7 kg, coffee 101.1kg, and 163.9 bunches of banana, 999.12 litres and 373.5 eggs compared to 342.6 kg of maize, 202.1 kg of beans, 75 kg of coffee, 108 bunches of banana, 1 120.6 litres of milk and 338.6 eggs for farmers not practicing agroforestry. The average household annual net income was Tshs 664 992 (US$ 665.0) and 547 608 (US$ 547.6) for farmers practicing and not practicing agroforestry respectively. The income per capita was Tshs 100 756 (US$ 100.8) for farmers practicing and Tshs 82 971 (US$ 83.0) for farmers not practicing agroforestry. However, the level of household farm production and net income was generally lower compared to most of findings from other agroforestry systems due to partial adoption of the agroforestry technologies to some farmers and poor management. Therefore, overcoming these constraints could improve and probably sustain productivity of the agroforestry systems and their contribution to poverty alleviation.

DECLARATION

I, Eustack M. Bonifasi do hereby declare to the Senate of the Sokoine University of Agriculture that this dissertation is my own original work and it has never been submitted for a degree award at any other University.

Signature..

Date.......22/11/2004..

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DEDICATION

To my beloved parents, wife, children and uncles.

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CBC	= Coffee Berry Disease
ERP	= Economic Recovery Programme
HADO	= Hifadhi Ardhi Dodoma
HASHI	= Hifadhi Ardhi Shinyanga
HIAP	= Handeni Integrated Agroforestry Project
HIMA	= Hifadhi Mazingira
ICRAF	= International Centre for Research in Agroforestry
IPRSP	= Interim Poverty Reduction Strategy Paper
LAMP	= Land Management Programme
NESP	= National Economic Survival Programme
SAP	= Structural Adjustment Programme
SECAP	= Soil Erosion Control and Agroforestry Project
SCAPA	= Soil Conservation and Agroforestry Project Arusha
SPSS	= Statistical Package for Social Science
SWCW	= Soil and water conservation measures
TAFORI	= Tanzania Forestry Research Institute
Tshs	= Tanzanian shillings
URT	= United Republic of Tanzania
US$	= United States Dollar

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Tanzania like other developing countries is facing a major problem of rapidly increasing number of poor people despite of her great attempts and strategies being made against poverty since independence (World Bank, 1993; Cooksey, 1994). About, half of her population today is basically poor and one third are living in abject poverty (World Bank, 2000). For instance, between 15 million and 18 million Tanzanians live below the poverty line of $0.65 a day. Of these, nearly 12.5 million live in abject poverty, spending less than $0.50 on consumption a day (URT, 2000). According to World Bank (1998), majority of the poor are living in rural areas, where over 80% of the economically active population of small-scale farmers is employed in agriculture (World Bank, 1994; Limbu, 1999).

The industrial and service sector jobs, which could serve as alternative sources of income through employment in the rural areas are growing slowly and poorly developed (Limbu, 1995; World Bank, 1996). The agricultural sector remains the main solution to rural poverty alleviation, but again has been declining rapidly to the extent that it can no longer meet the needs of rural people (Lipton, 1990; World Bank, 1994; 1996). Therefore, the poor typically lack capital and human assets; they are less educated, of ill health and have large families (World Bank, 1993; Cooksey, 1994; URT, 2000).

The major causes of the declining agriculture production in the rural areas have been the low use of mineral fertilizers due to low income; estimated high rates of soil erosion due to insufficient conservation measures; poor cycling of nutrients and negative farm nutrients balance (Kaoneka, 1993; World Bank, 1994, 1996). Others include rapid decline in average farm sizes which necessitate substantial change in traditional farming systems; production of only staple cereal crops while paying little attention to some potentially more profitable farm enterprises and elimination of the agricultural input and credit subsidies to the rural poor (Cooksey, 1994; World Bank, 1996, 2000).

In preparation for successful rural poverty alleviation the government emphasized on development and dissemination of appropriate and environmentally friendly agricultural technologies through the agricultural research centers; in order to promote sustainable food security, income generation, employment growth and export enhancement (World Bank, 1994; Limbu, 1999; URT, 1999).

Agroforestry is among such supporting technologies, which was purposely introduced to restore land productivity and improve the ecological and living conditions of the rural families (SECAP, 1991; Semgalawe, 1998). It can provide a wide range of goods and services to the rural community. Trees may provide food, shelter, energy, medicine, cash income, raw materials for crafts, savings and investments and resources to meet social obligations (Rocheleau *et al.*, 1988; ICRAF, 1995, 1996; Sanchez, 1995). May also provide varieties of services such as improvement of soil fertility for crop production, the improvement of microclimate, for crop growth and control of crop and pests (Young, 1989, Arnold, 1992; Nair, 1993). It can protect and improve the quality of natural resources including water, vegetation and soil and substitute for the destructive use of special environments like hill slopes, forests and fragile rangelands (Rocheleau *et al.*, 1988; Young, 1989). However contribution of agroforestry to household's agricultural production and income from elsewhere is well documented (Nair, 1987; Rugalema, 1992; ICRAF, 1995, 1996; Moshi, 1997; Tulchan and Jabbar, 2000; Dolberg, 2002).

In effect to that, to date many projects with various packages of agroforestry technologies have been launched in various parts of the country. Some of these projects include Soil Erosion Control and Agroforestry Project (SECAP) in Lushoto, Soil Conservation and Agroforestry Project Arusha (SCAPA), "Hifadhi Mazingira" (HIMA), "Hifadhi Ardhi Dodoma" (HADO), Land Management Programme (LAMP), Handeni Integrated Agroforestry Project (HIAP), Hifadhi Ardhi Shinyanga (HASHI) to mention a few. A lot have been done by these projects; starting from the point of sensitization to integration of various agroforestry technologies into the poor rural farming systems (Kerkhof, 1990; Johansson, 2001).

There are also other traditional agroforestry systems in Tanzania, which have lasted for generations and for decades and have been adopted by farmers in parts of the country. These include the Chagga homegardens (O'kting'ati, 1985) and those of Kagera (Rugalema, 1992).

However, the extent to which agroforestry contributes to poverty alleviation in the study area through improved agriculture production and household incomes is not adequately established and thus the remaining area for research and development.

1.2 Problem Statement and Justification

Rapid population growth rates (URT, 1988, 1991) and cultural change (Mersmann, 1993 cited by Johansson, 2000) has led to loss of biodiversity and agricultural complexity in the west Usambaras. Farmers gradually freed themselves from cultural and social constraints to resource mining that were implied by a pre-colonial social system; thus, become more selfish individualists seeking short-term profit at the expense of ecological sustainability, food security and social equity. The demand for fuelwood, food, settlements, and grazing and agricultural land had increased (Iversen, 1991; Kaoneka, 1993; Semgalawe, 1998; Monela *et al.*, 1999). Until 1970s hilltops and steep slopes of most of the west Usambaras were badly eroded. The natural vegetations were nearly disappearing and the weather conditions were changing together with the quality and quantity of water, vegetation and soils. There were no enough pastures and soil fertility was declining leading to serious deforestation, overgrazing and land degradation; vicious circle of poverty, deteriorating production capacity and thus serious food insecurity (Kerkhof, 1990; SECAP, 1991, 1999; Johansson, 2001).

To address the problem, the government of Tanzania in collaboration with the *Deutsche Gesellschaft fü Technische Zusammenarbeit* (GTZ) established and funded the Soil Erosion Control and Agroforestry Project (SECAP) in 1981, with major objectives of stabilizing the ecological conditions, restoration of land productivity and improving living conditions of the rural poor by increasing agricultural, livestock and wood production (SECAP, 1984, 1987, 1999; Scheinmann and Mchome, 1988; Kerkhof, 1990; Johansson, 2001).

Preliminary results indicate that, the project has been successful in impacting the intended development by integrating various agroforestry technologies into the poor rural farming systems leading to reversing environmental degradation, improving land productivity and welfare of the rural households. As a result, rural households have now developed highly varied and complex sets of livelihood strategies (Kerkhof, 1990, SECAP, 1999; Johansson, 2001). However, the biggest weakness was lack of sufficient baseline data influenced by the project on the socio-economic and cultural factors in the study area, which is mandatory in any intervention. For example, there was lack of information on exactly to which extent agroforestry was contributing towards poverty alleviation through sustainable household's farm production and income generation among the rural poor in the Lushoto District. Also, the socio-economic and social cultural constraints facing agroforestry practices towards alleviating poverty was not documented. Furthermore, little was known about farmer's attitude on the impact of the adopted agroforestry technologies to farm productivity. Therefore, a comparative households' farm productivity and income assessment between farmers practicing and not practicing agroforestry in the Lushoto District was important as a basis for understanding, improving and promoting agroforestry towards poverty alleviation.

1.3 Objectives of the Study

1.3.1 General objective

The general objective of this study was to assess contribution of agroforestry systems and practices to poverty alleviation in Lushoto District.

1.3.2 Specific objectives

1. To identify and assess status of the existing agroforestry systems and practices in Lushoto.
2. To determine and compare the level of household's farm production and the associated net income between farmers practicing and not practicing agroforestry in Lushoto.
3. To assess the socio-economic and social cultural constraints facing agroforestry practices towards improving household's farm production and income in Lushoto.
4. To indicate areas of intervention for improvement of agroforestry and its contribution to poverty alleviation in Tanzania.

1.4 Scope of the Study

Since it was hardly possible to combine all the indicators of poverty in a single study, poverty in this research was considered in a narrow sense of household's level of farm production and net income as proxy variables of poverty level. Other factors being constant, poverty alleviation was synonymous to an increase in household's income and farm production. Therefore, once households get products or income of which the value exceeds that of costs incurred, they would have surplus to reduce some deficiency in some spheres of life, be it in nutrition, housing, clothing, education, health or others.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Defining Agroforestry

A number of authors have defined agroforestry in different ways (Rocheleau et al., 1988; Young, 1989; Nair, 1993; ICRAF, 1996) but common to all is that, they based on its structure and objectives. In general, agroforestry emphasizes on maximum or sustainable production and optimum environmental conservation. It is for this reason that there has been a popular concept among agricultural development and environmental specialists and is often invoked by scientists and planners, as a solution to rural development needs in most developing countries (Balasubramanian and Egli, 1986; Rocheleau *et al*, 1988; Arnold, 1992; Scholes, 1994; ICRAF, 1995; SECAP, 1999).

However, for the purpose of this study, the definition given by Young (1989) has been adopted. The author defined agroforestry as a collective name for land use systems and practices in which woody perennials (trees, shrubs etc) are grown in association with herbaceous plants (crops, pastures) and/or livestock in a spatial arrangement, rotation or both and in which there are both ecological and economic interactions between the trees and non-tree components of the system. The main components of agroforestry being trees and shrubs, crops, pastures and livestock together with the environmental factors of climate, soils and landforms. The woody component may be intergraded for wood, fodder, food (fruit, leaves etc), shade, recreation and conservation. In this context therefore, the major goal is to optimize the production per unit area whilst at the same time respecting the principle of sustainable yields.

2.2 Criteria for classifying Agroforestry Systems

For any system to be easily analysed, evaluated and develop action plans for its improvement, there should be a means of classifying it. Likewise, there have been several criteria for classifying agroforestry systems (Nair, 1985a). These include those, which based on the system's structure, function, socio-economic, and ecological status (Nair, 1987, 1990). The most obvious and easily used criterion is the one based on the systems structure (Nair, 1985a). Therefore, for the purpose of this study, we adopted the structural classification criterion of the agroforestry systems.

2.2.1 Structural classification of agroforestry systems

By structural classification in agroforestry systems, we refer to the composition of the wood perennials, herbaceous and the animal components of the systems, spatial admixture of the woody component, vertical stratification of the component mix and temporal arrangement of different components (Nair, 1985a, 1987). It is well documented and widely recognized, thus, on this basis the land use systems could be grouped as agrosilviculture, silvopasture, agrosilvopasture aquasilviculture and apisilviculture (Nair, 1985a; Rugalema, 1992; Lulandala, 1994; Lightfoot, 1991 cited by Wouters, 1994; Moshi, 1997).

2.2.1.1 Agrosilvicultural system

This refers to the land-use and management system whereby there is a deliberate combination of woody perennials and agricultural crops on the same land management unit in various forms of configuration. The interactions are made in such a way that must permit significant economic and ecological interactions between the woody and non-woody components (Nair, 1987; Lulandala, 1994; ICRAF, 1996).

Several sub-systems can also be defined from this system according to the type and arrangement of its constituents like shifting cultivation, homegardens, alley farming/ hedgerow intercropping, taungya, boundary/shelterbelt/windbreak planting, live fences, mixed intercropping, rotational cropping systems and contour-ridge/contour-bunds planting as documented from elsewhere (Nair, 1987, 1990; Rocheleau *et al.,* 1988; Rugalema, 1992; Lulandala, 1994).

The system has high potential in areas where agricultural crops production is the dominant economic activity of the involved communities (Nair, 1985a; Lulandala, 1994; ICRAF, 1995).

2.2.1.2 Silvopastoral systems

This is an agroforestry system whereby there is a deliberate integration of trees/shrubs into the pasture or range land to increase its productivity (i.e. meat, milk, hides and skins, animal dung, fruits, vegetables) and make wood available for the community. Under this system, the overstorey tree component creates favorable microclimate conditions for growing forage (pasture or hay), while growing a tree crop at the same time. In this land management system animal component is the dominant feature of the farming system (Nair, 1985a; Lulandala, 1994).

2.2.1.3 Agrosilvopastoral system

This system involves a deliberate combination of woody perennials (trees/shrubs), animal component and herbaceous plants managed on same land unit. The interactions are intended and managed to permit significant economic and ecological interactions between the woody and non-woody components of the system. It is common in areas where the agricultural crops production and animal husbandry go hand in hand as equally important economic activities of the communities in question. The components of the system is sequenced in such a way that animal component enters the production system after the crop is harvested i.e. tree/crop then tree/animal. Sometimes through partial indirect arrangement, it is possible for the system to serve the tree/crop/animal at the same time. Therefore, during the cropping season, the animal components can continue benefiting from the system through a cut and carry mechanism of fodder material from the farm to the stall-fed housed livestock or supplementing the pastures external to the agrosilvopastoral system (Lulandala, 1994). The Chagga, Usambaras and the Haya traditional homegardens in Tanzania are among the typical examples of the system (O'kting'ati, 1985; Rugalema, 1992; Moshi, 1997).

2.2.1.4 Aquasilvicultural system

This is the system whereby management of aquatic life forms e.g., fish, crocodile, shrimps *etc* requires either directly or indirectly plants based materials (both aquatic and terrestrial) of which trees/shrubs are main component (Lulandala, 1994). In this system the aquatic life forms benefit from the trees through shade, food (leaves, flowers and roots) and also get safe areas for laying their eggs; mangrove system being a good example (Tejwani, 1987). Fish and sometimes prawns are grown in farm ponds, paddy fields and canals (Nair and Sreedharan, 1986). The interaction of aquaculture and forestry into agriculture based farms as a sustainable farming system is well documented from Malawi and Pakistan (Amin, 1989; Wouters, 1994).

