ATTITUDE, ADOPTION AND ECONOMIC POTENTIALS OF AGROFORESTRY IN KILOSA DISTRICT, MOROGORO REGION – TANZANIA

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN ENVIRONMENTAL AND NATURAL RESOURCES ECONOMICS OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA.

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ABSTRACT

Agroforestry have been proposed as the solution to the prevailing deforestation and land deterioration in developing countries like Tanzania. This study aimed at determining farmer's attitude, adoption and economic potentials of agroforestry practices in Kilosa District. Specifically it was intended to describe agroforestry systems and technologies, examining the level of attitudes towards agroforestry, identifying socio-economic factors influencing agroforestry adoption and estimating costs and benefits of agroforestry. Primary data were collected using structured questionnaire which was administered to a random sample of 120 households in four villages while data from key informants were collected using checklist. Secondary data from various sources were used to supplement the primary data. Data were analysed using Excel Software where cost benefit analysis was generated and Statistical Package for Social Sciences where descriptive statistics, factor analysis and logistic model were generated. Results revealed that agroforestry systems practiced were agrosilvopastoral and agrosilvicultural arranged in mixed intercropping, boundary planting and homegardens. The majority of the respondents had a positive attitude towards; commercialization (90%), land resource conservation (89%) and land productivity (82%). Farm labour force, attitude towards; land productivity, commercialization and land resource conservation significantly influenced adoption of agroforestry at $P < 0.05$. The selected agroforestry systems were economically viable at discount rate of 10% and on average had positive Net Present Value of 3,309,680Tshs, Benefit Cost Ratio of 1.6 and Internal Rate of Return was 73% indicating the worth of investing in agroforestry. Conclusively respondents appreciated the contribution of agroforestry in meeting the diverse needs to uplift their socio-economic status. The study suggested that the government and development agencies should strengthen education, training and agroforestry extension programs. Further, agroforestry disseminators should

improve the benefits of agroforestry since high attitude towards agroforestry were due to the respondents’ perception that investment in agroforestry was associated with more benefits than costs.

DECLARATION

I, FRANSISCA LUUMI, do herebydeclare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

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The above declaration confirmed

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PROF. Ephraim M.M. Senkondo Date

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BCR	Benefit Cost Ratio
CBA	Cost Benefit Analysis
CDM	Clean Development Mechanism
EPINAV	Enhancing Pro-Poor Innovation in Natural Resource and Value Chain
FA	Factor Analysis
FAO	Food and Agricultural Organization
GIS	Geographical Information System
Ha	Hectares
IRR	Internal Rate of Return
kg	kilogram
km	kilometre
LP	Linear Programming
ml	millilitre
MOTAD	Minimization of Total Absolute Deviation
MRPS	Marginal Rate of Product Substitution
NPV	Net Present Value
PCA	Principal Components Analysis
QRP	Quadratic Risk Programming
SPSS	Statistical Package for Social Science
SUA	Sokoine University of Agriculture
Tshs	Tanzanian shillings
URT	United Republic of Tanzania
USD	United States Dollar

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Throughout the world, natural resources degradation including rapid land deterioration is among the most critical challenge facing the world and indeed, the developing world today. There is decreasing agricultural productivity as a result of increasing land degradation, reduced ability of forest resources to provide goods and services due to deforestation and forest degradation (Gama *et al.*, 2013). However the increasing demand for fuelwood, fodder and timber has greatly resulted into forest degradation. One way that appears suitable for providing a solution to the adverse effect of deforestation is the adoption of agroforestry as an approach to sustainable land use system. Literature reveals that, agroforestry is a suitable farming system that imitates the structure and processes of natural forest vegetation. Such systems have high potential to increase the productivity of farming systems and sustain continuous crop production (Kalabisova and Kristkova, 2010).

Leakey (1996) has defined agroforestry as a dynamic, ecologically based natural resource management system that, through the integration of trees in farmland and rangeland, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels. The integration may either be a spatial mixture or in temporal sequence with both ecological and economic interactions between the woody and non woody components of the system. The practice of agroforestry is usually with the intention of developing a more sustainable form of land-use that can improve farm productivity and the welfare of the rural community as a whole.

Although agroforestry may not entirely reduce deforestation, in many cases it acts as effective buffer to deforestation (Singh *et al.,* 2011), and thus relieves pressure from natural forests and help alleviate rural poverty. In Tanzania the practice of agroforestry is common where several traditional agroforestry systems have been in practice (Lulandala, 2011). Farmers have always left certain tree species during land preparation because of values associated with them (Umeh, 2012), while some trees are planted or a mixture of both planted and naturally growing trees (Senkondo, 2000). Hence, understanding local usage of agroforestry systems and technologies is necessary for formulating adoptable agroforestry practices.

It has been well documented that, acceptability and adoption of agroforestry practices involves adequate knowledge of a number of factors including how users perceive the underlying problem, their attitude, beliefs and practices related to the intervening solutions offered to them by the technological innovation (Neupane *et al.,* 2002; Ajayi, 2007; Gao, 2012). The attitude of the individual farmer to agroforestry is crucial to the success of agroforestry adoption. Farmers' perceptions of the role that the system plays in their farms' production, its costs and benefits culminate in the socio-economic enhancement determine the extent and durability of adoption (Buake, 2005). Looking at this perceptive; these aspects need to be taken into account given that agroforestry can help to enhance socio-economic well being.

Socio-economic factors influencing local communities to adopt agroforestry practice need also to be addressed apart from the biological and physical aspects (Senkondo, 1992). In addition the sustainability of most agroforestry practices has seriously been undermined since they are influenced by socio-economic factors. It is therefore of scientific interest to examine socio-economic factors which influence both productivity and sustainability of agroforestry practice.

Research has shown that, agroforestry design strives to maximize positive interactions between trees and other elements (crops and animals) and minimize negative interactions (Umeh, 2012). For a better understanding of agroforestry design and the potentials for optimal realization of benefits of the system, it is important to take into account the likely impact of agroforestry practices in the economic return to farmers. In addition, evaluation of agroforestry economic return involves comparisons between agricultural costs and returns that occur annually (Franzel, 2004). Therefore, this study is designed to examine agroforestry in terms of costs and benefits that occur annually in order to provide an ex-ante estimate that will allow simple judgement on economics of agroforestry practice.

1.2 Conclusion

Demand for agricultural land and forest products is on increase in most developing countries such as Tanzania. This leads to shortage of arable land accelerating land degradation including deforestation and hence decline in agricultural productivity. Agroforestry technologies have been proposed as the solution of land shortage and productivity due to its great potential for both forestry and agricultural products (Mbwambo *et al.*, 2013). The technology adoption among farmers requires that the factors that influence their decisions to adopt or not to adopt the technologies be identified.

Moreover, the attitudetowards agroforestry can be introduced to farmers to evaluate its potential since they can decide if they will adapt the practice or not. Therefore it is important to examine farmer’s attitude towards the adoption of agroforestry practices. On the other hand the evaluation of agroforestry economic return involves comparisons between agricultural costs and returns that occur annually (Franzel, 2004). Therefore in addressing the main question about agroforestry it is vital to assess costs and benefits in terms of values perceived by farmers as a result of running agroforestry practices.

Based on the aforesaid, this calls for need of conducting studies that examines different socio-economic factors that influence the adoption of agroforestry technologies among peasant farmers. In addition this study seeks to determine attitude towards the adoption of agroforestry and estimating the costs of inputs and benefits accrued from agroforestry. In order to provide such information, the current studywas conducted in rural areas in Kilosa District.

1.3 Problem Statement

The increasing pressure on limited land resources is a problem being faced in the rural areas of Tanzania. Land degradation through poor agricultural practices has greatly impacted negatively on forest degradation (Gama *et al.*, 2013). Subsistence farmers in these areas still practice traditional bush clearing and burning bush at short intervals to grow annual food crops.

However the problem of population growth coupled with economic pressure has resulted in a high rate of deforestation of the country’s natural forests. Deforestation has also been on the increase due to the increasing demand for fuelwood, tree fodder, timber, poles and agricultural land. Therefore, deforestation has worsened the demand-supply situation of fuelwood, building materials and a highly demanded tropical timber (Senkondo, 2000). With the depletion of natural forests and increasing pressures on the forest reserves, research in agroforestry as a land use system is still important to reduce land degradation so as to guarantee the future of the existing forest reserves (Buake, 2005).

Consideration of agroforestry practices has been advocated to alleviate these problems (Senkondo, 2000) and is one of the options for reversing the prevalent land degradation thereby conserving the natural forest (Irshad *et al.*, 2011). The practice of agroforestry in Tanzania is widely spread, and its acceptability in terms of attitude, adoption of agroforestry systems and technologies have been well demonstrated in the country and in different regions of the world (Senkondo, 2000; Neupane *et al.*, 2002; Place *et al.*,2005; Simon *et al.*, 2011; Ajayi, 2007; Gao, 2012). These studies have revealed that, the potentials for optimal domestication of suitable tree species for use in agroforestry system depend on the attitude and perceived benefits by local users. However, this information and systematic feedback regarding farmers' attitude and adoption of the agroforestry is relatively insufficient in the context of Kilosa District. Therefore, this brings the need to unveil on why some farmers adopt agroforestry and others do not.

Most of the research studies on agroforestry have been studied from the biophysical perspective (Lambert and Ozioma, 2011; Senkondo, 1992). However, Mercer and Miller (1998) revealed that nothing much has been done on the socio-economic aspect especially as it affects the adoption of agroforestry technologies. This has caused a knowledge gap in agroforestry research. Therefore, there was a need of conducting a study on the factors particularly the socio-economic factors that influence adoption of agoforestry technologies in Kilosa Districts.

In developing agroforestry systems farmers tend to focus on the relative input and output prices of crops and trees (Cacho and Hean, 2004)with the aim of economic gain or benefits (Wijayanto, 2011). Since the trees components on farms are associated with costs and benefits values of which information is lacking, hence this study intends to estimate the costs and benefits associated with agroforestry practices in the context of Kilosa District.

1.4 Justification of the Study

This study aims at understanding farmer'sattitude towards agroforestry adoption and the associated economic potentials of agroforestry in the study area. Results from this study provide baseline information which will have potential value in the design of appropriate financial incentives for promoting the wider cultivation of mostly preferred suitable tree species in Kilosa District and other similar areas.

In addition, these findings can help to improve uptake of agroforestry technologies and in turn also improve farmer's livelihoods, mostly by designing diffusion processes that take into account the stage of knowledge about agroforestry, including their characteristics.

It is also hoped that these findings provide better understanding of household's economy in relation to agroforestry production cycle and thus contribute to the process of agroforestry implementation. Hence, estimation of costs and benefits is vital to provide information in terms of values perceived by farmers as a result of running agroforestry practices taking into consideration farmers expected benefits.