2.2.1.5 Apisivicultural system

This refers to the land management system, which involves a combination of tree based vegetation and keeping of insects. Beekeeping industry is highly dependent on the flowering plants of which trees/shrubs are main components (Lulandala, 1994). Some farmers place their beehives on the shade trees especially *Cordia africana, Croton macrostachys* and *Erythrina burana* (Poschen, 1986) and sometimes on Grevillea robusta (Fernandes *et al.* (1984) and harvest honey periodically, either for sale or consumption. Other apicultural systems include the production of some insects for food e.g. grasshopper, senene in the west lake Region of Tanzania, various types of caterpillars in Zimbabwe and southern highlands of Tanzania, and sexual winged termite or production of insects products e.g. silkworms for silk production in the far east Asian region (China, Japan etc) (Lulandala, 1994).

2.3 The Linkage between Agroforestry and Poverty Alleviation

The attributes of agroforestry are well matched to our need to maintain productivity and profitability, protect natural resources and the environment, and provide for people's needs, now and in the future. Therefore, the linkage can be explained/ justified under the social, ecology and economic considerations.

2.3.1 Social considerations

Introduction of tree farming into the rural world creates new employment through wood related industries and timber production under agroforestry systems (Kessy, 1992; ICRAF, 1996). This plays great role in poverty alleviation following that majority of the poor in the developing countries are living in rural areas and depend on agriculture for their survival of which also have been declining to the extent that can no longer meet their needs (World Bank, 1998). In addition, the industrial and service sector jobs are poorly developed, leading to increasing trends for the young people to migrate to urban areas in search for employment as hired personnel (Fernandes *et al*, 1984; World Bank, 1996). Therefore, agroforestry cannot only improve agriculture productivity but also occupy local labour in the rural areas, which would be temporarily underutilized in seasonal farming systems (Rocheleau *et al.*, 1988; Kessy, 1992). The trees and crops into such systems may contribute to the social integration for the rural populations like rangelands, they are not only stabilizing the ecology but also survive and earn their livelihood through improving farm production (Rocheleau *et al.*, 1988). Trees used in the agroforestry systems can provide variety of services such as improvement of soil fertility for crop production, the improvement of microclimate for crop growth and the control of crop pests (Swaminathan, 1988; Rocheleau *et al.*, 1988). They provide service functions like Nitrogen fixing, nutrient cycling, soil conservation, microclimate improvement and weed suppression (ICRAF, 1996). Therefore, for resource poor farmers' efficient nutrient management emanating from Nitrogen fixing, nutrient cycling, use of green manure or crop residues and proper soil conservation measures are the building blocks of sustainable productions, ecological stabilization and thus poverty alleviation (ICRAF, 1995; 1996).

The merit of agroforestry interventions in making the agricultural systems more robust can clearly be seen on the less endowed areas where rainfall is erratic, the soil is less fertile, topography is difficult and farmers have limited land and capital resources (Sanchez, 1995). Under such circumstances, the merit can be shown in terms of environmental sustainability even with low use of external inputs (Nair, 1993). This can also be explained in terms of conserving the soil, enhancing biodiversity, conserving carbon in terrestrial ecosystems and enhancing nutrient capture and retention (Young, 1989; Sanchez, 1995; Lassoie and Buck, 1999).

2.4 Constraints Hindering Agroforestry Productivity and the Possible Solutions

While the agroforestry potentials are well established, the systems may have various constraints, which in poorly planned and managed agroforestry systems can limit or even effectively mask their advantages (Lulandala, 1994; Nair, 1990, 1993; Swaminathan, 1987). Therefore, their identification and exclusion from the well-planned and properly managed agroforestry systems is key to optimally utilizing its full potential (Lulandala, 1994). Some of these problems include disease and pests, incompatibility of the system's components and competition between components.

2.4.1 Diseases and pests

According to Lulandala (1994), presence of tree vegetation on the land management unit may attract wild animals for example monkeys and rodents that can in turn cause problems to the associated crops. Trees also harbor birds for resting, food and nesting and in turn easy for them to feed on the associated crops. Sometimes, importation of trees/ shrubs into crop farms might import with them pathogens and encourage their infestation thus causes disease problems to the whole system. Insect pests may also be attracted by the trees/shrubs and as their population builds up and the trees are unable to sustain their food needs then insects may infest the associated crops in the system.

Although the pest and disease control associated with the agroforestry has been rarely studied; intergraded pest management, which involves non-overlapping pest crops and conservation of natural enemies, is very crucial (Swaminathan, 1987). Also we can effectively control pests population explosion in the agroforestry systems by adopting management options that includes species diversification and identification of the associated constraints, take them into account from the planning phase and weigh against possible advantages, the selected agroforestry technology could make available (Lulandala, 1994).

2.4.2 Incompatibility of the agroforestry components

Sometimes some components of the agroforestry system become difficult to exist together on the same land management unit at the same time. The trees/shrubs can have allelopathic effect on the associated crops or vice versa. Also, some components of the system cannot occupy the same space at the same time like the crop and animal or the crop and the grass for pastures due to some practical negative interactive constraints (Nair, 1987; Lulandala, 1994). However these problems can be avoided through carefully selection of the plant components (woody perennials or crop) and temporal sequencing the components of the system (Lulandala, 1994).

2.4.3 Competition between agroforestry components

Competition in agroforestry systems has mainly been between the plant components. This is either above ground where plants compete for sunlight (shade) and growth space or bellow ground, where plants compete for soil moisture, plants nutrients and growth space for root. This can limit or even effectively mask the advantages of the agroforestry systems (Lulandala, 1994).

For example, yields of rice under alley cropping (with and without fertilizer) in Peru declined due to tree-crop root competition (Fernandes *et al.*, 1993a). In Sumatra yields of rice and cowpea alley-cropped with *P. falcataria, C. calothyrsus and G. sepium* also declined over four years to unacceptable low levels (cowpea) or to crop failure (rice) due to poor growth resulted from competition (Evensen *et al.*, 1995). Nair (1989), reported reduction of outputs of food crops where trees compete for use for arable land and /or depress crop yields through shade and root competition.

However, it is recommended that, under such a situation, the effect of shade can be avoided through incorporation of deciduous trees such as *Faidherbia albida* which shades its leaves on the onset of rains (Poschen, 1986). Alternatively, *Dalbergia sisoo* may be incorporated into the system because it shades leaves during the autumn to enrich the soil while the availability of solar radiation under the tree increases (Swaminathan, 1987). Competition for the nutrients could be avoided through careful selection of trees especially those with vertical oriented deep root systems since the herbaceous crop roots occupy a shallow soil horizon i.e. mainly within top to 45cm deep (Lulandala, 1994). Some nutrients, otherwise unavailable to crops because they are below the rooting zone of the crops, might be brought into the system from deeper layers by deep-rooting trees (Young, 1989, Palm 1995). The competition for sunlight and growth space can be avoided through proper tree spacing and selection of tree species with long narrow vertical crowns with limited branching and sparse narrow leaves (Lulandala, 1994).

2.4.4 Other constraints

Recent studies from elsewhere have shown that there are various problems facing agroforestry systems especially in the course of trying to improve / optimize production and sustaining yields. These problems differ according to the type, agro ecological areas and even the country from which these agroforestry systems are found (Amin, 1989; Chambers, and Leach, 1990; Rugalema, 1992, Kessy, 1992; Moshi, 1997; Semgalawe, 1998).

In Indonesia for example, the average yield of rubber in the agroforestry systems went down due to lack of improved planting materials of which necessitate farmers to use '*jungle rubber*' i.e. the unselected rubber seedlings and germplasm obtained from natural forests (Penot, 1995).

The cases of poor/ narrow adoption of the suitable agroforestry technologies for many traditional societies is well documented especially when the pre-packaged technologies imposed upon the rural poor do not meet the local, social, cultural and economic conditions (Just and Zilberman, 1985; Kerkhof, 1990; SECAP, 1991; Semgalawe, 1998 Senkondo *et al*, 1998).

Insufficient and timely available labour, small farm sizes, price instability of the crops, lack of technical know how and poverty also affects the level of production of agroforestry systems (Liyange, 1984; Shayo, 1991; Moshi, 1997). Migration of youths to urban areas in Kilimanjaro, Tanzania reached a point that mostly old people were left in rural areas, thus present difficulties for extension workers to effectively introduce innovations of which affected the level of production (O'kting'ati, 1985; Fernandes et al, 1984 cited by Moshi, 1997).

Soil degradation and demographic pressure; scattered distribution of farmers and farm families create difficulties in effective extension services for agroforestry (Balasubramanian and Egli 1986). Population increase in Indonesia is constraining optimum production of the multistoried agroforestry system (Michon *et al.*, 1986), while in the Bukoba homegardens in Tanzania; the major problems including population pressure have been banana weevils and low livestock population (Rugalema, 1992). In the west Usambaras, the low soil fertility is attributed to insufficient replenishment of soil nutrient through manuring and leaching due to heavy rainfall and permanent cropping system, which continuously remove nutrients from the soil. Others include poor extension services attributed by poor transport and working incentives for extension staff and low prices offered to agricultural crops, which in turn make farmers loose interest to invest in crop production (Kerkhof, 1990; Kaoneka, 1993; Moshi, 1997; Johansson, 2001).

In Kerela Southern India, there has been inadequate research on agroforestry systems resulting into low use of tree crops in homesteads (Nair and Sreedharan, 1986; Chambers and Leach 1990).

2.5 Agroforestry Systems in the West Usambaras

Although no one can tell exactly when the agroforestry systems in the west Usambaras became social, cultural and economic units of the families; there was a belief that it might have originated as early as about 2000 years ago (Hamilton, 1987). Nowadays, there are two forms of land use and management systems i.e. the indigenous agroforestry systems and the agroforestry systems under the influence of SECAP (Kerkhof, 1990). Although the traditional agriculture of the Shambaa people was highly adapted to the specific characteristics of their mountainous environment (Pfeiffer, 1990); later their life-style seemed not to subsist in equilibrium with the ecology of the area. This caused severe soil erosion, declining soil fertility and agricultural production (Iversen, 1991). Therefore, SECAP was introduced in order to address the problem (SECAP, 1984; Kerkhof, 1990).

2.5.1 Indigenous agroforestry systems in the west Usambaras

The Sambaa people are traditional agropastoralists (Iversen, 1991). They are skilled farmers growing banana in the mountains and maize in the plains and foothills bellow but always in combination with large number of indigenous plants. The plants include trees of genera *albizia, Erythrina, Rauwolfia, Cordia, Cussonia and Ficus,* and secondary crops like beans and peas, pumpkins, tree tomatoes, different types of tubers including cocoyams, cover crops like *mayombo* beans and sweet potatoes. Climbers like the oil producing *Kweme* nut (*Telfaria pedata*) and different yam species (*Dioscorea*) and on plot boundaries pigeon pea and sugar cane are also grown. They owned small plots, which were planted with cassava or maize alone with many different local varieties of each; they kept cattle and sheep (estimated about 60,000 heads), and maintained extensive irrigation system with channels that were many miles long and sophisticated methods for soil erosion conservation and fertility improvement (Iversen, 1991; Johansson, 2001).

Land was clan held but individually cultivated so every farmer would use several small plots of different types and distance from home. Men were responsible to irrigate banana homegardens that were producing much of the staple food whereas women were allocated more remote fields where they grew mainly maize. In order to minimize risks farmers cultivated plots in three different altitudinal zones; the low land, the banana zone where the settlements were and the highlands above. They planted crops in three different rainy seasons i.e. (Aug-Sept) '*Mluati*', (Nov-January) '*Vuli*' and '*Masika*' (March-May) (Johansson, 2001).

Due to increased population pressure (Iversen, 1991; Kaoneka, 1993) and cultural change (Mersmann, 1993 cited by Johansson, 2001), the traditional agriculture systems of the Sambaa failed to subsist in equilibrium with the ecology of the area leading to severe soil erosion, declining soil fertility and agricultural production (Pfeiffer, 1990; Iversen, 1991). After independence the government failed to match the problem of land scarcity with soil conservation when it allocated 13,000 ha of the Shume–Magamba forest reserve for farming thus making the situation worse (Johansson, 2001).

So until 1970s, the slash-and-burn cultivation and the traditional shifting cultivation was and in most places practiced all the way up to the hill tops, large areas of the forests on steep slopes were converted into farm lands and bush fires was common in the drier areas (Iversen, 1991).

This resulted into serious deforestation, overgrazing and degradation of hilltops and steep slopes; a vicious circle of poverty, deteriorating production capacity and over-cropping (Kerkhof, 1990; Johansson, 2001).

However, despite the limitations caused by the old traditional life-style, still the indigenous agroforestry systems is in practice in parts of the West Usambaras especially where the SECAP innovations have not yet reached (Moshi, 1997). Nowadays the farming systems are based on continuous improvement of the old farming methods with adaptation of the necessities of cultivation with the use of external help (Iversen, 1991). Most of them have adapted the permanent crop cultivation and stall-fed system instead of the old, shifting cultivation and free livestock grazing system (Johansson, 2001).

According to Moshi (1997), three traditional land-use farming systems could be identified i.e. the valley bottom farms, the crop plus tree farms and the homegardens. The valley bottom farms represent the typical pure agricultural crop production system with one or mixed agricultural crops. The crop plus tree and homegardens represent the indigenous *agrosilvicultural* and *Agrosilvopastoral* systems.

2.5.2 Agroforestry systems under the influence of SECAP in the west Usambaras

Soil Erosion Control and Agroforestry Project (SECAP) is a project, which was launched in Lushoto district started in 1981. It preceded the Livestock Development Project (LDP) of 1979. The major goals of the project were to improve the economic situation of peasantry by increasing agricultural/wood production and availability of water and stabilization of the ecological situation (SECAP, 1991). It must be noted that, when SECAP was launched in Lushoto, many areas were badly denuded and agricultural productivity was very low. Therefore, to recover the situation while meeting its goals, SECAP had to meet the following tasks (SECAP, 1984; Kerkhof, 1990; Johansson, 2001):

1. To replace the traditional free livestock grazing system with zero grazing mostly of crossbreed dairy cattle in more humid parts of the area. By so doing, manure could no longer be wasted instead was recycled into the field.
2. To arrest soil erosion and contribute to improve farm production by ensuring terraces and other soil conservation measures cover hilltops and slopes.
3. To protect the most strategic catchment forest areas, partly reforested and put under community forest management regime where necessary in order to improve water discharge for irrigation and domestic uses.

In effect the project introduced labour saving biological measures called macro-contour lines (a kind of improved grass strip) which comprised of four different plant components i.e. agroforestry trees, grass, creeping legumes and fodder shrubs. These were planted across fields along the high contours meant to check surface run off, trap silt and to produce fodder (Pfeiffer, 1990; SECAP, 1991).

The macro contour line basically consist of approximately 0.7m wide strip of grass to control soil erosion and at the same time to provide animal fodder and mulching material. The distance between the strips varied depending on the slope. The steeper the slope, the smaller the distance between the strips, varying from 5-20m (Pfeiffer, 1990).

The macro-contour line was followed by physical soil conservation measures like cut-off drains, bench terraces, "fanya juu" terraces and another methods for soil erosion control (Pfeiffer, 1990; SECAP, 1999; Johansson, 2001).

SECAP introduced heifer loan to the local communities followed by village bull programme as the way of improving stall-fed livestock production. However, it is the village bull programme that seemed to be more successful than the heifer loan (Johansson, 2001). It aimed at improving genetic potentials of the local cattle and milk production. Until the time when SECAP was phasing out, a total of 104 bulls were given to village bull centres in Lushoto District and was estimated that more than 5000 cows were mounted annually. This would result into increased number of crossbred cows, the same to milk production and manure for agriculture production (SECAP, 1991, Johansson, 2001).

In order to get the required and enough trees for the aforestation activities and those suitable for agroforestry, SECAP through its forestry section firstly decentralized the production of seedlings and support the project villages with tree growing inputs such as tools, polythine pots and seeds. They launched training programmes for village tree nursery attendants where hundreds of villagers were trained in nursery techniques. This was meant to increase production and varieties of tree seedlings that are adapted to local conditions, therefore, reverse the trend of deforestation in the district by planting more trees than harvested and by protection and management of forests under district and village control (Kerkhof, 1990; Johansson, 2001).

According to Johansson (2001) up to the time SECAP was phasing out; the following achievements were made as shown in table 1.

Therefore, SECAP was geared to improve the old traditional farming systems/methods in Lushoto by persuading, improving the old farming methods using external help where necessary and introducing new and more sustainable agricultural methods. Farmers are trying to develop these new technologies and are demonstrating the possibility of an ecologically oriented agriculture, which is real and conducive to modern agriculture (Johansson, 2001).

Table 1: Achievements made by SECAP

SOIL AND WATER CONSERVATION	
Catchment conserved	55 catchments
Farmers applying SWCM	5,245 farmers
Grass-macro contour lines	5,200 km
Cut-off drains	65 km
Fanya-juu terraces	327 km
Bench terraces	633 km
Grassplits	16,900 km
Area conserved by physical SWC	1,500 ha
TREE SEEDLINGS RAISED AND DISTRIBUTED	
Central nurseries	4.4 million
Private nurseries	7.9 million
Contact nurseries	0.6 million
TREE PLANTING	
Hill top aforestation area	6200 ha
Farmland under agroforestry	79,000 ha
LIVESTOCK	
Heifers loaned	194 heifers
Bulls given to villages	104 bulls
Oxen sold to farmers	34 oxen
HORTICULTURE	
Horticultural seedlings produced	152,000 seedlings
Horticultural seedlings sold	50,000 seedlings
TRAINING	
Farmers trained in SWCM	12,042 farmers
Farmers trained in animal husbandry	3,130 farmers
Farmers trained in horticulture	1,205 farmers
Farmers trained in tree raising	1,723 farmers
Women group seminars	217 groups

Source: SECAP monitoring data 1981-1999.

NOTE: **SWCM;** *Soil and Water Conservation Measures*

2.6 Defining Poverty and the Poor

Poverty has many faces, changing from place to place and across time, and has been described in many ways (World Bank, 1998). A number of researchers have been attempting to define poverty but most often they have been using monetary and non-monetary measures of welfare (URT, 1999; Banturaki, 2000; World Bank, 2000). Two broad categories of the non-monetary measures of poverty can be recognized which are the basic needs and social services. The former category contains food, shelter and clothing. With regard to this category, people with access to high quality and quantity of these needs are said to be non-poor. The category of social dimensions of poverty includes good or poor access to health, education, water, sanitation and employment. Monetary measures of poverty mainly concentrate on income, expenditure and consumption levels. The non-poor people have large amounts and quality of these, while the poor have less of these in quantity and quality. Therefore, poverty may be defined as deficiency in various spheres of human life including nutrition, education, housing, clothing, healthy, water, sanitation, employment, expenditure income and consumption (Banturaki, 2000; World Bank, 2000). It is a state of deprivation and prohibitive of descent life that result from many mutually reinforcing factors including lack of productive resources to generate material wealth, illiteracy, prevalence of diseases, discriminative socio-economic factors and political systems and natural calamities like draught, floods and wars (URT, 1999).

2.7 Poverty in Developing Countries

Although poverty is pervasive in the world with varying extent; yet it is more severe in developing countries (World Bank, 1990). About 90 percent of the developing world's poor live in Asia and Sub-Saharan Africa (Rodgers *et al.*, 1989; Hazell, 2001), and their number has been increasing especially in the past 30 years (World Bank, 2000). Vast majority live in rural areas and about three-quarters depend on agriculture for their daily existence (Glewwe, 1990; Hazell, 2001). This has been aggravated by increased population pressure and land degradation thus slowing down their effort to increase agricultural production, reduce poverty and alleviate food insecurity (World Bank, 1996).

Within rural areas, the poor are located in areas where arable land is scarce and agricultural productivity is low (World Bank, 1998). More severe poverty is found where rainfall is unreliable, physical structures are poor and people have poor access to markets (World Bank, 1998; Hazell, 2001). The more poor are affected by the degrading conditions of life including diseases, illiteracy, malnutrition and neglect. They consume more staple food than what they can produce (World Bank, 1990).

In Asia for example, 800 million people still live in poverty and 20 million preschool children remain malnourished. They do not have the means to buy the food they need, in spite of its ready availability (Hazell, 2001).
Sub-Saharan-Africa remains the only region in the world where the number of poor people (less than US$1 per day of income) has been increasing in the past decades. This is a result of poor growth in industrial and service sector jobs; lower density of infrastructure and weaker institutions to support agriculture, insufficient market and higher transport costs (Hazell, 2001; World Bank 2000).

2.8 Fighting Against Poverty in Tanzania

Although poverty in Tanzania remains predominantly a rural phenomenon (World Bank, 1993; Semboja, 1994), the number of poor in urban areas, mainly the unemployed and those engaged in the informal sector, is also growing fast (URT, 2000). In both rural and urban areas, the poor typically lack capital and human assets: they are less educated, of ill health and have large families (World Bank, 1993). The vulnerability of the poor is increased by preponderance of disease, including the rapid spread of HIV/AIDS (URT, 2000).

It has long been a big enemy of development like in other developing countries and thus ought to be fought, reduced to at least relative poverty and if possible eradicated (World Bank, 1998). It was one of the three enemies of national development, others being ignorance and diseases. Since independence in 1961 the government has had poverty reduction as its main goal (Mtatifikolo, 1994).

Poverty eradication as an objective has been pursued through a long term strategy aimed at achieving higher economic growth, improving economic opportunities for the poor, building human capital, and empowering the poor to participate in the development strategy (URT, 2000).

In 1967 for example, the government of Tanzania introduced Arusha Declaration, which proclaimed the policy of self-resilience emphasizing rural development to bridge income gaps between the urban and rural people and reducing income differentials among regions and wage earners (Collier *et al.*, 1986). From 1981 to 1983, the National Economic Survival Programme (NESP) and Structural Adjustment Programme (SAP) were tried as the homegrown economic programmes.

The World Bank sponsored Structural Adjustment Programmes (SAPs), which were adopted in 1986 and implemented in the form of the first Economic Recovery Programme (ERP -I) of 1986/87 to 1988/89 and ERP-II of 1989/90 to 1991/92 was other efforts of the government to reduce poverty (World Bank. 1998). Further efforts were implied in the Tanzania Policy Framework Paper of 1991/92 to 1993/94 and in the Rolling Plan and Forward Budget for 1993/94 to 1995/96 (Kayunze, 1998).

According to URT (2000), the government of Tanzania adopted the National Poverty Eradication Strategy in 1997, which spells out a vision of a society without abject poverty, and with improved social conditions. This vision, is in line with the International Development Goals, and remains a point of reference for current poverty actions.

In June 1999, the Government issued "Poverty and Welfare Monitoring Indicators," a document intended to provide the basis for monitoring the implementation and evaluating the impact of poverty eradication programs. The National Poverty Eradication Strategy and the Poverty and Welfare Monitoring Indicators were developed in collaboration with a wide range of stakeholders. The indicators expected to facilitate the development of baseline data for assessing the status of poverty and welfare, in order to guide policy and programs for reducing poverty.

In 2000, the Interim Poverty Reduction Strategy Paper (I-PRSPs), was prepared summarizing the existed knowledge and assessment of the country's poverty situation, describing the poverty reduction strategy, identifying gaps in poverty data, diagnostics, and monitoring capacity, and lay out the process for addressing those gaps (URT, 2000).

In preparation for successful rural poverty alleviation, the government emphasized on development and dissemination of appropriate and environmentally friendly agricultural technologies through her agricultural research centers; in order to promote sustainable food security, income generation, and employment growth and export enhancement (World Bank, 1994; Limbu, 1999; URT, 1999).

Agroforestry is among the technologies that were introduced for rural poverty alleviation. Nowadays agroforestry systems are almost all over the country but with special consideration in the areas where land degradation was more severe. The major goals are those of stabilizing the ecological situations, restoration of land productivity and poverty reduction through improvement of the farm productivity i.e. increasing agricultural, livestock and wood production (ICRAF, 1996; Nair, 1993; Young, 1989).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study Area Description

3.1.1 Location

Lushoto district is one of the seven districts of Tanga Region located in northeastern part of Tanzania. It lies between longitude 38° 10' and 38° 36' East and latitudes 4° 24' and 5° 15' South. The altitude ranges between 800 – 2300 m above sea level. It borders the republic of Kenya in the north, Kilimanjaro Region in the northwest and Korogwe district to the south and east (Fig. 1). Administratively, Lushoto district is divided into eight divisions namely Bumbuli. Lushoto, Mgwashi, Mlalo, Mlola, Mtae, Soni and Umba (Kerkhof, 1990).

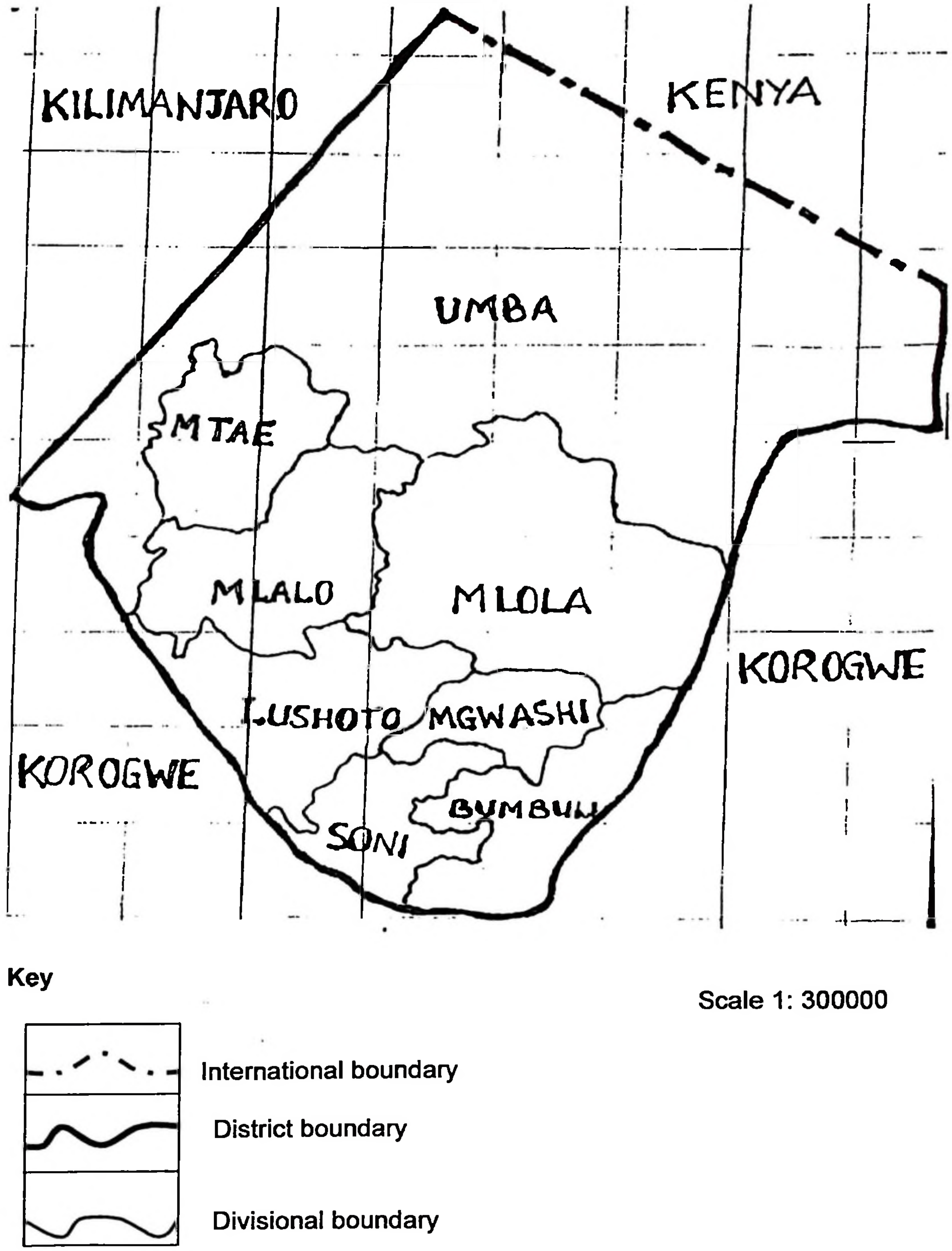


Figure1: Map of Lushoto District

3.1.2 Population and land use

According to the Tanzania Population and Housing Census of 2002 (URT, 2002), Lushoto district, which covers a landmass of about 4500-square kilometer, has an estimated total population of about 419,970 people. There are about 90,263 households with an average of 4.7 persons per household.

The population density is unevenly distributed and directly related to the agro-ecology of the area (Pfeiffer, 1990). The predominant tribe is the Sambaa constituting about 80% of the total population followed by the Pare (14%) and Mbugu (5%) while other tribes contribute only (1%) (Johansson, 2001). The Pare and Mbugu are mainly found in the northwest of the area.

About 70% of the total agricultural land is cropped, 15% is classified as forest reserve, 15% as pasture or bush fallow. About 84% of the cropland is devoted to dryland cropping, 11% to tree crops and 5% is irrigated (TIRDEP, 1977 cited by Moshi, 1997). The Sambaa people are primarily arable cultivators, though livestock keeping is also important. Major crops grown are maize, beans, sugarcane, vegetables, temperate fruits, tea, cardamon, cassava, coffee, Irish and sweet potatoes and bananas. Farm sizes are generally small with average sizes from 0.5 – 2.5 ha (Shelukindo, 2000). Local governments have abandoned the traditional practice of free livestock grazing and instead farmers are practicing stall-feeding and others just tie their animals close to their households and feed them with crop residues and collected fodder as one way of addressing the problem of land degradation (SECAP, 1991; Johansson, 2001).

3.1.3 Climate

The district receives bimodal pattern of rainfall; long rains falling between March and May while short rains between October and December. The mean annual rainfall ranges between 600 – 1200 mm (Msangi, 1990). Generally, the mean annual temperatures vary with altitude. At 500m above sea level, temperature ranges from 25 to 27° C while between altitudes 1500 – 1800m above sea level, the temperatures are from 16 – 18°C (Wiersum *et. al.*, 1985). The period between the months of June to early September mark the coldest period of the year with temperature of 15 to 20°C, and occasionally drops to 3° C (SECAP, 1991).

3.1.4 Topography, geology and soils

Lushoto district, which covers most of the West Usambara Mountains in the north - eastern part of Tanzania, forms part of the Eastern Arc Mountains (Msangi, 1990). These mountains consist of uplifted block of highly folded, metamorphosed volcanic rocks rising from the surrounding plains at approximately 600m altitudes. They have irregular eastward-sloping upper plateau at about 1300 – 1900m and maximum altitude of 2300m (Wiersum *et al.,* 1985).