1.5 Objectives of the Study

1.5.1 General Objective

The main objective of this study was to determine farmer's attitude, adoption and economic potentials of agroforestry practices using Kilosa District in Tanzania as a case study.

1.5.2 Specific Objectives

Specifically the study aimed at,

1) Describing the existing agroforestry systems and technologies practiced.
2) Examining the level of attitudes of local community towards agroforestry practices.
3) Determining socio-economic factors influencing adoption of agroforestry and
4) Estimating the costs and benefits of agroforestry practices.

1.6 Research Hypothesis

1) Farmers' attitude is significant in uptake of agroforestry practices.
2) Socio-economic factors are significant in explaining uptake of agroforestry.
3) Agroforestry practices are beneficial in the long run.

1.7 Significance of the study

The study is significant in terms of its contribution to both theory and practice. It provides insights into contribution of agroforestry to the livelihoods of large and small households. Moreover the study findings were of significance by providing empirical information on how toimprove the benefits of agroforestry. In view of the fact that high attitude towards agroforestry imply that respondents perceive agroforestry investment is associated with more benefits than costs.

The results of this study can be useful in redirecting, improving and strengthening the existing agroforestry programmes. However, the information generated may give some guidelines for implementation of some agroforestry programmes in similar areas. In addition the results of the study were of significance to facilitate stakeholders to design strategies for scaling up adoption of agroforestry technology so as to attain sustainable productivity, improving farmers' livelihood, to ensure food security, increasing rural income and ultimately poverty reduction in the country.

Theoretically, this study made constructive additions to the existing body of knowledge with regard to the topic in question by assessing how attitude of local communities and the associated socio-economic status influence adoption of agroforestry practices. Further, the study provided a foundation for further studies related to adoption of agroforestry practices in order to improve farming activities and hence improving agricultural productivity.

1.8 Conceptual Framework of the Study

Fig. 1 presents the conceptual framework for the study. Adoption of agroforestry practices is a rational decision making process that begins with the individual farmer as the main actor and then influenced by other factors (Oino and Mugure 2013). As noted by Kalabisova and Kristkova (2010), Parwada *et al.* (2010) and Irshad (2011) agroforestry adoption is a decision based on socio-economic factors which are important in technology diffusion and adoption processes (Knahal, 2011). The model indicates that adoption of agroforestry can be influenced by the household's social-economic aspects including; age, education, sex, farm labour force and farm size (Fig. 1). On the other hand in order to make rational decisions on whether an agroforestry system should be promoted or not economic analysis is crucial. In the present study the cost of inputs and the benefits accrued were estimated to explain agroforestry practices. Fig. 1 further show that the attitude towards agroforestry is essential towards adoption of a technology. If the household forms a favourable attitude towards agroforestry practice, it will be willing to adopt the practice contrary if it has a negative attitude.

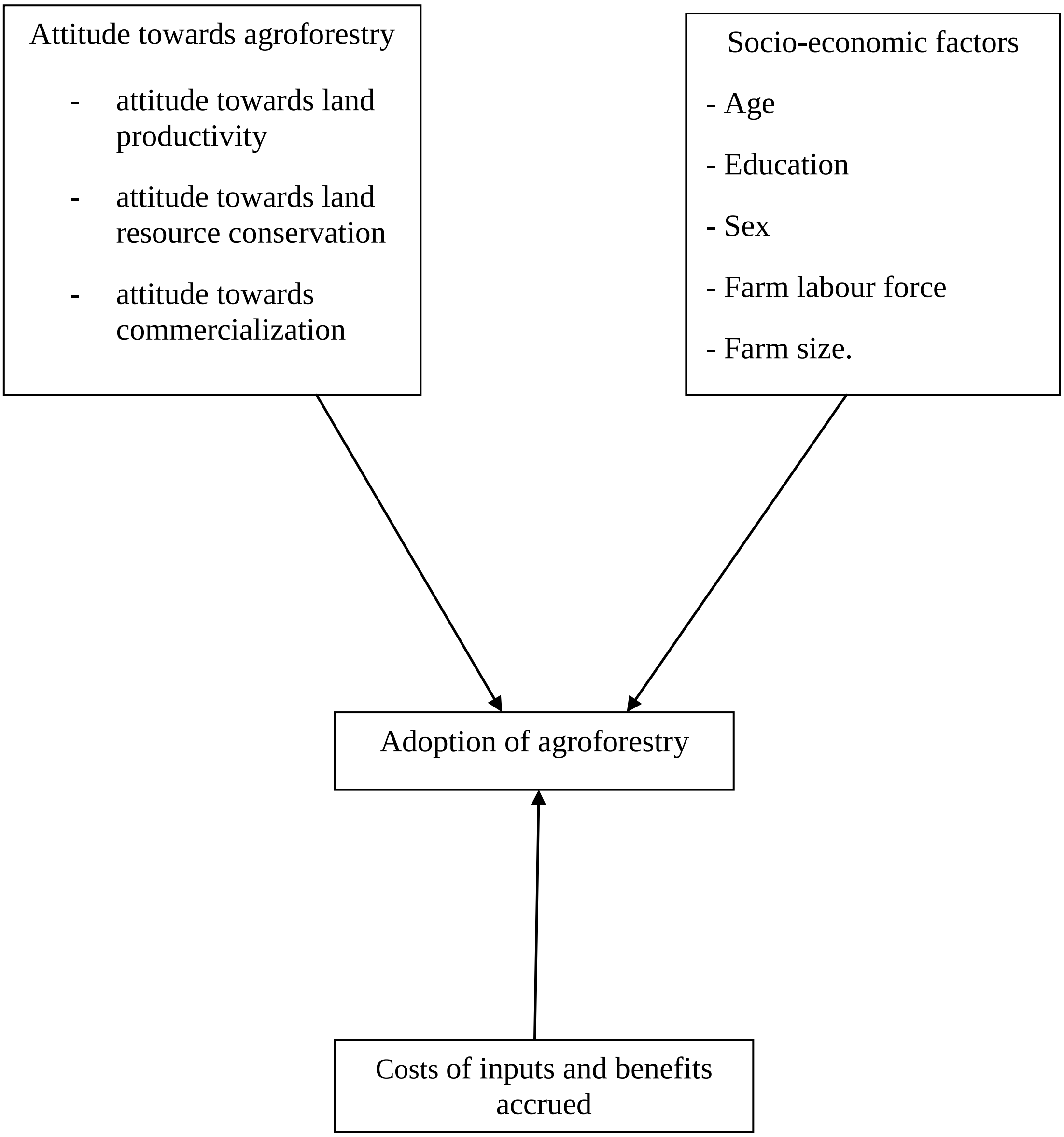

Figure 1: Conceptual framework for examining factors influencingagroforestry practice

Source: Adapted from Meghan *et al.* (2008)

CHAPTER TWO

2.0 LITERATURE REVIEW

This chapter provides a review of the literature which is discussed in relation to the objectives of the study, which include the following issues: overview of agroforestry adoption, the historical perspectives that explain the economics of agroforestry, the socio-economic factors influencing agroforestry practices, general idea on attitudes towards agroforestry adoption and cost benefit analysis in agroforestry. Finally, the chapter reviewed the methodological aspects that were applied in this study.

2.1 Agroforestry Adoption

According to Rogers (2003), adoption occurs when one has decided to make full use of the new technology as a best course of action for addressing a need. Rogers (1995) developed the adoption and diffusion of innovations theory, which has been widely used to identify factors that influence decisions to adopt or reject an innovation. The author defines an innovation as a “new idea, practice or object that is perceived as new by an individual or other unit of adoption” and said that the perceived newness of the idea for the individual is what determines their reaction to it (Rogers, 1995).

Adoption is determined by several factors including socio-economic, environmental and mental processes (Thangata and Alavalapati 2003). The mental processes are governed by a set of intervening mental processes variables such as individual needs, knowledge about the technology and individual perceptions about methods used to achieve those needs. Adoption is also viewed as a variable representing behavioral changes that farmers undergo in accepting new ideas and innovations in agriculture. The term behavioral change refers to desirable change in knowledge, understanding and ability to apply technological information, changes in feeling behavior such as changes in interest, attitudes, aspirations, values and the like; and changes in overt abilities and skills (Ray, 2001). Some significant variables that affect adoption, which have also been used in other adoption studies include educational level, farm size and income. For example a study on adoption of rotational woodlots in Tanzania by Simon *et al.* (2011) and studies elsewhere by Kabwe (2010) in Zambia, Meghan *et al.* (2008) in Brazil, Muneer (2008) in Sudan and Neupane *et al.* (2002) in Nepal.

2.2 Economics of Agroforestry: A Historical Perspectives

A number of studies applying economic principles in agroforestry have been documented. A noble pioneer study is that of Filius (1983). The study applied production economic theory principle of production possibility curve to explain joint production of forest and agricultural products. In the presence of output prices of agricultural and forest products, a combination of the two products that maximize revenue can be derived at a point where iso-revenue line is tangent to the production possibility curve. This kind of study could also be extended to cater for changes in production technology depicted by the shift of production possibility curve as technology changes.

Suppose the price of agricultural product is denoted as P_{y1} and that of forest product as P_{y2} and agricultural product depicted as Y_1 and that of forest productas Y_2, the amount of agricultural product and that of forest product to produce in order to maximize revenue occur at a point where the slope of production possibility curve (also known as Marginal Rate of product Substitution – MRPS) is equal to the slope of iso-revenue line. This is depicted in (Fig. 2). Betters (1988) extended the economic principles explained by Filius (1983) to describe how to obtain optimal agroforestry strategies using Linear Programming. An example of empirical application of this approach is the study by

Senkondo (1996) which used linear Programming to design optimal agroforestry strategies of Uluguru Mountain in Tanzania. Agroforestry production is characterized by income variability or risk. Decision makers' behavior towards risk and uncertainty has been recognized as an important economic phenomenon. It is acknowledged that several techniques for incorporating risk in linear Programming (LP) have been developed. In agroforestry for example and as pointed above, the use of LP has been demonstrated in the past (Senkondo, 1996; Betters, 1988; Dykstra, 1984).

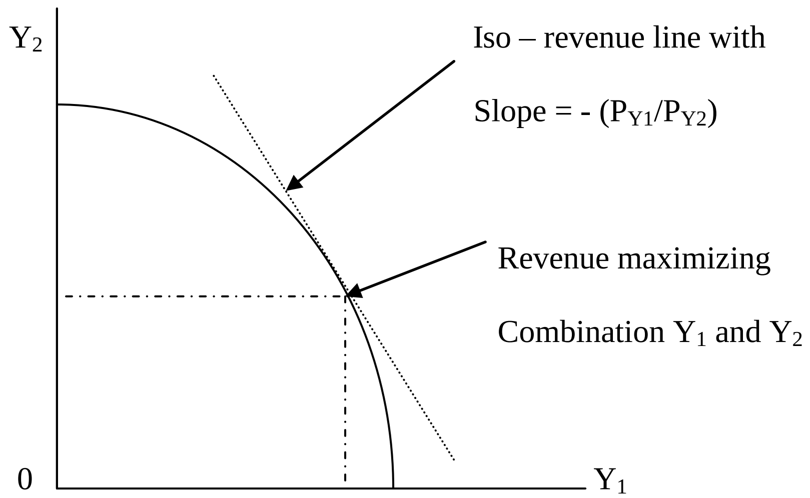

Figure 2: Production possibility curve in agroforestry

The approach used in LP is typically deterministic modeling, but as empirical studies have shown agroforestry farmers in developing countries face a lot of uncertainties due to the variations in agro-ecological and institutional factors (Senkondo, 2000). Portfolio theory as presented (with respect to agroforestry) by Lilieholm and Reeves (1991) and by Blandon (1985) offers an alternative to deterministic modeling that allows for explicit recognition of risk in Quadratic Risk Programming (QRP) models. The use of QRP models assumes that the farmers' net revenues are normally distributed and their utility functions are quadratic (Hardaker *et al.,* 1997). In real situation the distributions of net revenue vary from case and may not be normal. Quadratic utility functions are not increasing at all points and may be fitting farmers' data on specific situations such as during the situation of inadequate cash (Senkondo, 2000). Minimization of Total Absolute Deviation (MOTAD) developed by Hazell (1971) is an LP approximation of the QRP formulation. The variance constraint of QRP is replaced with constraint on mean absolute deviation of net incomes. Mean absolute deviation can be obtained as a linear expression, therefore requiring only LP to generate the solutions (Hardaker *et al*., 1997).

Two important limitations become apparent when applying programming models in agroforestry. The first one is that interactions between crops and trees in agroforestry that affect overall yield are difficult to model. Various remedies are discussed in Senkondo (1996) and in Lilieholm and Reeves (1996) to overcome these limitations as follows: The most preferred approach is to define decision variables as complete systems, each with a set of expected yields for each component crop or tree. The mathematical programming model then allocates hectares of land to systems rather than individual crops (Senkondo, 1996). The main premise of this approach is that any interactions that affect yields are reflected in each system's yield.

However, another problem that arises especially when defining agroforestry as complete systems is the time difference that is required by the different components of agroforestry to be harvested. Basically, wood perennial components of agroforestry system require analysis over a multi-period time frame. In addition to the above two limitations, analysis of agroforestry system should also take into account soil fertility changes as a result of continuous cultivation and a typical characteristic of tropical soils.

To address this limitation, the use of cost benefit analysis to generate Net Present value (NPV) of each system is advocated. The present study used cost benefit analysis todescribe economic analysis of agroforestry also applied by Senkondo (1992) and Wahl *et al.* (2009) (see also section 2.6). However, programming techniques and programming with incorporation of risk component were not applied in this study. This was mainly because of time constraint and the focus of the study.

Some economic studies in agroforestry hinged on adoption of agroforestry as a technology. For example a study on adoption of rotational woodlots in Tanzania by Simon (2006) and studies else where by Kabwe (2010) in Zambia, Meghan *et al.* (2008) in Brazil, Muneer (2008) in Sudan and Neupane *et al.* (2002) in Nepal.

Adoption of technology is an important factor for economic development especially in developing countries. Consequently many adoption studies have been undertaken to single out the most important factors that determine the diffusion of innovations. Since the earlier work of Rodgers (1962) efforts to explain determinants of adoption have been expended. Nkyona *et al.* (1997) pointed out that factors affecting adoption differ across countries and are locations specific, thus calling for studies that are location specific in examining the factor affecting adoption of technologies or techniques.

Adoption of technologies is closely related to investment decisions on the farm. Like in any other investment, profit motive plays an important role. Cary and Wilkinson (1997) singled out perceived profitability as the most important factor influencing the use of new technologies. A farmer or a household is basically involved in making investment decision on the farm that is decision on production, consumption and marketing. In the face of a new technology, the adoption and use of it affects the production, consumption and marketing patterns of a farmer or household. As a result the integration of household decision allows the construction of a theoretical framework that helps in the determination of the effects of a new technology on households' well being.

Economic adoption models for example a class of probability models such as probit, logit and tobit models has provided a basic analytical approach to adoption of technologies (Senkondo *et al.,* 1998). However, most users have provided a limited assessment in most cases omitted in these types of analyses. The present study tries to incorporate attitudinal and perception issues in probability models (logistic model) to determine factors influencing adoption of agroforestry technologies.

2.3 Socio-Economic Factors Influencing Agroforestry Technologies

Education enables farmers to effectively process information on new innovation and in most cases came up with right messages intended from an extension agency or more able to deal with technical recommendations that require a certain level of literacy. Muneer (2008) indicated that farmers' adoption of agroforestry farming system in Sudan was significantly affected by the farmers' level of formal education. The author found that majority of the respondents had no formal education hence they are expected to represent a major constraint to the efforts exerted to disseminate agroforestry farming system and convince farmers to adopt it. Also studies by Enete *et al*. (2010) has pointed out that highly educated women were likely to make higher contributions to farming decisions than less educated ones.

Age

Farmers' age can increase or decrease the probability of adopting agroforestry technology. Older farmer may have more experience that allows them to adopt improved technologies than young farmers. Enete *et al*. (2010) found that the older a woman gets, the more her opinion is respected and sought after in decision making in farming system. Contrarily to the study done by Muneer (2008) observed that young farmers have been found to be more innovative than their older counterparts. Kweka (2004) also found that age of the head of the households had a significant influence on the total number of trees retained in East Usambara area. These findings suggest that, age can influence agroforestry adoption positively or negatively.

Land tenure

Land tenure systems have been considered as critical factors in determining the potential acceptability and viability of agroforestry. Results of studies conducted in the Southern African region by Kalaba *et al*. (2010) revealed how farmers do appreciate agroforestry and its potential linkage to food security and household welfare indicators, but they face some challenges to the widespread uptake of agroforestry including land constraints. Moreover, Ajayi (2007) found that the extent to which land tenure affects adoption of agroforestry technologies varies by geographical location, type of culture and whether the technologies is tree-based or annual shrub based.

FAO (2005) report that, critical constraint especially in semiarid and arid zones, is that livestock often graze freely, feeding on or trampling newly planted trees. This implies that, farmers with insecure land rights are unable or unwilling to plant trees. Kabwe (2010) noted that limited land influence agroforestry practice and therefore deserves particular attention when planning and implementing agroforestry development. Generally, both land tenure and inheritance rights significantly affect adoption of agroforestry technologies.

Farm size

Farm size is often hypothesized as a determinant of agroforestry adoption. Farmers with larger farm size are probably able to plant trees compared to farmers with small farm size who are unable or unwilling to plant trees. Buake (2005) revealed that small farm sizes are further reduced with increasing population pressure and unfavorable land tenure systems which often result in fragmentation of holdings.

Gender

The household head's gender becomes important in circumstances where the farming community allocates responsibilities based on gender differences or differences in ownership of crops or livestock enterprises as well as other productive resources. Results presented in a study by Kweka (2004) observed that gender had significance influence on the number of indigenous trees retained and number of multipurpose trees species retained in East Usambara area. The author found that male respondents retained or planted more trees species in their farms compared to female respondents. This observation was explained by the insecurity of land tenure faced by women as the land ownership in area is patriarch and only few widowed can inherit land.

Labour

Labour requirements have been highlighted as one of the major factors influencing farmer acceptability of agroforestry (Buake, 2005), since some agroforestry practices have been found to be labour intensive and thus their adoption are sensitive to labour position of the farm family (Muneer, 2008).Consequently; this brings about the strong competition for household labour with other activities in the farming system particularly during critical periods in the agricultural seasons which would obviously influence farmers' decision about adopting agroforestry.

Another important determinant of the farmers' agroforestry adoption is the degree of their contact with the extension service. This can be through the extension agent visits to the farmers or the farmer visits to the extension office seeking information and advice. Agricultural extension is considered a type of informal adult education that is intended to enhance farmers' knowledge in certain areas and enables them to benefit from available agricultural technologies and improved practices (Muneer, 2008). In this way, the extension service supplements the deficiency in the farmers' formal education.

2.4 Farmers' Attitudes towards Agroforestry Practices

The decision of farming communities to adopt new agricultural technologies is strongly influenced by attitude between the existing and the new agroforestry technology (Ajayi, 2007; GAO, 2012). For example Kalineza *et al.* (1999) observed that, tree planting in Gairo-Tanzania was the most popular soil conservation practice not only because of relatively low labour demand but also because trees have multipurpose uses to farmers. In addition, Hussain *et al.* (2012) observed that, farmers who have planted trees in Pakistan have assessed the economic and environmental benefits to outweigh the perceived adverse effects of trees. Favorable attitudes towards farm forestry system from their beliefs suggested that planting tree will increase income; meet household requirements for fuelwood, timber, controlling pollution and providing shade for human and animals. According to Simon *et al.* (2011) regardless of recognition of a problem, farmers will only adopt technologies perceived to have greater benefits. Farmers compare benefits of the available technology with the newly introduced one and select the one with more perceived benefits.

2.5 Methodological Aspects

2.5.1 Methodologies for developing index variables

Attitudes is a multi-dimensional variables that is more accurately measured with instruments like indices and scales than yes-no or scalar-response questions. It is a result of aggregate effects of a number of individual factors and in most cases, the individual factors determining a certain variable may be expressed in different units. To formulate a single number representing aggregate effects of a number of individual factors may need conversion of units into a common one which in most cases involves a complex procedure, time consuming and requires formulation of assumptions which may not hold true in real situation (Simon *et al.*, 2011). To avoid all these, indices have been used widely. This section reviews methodologies used to develop various indices for Attitude towards Land Productivity, Land Resource Conservation and Attitude towards Commercialization.

Senkondo (2000) developed Attitude towards Land Resource Conservation and Commercialization Index by giving weights to responses on whether respondents strongly agree, agree, undecided, disagree or strongly disagree indicating the benefits and disadvantages of agroforestry. A strongly agree response was given a weight of 5, agree = 4, undecided = 3, disagree = 2 and strongly disagree =1. These responses were then added up to form what is called Attitude towards Land Resource Conservation Index and Attitude towards Commercialization Index (Senkondo, 2000). Likewise the same procedures were used by present study to develop the Attitude towards Land Productivity Index, Attitude towards Land Resource Conservation Index and Attitude towards Commercialization Index.