The main rock types are gneiss intruded by quartzite veins with varying amounts of pyroxene, hornblende and biotite. The soils derived from these rocks are generally latosols (highly weathered and leached soils) predominantly acidic, with a pH range of 3.5 – 5.5, and poor in nutrients content. In the lower wetter areas, soils are humic ferralitic due to high precipitation and humic ferrisols in drier, cooler areas (FAO/UNESCO, 1973). The color is red to yellowish red, but the topsoil is darker, owing to the high organic matter of the original forest soils, which ensures high cation exchange capacity but disintegrates quickly under cultivation. The soils have high clay loam and sand content but low in silt and freely drained and have their nutrients concentrated in the topsoils, which is no more than 30 cm deep (Wiersum *et. al.*, 1985).

3.1.5 Natural vegetation

Generally, three distinct natural vegetation types are recognized in Lushoto district as a function of soils and altitude. These include the lowland evergreen forests, which lie below 750 m above sea level at the eastern foothills of the East Usambara Mountains. The intermediate evergreen (submontane) forests occurring in fully humid climates from 750 – 1400 m above sea level, dominated by *Juniperus procera* and *Olea hochstetteri* as the main associate species. The third one is the highland evergreen (montane) rain forests above 1400 m above sea level dominated by *Podocarpus spp.* and *Ocotea usambarensis* with co-dominants like *Albizia spp.*, *Cassipourea spp*, *Chrysophylum spp.*, *Ficalhoa laurifolia*, *Macaranga kilimandscharica*, *Olea hochstetteri*, *Parinari excelsa*, *Polycias spp.*, *Pygeum africanum and Syzygium guineese*. The mountain area covers about 2000 km^2 but the forest is currently restricted to about 340 km^2 while the 140 km^2 are badly eroded. Consequently, the area remained for subsistence, commercial farming, grazing and settlements, is only about 1500 km^2 (Wiersum *et. al.*, 1985). The available national forest reserves include Shume-Magamba (13,950 ha), Shagayu (8,897.3 ha), Mkusu (4,175.5 ha), Baga (3,476.4 ha), Mzinga (399.1 ha), Balangai (1,126.8 ha), Ndelemai (1,615.4 ha), Mahezangulo

(3,65.9 ha), Kisima gonja (1,617.7 ha), Mwenegombero (1,169.5 ha), Bumba Mavumbi (1,186.4 ha), Kwekanda (112.3 ha), Manka (151.8 ha), Kikongoli (278.6 ha), Kitivo North (70.9 ha), Kitivo South (43.2 ha), President's lodge (54.5 ha), Lushoto (26.4 ha) (Johansson, 2001).

3.1.6 Agro ecological zones

Three main agro-ecological zones are distinguished in the study area (Pfeiffer, 1990). These include the Humid / warm zone, Dry / warm zone and Dry / cold zone.

The **"humid - warm zone"** occupies the south, southeast and western central part of the West Usambara between 800 – 1500m above sea level. It is characterized by annual rainfalls of 800 – 1700mm, average daily temperatures around 18° C, three continuous relatively dry months (January – March) and intermediate rains during June/July (Pfeiffer, 1990).

The **"dry – warm zone"** occupies the northwest area between 800 – 1800m above sea level and is characterized by 500 – 800mm of rainfall annually with average daily temperatures of above 20° C. The dry period starts from June to September. In the north and northeastern fringes, the NE –trade winds cause maximum rainfall in November/December whereas the long rains in April/May are often unreliable (Pfeiffer, 1990).

The **"dry cold – zone"** occupies the northwest area between 1700 – 2100 m and is climatologically characterized by 500 – 800 mm annual rainfall, average daily temperatures around 16° C, a four month dry period (May – August) and slight frosts, which occur during the dry periods in the valley bottoms (Pfeiffer, 1990).

The exiting land use pattern is divided into four categories namely dry land farming constituting 58%, tree crops or irrigated area (11%), forest reserves (16%) and grazing areas (15%) (ibid.). This land use pattern makes the West Usambaras one of the most intensely farmed areas of Tanzania (Pfeiffer, 1990).

3.2 Data Collection

3.2.1 Instruments for data collection

The main instrument used for primary data collection was structured questionnaires with both open-ended and closed-ended questions. The open-ended questions aimed at getting the in-depth information from the respondents. Two types of questionnaire were developed, one for the household and another for the key informants.

3.2.2 Research design

In this study data was collected in a cross-sectional design. Such a design according to Babbie (1990) cited by Merina (2001) allows data to be collected at a single point in time without repetition from the representative sample. The reason for the choice of such a design is that, it is easier and economical to conduct especially where resource constraints like time, labour and money dictate the results, as it was the case for this study. The limitation of this design is that it allows data to be gathered only once and not over extended period of time.

3.2.3 Research phases and questionnaire pre-testing

This study was carried out in two phases. Phase one involved a reconnaissance survey. The second phase was mainly based on questionnaire survey. The reconnaissance survey was conducted in order to observe the general conditions of the farming systems; make researcher be acquainted with the study area; select study villages and the sample size required; and pre-test the questionnaires to check for its validity and reliability, to fit the local condition as recommended by Goldman and Macdonald (1987) cited by Kayunze (1998).

Questionnaires were pre-tested using 44 respondents from four villages. Eight respondents (4 from participants and 4 non-participants of the agroforestry practices) and 3 key informants were picked from each village. However, most of the questions were responded thus, very little modifications were made to the original questions (Appendix 1 & 2).

Questionnaire surveys involved formal interviews; this provided detailed information including both quantitative and qualitative data.

3.2.4 Sample villages' location and household characteristics

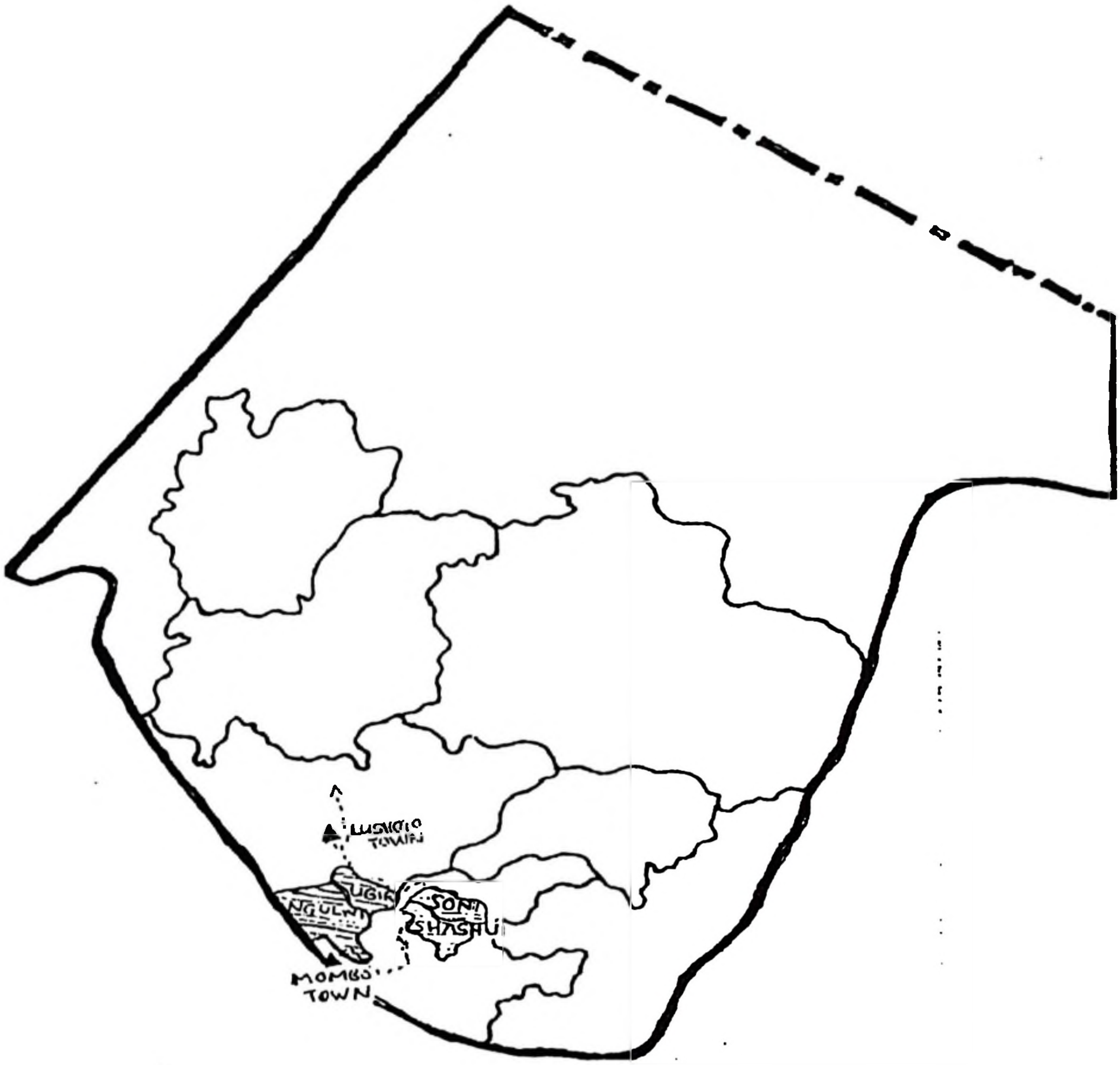
Of the three main agro-ecological zones found in Lushoto District, the "humid – warm zone" (3.1.6), was deliberately adopted in order to avoid unnecessary variations in the farm parameters including rainfall, temperature, slope, and the type of trees/crops admixture.

From this zone, two wards namely Soni and Ubiri and four villages two from each ward were randomly selected. In Ubiri ward, Ngulwi and Ubiri villages were selected whereas Soni and Shashui villages were selected from Soni ward. The locations of the sample villages are as shown in Fig. 2.

The total number of households in the surveyed villages ranged from 600 to 853 households; Ubiri village leading by having more households as shown in table 2.

Table 2: Demography and households' composition of the survey villages

Village	Total popn	Males	Females	M/F Ratio	Total h/holds
Ubiri	3753	1815	1938	0.9	853
Ngulwi	3282	1482	1800	0.8	673
Soni	2736	1055	1681	0.6	545
Shashui	2300	1500	1800	0.8	600
Total	12071	5852	7219		2671



Key

Sample village

Town

Main Road

Scale 1: 300000

Figure1: Location of the Sample village

3.2.5 Sampling procedures and sample size

The target group for this study was all farmers practicing and not practicing agroforestry in the Lushoto district. The sampling unit was the household. A household in this study is referred to as a single person or group of persons who live and eat together and share common living arrangements i.e. share expenses (URT, 1994).

For any land use systems to qualify as an agroforestry system(s), there must be a woody perennials (trees, shrubs etc) deliberately combined with herbaceous plants and or livestock in spatial, rotational or both in which there are both ecological and economical interactions between the tree and non-tree components of the system (Young, 1989; ICRAF, 1996). And also it was hardly possible to find a single household's farm without trees and /or shrubs in the study area. Then, the criterion used to obtain farmers practicing and not practicing agroforestry was based on the number of trees found in the household's farm.

Therefore, for the purpose of this study, farmers who had less than 20 trees/ ha were regarded as not practicing agroforestry while those with more than 20 trees were practicing agroforestry.

It was assumed that, other factors being constant, farmers with many agroforestry trees and which are properly arranged and managed could have higher income resulted from positive interactions between the tree and non-tree components of the system(s) than those with fewer trees, thus poverty alleviation.

After identifying farmers practicing and not practicing agroforestry; simple random sampling technique was applied to select households from the study villages. Equal number of households from both farmers practicing and not practicing agroforestry in each village were picked for the interview for comparison. A random sampling intensity of at least 5% was used to determine the sample size of the households interviewed in each village as described by Boyd *et al.* (1981) cited by Kayunze (1998). Therefore, a total of 134 households were picked for the study and as shown in Table 3.

Table 3: The distribution of selected households in the survey sample

Village	Number of selected h/holds	Percent of the sample
Ubiri	42	31.3
Ngulwi	34	25.4
Soni	28	20.9
Shashui	30	22.4
Total	134	100.0

3.2.6 Primary data

Several methods were used for primary data collection. These include household questionnaire survey, focused group discussion with the key informants using a checklist of questions and physical observation. The aim was to cross check and verify information obtained through these different methods regarding the topic in question.

3.2.6.1 Physical observation

A reconnaissance survey was conducted in the selected households' farms during the first phase of this study to observe the general conditions of the farming systems, the existing and extent of agroforestry systems and practices, and their management i.e. identification of various agricultural crops, livestock, and trees / shrubs that are grown and their arrangement, management and position in the vertical structure.

The aim was to enable the researcher understand what the farmers were doing, how and why? Also, to get information that was very useful especially when discussing with farmers and the key informants regarding the agroforestry systems to check with what they said against what had been seen.

3.2.6.2 Focused group discussion

This was also conducted during the first phase of this study. A discussion was carried out with the key informants guided by a checklist of open-ended questions. The key informants considered here were the village leaders; village extension officers, district agricultural and livestock development officers, and other people with great depth of knowledge about the topic in question. They provided useful information regarding common problems facing the farming system, their attitude about the impact of agroforestry practices on farm productivity and their experience on the general trends of the system's productivity with time.

3.2.6.3 Household questionnaire survey

This was conducted during the second phase of this study. Both open and close-ended questions were used. Information on the type and population of livestock kept, crops produced and their yields, cost of production, selling prices and revenue of each produce, types and number of trees/shrubs planted and their uses, and constraints to the system's productivity were captured. In addition, people's attitude on the future productivity of the system were also captured and documented.

3.2.7 Secondary data

Secondary data was obtained by consulting various relevant documents and records, both published and unpublished, from different sources to form an overview and identity gaps in information regarding the topic in question.

3.3 Data Analysis

3.3.1 Methods of data analysis

Data collected in this study were analysed by using both qualitative and quantitative methods. The qualitative data were analysed by using Content and Structural-Functional methods while Descriptive and Inferential statistics methods were applied to analyse the quantitative data.

3.3.1.1 Descriptive and inferential statistics

In using the Statistical Package for Social Science (SPSS) computer package software, the quantitative information was first edited and later coded whereby variables were defined and given numeric values. Secondly, the data were explored for distribution of responses, central tendency and dispersion. The third step was to carry out cross tabulation analysis which was meant to provide an idea whether there was a significant difference in contribution of the agroforestry to poverty alleviation between farmers practicing agroforestry and those who are not practicing. This was followed by inferential statistical analysis in this regard multiple linear regression analysis.

The multiple linear regression model was developed in order to predict whether or not the dependent and independent variables were significantly related and measure the strength of their relationship. Therefore, the dependent variable, net income of the household's farm production, was regressed on the independent variables (farm size, household size, number of trees planted, number of livestock kept, varieties of crops grown and cost of production) to find the standard regression coefficient, the beta weight (ß) of each independent variable, the multiple correlation, R, and the multiple coefficient of determination, R^2

The general model used in linear regression was:

$Y_i = a + b_1x_1 + b_2x_2 + \ldots\ldots\ldots\ldots\ldots + b_jx_j + e_i$

Where:

Y_i = The i^{th} observed value of the net income of the household's farm production (dependent variable).

a = Intercept

b_1 to b_6 = Independent variable coefficients

X1 = Farm size

X2 = Household size

X3 = Number of trees planted

X4 = Number of animals kept

X5 = Varieties of crops grown

X6 = Cost of farm production

e_i = Random error

The above six independent variables were included because they were thought to be able to account for more of the variation in the dependent variable. The reminder of the variation would be due to independent variables not included in the model, incorrect model formulation and errors in the research.

3.3.1.2 Content and structural – functional analysis

The Content and Structural analysis techniques were used to analyse the qualitative data and information. The components of verbal discussion held with key informants were analysed in detail with the help of content analysis method. In this way the recorded dialogue with respondents was broken down into smallest meaningful units of information or themes and tendencies. These helped the researcher in ascertaining values and attitudes of the respondents. Structural – Functional analysis sought to explain social facts by the way in which they relate to each other within the social system and to the physical surrounding. This type of analysis helped the researcher to distinguish between manifest and latent functions. Manifest functions are 'those consequences which are intended and recognized by actors in a system'. Latent functions are 'those consequences which are neither intended nor recognized' (Merina, 2001).

3.4 Limitations of the Research

1. There were no records on cost of production inputs to most of respondents involved in the study. Therefore, some of respondents did not remember the actual amounts of products they produced and services they provided in 2002 (January to December) and said "to estimate, we got .... amount." So, the results are estimates, but of course given by respondents. However, the figures are proximate indicators of the actual situation in Lushoto district.

2. Data collection was done during planting season thus difficult to find respondents at home. Also there is high farm fragmentation in the study area. Therefore the researcher was obliged to visit them in farm plots, which were far away from homes thus interfered with the field timetable extending the period of data collection and the costs.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter presents results and discussion of the findings under the following sub-sections:

i. Farmer's socio-economic characteristics
ii. Agroforestry systems in practice in the Lushoto District.
iii. Productivity of the agroforestry systems in the Lushoto District.
iv. Household cash income from the agroforestry systems.
v. Factors influencing household's net income from the agroforestry systems.
vi. Constraints to agroforestry practices in the Lushoto District.

4.1 Farmer's Socio-economic Characteristics

The socio-economic characteristics of farmers examined in this study were sex, marital status, age, household size, Farm size, education level and the main occupation. The purpose of choosing these characteristics was to get the general overview of what the respondents are composed of and how could that influence the agroforestry practices towards poverty alleviation in the study area.

4.1.1 Sex and marital status

Table 4 shows sex and marital status of farmers in the study area. Of the 134 farmers interviewed, the highest percent (79.1%) were males and 20.9% females. Females had smaller representation despite the fact that they are the key players in most of the household's farm activities. The reason behind is that the study targeted the heads of the households as the responsible main decision maker of the household affairs. Therefore, except for the few households, which were headed by females, the majority were males. Sometimes, females had to respond on behalf of their husbands when they were no available. Therefore, combining some of the households which were headed by males and others with females; 87.3% of the interviewed farmers were heads of the households while 12.7% not heads of the households. This implies that most useful information regarding the topic in question was obtained because majority, the heads of the households, provided it.

The findings also show that 85.8% of the respondents were married, 6.7% divorced, 3.7% widowed and 3.7% separated.

Table 4: Sex and Marital status of the respondents (n = 134)

Variable	Characteristics	Number	Percent
Sex	Male	106	79.1
	Female	28	20.9
Marital status	Married	115	85.8
	Divorced	9	6.7
	Widowed	5	3.7
	Separated	5	3.7

4.1.2 Age, household size and occupation

The study found age distribution of farmers varying from 22 – 70 years. The average age was 45 years. Majority (79.1%) was in the age's group 31 – 64 years, whereas 12.7% were above 64 years and 8.2% bellow 30 years (Table 5). This implies that most of farmers (79.1%) were in the economically productive age group with great experience in agroforestry both before and after SECAP. Majority have been there for more than 30 years the period which enabled them to experience the indigenous agroforestry practices which ought to prove failure to most parts of the study area and later on replaced by SECAP innovations. Therefore their experience was very useful in the success of this study

According to Mandara (1998) and Mtenga (1999), household members are considered economically productive from the age of 16 to 64 years. The age group bellow 16 years are children whom some attend schools and others too young to participate in farming activities. The age group above 64 years is considered less economically active because the members are too old.

Table 5: Age group of the respondents (n = 134)

Age group	Number	Percent
Bellow 30 years	11	8.2
Between 30 – 64 years	106	79.1
Above 64 years	17	12.7
Total	134	100

The mean household size was 6.6 persons. The smallest household had 3 persons while the largest had 11. The reported mean is slightly higher than that of 4.7 persons reported in the recent past National Population and Housing Census of 2002 (URT, 2002) in Lushoto District and at the same time lower than that of 8.8 persons reported by Moshi (1997) in the west Usambaras.

The average household size bellow the age of 16 years was 3.0 persons, 2.8 persons between 16 – 64 years and 0.8 persons above 64 years. This implies that at least every household in the Lushoto District has an average of 2.8 persons who can actively participate in farming activities.

The results also show that, 95% were smallholder farmers whereas 3% employed and 2% petty businessmen. Therefore, majority depends on agroforestry as the main source of income for their families.

4.1.3 Education level

The education levels of the respondents are as shown in table 6. Majority (71.6%) had primary education, 14.2% secondary, 8.2% adult education, 3.7% no formal education while 2.2% diploma. There was no respondent who had university level education. However, generally, except for the minority (3.7%) who had no formal education, most of the respondents were educated. This implies that, the introduction of various agroforestry innovations in the study area are likely to be achieved because the majority could not only be trained by the extensionists but also read from books and newsletters and other sources of information.

Table 6: Education level of the respondents (n = 134)

Education level	Number	Percent
No formal education	5	3.7
Adult education	11	8.2
Primary education	96	71.6
Secondary education	19	14.2
Diploma	3	2.2
Total	134	100

4.1.4 Farm size

Table 7 summarizes classes of distribution of the household's farm sizes in the study area. Generally, majority (38%) had farm sizes bellow or equal to 2 hectares. The average farm size was found to be 3.1ha while the minimum and maximum farm sizes were 0.7 and 4.5 hectares respectively. However majority of the households with farm sizes greater than 3 hectares had plots of woodlots some planted with black wattle (*Acacia meansii*) and others planted various tree species for timber, firewood, poles and other building materials among which being eucalyptus and grevillea. Further observations have shown that there is high farm fragmentation ought to be influenced by the former system of shifting cultivation. Farmers have several farm plots of various shapes and sizes located into different places within and sometimes even out of the sample village.

The agrosilvicultural system is practiced on the upland farms, which is just after the valley bottom farms followed, by the agrosilvopastoral (homegardens) system above. Different types of crops (Table 8) and vegetables (Table 9) are grown into these systems depending on the seasons i.e. "*vuli*" which starts from November to January, "*masika*" which starts from March to May and "*mluati*" August to September. Also various trees species and shrubs (Table 10) were either retained or planted.

Table 8: Agricultural crops grown in the Lushoto agroforestry systems

Local name	Scientific name	Common name	Remarks
Kahawa	*Coffea canephora*	Coffee	cash crop
Manga	*Manihot esculentum*	Cassava	staple food, vegetable
Mapemba	*Zea mays*	Maize	staple food, fodder
Mahaagi	*Phaseolus vulgaris*	Beans	staple food, cash
Vindoo	*Ipomoea batatas*	Sweet potato	food, cash, vegetable, fodder
Matindi	*Mussa sapientum*	Banana	staple food, cash, fodder
Viazi	*Solanum tuberosum*	Irish potato	staple food, cash
Mavuga	*Xanthosoma spp.*	Cocoyam	food
Miwa	*Saccharum officinarum*	Sugarcane	cash, fodder, local beer
Kabichi	*Brassica oleracea*	Cabbage	cash, vegetable, fodder
Nkungu	*Telfairia pedata*	Oyster nut	cash, source of oil

Table 9: Vegetables grown in the Lushoto agroforestry systems

Local name	Scientific name	Common name	Plant part eaten
Mchicha	*Amaranthus spp.*	Amaranths	leaves
Mbwembwe	*Bidens pilosa*	Black jack	tender leaves
Mngereza	*Galinsoga parviflora*		leaves
Kidendeezi	*Stellaria sennii*		leaves
Mnavu	*Solanum nigrum*	Black nightshade	leaves/flower/fruit
Mchunga	*Sonchus luxurians*	Milk thistles	leaves
Mkutu	*Ipomoea batatas*	Sweet potato	selected leaves
Maboga	*Cucurbita maxima*	Pumpkins	leaves/flower/fruit
Maeze	*Xanthosoma spp.*	Cocoyam	tender leaves
Kisamvu	*Manihot spp.*	Cassava	leaves
Mlenda	*Grewia tembensis*		leaves
Ndelema	*Bassella alba*	Malabar spinach	leaves
Ushwe	*Momordica foetida*		leaves
Thekizeru	*Chenopodium spp.*	Goosefoot	leaves
Eza	Crassocephalum bojeri		leaves
Ipwake	*Sonchus oleraceus*	Milk thistles	leaves

Table 10: Trees and shrubs grown in Lushoto agroforestry systems

Local name	Scientific name	Common name	Uses / function
Mchongoma	*Grevillea robust*	Grevillea	shade, soil fertility, fuelwood
Mshai	*Albizia schimperana*	Albizia	timber, fuelwood
Mparachichi	*Persia americana*	Avocado	fruit, fuelwood, cash
Mwembe	*Mangifera indica*	Mango	fruit, fuelwood, cash
Msambia	*Eriobotrya japonica*	Loquat	fruit, building material
Mkuyu	*Ficus vallis-chaudae*	Fig	fuelwood, shade, retaining water
Mshaiwawa	*Albizia gummifera*	Albizia	building material, fuelwood
Mfufu	*Cordia africana*	Cordia	timber, shade, fuelwood
Muungu	*Erythrina abyssinia*		medicinal, fuelwood
Mbombwe	*Commiphora eminjii*	Myrrh	fodder, medicinal, fencing
Mfyoksi	*Prunus persica*	Peaches	fruit, fuelwood, cash
Mpera	*Psidium guajava*	Guava	fruit, fuelwood, cash
Mchungwa	*Citrus sinensis*	Orange	fruit, fuelwood, cash
Mgogwe	*Capsicum frutescens*	Bird chilies	spices
Mntindi	*Cussonia holstii*	Cabbage tree	medicinal, fodder, fuelwood
Mcheemoja	*Annona cherimola*	Custard apple	fruit, fuelwood
Mweti	*Rauvolfia cafra*		fodder, medicinal, fuelwood
Mwiza	*Bridelia micrantha*		fruit, fuelwood, medicinal
Misaji	*Senna siamea*		fuelwood, building material
Mpapai	*Carica papaya*	Paw paw	fruit, cash
Mngwengwe	*Dracaena usambarensis*	Dragon tree	fuelwood, building material
Mjakaranda	*Jacaranda mimosifolia*	Jacaranda	fuelwood, building material
Muakrokapasi	*Acrocarpus fraxinifolius*		timber, building material, fuelwood
Mtei	*Maesa lanceolata*		fuelwood
Miwato	*Acacia meansii*	Black wattle	fuelwood, timber, cash
Mficus	*Ficus thonningii*	Strangler fig	fuelwood, shade, retaining water
Mkrotoni	*Croton megalocarpus*		fuelwood
Mlusina	*Leucaena letifolia*	Leucaena	fuelwood, fertility, fodder
Mshunduzi	*Croton macrostachys*		fuelwood
Msonobari	*Eucalyptus saligna*	Eucalyptus	fuelwood, timber, building material
Mivumo	*Ficus natalensis*	Fig	fuelwood, retaining water, shade
Mstaferi	*Annona muricata*	Soursop	fuelwood, fruit
Msida	*Juniperus procera*	Cedar	fuelwood, timber, building material
Msaiprasi	*Cupressus lusitanica*	Cypress	timber, building material, fuelwood
Mitarawanda	*Markhamia lutea*	Markhamia	Fuelwood, timber
Mtiki	*Tektona grandis*	Teak	timber, building material, fuelwood
Miviru	*Vangueria infausta*		fuelwood
Mlimao	*Citrus limon*	Lemon	fruit, fuelwood, cash
Mbokoboko	*Entandrofragma excelsum*	Mahogany	fuelwood
Mringaringa	*Cordia monoica*		fuelwood
Msindano	*Pinus patula*	Pines	timber, building material, fuelwood

4.2.1 Silvocultural system

This agroforestry system represents the households' farms in the study area, which were intercropped with various agricultural crops and different tree species and or shrubs as shown in table 8 and 10. To some farmers these farms were located away from the homesteads while to others were near depending on the availability of land. The farms are highly fragmented with different sizes and shape.

Except for some few farmers, the crops were randomly planted without specific spacing probably to maximize utilization of the available land area by planting as many crops as possible. However, where crops planted on lines the observed spacing between rows depended on the types of crops involved and always decided by farmers themselves. Most of the trees and shrubs were planted along the farm boundaries and few along the contour lines, others in wide intervals. Few farmers had strips of sugarcanes in their farm plots.

Vertically the components of this agroforestry system were arranged in two strata. The first stratum (0 – 2 m) comprised of all food crops while the second stratum (above 2 meters) was formed by various types of trees and / or shrubs of varied ages.

Temporal arrangement of the components was space dormant and always determined by the lifespan and rainfall requirements of the crops. The annual crops were cultivated at intervals i.e. some were cultivated during long rain seasons for example maize and beans while others during intermediate and short seasons.

The agricultural crops provided farmers with staple food and cash from sale of the surplus produce. Trees provided various productive and service functions. For example, albizia provided shade to coffee and grevillea provided firewood, poles and other building materials. The fruit trees like avocado, mangoes, peaches, oranges etc provided fruits for both food and cash.

Management of the system's components was depending on the type of the component and season. The agricultural crops grown during long rain season were weeded up to trice per season while those grown in the short rain seasons weeded mostly twice. Majorities were using the locally available seeds instead of the recommended hybrids in that area due to that could not afford the price. Therefore, after harvesting, a portion of the crops e.g. maize, beans etc were left to be planted during the following season. Few farmers (16.7%) were applying inorganic fertilizers. Majority although not all were keeping cows, applied animal manure especially during planting. The animal manure was bought at Tshs 50 per bucket. Tree species and shrubs were frequently pruned for different intentions. Sometimes pruning was meant for providing firewood, fodder or poles. During planting season pruning was done to avoid shading to the associated crops.

The fact that most of the trees were planted on the farm boundaries and sometimes in wide spacing and also farmers do not use hybrids implies that generally they are still not able to thoroughly follow up the recommended management techniques.

4.2.2 The homegardens (Agrosilvocultural systems)

This system represent the farm plots in the Lushoto District around the houses and home compounds on which the households cultivate and grow a mixture of agricultural crops (Table 8 and 9), various tree species and shrubs (Table 10) and keep different types of livestock like cows, goats, sheep, chicken and ducks. The homegardens were located on the upland farms just after the agrosilvicultural systems up the valley. Most of the houses were located on the upper side of the homegardens probably to facilitate the work of throwing and spreading the homestead wastes/ refuse, manure and compost to the field.