2.5.2 Factor analysis

Factor analysis (FA) is a form of multivariate analysis and represents a data reduction technique (Pallant, 2007). The core objective of FA is to reduce a large number of variables into a smaller set of variables (also referred to as factors). According to Senkondo (2000), the aim of factor analysis is to identify a relatively small number of factors that can be used to represent relationships among sets of many interrelated variables. The author used factor analysis to pick the reliable group of items determining farmers' attitude towards an innovation. The principal components analysis (PCA) which is a default method for factor extraction in SPSS/PC+ was used as a method of factor extraction. In the present study, factor analysis has been used as method of item analysis for the index variables like Land Productivity Attitude Index, Land Resource Conservation Attitude Index and Commercialization Attitude Index. According to (Tabachnick and Fidell, 2007) factor loading of items of at least 0.3 is preferred for the analysis of index variable. Therefore, all variables with factor loading of 0.3 and above (absolute value) were considered to be appropriate determinants of the index variables in question.

2.5.3 The binary response models

Binary response models are common models to analyse adoption problems due to the categorical nature of the decisions whether to adopt a new technology or not. Logit and probit models are among the models used in analyzing binary choice decisions. Probit analysis focuses on proportions of cases in two or more categories of the dependent variable, although it is highly related to logistic regression. Probit analysis has an underlying assumption that the distribution is normal, thereby making it more restrictive than logistic regression (Tabachnick and Fidell, 2007). Logistic regression is associated with cumulative distribution function in order to generate efficient bounded probabilities within zero to one interval (Kabwe, 2010). According to Tabachnick and Fidell (2007), probit analysis would be effective for studies that focus on effective values of predictors for various rates of responses.

Logistic regression is free of restrictions and it has capacity to analyse a mix of all types of independent variables (continuous, discrete and dichotomous) (Pallant, 2007). The logistic models have been used widely in adoption studies. Some studies that have used logit model to assess adoption of technologies include; Kabwe (2010), Enete *et al.* (2010), Kalineza *et al.* (1999), Neupane *et al.* (2002), Meghan *et al.* (2008) and Mai (1999). Variables used in the logistic regression can be selected from either previous research or from the theoretical model under consideration. They can also be those that have not been researched before or for which no theory exists but might logically be related to predicted groupings for the independent variable (Kabwe, 2010).

2.5.3.1 Assessing overall fit of the model

Goodness of fit referred to as evaluating predictive efficacy, assesses the extent to which prediction error is reduced when using the predictor set (Kabwe, 2010). The Hosmer and Lemeshow test is one of the statistical measures to assess the overall fit of the logistic regression model. It is a non-significant value that indicates that the model is acceptable (Hosmer and Lemeshow, 2000). However, several measures have been suggested the Cox and Snell R^2, the Nagelkerke R^2 are other measures of fit (Pallant, 2007). Values less than 0.5 are said to be low for the purposes of practical significance. However, Cox and Snell R^2 cannot achieve a maximum of 1, and therefore Nagelkerke measure adjusts it so that a value of 1 could be achieved (Tabachnick and Fidell, 2007).

Based on the discussion above, logistic regression was selected in this study to determine the socio-economic factors influencing adoption of agroforestry practice. This is because dependent variable was binary response variable taking the values of 0 and 1; and the independent variables were a mixture of nominal, ordinal and continuous variables as discussed earlier. In addition the present study tried to incorporate attitudinal issues in probability models (logistic model) to determine factors influencing adoption of agroforestry technologies.

2.5.3.2 Setbacks of probability models

Several criticisms have been raised with respect to these models (Senkondo *et al.,* 2011). These are: (i) probability models may inherit heteroscedastic properties, (ii) they posses elements of non-normality and (iv) the predicted value of dependent variable may not fall within the unit interval. However, these models have been applied in agriculture.

2.6 Cost benefit analysis in agroforestry

The economic performance of any agroforestry system depends on economic variables such as output prices, establishment costs, labour costs, discount rate, management decisions such as area planted to crops and trees and the intensity of the harvest regime (Wise and Cacho, 2002).

In literature and in current practice, a methodology highlighting the feasibility of investment projects in terms of economic and social impact is the Cost-Benefit Analysis (CBA). CBA represents a framework where all project benefits and costs are identified, quantified, valued and compared against a range of optimality criteria on an *ex-ante* (before project) and *ex-post* (after project) basis. The main purposes of CBA are to evaluate whether resources are used efficiently in a project compared to some reference alternative and to highlight the fact that the cost is not greater than the net benefit of society.

2.6.1 Categories of costs in CBA

In order to reach a conclusion as to the desirability of all aspects of the project, positive and negative impacts must be expressed in terms of a common unit. Two categories of costs are considered in CBA as indicated by Valentin *et al*. (2009);

(i) Direct costs (for example land costs, technology costs, operating costs, management costs and financing costs among others) and

(ii) Indirect costs, from externalities (positive and negative impacts). These costs are present in all proposed actions and depend on the specifics of the projects. It is therefore necessary to identify externalities case by case when the CBA is done. The most difficult part is their monetization and inclusion in the analysis, since it will lead to their transformation into economic terms by assigning a price or a cost. The difficulty is that, by definition, externalities do not have a price determined by the market. It is therefore necessary to use approximations to convert them into economic terms. But, to avoid distortion, it is necessary to restrict the analysis at those externalities for which there is a strong economic justification and for which a monetization or a realistic estimate is possible.

2.6.2 Sensitivity analysis

There are several sources of uncertainty associated with analysis of costs and benefits of a particular project. Thus, it is very important to evaluate how sensitive the result is for small changes in key variables. One key factor is the discount rate; a higher discount rate implies that the present value of future benefits and costs decreases.Due to the fact that the choice of discount rate is arbitrary to some extent, it is important to evaluate how sensitive the result is to changes in the discount rate (Hanes and Lundberg, 2008). In addition other factors to consider in sensitivity analysis are changes in prices of inputs and outputs which may change the decision criteria.

Most of the studies (Senkondo, 1992; Knahal, 2011; Kabwe, 2010; Wahl*et al.*, 2009, Franzel, 2004), have estimated CBA of agroforestry system using the Net Present Value (NPV), Benefit Cost Ratio (BCR) and Internal Rate of Return (IRR) based on the assumption that, costs and benefits are available. Sensitivity analysis has also been employed by these studies to estimate the "switching value" of important variables needed for reducing NPV to zero. This has been carried out in order to assess the stability and performance of the indicators of project feasibility.

2.7 Summary

Previous studies in relation to agroforestry practice and its adoption, the socio-economic factors influencing agroforestry practices, the attitudes towards agroforestry adoption and cost benefit analysis in agroforestry in developing countries including Tanzania were discussed. It was realized that factors affecting adoption differ across countries and are locations specific. Despite the fact that a number of studies have been conducted across the world on factors affecting agroforestry adoption, there is lack of information on the specific socio-economic factors that influence agroforestry adoption especially among small scale farmers in Kilosa District.

Moreover very little research has analyzed the attitudes of local communities towards agroforestry adoption and the perceived benefits and cost of inputs associated with agroforestry in the area. This study thus bridged the knowledge gap in the area by assessing farmer’s attitude towards agroforestry adoption and the economic potentials of agroforestry practices. This is important if agroforestry adoption among farmers is to be enhanced and agricultural productivity improved. On the whole, the literature review pointed the research problem, highlighted possible research methodologies, provided a broad picture on how data can be interpreted and established the extent to which the research findings related to previous studies of a similar nature.

CHAPTER THREE

3.0 METHODOLOGY

This chapter describes the research methodology that was used for this study. Specifically, the chapter provides description of the study area, outlines the study population, sampling procedure including sampling design and sample size, data collection procedure and data analysis procedure.

3.1 Description of Study Area

This research was conducted in Kilosa District, one of the six districts that comprise Morogoro Region. It is located in East central Tanzania 300 km west of Dar es Salaam (Fig. 3) and is bounded by latitude 5°55’ and 7°53’ South and longitudes 36°30’ and 37°30 East. Kilosa borders Mvomero District to the East, Iringa Region to the South, Dodoma Region to the West, Manyara and Tanga Regions to the North. The district has a total area of 14 567.9 Km^2 (456 790ha) of which 536 590ha are suitable for agriculture. Natural pastures covers 483 390 ha, 323 000ha under Mikumi National Park while 80 150ha is under forest cover and 14 420ha urban areas, water and swamps. According to (URT, 2012) the district has a population of 438 175 people of whom 218 378 are males and 219 797 are females having an average of 4.2 people per family.

The highest parts of the District get annual rainfall between 1000mm-1600mm whereas the central and southern part gets an average rainfall of 800mm -1400mm. Short rains starts in October to December and the long rains start in February and continue to May. The annual temperature is between 25°C and 30°C. The vegetation is complex but the miombo woodlands and savanna grasses dominate.

Agriculture is the main economic activity and most of the people engage in farming of both subsistence and cash crops. The major food crops are paddy, maize, beans, cassava and bananas and major cash crops are sisal, sugar cane, cotton, simsim and sunflower. However, crops like rice, maize and beans can fall into both categories. Besides farming activities, livestock keeping is another economic activity undertaken in the district. It includes keeping cattle, goats, sheep, pig, poetry and cows. Grazing is the major type of livestock feeding used by livestock keepers which in turn create social and environmental consequences.

3.2 Sampling

3.2.1 Sampling design and sample size

The sampling units of the study were households in the four villages namely Kitete, Magomeni, Nyameni and Peapea. The study was carried out in four randomly selected villages out of the eight villages under the EPINAV project on "Lesser Known and Lesser Utilized Indigenous Agroforestry Timber Tree species" which is implemented in Kilosa District.

Households' respondents from each village were randomly selected so as to capture both agroforestry adopters and non adopters. 5% of the total households in the four villages were randomly interviewed which is considered adequate to represent the entire population (Boyd *et al.,* 1981) as cited by (Ishengoma, 2002). The formula below was applied;

$n/N \geq = 5\%$

where; N = is the total households in the village

n = is the number of selected households.