The number of the agricultural crops and tree species and shrubs managed in the homegardens differed from one farmer to another. They ranged from few trees and shrubs in a small vegetable and herb garden to a dense multistoried plot of fruits, vegetables, herbs and cash crops with trees planted for timber, fuelwood and / or fodder around houses and home compounds

Vertical arrangement of the homegardens components was in four strata. The lower stratum composed of different crops among which are pumpkins, sweet potatoes, beans; various vegetables including cabbage, galinsoga and amaranths; spices like onions, cardamon and ginger; and grasses like guatemala, setaria, desmodia and camelina. The second stratum composed of crops like cassava, maize, coffee, and sugarcanes, saplings of various trees and shrubs and red pepper. The third stratum is composed of various fruit trees like mangoes, pawpaws, oranges, lemons, peaches, pears and apples. The fourth stratum composed of banana plants and various trees including shade trees, those providing fodder, fruits, fuelwood and valuable timbers. Examples are ficus, avocado and mango trees, albizia, cordia erythrina etc to mention a few. However, this arrangement conforms to other homegardens in Nigeria as reported by Okafor and Fernandes (1986) and in the Chagga and Kagera homegardens Tanzania by O'kting'ati (1884) and Rugalema (1992) respectively.

Temporal arrangement of the components was also space dormant and always determined by the lifespan and rainfall requirements of the crops. This arrangement provided for various crops to have different maturity stages at different seasons. Therefore, farmers have opportunity for continuous production of different crops and tree products throughout the year.

Except for chicken and ducks, which range freely, the rest of the livestock, were stall-fed. They get fodder from the trees, grasses and agricultural crops found in the homegardens. Some farmers had strips of fodder grasses and sugarcanes planted both along the contour lines and farm boundaries. So, depending on the management system and number of livestock's and the farm size per household; some few homegardens were providing enough fodder while others, the majority were not. These livestock in turn provided manure for the agricultural crops and vegetables. Farmers were getting food (from the livestock, trees and agricultural crops), timber, firewood, and other building materials from trees and cash from sale of the surplus produce. Some of trees provided shade to crops, which need it like coffee; help to cut off soil erosion and strengthening the physical soil erosion control structures.

4.2.3 The valley bottom farms

The study also identified valley bottom farms, which represent a typical pure agricultural production system. In these farms you could find either one type or mixed crops mainly vegetables. The farms are mainly market oriented and are used for providing green or fresh vegetables especially during dry seasons and between the harvest of the main crops. Sometimes these crops are used as a security measures against possible failures of the main crops.

Some of the vegetables grown including cabbage (*Brassica oleracea*), eggplant (*Solanum melongena*), lettuce (*Lectuca sativa*), tomato (*Lycopersium esculentum*), sweet pepper (*Capsicum spp.*) and bird chilies (*Capsicum frutescens*), carrots, onion etc to mention a few. Sometimes maize, beans, Irish potato and other varieties of crops are planted during the main crop seasons but in a small scale.

During planting, farmers mostly use animal manure, which is mixed up with the soils of the pit in which the vegetable plants are planted. Irrigation is sometimes done especially during the dry seasons.

4.3 Use of Inputs in the Agroforestry Systems

4.3.1 Labour

Table 11 shows that 73.9% of the farmers were depending on the household members as the main source of labour for the farming activities About 25.4% reported that the household labour was not sufficient for all farming activities. They were therefore combining hired labour from time to time with the family members. Only one respondent (0.7%) depended totally on hired labour.

Table 11: Main source of labour for farming activities (n = 134)

Source of labour	Number	Percent
Family members	99	73.9
Family members and hired labour	34	25.4
Hired labour	1	0.7
Total	134	100

This implies that majority of farmers are relaying mainly on the family members as the major source of labour for the farming activities. Therefore, the observed household size of 2.8 persons who can actively participate into the farming activities provides enough labour to the majority.

It is important also to note that most of the farmers using hired labour had dairy cattle and were practicing agroforestry and income wise are better off. This means that they hire labour because they can afford to do so. To some farmers sometimes the agroforestry systems could not offer sufficient fodder and therefore, labour was required to fetch them outside their farms.

Focused group discussion also observed that farmers in Lushoto District sometimes work in groups in order to meet timely labour requirements. Those farmers who knew each other organized well in smaller neighbourhood groups under informal hamlet leaders. Therefore, when they went to work in one of their member's farm, the host farmers was responsible for providing them with food. This finding is also in line with the study by Johansson (2001) in the west Usambaras.

4.3.2 Chemical fertilizers and biocides

Few households (16.7%) reported to use inorganic fertilizers, majority of them being farmers not practicing agroforestry and who had no dairy cattle. They were using inorganic fertilizers from time to time especially when the alternative for the animal manure was not available. Unfortunately no single farmer could remember which type(s) of fertilizer(s) that were used. They normally get instructions from the shopkeeper concerned the type of fertilizer specifically suitable for his/her production.

Majority of the farmers (83.3) were not applying inorganic fertilizers in their farms because these fertilizers were expensive and in addition due to the notion that they are bad to soils especially when used continuously in a long run. These were the answers frequently given by many of the sample households.

Eighty five percent (85%) of the surveyed farmers reported to have ever applied biocides in their agricultural crops and livestock production. These biocides included pestcides, insecticides and other various types of biocides used to control pests and diseases to animals and crops. Mostly they were used in coffee production especially to control Coffee Berry Disease (CBD) and also in tomatoes, cabbages and potatoes and in livestock production to control pests and diseases. However, at present, few farmers (22%) were still using these biocides many from the farmers practicing agroforestry mainly for livestock production. Farmers were asked to give reasons for not using these inputs, and the general answers were that, these inputs are too expensive compared to the past time and others are harmful to people and also due to the unattractive producer prices of other crops including coffee.

For example, results from group discussion showed that some of the biocides like Dieldrin and DDT are harmful not only to people but also to livestock, so farmers are no longer using them. Some biocides required curing animal diseases and pests have been expensive that some farmers could not afford Further observations have shown that several households were formerly keeping dairy cattle but later stopped because they failed to manage them. Many of the livestock died of diseases. Coffee production has also been abandoned by the majority due to higher prices of the associated inputs and unattractive producer prices. Formerly coffee used to fetch good price ranging from Tshs 1000 to 1500 / Kg but at present the price has dropped raging from Tshs 350 to 450 / Kg. Therefore, many farmers have opted for other more economically productive crops other than coffee because the prices could not cover the costs of the inputs.

Of all farmers, only 30 households had coffee plants in their farm plots, which were few and poorly managed.

4.3.3 Use of organic matter

About (83.3%) of the surveyed households reported to be using animal manure in their farming systems. Only 16% of the sample households were using both animal manure and inorganic fertilizers, leaving 0.7% using neither animal manure nor industrial fertilizers. Further observations showed that majority (48.4%) of the households using only animal manure were keeping dairy cattle and many of them were farmers practicing agroforestry. The remained 34.9% many being farmers not practicing agroforestry, reported buying animal manure from neighbours. Results from the group discussion have shown that many farmers are interested in animal manure as the main input that could improve their systems productivity because of its cheaply availability and sold at lower prices compared to inorganic fertilizers. Other organic inputs that are recycled into the agroforestry systems were household refuse and crop residues.

4.3.4 Capital inputs

No single respondent in the sample villages was using any sophisticated machinery in farm operations. They were mainly using the simple traditional farm tools like hand hoes, fork hoes, spades, axes and machetes. It was also found that no single respondent was getting loans / credit from any financial institution.

Results from the group discussion also showed that cash is scarce in the study area, and scarcity of cash is undoubtedly one of the major limitations of productivity of the agroforestry systems. Respondents claimed that they were facing severe scarcity of cash necessary to acquire the traditional inputs and biocides for livestock and crops production. Therefore availability of credit would likely be a strong incentive for cash poor farmers and thus improve the systems productivity.

4.4 Productivity of the Agroforestry Systems

Various levels of farm production were observed in the study area between farmers practicing and not practicing agroforestry as described in the subsections here under.

4.4.1 Animal husbandry

Table 12 and 13 show distribution of various livestock per household for farmers practicing and not practicing agroforestry respectively. Nearly every household (94%) keeps at least one kind of livestock. Chicken was the most preferred livestock (88.8%), followed by cows (46,5%), goats (43.8%), sheep (22.4%) and ducks (9.7%). Chicken was preferred because it was easy and cheap to manage as need only small initial capital compared to other livestocks. On average every household had a total of 9.7 chicken, 2.4 cows, 3.1 goats, 2.6 sheep and 1.2 ducks. The minimum and maximum number was 2 and 25 for chicken, 1 and 5 cows, 1 and 10 goats, I and 6 sheep, and 1 and 4 for ducks respectively.

Generally, farmers practicing agroforestry had significantly greater averages than those not practicing ($P<0.05$). Sheep and ducks were the least preferred animals in the study area. In Soni village for example, none of the farmers practicing agroforestry was keeping ducks (Table 12), whereas in Ngulwi and Shashui villages' results show that none of them was keeping either sheep or ducks among farmers not practicing agroforestry (Table 13).

Table 12: Average number of livestock kept per household for farmers practicing agroforestry

Village	Average number per household				
	Cows	Goats	Sheep	Chicken	Ducks
Ubiri	2.7	3.3	3.3	10.5	2.0
Ngulwi	2.8	3.1	4.8	11.6	1.0
Soni	2.6	3.2	2.6	9.9	0.0
Shashui	2.8	3.9	4.0	9.1	2.0
Average	2.7	3.4	3.7	10.3	1.3

Table 13: Average number of livestock kept per household for farmers not practicing agroforestry

Village	Average number per household				
	Cows	Goats	Sheep	Chicken	Ducks
Ubiri	2.0	2.1	2.7	6.6	1.5
Ngulwi	2.0	3.0	0.0	14.4	0.0
Soni	2.1	3.8	3.0	5.7	2.7
Shashui	2.3	2.5	0.0	10.2	0.0
Average	2.1	2.8	1.4	9.2	1.1

Table 14 shows production of milk and eggs by both farmers practicing and not practicing agroforestry. On average, the level of production was significantly different between farmers practicing and not practicing agroforestry ($P<0.05$). Comparatively, farmers not participating agroforestry had higher level of milk production (487.2 litres/cow) than the participants (434.4 litres/cow). The reason for this was due to increased availability of high quality fodder as well as improved breeds to majority. The minimum and maximum level of milk produced was 341.1 and 560.2 litres/cow for farmers not practicing agroforestry and 347.4 and 554.2 litres/cow for those practiced agroforestry respectively. Milk production per cow per day ranged from 1.5 litres to 8 litres. This level is low especially when compared to the one reported by Tulchan and Jabbar (2000) of 10 to 30 litres/cow/day under agroforestry systems. This implies that farmers in the Lushoto district still have a long way to go towards improving milk production.

Farmers practicing agroforestry produced more eggs (40.6 eggs/hen/yr) compared to 36.8 eggs/hen/yr for that not practicing agroforestry and the reason was that, they had more chicken. The minimum and maximum level of eggs produced was 24 and 60 eggs/hen respectively. Goats and sheep were meant mainly for meat production although the averages per household were too low to justify the intended goal i.e. an average of 3.1 and 2.6 for goats and sheep respectively. There were no goats kept for milk production.

Table 14: Distribution of milk and eggs production for farmers practicing and not practicing agroforestry

Village	Farmers practicing agroforestry		Farmers not practicing agroforestry	
	Milk (Litres/cow)	Eggs (Eggs/hen)	Milk (Litres/cow)	Eggs (Eggs/hen)
Ubiri	470.2	43.1	560.2	33.2
Ngulwi	554.2	45.4	510.0	33.5
Soni	347.4	38.1	537.7	44.8
Shashui	365.8	35.9	341.1	35.8
Average	434.4	40.6	487.2	36.8

Farmers were asked to give trends of the level of milk production for the past ten years; the majority (48.5%) said it was decreasing, 29.1% uniform, 17.2% increasing and 5.2% were not keeping dairy cattle. Milk production has been going down probably due to poor livestock management resulting from inadequate extension services, high costs of livestock inputs, diseases and insufficient fodder supply from the agroforestry systems.

However, observations made through focused group discussion showed that, there are opportunities for farmers to improve their livestock's level of milk production. This is because most of the surveyed households (80%) had crossbred stall-fed dairy cows of which if properly managed can improved milk production. The problem was that some of the dairy cattle were not fed well because sometimes farmers were forced to either buy fodder or hire labour to fetch them outside the agroforestry systems. This increases costs of livestock production and to reduce the costs probably the animals do not get enough fodder, thus, the low milk production. Therefore if farmers could improve fodder production then the animals will get enough to eat and thus improve milk production. Study by ICRAF (1996) and Gatsi *et al.* (2000) have shown higher level of milk production after the improved dairy cattle got enough fodder.

4.4.2 Crop production

Table 15 and 16 show household's level of production of various crops for farmers practicing and not practicing agroforestry respectively. The level of production was significantly different between farmers practicing and not practicing agroforestry ($P<0.05$). Generally, farmers practicing agroforestry had higher level of production than those who were not practicing. On average, farmers practicing agroforestry produced up to 137.4 $kgha^{-1}$ of maize, 72.8 $kgha^{-1}$ beans, 32.6 $kgha^{-1}$ of coffee and 52.9 bunches of banana per hectare (Table 15) compared to 110.5 $kgha^{-1}$of maize, 65.2 $kgha^{-1}$beans, 24.2 $kgha^{-1}$coffee and 34.9 bunches of banana for farmers not practicing agroforestry (Table 16).

Considering the observed average farm size of 3.1 ha; farmers practicing agroforestry therefore produced up to a total of 425.9 kg of maize, 225.7 kg beans, 101.1 kg coffee and 163.9 bunches of banana compared to 342.6 kg of maize, 202.1 kg beans, 75.0 kg coffee and 108 bunches of banana from farmers not practicing agroforestry annually.

Several factors could have contributed to these differences. General observations showed that, there were more households (58.4%) keeping livestock especially dairy cattle among farmers practicing agroforestry compared to 36.7% who were not practicing. Therefore majority had enough and cheaply available animal manure to apply in their farm plots for crops production than others not practicing agroforestry who had to buy from neighbours. Also, by using the income obtained from milk production some few farmers practicing agroforestry afforded to buy some suitable hybrids and thus higher level of crops production.

Table 15: Distribution of production of various crops for farmers practicing agroforestry

Village	Maize (Kg/ha)	Beans (Kg/ha)	Cassava Bags/ha)	Potatoes (Bags/ha)	Tomatoes (Baskets/ha)	Coffee (Kg/ha)	Bananas (Bunches/ha)
Ubiri	176.8	104.4	3.1	2.1	66.7	25.5	60.6
Ngulwi	131.1	67.9	1.9	1.2	73.3	25.7	43.3
Soni	135.6	69.4	3.9	1.2	83.2	46.6	52.5
Shashui	105.9	49.5	2.6	1.1	77.3	32.5	55.1
Average	137.4	72.8	2.9	1.4	75.1	32.6	52.9

Table16: Distribution of production of various crops for farmers not practicing agroforestry

Village	Maize (Kg/ha)	Beans (Kg/ha)	Cassava Bags/ha)	Potatoes (Bags/ha)	Tomatoes (Baskets/ha)	Coffee (Kg/ha)	Bananas (Bunches/ha)
Ubiri	158.7	82.3	2.4	1.9	64.8	11.6	40.9
Ngulwi	92.3	60.9	1.7	0.6	31.5	8.7	30.1
Soni	108.7	56.7	3.1	0.9	60.7	56.7	38.5
Shashui	82.4	60.9	1.6	0.5	45.7	19.8	30.2
Average	110.5	65.2	2.2	0.9	50.7	24.2	34.9

Except for some few types of crops like maize, beans and cassava, which were commonly grown by almost every farmer (practicing and not practicing agroforestry), generally the number and types of crops cultivated varied from one household to another. Some farmers preferred to grow more of the long rain crops while others short rain crops. However, 43% of the surveyed farmers reported uniform trends of the levels of crop production for the past ten years, whereas 40% decreasing and 17% increasing. Implying that majority (60%) are benefiting from the systems productivity although not at optimal level because to them, production has either been uniform or improve to some extent compared to the past. Furthermore, 47% were expecting future productivity of their agroforestry systems to be the same as the present time while 28.4% poor and 24.6% to improve.