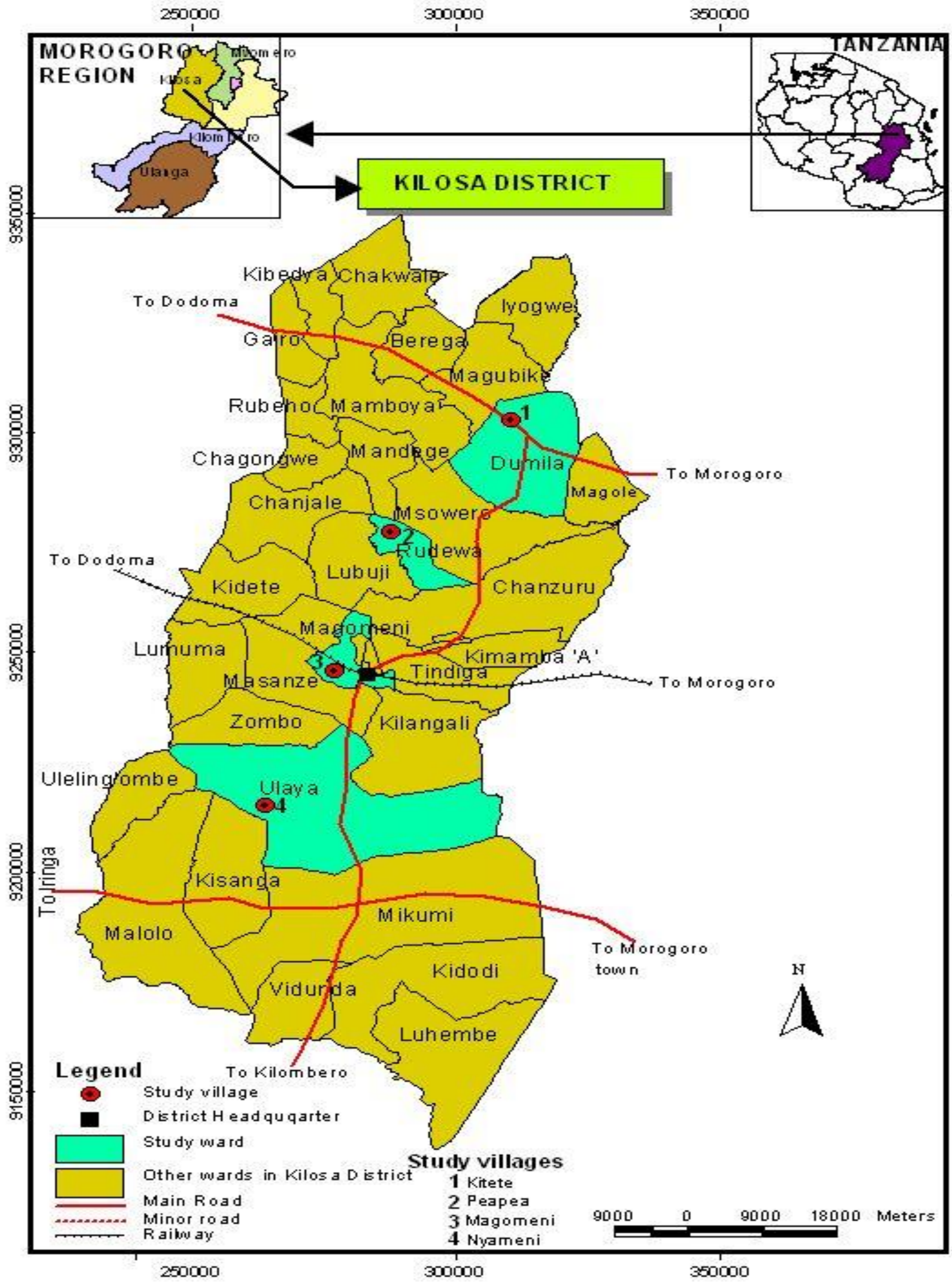

Figure 3: **Map showing position of Kilosa District and Surveyed Areas**

Source: Adopted from the GIS and remote sensing laboratory SUA

The sampling frame was based on a village register and respondents were selected by random sampling. Therefore, a sample of 30 farmers from each of the four villages was selected making a total sample of 120 farmers which was used in generating the information base for the study area.

3.3 Data Collection

The study utilized both primary and secondary data sources. In the selected villages primary data were collected through the following methods; reconnaissance, social and field surveys.

3.3.1 Primary data collection

3.3.1.1 Reconnaissance survey

Reconnaissance survey was carried out before conducting the detailed data collection. The aim of the reconnaissance survey was to get familiar with the village administration and to gain initial information on the nature of the district, farming systems including agroforestry systems and techniques. A pre-test of the questionnaire was done to check for clarity and improve reliability before the actual data collection. Important omissions were incorporated that might have been overlooked during the designing of the questionnaire. A sample of 20 farmers was used for pre-testing the questionnaire. These farmers were picked at random from the list of farmers in the respective village registers. A small sample sufficed because the aim was to get an insight into the farming operations and to use the information for further probing the questionnaire. The sample was also enough to test the adequacy of the designed questionnaire.

3.3.1.2 Social survey

During the social survey primary data were collected using a structured questionnaire (Appendix 1) while the checklist of probe questions was used in retrieving data from key informants as shown in Appendix 2.

3.3.1.3 Field survey

Random field visits were made by the researcher to counter check some of the response of farmers and to get an insight to the actual field conditions for example to make observation of the existing agroforestry systems and technologies.

3.3.2 Secondary data collection

Secondary data were obtained from the various sources including District Agriculture Office and District Livestock Office. Maps, journals, publications, published or unpublished reports, relevant literature were consulted in the library and the relevant websites to make better understanding, interpretation and analysis of the research. The data were used to supplement and in some cases to compare with the primary data collected from the field.

3.4 Data Analysis

The data were coded, categorized and fed in computer and analysed using computer software packages Microsoft Excel and SPSS (Statistical Package for Social Science) version 16. In addition, tables and figures were used to simplify interpretation of the results.

3.4.1 Statistical Data Analysis

3.4.1.1 The use of descriptive statistics

Descriptive statistics including; means, percentages and frequency distribution were used to summarize the data obtained aiming at describing the existing agroforestry systems and technologies practiced.

3.4.1.2 Logistic Regression Analysis

Adoption of agroforestry practice has been defined as a binomial variable taking the value of one in case a farmer has adopted agroforestry and zero when otherwise. In this study a farmer was considered as an adopter when he or she has included at least a single tree on the farm and non adopter when he or she has not included a tree on farm. The logistic model was applied to the data using the Logistic Regression command in SPSS version 16.

The model was expressed as follows;

$$\text{Log}\,[Pi/1 - Pi] = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots, + \beta_k X_k + e_i$$

Where: i = 1, 2, … , k = are the observation, β_o = Intercept, β = Regression parameter to be estimated, $X_1, X_2, X_3, \ldots, X_k$ = Independent variables, Pi = The probability of observing a specific outcome of the dependent variable (adoption) and e = Random error term.

3.4.1.3 Variables included in the logistic regression analysis

1) Dependent variable

Adoption of agroforestry was the dependent variable.

2) Predictor variables

The following predictor variables were included in the model; sex and education level were entered in the model as dummy variables taking value of 0 and 1. Age (in years), farm labour force (in number), attitude towards land resource conservation (measured as an index), farm size (in number of hectares), attitude towards commercialization (measured as an index) and attitude towards land productivity (measured as an index) were entered in the model as continuous variables. The attitudinal indexes used in logit model were automatically calculated by the SPSS program. The explanatory power of the models was based on the value of the coefficient of determination of Cox and Snell R^2 and Negelkerke R^2. These provide estimates of the proportion of variability accounted for by all of the independent variables. Higher value of (R^2) indicates that large proportions of the observed variations in the dependent variable are explained by the included independent variables.

3.4.1.4 Development of attitudinal index variables

Three indices were developed namely the attitude towards Land Productivity, Land Resource Conservation and Attitude towards Commercialization. In this research thirty seven items or statements concerning the above attitudinal variables were included in the questionnaire (Appendix 4). Thirty seven items/ statements were then clustered into the above attitudinal variables. Developing such statements was necessary because it was not easy to seek information for such variables by asking one question to a respondent. Answers from those statements were entered into factor analysis to determine the most important factors among the sets of statements determining each index variable.

The respondents were asked to rank the statements based on their opinion on the extent to which they can favour or disfavour land productivity, land resource conservation and commercialization as a result of practicing agroforestry as pointed out in section 2.5.1. A wider choice of responses was made to ensure that farmers give as correct choices as possible. Later in the analysis, responses of 'strongly agree' and 'agree' were combined into 1 showing agreement with the statement and responses in 'strongly disagree' and 'disagree' were re-coded into 2 showing disagreement. Responses with neither 'agree' nor 'disagree' were not included in the analysis.

The combination of responses was mainly done to simplify the process of data analysis. These thirty seven statements were either derived from other studies (Magayane, 1995 and Senkondo, 2000) and adapted or newly constructed based on the objectives of the research as well as on their validity. The factors were then subjected to factor analysis with the aim of identifying a relatively smaller number of factors that can be used to represent a relationship among sets of interrelated items. In factor analysis, Principal Components Analysis (PCA), a default method for factor extraction in SPSS/PC + was used as a method of factor extraction. PCA is effective and widely used as a means of exploring the interdependence among the variables. The use of PCA makes it possible to identify the best factors in terms of explaining the variance of the sample. It gives uncorrelated, linear combinations of the observed variables in a rank order. Ranking is based on the amount of variance in the sample accounted for by the linear combinations. The first linear combination of observed variables (principal components) accounts for the largest amount of variance in the sample followed by the second and so on (Pallant, 2007).

The total variance explained is shown by the Eigen Value. Eigen Value was therefore used as a measure of variability of the factors. Selection of the items/variables was based on the Eigen value of the extracted factor. Items falling under the factor with the highest Eigen Value have their respective factor loading. The higher the factor loading the more that item contributes to the total score of that factor. Eigen Value and factor loading are generated directly by SPSS/PC + during factor analysis. The factor with the highest Eigen Value (normally >1.0) was selected to give the score for the attitudinal concept/latent variable depending on the relative factor loading of the items. Factor loading of statements of at least 0.3 were considered to be significant factors determining the index variables and therefore selected (Tabachnick and Fidell, 2007; Simon *et al.*, 2011). The selected statements were then used to calculate the index variables.

Varimax was used as the method of rotation, which minimizes the number of variables that have a high loading on a factor, thereby enhancing the interpretation of the factors. Pairwise deletion was the method used for treating the missing variables. To develop the

Land Productivity Index, Land Resource Conservation Index and Commercialization Index the weights of all the selected factors were added up. All three indices show the level of attitude toward land productivity, land resource conservation and commercialization if the household is affected by those factors.

The following sections briefly describe the individual indices which were generated directly by SPSS version 16 programme.

(a) Land productivity index

The factors were formulated and in this case were viewed as individual's positiveness or negativeness towards productivity of land. A positive attitude towards land productivity is related to the benefits associated with agroforestry practice and negative attitude towards land productivity is related to the disagreement with statements that disfavour land productivity as a result of practicing agroforestry. The statements associated with this index are indicated in Appendix 4.