However further observations have shown that the majority of farmers practicing agroforestry had managed to arrest the problem of soil erosion to some extent; firstly by stopping the former system of free livestock grazing of which was accelerating the problem and secondly by planting more plants. Therefore, with such achievements, future productivity of the systems could probably improve depending on the management system. Apart from arresting soil erosion, farmers need also to frequently add animal manure and plant the recommended improved crop seeds suitable to this area instead of the commonly used local seeds. Study by ICRAF (1996) has shown improvement in productivity of the agroforestry systems especially after using improved crop seeds. For example, yields of wool and mutton were improved from 3.25 to 17.30 tones/ ha as a result of growing improved seeds, which were also well managed.

Comparatively the observed average yields from farmers practicing agroforestry (Table 15) were generally lower than other yields reported by Fernandes *et al.* (1984), Frozen and Oberholzer (1986), Rugalema (1992) and Moshi (1997). For example, Moshi (1997) reported 156.25 $kgha^{-1}$ of coffee, 92.97 $kgha^{-1}$ of beans, 235.16 $kgha^{-1}$ of maize and 163.28 bunches of banana per hectare from the west Usambaras homegardens. Study by Fernandes *et al.* (1984) have shown a total of 412 $kgha^{-1}$ of coffee, 148 $kgha^{-1}$ of beans and 404 bunches of banana per hectare from the Chagga homegardens. In western Nepal, the average annual yield was 899$kgha^{-1}$ for maize, 637 $kgha^{-1}$ for wheat, 206 $kgha^{-1}$ for millet and 186 $kgha^{-1}$ for rapeseed (Frozen and Oberholzer, 1986). The Kagera homegardens in Tanzania was producing up to 200 $kgha^{-1}$ of beans, 135 $kgha^{-1}$ of maize, 175 bunches of banana ha^{-1} annually (Rugalema, 1992).

This implies that, farmers still have a long way to go towards improving the productivity of the agroforestry systems in the study area. However, general observation have shown that, several factors could have contributed to the observed level of production including the problem of low soil fertility, expensive farm inputs, and unattractive producer prices to some crops. Also there was partial adoption of the agroforestry technologies for example, some farmers had few numbers of trees species and shrubs in their farms. Therefore, overcoming these constraints could probably lead to opportunities of improving the system's productivity.

4.4.3 Trees and shrubs production

Table 17 shows distribution of the average, minimum and maximum number of trees planted by the farmers practicing and not practicing agroforestry. The average, maximum and minimum number of trees for farmers practicing agroforestry was 62.9, 238 and 23 trees/ha, and 10.36, 3 and 19 trees /ha for those not practicing agroforestry respectively. Generally these are the multipurpose trees and shrubs deliberately intended for production of timber, poles, fuelwood, fodder and food/fruits and provide shade, restore soil fertility, cut down soil erosion and improve the microclimate by reducing temperature extremes.

Table 17: Number of trees planted by farmers in the study area

Village	Farmers	Number of trees planted (ha^{-1})		
		Average	Minimum	Maximum
Ubiri	Practicing agroforestry	43.05	30	69
	Not practicing agroforestry	11.77	3	19
Ngulwi	Practicing agroforestry	74.24	23	210
	Not practicing agroforestry	9.82	5	14
Soni	Practicing agroforestry	95.36	29	238
	Not practicing agroforestry	7.28	3	10
Shashui	Practicing agroforestry	47.53	31	79
	Not practicing agroforestry	12.07	4	18

Observations have shown that most trees and shrubs were planted along the farm boundaries rather than contour lines. To the majority (80%) this makes a considerable sense from the point of view that planting trees on the boundaries causes less competition with crops. To some farmers the interval between trees was too wide to effectively support the intended goal of reducing soil erosion. Furthermore few households had trees mainly *Leucaena leucocephala* meant for soil fertility restoration in their farm plots and of which also were very few in numbers. The reason given during focused group discussion was that these trees do not perform well in the study area. However, although do not perform well, majority grew *Leucaena* mainly for cattle fodder. This implies that the best and only remained ways for farmers to improve soil fertility is through manuring and industrial fertilizers. Most of the trees therefore were planted to save other purposes including food, fodder, timber, firewood, poles and other building materials and cut down soil erosion. According to Kerkhof (1990) and SECAP (1991) some of the trees and shrubs introduced into the study area like *Leucaena* *leucocephala, Leucaena diversifolia, Calliandra callothyrsus, Stylocenthus spp. and Desmodium spp.* for soil fertility improvement performed poorly due to edaphic and climatic factors. Therefore farmers have found difficult to establish.

The fruit trees including mangoes, avocado, peaches, oranges, lemons, pawpaws, loquat etc to mention a few provided farmers with fruits for consumption and cash income from sale of the surplus. Through pruning of the trees and shrubs also farmers get firewood and building materials and fodder for the livestock. Results from the focused group discussion have shown that, on average a household needed up to 4 headloads of firewood per week.

Thirty eight percent (38%) of farmers were obtaining firewood from trees planted on their farms, implying that to this group of farmers the agroforestry systems had enough trees to meet the household's annual demand for firewood. Majorities were from the Soni and Shashui villages with trees planted long time ago before SECAP under indigenous agroforestry systems. Forty five percent (45%) of the farmers were depending both on trees planted on their farms and buying firewood from neighbours. This represents both farmers practicing and not practicing agroforestry whose systems were not supplying adequately annual firewood requirements. Majorities of this group of farmers had trees planted during SECAP i.e. trees were bellow 20 years. The remaining 17% of farmers were mainly buying firewood from the neighbours. This is the group of the farmers who were not practicing agroforestry.

The study also evident Grevillea (*Grevillea robusta)* being the most preferred tree species in the study area. Almost every household was growing it on their farm plots. Results from group discussion have shown that majority were mostly interested in grevillea simply because it grows fast, easy to manage and do not have adverse negative interactions with most of the associated agricultural crops. Also most of the seedlings to the majority were supplied by SECAP free of charge. However, the finding is different from the study by Moshi (1997) who documented Albizia as the most preferred tree species in the west Usambaras followed by grevillea and avocado.

4.5 Household Cash Income

Table 18 shows distribution of the household's annual net income for farmers practicing and not practicing agroforestry. The calculated net income reflects aggregated values of the effects of agroforestry to the households in the study area and thus the contribution to poverty alleviation. However, 90% of respondents depend mainly on farming activities as the main source of the household's income.

Comparatively, the net income for farmers practicing agroforestry was significantly different ($P<0.05$) from those not practicing agroforestry. On average farmers practicing agroforestry had higher net income of Tshs 664 992 (US$ 665.0) compared to Tshs 547 608 (US$ 547.6) for those not practicing. The calculated income per capita (households averaged 6.6 persons) was Tshs 100 756 (US$ 100.8) and Tshs 82 971 (US$ 83.0) for farmers practicing and not practicing agroforestry respectively. Therefore considering the observed average farm size of 3.1 ha, a farmer practicing agroforestry was earning up to Tshs 214 513 ha^{-1} (US$ 214.5) compared to Tshs 182 536 ha^{-1} (US$ 182.5) for those not practicing. This implies that farmers practicing agroforestry are better off than those not practicing. They have more income that could help solve many of their daily socio-economic problems hence contribute more to poverty alleviation than those not practicing agroforestry.

Table 18: The household's annual net income

Village	Household's annual net income	
	Farmers practicing agroforestry	Farmers not practicing agroforestry
Ubiri	723 628	553 069
Ngulwi	715 359	696 535
Soni	588 780	516 479
Shashui	632 201	424 350
Average	664 992	547 608

However the observed income from the farmers practicing agroforestry was different from the study by Moshi (1997) in the west Usambaras homegardens. He reported a total income of Tshs 495 091 (US$ 990) yearly from 1.28 ha, which is equivalent to Tshs 386 789 per hectare, and the income per capita of Tshs 56 260 (households averaged 8.8 persons). This implies higher level of income (Tshs 386 789 ha^{-1}) than the one observed in the present study (Tshs 214 513 ha^{-1}).

The study also found that 90% of the surveyed farmers were merely depending on agroforestry as the main source of income. Therefore based on this finding it could be said that, the per capita income of Tshs 100,756 (US$ 100.8) for farmers practicing agroforestry is still lower compared to the average national per capita income of Tshs 120 000 (US$ 120) and 242 000 (US$ 242) in 1997 and 2000 respectively (URT, 1997; 2000). For that reason farmers in the study area are still living in abject poverty spending less than US$ 0.50 on consumption a day i.e. Tshs 276 or US$ 0.28. Implying that, despite the relatively higher contribution shown by agroforestry to poverty alleviation, the production level and net income is generally low and therefore more efforts and strategies are needed towards improving the systems' productivity otherwise poverty will still remain a problem in this area.

Farmers were asked to say whether the income was satisfactory to most of the household requirements, 85% said was not satisfactory, 13.6% satisfactory to some extent and only two farmers (1.4%) said was very satisfactory. This implies that majorities do not get enough income to meet most of their daily family requirements. Most of the incomes although not enough has been to the majority (80%) spend in basic needs, (16%) school fees and health services and (4%)hired labour and purchase agricultural inputs.

However, further observations have shown that, there are opportunities for improving productivity of the agroforestry systems. For example the individual farmers who managed to afford costs of most of the agricultural inputs had higher yields and incomes than others. Implying that if many more farmers could afford the prices then production will improve the same to the net income. Also, sooner or later many more farmers could start benefiting from selling timber and firewood especially when most of the tree species on their farm plots reached the rotation ages. This could probably improve the observed household's level of income because during data collection for this study, most of the trees were bellow 20 years since were planted during SECAP. Only few farmers (20%), majority from Soni and Shashui villages had many tree species, which had reached rotation ages and who had started to sell to the neighbours. Many of these trees were eucalyptus and grevillea planted under the indigenous agroforestry systems and depending on their size; one tree was sold either for timber or firewood fetching prices ranging between Tshs 10 000 to 20 000.

4.6 The Factors Influencing Household's Net Income from the Agroforestry Systems

Table 19 presents the results of the regression model of the factors that were thought to be able to account for more of the variation in the household's net income from the agroforestry systems. Therefore the predictors, that is, farm size, household size, number of trees planted, number of livestock kept, varieties of crops grown and cost of farm production were regressed against the household's net income.

From the regression, it was observed that the mentioned factors somehow explained the household's level of net income from the agroforestry systems because none of their standard coefficients was equal to zero. Also, the regression model explained 71% of the variations in the factors affecting the household's net income as the R^2 signifies (Table 19).

Results in table 19 show that three of the six predictors included in the analysis, that is, the household size, number of trees planted and the annual cost of the household's farm production were statistically significant at 0.01 level ($P<0.01$). This implies that the three predictors had an impact on the household's net income in the study area than others. Therefore increase in size of these predictors brought about an increase in the household's annual net income at magnitudes indicated by their respective coefficients, and thus contributing to poverty alleviation.

Production cost was the highest predictor of the household's net income (β value of 0.475 with unstandardized regression coefficient (B) of 1.179) while number of trees planted the second predictor (β = 0.350 with B = 238.479) and household size the third predictor (β = 0.201 with B = 21365.228) (Table 19). The remained predictors were not statistically significant in influencing the household's net income ($P<0.05$). Observations have shown that net income improved with increasing the household's size of the number of people who could actively participate into farming activities. Therefore farmers could improve production at low costs since they had sufficient and timely available labour thus, no need for hiring.

From the regression results the household's annual net income increased significantly with increasing costs of agricultural production. Implying that in order for a farmer to keep his/her system(s) at high production level had to incur more costs associated with that type of production. For example observations have shown that individual farmers who managed to meet all/ most of the costs of inputs associated with livestock and crop productions had higher level of milk and crops production and thus higher net income. There was a problem of soil fertility, expensive livestock and crop production inputs and insufficient fodder supply from the agroforestry systems to the majorities. Therefore, in order to improve production one has to add animal manure of which some had to buy from neighbours and/or inorganic fertilizer, buy enough fodder and improved crop seeds and ensure constant control of pests and diseases for both livestock and crops. All these came with cost element and thus high cost of production. In other words, the present conditions of agroforestry systems need more inputs in order to improve and possibly sustain their productivity.

Table 19: Regression results of the factors influencing the household's net income

Predictor	Standardized coefficients (β)	Unstandardized coefficients (B)	(Std. Error)	Significant t	Significant P
Constant		209595.970	93368.536	2.245	.027
Farm size	-.095	-15478.966	10859.337	-1.425	.157
H/hold size	.201	21365.228	6925.839	3.085	.003**
No. of trees	.350	238.479	49.99	4.775	.000**
No of livestock					
1. Cows	-.125	-18475.335	10334.087	-1.788	.076
2. Goats	.034	3716.634	7663.969	.485	.629
3. Sheep	-.037	-4629.223	8306.512	-.557	.578
4. Chicken	.023	794.272	2266.059	.351	.727
5. Ducks	-.024	-8058.559	21895.952	-.368	.713
Crop varieties	.082	15520.541	13037.613	1.190	.236
Production cost	.475	1.179	.174	6.767	.000**

R^2 = 0.7082
Adjusted R^2 = 0.6515
** = Significant at P<0.01

The household's annual net income improved significantly with increasing number of trees in the farm plots. Implying that individual households, which had many tree species and shrubs, had higher net incomes. However, observations have shown that farmers with many agroforestry trees and /or shrubs had higher income because instead of buying fodder, firewood, timber and other construction materials from neighbours could obtain them directly from the agroforestry systems thus save money. They could also obtain income from sale of the surplus fruits from the agroforestry system(s). The trees also helped to provide shade to some crops including coffee and cut off soil erosion thus contribute to improving productivity of the agroforestry systems.

Results in table 19 also show that the farm size and the number of cows, sheep and ducks kept influenced the household's annual net income negatively, and were not found statistically significant. This implies that as the number of these animals increased, there was a decrease in the household's net income. However further observations showed that majority of the farmers had a problem of insufficient fodder production from the agroforestry systems. Therefore, including other associated costs of the livestock inputs; increase in number of the livestock's decreases the net income, as there were added costs of buying fodder and other inputs and since majority could not afford then the livestock's were poorly fed thus low production as well as net income. In addition, there was a negative influence of the farm sizes to the net income probably because productivity of the farming systems was depending mostly on how best the systems were managed than their sizes. A farmer with a well-planed and managed agroforestry system could have higher yield regardless of the farm size given that there is a good management systems.

The varieties of the agricultural crops grown under the agroforestry systems and the number of livestock kept like goats and chicken had positive influence on the household's annual net income although they were not statistically significant. This implies that, farmers with many varieties of crops associated with the agroforestry trees and /or shrubs had more yields and net income than others. Goats and chicken also contribute to the net income probably because they require less initial capital and management costs. For example, management of chicken in the study area was basically through free-range system.