(b) Land resource conservation index

In order to estimate the level of respondent’s attitude towards land conservation statements related to positive or negative attribute of land resource conservation were constructed. The statements associated with this index are indicated in Appendix 4.

(c) Commercialization attitude Index

The factors hypothesized to favour or disfavour commercialization attitude were constructed to seek respondents opinions. For example an individual who places more emphasis on producing agroforestry products for sale than for his/her own household consumption would have a higher score on the commercialization scale. On the other hand, if one places more emphasis on the production of agroforestry products for own household consumption would have a lower score on this scale. The statements associated with this index are indicated in Appendix 4.

(d) Hypothesis regarding the attitudinal items

The researcher’s hypotheses regarding the attitudinal items were made on whether to agree or disagree with the actual farmers responses as indicated in section 4.3.

3.4.2 Cost benefit analysis

Cost-Benefit Analysis (CBA) was applied to estimate only the tangible costs and benefits accrued from agroforestry practices. Intangible costs and benefits such as improved soil fertility and reduction of soil erosion among others were reflected in crops yield and tree growth by using a system approach. CBA approach in this study considered all costs and benefits over the lifetime of the production system. CBA was evaluated by using Net Present Value (NPV), Benefit-Cost Ratio (BCR) and Internal Rate of Return (IRR). These economic criteria were computed using Microsoft excel computer programs. The NPV, IRR and BCR of the selected agroforestry system were calculated by the following formula:

1) Net Present Value (NPV)

This is the difference in value today of all present and future benefits and the value today of all present and future costs. This measure discounts the costs and benefits stream over the lifetime of the agroforestry production system.

$$\text{NPV}=\sum_{t=1}^{T}\frac{B_t-C_t}{(1+r)^t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

2) Benefit–Cost Ratio (BCR)

This is the ratio of the value today of all benefits and the value today of all costs. A BCR of greater than 1 means the project is profitable while a BCR of less than 1 means the project generates losses.

$$\text{BCR}= \frac{\sum_{t=1}^{T} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{T} \frac{C_t}{(1+r)^t}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

4) Internal Rate of Return (IRR)

This is the maximum interest rate that agroforestry system can pay for the resources used, while still recovering all investment and operating costs that equates the NPV to zero.

$$\text{IRR}= \sum_{t=1}^{T} \frac{B_t - C_t}{(1+r)^t} = 0 \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

For both (1), (2) and (3) B_t = stream of benefit in year t, $C_{t=}$ cost in year t, T= length of time horizon, r = discount rate and t = number of years $(1 + r)^t$ = discount factor. The major assumptions introduced were discount rate (r) and the time horizon (T).

3.4.2.1 Discount rate and time horizon

The major assumptions introduced in this study were the time horizon and the discount rates. Since costs and benefits of tree production occur over a long period of time, it is essential to convert the future costs and benefits into present value by discounting. According to World Bank (2010) a 10% discount rate is proposed which is considered as the opportunity cost of capital in Tanzania, and indeed for developing countries projects. This rate was used as the opportunity cost of capital in this study. The time horizon used in this study was taken to be 20 years rotation so that farmers can benefit from larger volumes. This was based mainly on two arguments as indicated in the literature (Kessy, 1993);

(i) Available literature shows (based on their biological growth characteristics) that by age of 20 years most of the tree species planted in the project can reach economic maturity for example Grevillea species.

(ii) With high discount rates and characteristics in the third world, revenue realized beyond 20 years has insignificant value to the farmers.

3.4.2.2 Prices of agroforestry components and valuation of labour

In investment analysis prices play an important role. As explained by Senkondo *et al.* (2004), normally market prices are used, although there may be differences in prices right after harvest and the prices received after farmers have stored their produce. The authors further stated that a decision between the uses of current prices versus constant price needs to be made before hand as it has implications in incorporating inflation in the calculation, since it is difficult to forecast inflation beyond say three years. In the present study, economic analysis was undertaken using prices that reflect real resource use. Constant 2012 market prices were directly used to estimate economic value of inputs and outputs which were believed to reflect the opportunity cost. In addition transfer payments (such as taxes, subsidies and credit transactions) were eliminated in this study.

It is reported that, minimum wage usually over-estimate labour opportunity costs in the rural areas (Senkondo *et al.,* 2004). Therefore the present study disregarded the use of minimum wage and took into account the opportunity costs of labour.

The cost of hired labour in the study area varies with seasons and between the four villages surveyed. For example during slack season the cost is low. An average value Tshs 4500 per day was considered as the opportunity cost of labour in Magomeni, Peapea and Kitete villages whereas 3000 Tshs was used in Nyameni village. These prices were considered for the two agricultural seasons (*Vuli* and *Masika*).

3.4.2.3 Sensitivity analysis

As pointed out in section 2.6.2 sensitivity analysis was done to evaluate how sensitive the result is for small changes in key variables.

3.5 Summary

Chapter three discussed various issues including the description of the study area, the study population, sampling procedure including sampling design and sample size, procedure for data collection and data analysis. The main themes that emerged in the chapter were that, the use of logit model for analyzing the factors that influence farm household's decision to adopt agroforestry practices was consistence with the literature on adoption. This intended to describe the process of adoption as taking on a logistic nature. Moreover the implication for applying the logit model in this study is that, the farmer would decide to adopt agroforestry at a given point in time when the combined effects of certain factors exceeds the inherent resistance to change in him or her.

It was also important for the present study to use cost benefit analysis to describe economic analysis of agroforestry due to the problems (limitations) that arises especially when defining agroforestry as complete systems. For example the problem of time difference that is required by different components of agroforestry to be harvested. It was vital for the study to utilize factor analysis as a method of items (statements) analysis for attitudinal index in order to identify the appropriate items that determine attitude towards agroforestry.

Further descriptive statistics was important to summarize the data obtained aiming at describing agroforestry systems and technologies practiced. The data that was collected in the study addressed the research objectives. The research findings are now presented in Chapter four.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

The aim of the chapter was to report the outcome of the data analysis which transformed the raw data obtained from the study into meaningful facts. The data presented in this chapter was obtained from structured questionnaire and field observations. Data addressing a particular research theme are presented together. The study results are presented in symbolic representations which included tables and figures. Four villages in Kilosa districts were surveyed which included Kitete, Nyameni, Peapea and Magomeni. One hundred and twenty respondents were interviewed to generate the information base for the study area. The checklist was also applied in retrieving data form key informants where ten officers in the surveyed villages were interviewed.

4.1 Socio-economic Characteristics of Respondents

Results in Table 1 indicate that a small proportion of respondents in this study were female headed households. Peapea village had a high proportion of female headed household (30%) as compared to other villages. Similar results were found by Hess *et al.* (2008) in the study on livelihoods in the Uluguru Mountains of Tanzania that most of the households had a male head than their counterparts. In addition Kweka (2004) revealed that male respondents planted and retained more tree species in their farms compared to female respondents.

Table 1 depicts respondents' age categories. From the table, it shows that the most frequent age group of respondents was between 21 to 40 years which is within the economically active age group (62.5%). As defined by URT (2006) economically active age group is the persons in the age between age-group 10 to 64 years. Only 7.5% were below 20 years whereas 30% were above 40 years. Some agroforestry practices have been found to be labour intensive and thus their adoptions are sensitive to labour position of the farm family (Muneer, 2008). This implies that the potential availability of the most active working age groups in the family is essential for labour intensive technologies rather than the dependent age groups. Findings in Table 1 indicate that majority of the respondents (79.2%) were married and only 9.2% were widowed. This trend was also observed in other studies (Buake 2005 and Hess *et al.,* 2008).

Table 1: Socio-economic characteristics of farmers

Village/Characteristic	**Kitete (n=30)**	**Magomeni (n = 30)**	**Nyameni (n = 30)**	**Peapea (n =30)**	**Total N = 120**
	% of respondents				
Gender					
Male	86.7	76.7	90.0	70.0	80.8
Female	13.3	23.3	10.0	30.0	19.2
Age					
Below 20 years	6.7	3.3	13.3	6.7	7.5
21 - 40 years	56.7	66.7	66.7	60.0	62.5
Above 40 years	36.7	30.0	20.0	33.3	30.0
Marital Status					
Divorced	6.7	0	6.7	6.7	5.0
Married	86.7	76.7	86.7	66.7	79.2
Unmarried	0	10.0	6.7	10.0	6.7
Widower	6.7	13.3	0	16.7	9.2
Education					
Primary education	80.0	73.3	86.7	83.3	80.0
Secondary education	0	13.3	3.3	3.3	5.0
Not educated	20.0	13.3	10.0	13.3	14.2
Occupation					
Crop and livestock production	36.7	17.2	41.9	63.3	40.0
Crop production activities	30.0	44.8	32.3	26.7	33.3
Livestock keeping	37.9	33.3	22.6	10.0	25.8
Wage employment	0	0	3.2	0	0.8
Source of Labour					
Family and hired	55.2	19.4	53.3	63.3	47.8
Family	34.5	74.2	46.7	33.3	47.2
Hired	10.3	6.3	0	3.3	4.9

The high percentage of married respondents observed in all villages could probably be among the factors that contributed to increase in yields since the households will have more members who can engage in farm activities. Buake (2005) points further that when farming is left to men only there is bound to food insecurity when they are indisposed and this can have far reaching consequences on the livelihood of the household.

Results in Table 1 present the education level of respondents whereby 80.8% of respondents had formal primary education and only 5% have attended secondary education. There were little variation among villages with respect to primary education and other levels of education. The predominance of heads of households (decision-makers) with formal education in rural areas signifies that households can accept and use new technologies to a greater extent. The study by Kofi *et al.* (2003) noted that, there is a positive correlation between formal education and productivity of labour. These findings are shared by Adekunle (2009) who found that the level of education will directly affect one's ability to adapt, to change and to accept new ideas.

Majority (40.0%) of respondents in the study area are engaging on both crop and livestock production as their main occupation (Table 1) followed by those engaged on crop production only (33.3%). Only 0.8% was depending mainly on wage employment whereas Kitete village had high proportion of respondents engaged on livestock farming (37.9%). Since adoption of agroforestry is associated with farming activities for it to be practiced, thus occupation of most of the respondents in the study area could probably explain the presence or adoption of agroforestry.

In the villages surveyed, the sample showed an average family size of nine in Nyameni, Magomeni and Kitete while 8 in Peapea village (Table 2). The average household size of 9 persons for the sample households was considerably larger than the national average household size of 4.8 (URT, 2012). According to Kofi *et al.* (2003), the average household size of eight persons implies that there would be labour for carrying out the various activities of the system when adopted. In this study the adult labour equivalent was 3.7 on average.

Table 2: Average Household Size and Distribution of Age Groups within the Household

Age group	Magomeni (n = 30)	Nyameni (n = 30)	Peapea (n = 30)	Kitete (n = 30)	Total (N =120)
0 -5	1.25 (19.4)	1.44 (25.8)	1.50 (29.0)	1.62 (25.8)	100
6-10	1.65 (27.9)	1.31 (21.3)	1.56 (29.5)	1.54 (21.3)	100
11-17	1.70 (29.4)	1.56 (23.5)	1.54(19.1)	1.68 (27.9)	100
Adult male 18-60	1.57 (23.2)	1.27(26.3)	1.48(23.2)	1.59(27.3)	100
Adult female 18-60	1.64 (24.6)	1.31 (25.4)	1.38(25.4)	1.54 (24.6)	100
Over 60	1.19 (57.1)	1.00 (7.1)	1.40 (17.9)	1.00 (17.9)	100
Average household size	9.00	9.00	8.00	9.00	

Note: Number in the parenthesis indicate percentage of each age group

Household size between villages was significantly large at $P < 0.05$. This suggests that adoption of agroforestry was associated with large household sizes probably due to higher labour requirement for performing agroforestry activities. Household size and their proportions are shown in (Table 2) and adult labour proportions in (Table 3).

Table 3: Proportion of adult labour in the surveyed villages

Village	Mean	N	% of Total Sum
Kitete	3.3	30	22.3
Magomeni	4.5	29	29.1
Nyameni	3.5	31	24.1
Peapea	3.6	30	24.5
Total	3.7	120	100.0

Table 4 shows that majority of the respondents used hired labour to solve the household labour shortage problems (50% of the respondents). From the discussion with respondents the payment for hired labour was either immediately after completion of an agreed piece of work or at the end of the agreed period. Other strategies are as shown in Table 4.

Table 4: Distribution of Respondents by Strategies to Reduce Labour Shortage

Strategies to reduce labour shortage	Frequency	Percentage
Use hired labour	60	50.0
Did not use any strategy	32	26.7
Leave some planted area unattended(2-3hours)	14	11.7
Increasing working hours	12	10.0
Hiring Tractor	2	1.7
Total	**120**	**100.0**

Table 5 shows that majority of the respondents own the land they are cultivating (63.3% of the respondents) while 27.5% of the respondents have rented the land. These findings indicate that the respondents who own the land have the opportunity to grow permanent crops and trees on the land than their counterpart. For those farmers who do not own land given the limitations of their agreement, they cannot grow or retain trees on the rented land. These findings were also shared by Buake (2005), that land tenure has a relationship to the adoption of a system like agroforestry.

Table 5: Ownership of Land by the Respondents

Ownership/Village	Kitete (n=30)	Magomeni (n=30)	Nyameni (n=30)	Peapea (n=30)	Total (N=120)
			% of respondents		
Self ownership	70.0	70.0	83.3	30.0	63.3
Self and rented	16.7	0	0	20	9.2
Rented	13.3	30.0	16.7	50.0	27.5

Moreover the study has revealed that the average farm size was 2.7 in the sampled villages (Table 6). Peapea village was observed to have small farm size compared to the rest of the villages since small farms are those with less than 2 hectares of cropland (Hazell *et al*., 2007). The average distance from household to the farm plot was observed to be 2.3 (Table 6). The smallest distance observed in Peapea and Kitete villages reveal that the farm plot are near to the households while the largest distance was observed in Magomeni villages.

Table 6: Total Land Owned by the Respondents and the Estimated Distance

Village	Mean average of land owned (hectares)	Mean average of estimated distance to the farm plot (km)
Kitete	4.30	0.65
Magomeni	2.53	5.26
Nyameni	2.37	2.30
Peapea	1.63	0.97
Total	2.71	2.29

Table 7 presents various sources of equity capital in the study area. Farmers said it was difficult to obtain equity capital. They supplement their financial difficulties through credit cooperatives, money lenders and relatives. Most of the sources of equity capital to farmers came from their personal savings (67.8% of the respondents) followed by family member support (13.7%) as shown in Table 7. This suggests that farmers require equity capital in order to increase their farm production. Similar results were also observed in Ghana by Buake (2005) that, most of the equity capital to famers came from their personal contribution.

Table 7: Sources of equity capital

Source of equity capital	Percentage	N
Personal savings	67.8	81
Family member support	13.7	16
Cooperatives	11.9	15
Money lenders	6.6	8
Total	100.0	120

4.2 Agroforestry Practices in the Study Area

Results showed that, on average about 87.5% of the respondents practice agroforestry while 12.5% do not practice agroforestry (Table 8). Therefore, agroforestry practice was not new to the study area which might be due to various sources of information that contributed to the practice of agroforestry.

Table 8: Proportion of Respondents Practicing Agroforestry

Village	**Kitete (n=30)**	**Magomeni (n=30)**	**Nyameni (n=30)**	**Peapea (n=30)**	**Total (N=120)**
			% of respondents		
Adopters	96.7	73.3	96.7	83.3	87.5
Non adopters	3.3	26.7	3.3	16.7	12.5

Table 9 shows various sources of information in the study villages where most of the respondents have got the information from fellow farmers (30.8%). Extension workers and agricultural experts are the second source of information to farmers regarding agricultural production (Table 9). This shows that farmers perceived extension services and agricultural experts as important.

Table 9: Source of Information on Agroforestry

Source of information	**Percentage**	**N**
Radio	3.2	4
Agricultural experts and extension workers	24.4	29
Fellow farmers	30.8	37
Inherited from parents	20.0	24
NGO'S	2.5	3
Have no information	19.2	23
Total	**100.0**	**100.0**

The present study identified two types of agroforestry systems based on the components in the four villages surveyed. These were agrosilvicultural system (woody perennials and herbaceous crops) and agrosilvopastoral system (woody perennials, herbaceous crops and animals). Results in Table 10 shows that 36.1% of the respondents practiced both agrosilvicultural and agrosilvopastoral systems (36.1%). Kitete village had mainly agrosilvopastoral system (55%) due to large herd sizes of livestock whereas Nyameni, Magomeni and Peapea villages had mainly agrosilvicultural system (Table 10).

Table 10: Agroforestry Systems in the Surveyed villages

Village/Agroforestry system	Kitete (n=30)	Magomeni (n=30)	Nyameni (n=30)	Peapea (n=30)	Overall (N=120)
			% of respondents		
Agrosilvicultural	18	25	46.7	23.3	24.1
Agrosilvopastoral	55	15	20	26	29
Both agrosilvicultural and agrosilvopastoral	27	33.3	30.0	37.4	36.1
Non adopter	0	26.7	3.3	13.3	10.8
Total	**25**	**25**	**25**	**25**	**100**

4.2.1 Livestock components

Table 11 shows the average herd size in the surveyed villages. On average cattle (23.5%), goats (22.4%) and pigs (22%) were the dominant livestock.

Table 11: Average herd size per village

Livestock/Village	Kitete (n =30)	Magomeni (n =30)	Nyameni (n =30)	Peapea (n=30)	Total (N =120)
		% of respondents			
Goat	27.9	19.3	23.8	18.7	22.4
Cattle	29.4	25.5	15.3	23.6	23.5
Pigs	25.7	19.8	20.6	21.9	22.0
Chicken	10.0	17.9	20.9	15.0	16.0
Ducks	7.0	17.5	19.4	20.8	16.0

The methods of raising these livestock were mainly by zero and open grazing (12.5%) as shown in Table 12. Pigs and goats were raised by zero grazing whereas cattle were raised by semi grazing. Ducks and chickens are free range. Results revealed that most of the livestock in the surveyed area feed on more than one type of fodder tree.

Table 12: Methods of Raising Livestock

Method of raising livestock	Percentage	N
Do not purchase livestock	35.0	42
Open grazing	43.3	52
Semi grazing	4.2	5
Zero and open grazing	12.5	15
Zero grazing	3.3	4
Zero and semi grazing	1.7	2
Total	**100.0**	**120.0**

Table 13 shows the type of fodder trees that are used to feed the animals. Most of the fodder trees are found on the farming plots. Pigs feed mainly on *Afzelia quanzensis* and cattle feed on *Pentas pururea* and *Albizia gummifera* while goats feed on *Leucaenea leucocephala* and *Flueggea virosa.*

Table 13: Fodder trees and the type of livestock fed

Fodder tree	Livestock type	% of respondents using fodder trees
Afzelia quanzensis	Pigs	15.0
Albizia gummifera	Cattle	11.0
Flueggea virosa	Goats and cattle	50.0
Leucaenea leucocephala	Goats	25.0
Pentas pururea	Cattle and pigs	77.8

4.2.3 Tree components

Table 14 shows the proportion of farmers according to the type of trees on the farm. On average 27.5% of the respondents have maintained naturally growing trees while few farmers have planted trees (15.8%). Majority of the farmers (45.0%) have both a mix of planted trees and natural growing trees.

Table 14: Trees on farmland per village by way of regeneration

	Kitete (n=30)	Magomeni (n=30)	Nyameni (n=30)	Peapea (n=30)	Total (N=120)
			% of respondents		
Planted only	23.3	23.3	10.0	6.7	15.8
Natural tree only	20.0	33.3	16.7	40.0	27.5
Both natural and planted	53.3	16.7	70.0	40.0	45.0
Do not purchase any	3.3	26.7	3.3	13.3	11.7

There were also variations in the number of trees planted per hectare by different villages surveyed (Table 15). The highest number of planted trees was in Nyameni village (25 trees per hectare) and the lowest was in Kitete (11 trees per hectare).

Table 15: Mean number of trees planted per hectare per village

Village	Mean per hectare	Standard deviation trees per village
Kitete	11	15
Magomeni	17	21
Nyameni	25	33
Peapea	23	28

4.2.4 The use of tree species in the farmland of the surveyed villages

Table 16 shows the main use of trees on farmland. It can be seen that need for production of fruits (65.1%) and fuelwood (40%) were by far the most important uses of trees on farmland. Similarly Simon *et al.* (2011) found that benefits such as productionof fruitsand fuelwood can influence the adoption of the agroforestry technologiesby smallholder farmers. In addition Mbwambo *et al.* (2013) found the same observations that the need for fuelwood was common uses for trees planted in Musoma Rural District.