4.7 Constraints Facing the Agroforestry Systems

Table 20 shows various problems facing the agroforestry systems in the study area especially in the course of trying to improve and sustain the systems productivity. These were the problems, which need to be overcomed so that farmers could achieve optimal and sustainable production.

Table 20: Problems facing agroforestry systems in the study area

Problem	Number	Percent
Diseases and pests	123	91.8
Expensive farm inputs	122	91.0
Unreliable rainfall	112	83.6
Low farm yields	107	79.9
Poor market opportunities	105	78.4
Poor extension services	104	77.6
Shortage of fodder	89	66.4
Poor soil fertility	74	55.2

Of the surveyed smallholder farmers, 91.0% contended that, prices of the farm inputs were expensive and that majority could not afford. These inputs include biocides, seeds, fertilizers, livestock drugs and other necessary farm implements. Formally, such chemicals were provided to farmers on credit basis or sold at subsidized prices but nowadays such facilities are not available (District Agricultural Officer, Pers. commun.). As a result some farmers used to plant the locally available maize and beans seeds. They use traditional medicines to cure their livestock of which often not effective. This therefore reduces the productivity of the agroforestry systems.

Majority of the surveyed farmers (77.6%) contended that the extension service in the study area was not adequate (Table 20). Farmers were asked to give frequencies of contact with extension officers, the most frequent answer to majority (53.5%) was only once per year whereas 46.5% contacted them once when they had problem, which needed immediate action especially those regarding livestock production. They had to go and see them in their respective offices. However, according to the District Extension Officer, the inadequate extension service in the study area was a result of insufficient staffs, lack of transport and working incentives to the staffs (Pers. commun.). Therefore, this has to be overcomed in order to improve and sustain the productivity of the agroforestry systems.

Poor market opportunities for the agroforestry produces (78.4%) was another problem constraining productivity of the agroforestry systems in Lushoto. The price of some of the main agricultural crops had been too low that farmers lost interest to invest into crop production. For example the producer price of coffee has dropped from Tshs 1500 to 450. Other crops prices have been fluctuating from time to time. As a result, some of farmers have completely abandoned or shift to other production. Therefore, government should find ways of improving the market systems of the rural farmers. Attractive producer prices being one of the main factors that could motivate more crop production in the study area.

About 55.2% of the surveyed farmers reported that, there is a problem of poor soil fertility in the study area. Observations have shown that, there was a problem of nutrients transfer and insufficient replenishment of soil fertility through manuring to the majority due to lack of capital and adequate number of livestock. Some farmers were carrying the livestock manure obtained from feeding them with fodder harvested from the agroforestry systems to the valley bottom farms for vegetable productions thus poor nutrients cycling. Soil erosion has also been taking place although not severe especially to the household's farm plots that had no sufficient soil erosion control physical structures, fodder and trees/ shrubs. However, the problem of poor soil fertility was also reported by Moshi (1997) and Johansson (2001) in the west Usambaras that, the permanent cropping system of the area has resulted into continuous removal of nutrients from the soil through crops, weeds, fodder and trees. This reduces the productivity of the agroforestry systems. Therefore, to arrest this problem, farmers have to ensure constant replenishment of the soil nutrients through manuring, avoid transfer of the livestock manure to the valley bottom and instead carry it back to the agroforestry systems where fodder was harvested and abiding to the recommended soil erosion control measures.

Livestock production was constrained by shortage of fodder. Except for the few farmers who had enough fodder banks, majorities (66.4%) had to fetch fodder outside of their farm plots either by themselves or hired labour. This system resulted into poor feeding of the livestock and thus low milk production. Therefore, to arrest this problem, farmer must establish sufficient fodder bank.

Low productivity of the farming systems is another problem of the study area. This argument was supported by 79.9% of the surveyed farmers. However, the observed level of production for the main agricultural crops and milk was lower compared to other systems elsewhere. Therefore, in order to improve and sustain production the government should improve the extension services while at the same time farmers adopt the measures for improving productivity including soil fertility management and use of appropriate and improved breeds.

Of all the surveyed farmers, 91.8% contended that, diseases and pests was the problem constraining productivity of the Lushoto agroforestry systems. Various diseases and pests have been attacking their crops and livestock from time to time. Further observations have shown that some farmers had stopped dairy cattle production because in the past the cattle were wiped out by diseases, and could not treat them since they are poor. Chicken production was and still threatened by the deadly disease locally called "*kideri*". However farmers have been trying to control these diseases and pests using available traditional medicines but to majority did not work and as a result end up loosing their livestock's. Therefore, need for the government through its respective ministries to find immediate and sustainable measures of arresting these problems. Also while the government is on the process of solving these problems, farmers should on their own efforts concentrate on growing pest and diseases resistant crops.

Unreliable rainfall although it is not a common problem in the study area, was supported by 83.6% of the surveyed smallholder farmers. According to focused group discussion data for this study was preceded by a long period of drought of which lead to more people report it as another problem. The area normally receives substantial amount of rainfall almost every year but sometimes it comes late thus affecting the production at large like it was the case of the present study.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From this study it can be concluded that there are two agroforestry systems in the Lushoto District, which are agrosilvicultural systems and the homegardens (agrosilvopastoral systems). These systems are practiced on the upland farms intended to restore the ecology and ensure supply of different foods and other products over the year and thus important to the farm family socially, culturally and economically.

The level of the household's farm production and net income is greater among farmers practicing agroforestry than those who were not practicing, implying that, the agroforestry systems are significantly contributing to increase yields and income and thus poverty alleviation. The trees and crops into such systems produce both food for subsistence and cash, fodder for the livestock, and reduce the problem of soil degradation and water quality and quantity while solving the problem of energy crisis. The livestock are mostly stall-fed and contribute to the household's nutrition and income through sale of their products like milk, eggs and meat.

However, despite the fact that agroforestry is contributing to poverty alleviation; still, the systems are constrained by many problems. The problems are as described in section 4.7 in this study, and therefore overcoming them is the key towards improving the systems productivity and thus poverty eradication. In addition, with regard to the former extent of land degradation and the observed level of farm production and income, the period of about 20 years in practice of the SECAP innovations in the study area still is too short to say anything about optimal productivity and sustainability of the systems. Therefore, from the researcher's point of view, the agroforestry systems will take more time even under proper management practices for farmers to attain optimal production and probably sustain their productivity.

5.2 Recommendations

In order to improve the productivity and sustainability of the agroforestry systems of the Lushoto District and achieve poverty alleviation, the following recommendations are proposed:

5.2.1 Recommendations for improvement

Generally, the densities of the multipurpose trees and shrubs and fodder grasses on the agroforestry systems were low. They were mainly planted along the farm boundaries and in most cases not properly arranged. For that reasons, the intended goal of stabilizing the ecology and arresting soil erosion could not effectively be achieved. Therefore, there is a need for improving their densities especially on contour strips and arrange them according to their technical recommendations.

The efforts made by farmers towards improving their economic situation through agroforestry have mostly been constrained with problems like insufficient extension services, higher prices of the farm inputs and unattractive prices of most of their farm products. This resulted into poor yields to the majority. Therefore, there is need for the government to find measures to overcome these problems. Promotion of efficient uses of farm inputs and labour along with policies, which harness market incentives is a prerequisite. For example, where necessary, farm inputs should be provided to farmers on credit basis. Also, improvement of the market opportunities and extension services will motivate farmers to invest in crop production and thus improve the management and production at large.

It was also found that, there was a problem of nutrients transfer from the agroforestry systems. Some farmers were carrying the animal manure from the agroforestry systems down to the valley bottom farms for vegetable production. This affects productivity of the agroforestry systems because it encourages poor nutrients cycling within the systems. This is because the livestock are fed with fodder, which mostly obtained from the agroforestry, systems. Therefore, to improve and sustain the systems productivity, farmers must ensure that, the livestock manure, and other organic matter like agricultural residues and household wastes are carried back to the field where it was harvested.

Since the system of planting more trees along the farm boundaries and less on the contour bunds could not effectively restore the ecology and the systems productivity, then hedgerow-intercropping systems is recommend especially in the agrosilvicultural systems and where necessary the *calliandra spp.* should be included in order that, including others could save the problem of fodder shortage.

5.2.2 Recommendations for further research

The present findings on poverty alleviation were only based on the household's level of production and income from the agroforestry systems. Therefore, to get the exact picture of the poverty level in the study area, assessment of the contribution of both farm and off-farm activities to the household's income are recommended.

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APPENDICES

APPENDIX 1: HOUSEHOLD QUESTIONNAIRE

Date of interview...............

Village...........................

Ward ....

Division ....

A: INFORMATION ON THE HOUSEHOLD

1. Respondent's

    (a) Gender: (1) male (2) female

    (b) Status: (1) head of the household; (2) not head of the household

    (c) Age: (1) Below 16 years; (2) 16-64 years (3) Above 64 years

    (d) Level of education: (1) No formal education (2) Adult education

    (3) Primary education (4) Secondary education

    (5) Diploma level of education (6) University

    (e) Marital status (1) Single (2) Married (3) Divorced (4) Widowed

    (5) Separated

    (f) Main occupation: (1) Smallholder farmer (2) Petty business (3)Employee

    (4)Others(Specify)...

2. What is the main source of labour for your farm activities?

    (a)Family members (b)Hired labour (c) Both 1 & 2 above

    (d) Others Specify...

3. What is the size of your household members?

(a) Bellow 16 years (..........................) (b)16 – 64 years (..........................) (c) Above 64 years (..........................)

4. How many people from your family can actively participate into farming activities? (............)

5. What is the main source of income for your family?

(a) Farm activities (b) Off-farm activities (c) Salary / wages

(d) Both 1 & 2 above (e) Others (Specify)...

6. What is the average annual income category from your farm activity do you belong to? (Tshs/ annual).

(a) Less than 200 000 (b)200 000-500 000 (c)Above 500 ,000

7. How do you mostly spend the income accrued from the farming systems

(a) Basic needs (clothes, foods shelter) and health services

(b) Invest into off- farm activities (c)Hired labour and purchase of farm inputs

(d) Others(specify) ....

8. Do you think the income obtained is satisfactory to most of your family requirements?

(a)Yes, very satisfactory (b)Yes, to some extent (d) No, not satisfactory

B. LANDUSE AND FARM SIZE CHARACTERISTICS

9. What is the size of your farm?.........................acres/ hectare.

10. Is your farm size enough for farming activities? 1. YES 2. NO

11. What size of your farm was under cultivation in the year 2002?.........acres/ hectare

12. Which crops do you raise in your farm and their uses?

CROPS		MAIN USES				
Local name	Scientific Name	Food	Fodder	Cash	Medicinal	Others

13. What was the level of production per crop, cost of production and the selling prices for the year 2002?

CROP	Amount produced / yr	Amount sold/ yr	Selling price/ unit	Production cost/ year	Revenue/ year	Net Income/ yr

14. What can you say about the trend of crop production for the past ten years now?

(a) Increasing (b)Decreasing (c) Uniform trend

(d) Others (specify...

15. What problem (s) do you face regarding crop production?

....

....

16. Of the problems you have just mentioned, which ones do you considered to be the most three critical problems in this area and how do you go about them?

CRITICAL PROBLEM	SOLUTION

17. Do you keep livestock?

(a)Yes (go to 19) (b) No (go to 18)

18. Why don't you keep any livestock?

(a) Shortage of grazing land (b)Shortage of fodder

(c) Lack of capital to buy animals (d)Vulnerability to diseases

(e) Others(Specify) ....

19. What types of livestock do you keep in your farm?

Type of livestock	Number	Reasons			
		Meat	Milk	Manure	others

20. What was the production per animal, cost of production and the selling prices of their products for the year 2002?

Animal (Out put)	Quantity/ year	Cost of production/ year	Selling Price/ unit	Revenue/ year	Net Income/ year

21. What can you say about the trend of livestock production for the past ten years now?

(a) Increasing (b)Decreasing (c)Uniform trend

(e) Others (specify...

22. What problem (s) do you face regarding livestock keeping?

……………………………………………………………………………………………

……………………………………………………………………………………………

23. Of the problems you have just mentioned, which ones do you considered to be the most three critical problems in this area and how do you go about them?

CRITICAL PROBLEM	SOLUTION

24. Which tree species are present in your farm? (Both exotic and indigenous)

No	Tree type			Main uses / function					
	Local name	Indigenous / Exotic (I / E)	Amount of trees planted	Timber	Poles	Fruits	F/wood	Fodder	Others
1									
2									
3									

25. Can you briefly explain the way you manage the crops, trees and livestock/ animals in your farm?

Crop management (seasonal crops)

CROP	Planting time (Month)	Weeding (How many times/season)	Pest & disease control (Chemicals mostly used)	Fertilizer application (Type(s) used both organic & inorganic)	Harvesting time (Month)

Tree management

Location of the trees/shrubs	Pruning period (months) how many times/ year	Reason (s) for pruning
Boundary		
Contour bunds		

Animal management

Animal	Stall-fed/ Grazed (S / G)	Chronic disease/ Pest in the area	Most useful chemical (s) used for treatment

26. Which inputs did you apply to your farm in 2002 and their cost?

	Crop production		
	Input	Amount bought	Cost/unit
1			
2			
3			
	Livestock production		
	Input	Amount bought	Cost/unit
1			
2			
3			

C. GENERAL QUESTIONS

27. Do you receive extension services?

(a). Yes (b). No

If Yes, how many visits per week/ month/ year..................................

28. Do your apply inorganic fertilizers in your farm? (a). Yes (b) No

If NO, Why? ....

29. Assessing your farm now, would you say it is:

(a) In very good state (b) In good state (c) Average state

(d) In poor state (e) Very poor state

30. In general, how do you view the future productivity of your farm?

(a) Bright (b) Same as now (c) Bleak / worse

31. What is your fuelwood requirement per month? (......................................)

head-loads; Where do you obtain them?

(a) Planted trees on my farm (b) Nearest forest (c) Both 1 & 2 above (d) Buying

(e) Others (Specify) ....

D. PERSONAL OPINIONS

32. What exactly has forced you to adopt the type of farming system you are practicing now? ……………………………………………………………………

33. Considering the observed density of trees and / or shrubs and their arrangement in your farm; do you think they are efficiently conserving soil while providing other products to your family? If NOT then; what is your future plans?

……………………………………………………………………………………………

……………………………………………………………………………………………

34. Looking at the level of your farm production; do the level of production and income satisfy most of your household's basic needs? If NOT; what do you think should be done to improve the condition?

……………………………………………………………………………………………

……………………………………………………………………………………………

APPENDIX 2: QUESTIONNAIRE FOR THE KEY INFORMANTS (CHECKLIST)

1. What can you comment on the trends of the agroforestry systems productivity in this area for the past ten years now?

2. Having seen the trends of the systems productivity for long now, what do you think should be done in order to improve the condition?

3. What do you consider to be the common problems facing the agroforestry systems productivity in this area? Have you ever tried to solve some of them? How?

4. Where do most farmers sell their farm products? Nearby markets?..................... Individual buyers?.............

5. How can you explain the market of the farm products in this area? Well or poorly organized? What do you think should be done to improve the situation?

6. How do you view the nature/ extent of extension services in this area? Is the service provided satisfactory? Do you think most of the farmers will be able or, are effectively implementing the intended packages of extension skills and technologies rendered to them? If NOT, why?

7. In general, how do you view the future productivity of agroforestry in this area?

8. Regarding to the agricultural inputs; Are they readily available and at affordable prices? If NOT; how do you go about this?

9. What can you comment on the trends of rainfall in this area?