Table 16: Functions of trees on crop land by village

Village/Use	Kitete (n=30)	Magomeni (n=30)	Nyameni (n=30)	Peapea (n=30)	Total (N=120)
			% of respondents		
Field boundary	30.0	73.3	53.3	30.0	28.2
Fence	0.0	16.5	36.7	3.7	14.2
Fodder	40.0	8.7	36.7	6.6	23.0
Fruits	73.4	36.7	83.4	66.7	65.1
Erosion control	3.3	13.2	20.0	26.7	17.8
Timber	36.6	6.6	33.3	10.0	21.6
Fuelwood	30.0	27.0	49.0	54.2	40.0
Shade	3.3	6.6	3.3	16.6	7.5
Medicine	0.0	3.3	0.0	0.0	0.8
Windbreak	10.0	3.3	6.6	13.3	8.3

Table 17 shows the names of farm trees and their uses in the surveyed villages. The most popular timber species were *Grevillea robusta, Brachystegia microphylla* and *Abizia gummifera* while famous firewood species were *Acacia polyacantha*, *Khaya anthotheca* and *Senna siamea*. Most of the trees planted or left on the farms are multipurpose trees, as shown in Table 17. The most common indigenous species were *Lonchocarpus capassa*, *Albizia gummifera*, *Brachystegia microphylla*, *Stereospermum kunthianum* and *Flueggea virosa* (Table 17).

Table 17: Farm trees and their uses in the study area

Common name/ Local name	Scientific name	Uses
Mangoes (E), Mwembe (S)	*Mangifera indica*	Fruits, soil fertility
Oranges (E), Mchungwa (S)	*Citrus cinensis*	Fruits
Coconut (E), Mnazi (S)	*Cocos nucifera*	Field boundary
Grevillea (E), Mgivea (S)	*Grevillea robusta*	Timber
Mkenge (L)	*Albizia gummifera*	Timber, fodder
Mitalula (I)	*Acacia polyacantha*	Shade, firewood
Mjohoro (S)	*Senna siamea*	Firewood, windbreaks
Mkangazi (S)	*Khaya anthotheca*	Firewood and timber
Lucina (S), Leucaena (E)	*Leucaena spp*	Fodder, fuel wood
Limau (S), Lemon (E)	*Citrus limon*	Fruit and firewood
Cedrella(E)	*Cedrella odorata*	Field boundary
Muarabaini (S) Neem (E)	*Azadirachta indica*	Medicine, firewood
Mzambarau (S), Jambolan (E)	*Syzygium cwninii*	Fruit, shade, charcoals
Papai (S) Pawpaw (E)	*Carica papaya*	Fruit
Sugar cane (E)		Field boundary
Magugu (P)	*Pentas pururea*	Fodder, firewood
Mkwambe (L)	*Flueggea virosa*	Fodder, firewood
Mkongo (L)	*Afzelia quanzensis*	Fodder, timber
Mchikichi (S)	*Elais guineense*	Palm oil
Mlidu (M)	*Cassia sp*	Fodder, firewood
Mfumbii (S))	*Lonchocarpus capassa*	Fuelwood
Msani(L)	*Brachystegia microphylla*	Timber
Mwegea (S)	*Stereospermum kunthianum*	Firewood

S = Swahili; E = English; L = Luguru: = (Iraqw); P = (Pogoro); M= Makonde
Local and Scientific names were verified from Makonda *et al.* (2010)

Whereas one of the highly ranked uses of trees in the farmland was for firewood, households still said that their main source of firewood is from natural forests (63.3% Table 18) implying that planted trees do not completely meet the peoples' fuelwood requirements. These results are in conformity to that observed by Gama *et al.* (2013) that natural forests in Tanzania are the major sources of fuelwood supply. This implies that much effort for alternative agroforestry practices is required in both villages by introducing multipurpose fast growing trees as a solution in order to relieve pressure from natural forest.

Table 18: Source of firewood in the study area

Source/Village	Kitete (n=30)	Magomeni (n=30)	Nyameni (n=30)	Peapea (n=30)	Total (N=120)
	% of respondents				
Buying	6.7	23.3	0.0	3.3	8.3
Near homestead	3.3	0.0	0.0	0.0	0.8
Cultivated agroforestry land	10.0	33.3	43.3	6.7	23.3
Natural forests	73.3	33.3	56.7	90.0	63.3
Not using firewood	6.7	10.0	0.0	0.0	4.2
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

4.2.5 Integration of tree components with agricultural crops

Results in Table 19 summarize the dominant agroforestry mixtures in the surveyed villages. Appendix 3 shows on detail the dominant agroforestry mixtures and the proportion of farmers who practiced them. Fig. 4 shows one of the agroforestry system observed in Nyameni village with the mixture of Maize/Banana/Coconut.

Table 19: Dominant agroforestry mixture in the village surveyed

Village	Dominant agroforestry mixture
Kitete	Maize / Beans/ *Leucaenealeucocephala /Livestock* Maize /Coconut / *Albizia gummifera/Livestock* Maize / *Mangifera indica* /*Albizia gummifera/Livestock*Bananas/ Coconut / *Leucaenealeucocephala/Livestock*
Magomeni	Maize/*Citrus cinensis*/Coconut Maize/ *Mangifera indica* /*Leucaenea leucocephala*
Nyameni	Rice /Coconut / *Mangifera indica* Maize/ Coconut/*Grevillea robusta* Maize / *Citrus sinensis* /Beans
Peapea	Maize /*Mangifera indica* /BananaMaize / Sunflower / *Citrus cinensis/* Banana

Agroforestry can also be classified on the basis of how the various agroforestry components are arranged on the resources management unit (agroforestry technologies).The arrangements of biotic components in the surveyed villages were mixed intercropping, boundary planting and homegardens or a mixture of both as shown in table 20. On average mixed intercropping arrangement was more common compared to other technologies (33.3%) in both villages as shown in Table 20.

In mixed intercropping practices trees were left in a scattered manner on the cropland in very small densities and they are useful as mulch for soil enrichment. They also provide fodder to feed animals, fuelwood for the household, poles and timber. Some of the trees which were left for the beneficial effects on soil and crop yields include *Albizia species*, *Mangifera indica* and *Leucaena leucocephala* which were intercropped with maize, beans, banana, sunflower and simsim. In boundary planting trees were planted along the boundaries of the land management (2.5%).

From the interview conducted and observation made by a researcher trees planted along the boundaries of the land management were coconut, *Cedrella odorata* and *Flueggea virosa*. Home garden was another agroforestry arrangement observed in the four villages where there is interaction of wood perennial and herbaceous crops in the land management system near or around the household which accounted about 15.8% (Table 20). The main components of agroforestry observed in homegardens were a mixture of crops components such as maize, beans, banana with tree components like oranges, mangoes, *Senna siamea*, *Acacia polyacantha* and *Syzygium cumini*.

Table 20: Proportion of respondents practicing different agroforestry technologies

Technology/Village	Kitete (n=30)	Magomeni (n=30)	Nyameni (n=30)	Peapea (n=30)	Total (N=120)
		% of respondents			
Boundary planting	0	10.0	0	0	2.5
Boundary planting and mixed intercropping	6.7	13.3	46.7	16.7	20.8
Homegarden	0	3.3	0	3.3	15.8
Boundary planting , mixed intercropping and homegarden	10.0	16.7	30.0	6.7	1.7
Mixed intercropping	40.0	20.0	20.0	53.3	33.3
Mixed intercropping and homegarden	36.7	10.0	0	6.7	13.3
Not practicing agroforestry	6.7	26.7	3.3	13.3	12.5
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Figure 4: Agroforestry system in Nyameni village with the mixture of Maize/Banana/Coconut

4.2.7 Agroforestry Motive Factors

When farmers were asked on the motive factors that make them to practice agroforestry system approximately 22.4% of the farmers indicated that trees on farm help them to get fruits (Table 21) followed by provision of firewood (19.7%). Table 21 shows a ranking of different motives for practicing agroforestry by farmers. This suggests that, respondents appreciate the contribution of agroforestry systems on environmental services as well as provision of adequate food at different times of the year from diverse products.

Table 21: Motivation factors for adoption of agroforestry

Motive	**Percentage**	**N**
Rainfall attraction	4.0	5
Water conservation	3.3	4
Fruits	22.4	27
Enhancement of soil fertility	10.2	12
Simplification of farm operations	2.5	3
To get firewood	19.7	23
To get timber	5.4	6
Shade/wind break	12.2	15
Income	13.3	16
Food security	7.0	9
Total	**100.0**	**120.0**

4.2.8 System constraints

Agroforestry systems in the four villages surveyed are constrained by a number of problems as shown in table 22. Lack of education on agroforestry (27.1%) was the biggest constraint that prevents adoption of agroforestry system followed by small farm size (24.2%) and lack of seedlings (17.2%). However, this constraint was observed in Zambia by Kabwe (2010) who revealed that, sometimes seedlings and preferred tree species were found to be insufficient to meet the needs of the farmers. Kofi *et al.* (2003) also found that lack of seedlings was a setback in practicing agroforestry. The respondents indicated that on the part of the regularity of extension services, approximately 22.3% said there was none available.

Table 22: Limiting factors for adoption of agroforestry

Factor	Percent	N
Hired farm	2.1	2
Lack of education on agroforestry	27.1	33
Lack of extension services	22.3	26
Small farm size	24.2	29
Yield drop due to shade	7.1	9
Scarcity of seedlings	17.2	21
Total	**100.0**	**120**

4.3 Attitude towards Agroforestry Practices

4.3.1 Attitude towards Land Productivity

Table 23 shows the factor loading of each item and their hypothesized signs. Results of factor analysis show that statements T1 and T2 had a low factor loading compared to others and were therefore not used for further analysis. Famers' outcome concided with researchers' hypothesis on the remaining statements. The initial Eigen Value was about 1.634 and 73.5% of the variations were explained by the included statements in the factor. The factor loading of the remaining statements (T3, T4, T5, T6 and T7) were greater than 0.3 (acceptable factor loading refer chapter 3 section 3.4.1.4) and were used to calculate factor scores in measuring the attitude towards land productivity (Table 23).

Table 23: Statements and their factor loadings, measuring the attitude towardsland productivity

Item	Researchers' Hypothesis	Outcome from farmers	Factor Loading[a]
T1- I worry that the land will not produce much when tree are on farm	Agree	Not Used	-
T2 - Reduce chance of complete crop failure	Agree	Not Used	-
T3-Trees on farm have no effects on crop yield	Disagree	Disagree	-0.486
T4- If I keep trees on farm crop yield decrease	Disagree	Disagree	-0.616
T5 - Planting trees on farms increase soil fertility	Agree	Agree	0.440
T6- Planting trees on farm make the land having low fertility	Agree	Agree	0.630

[a]Un-rotated factor loading computed from factor analysis

Statements T3 and T4 show a negative attitude towards the availability of trees on farm implying less importance of land productivity to agroforestry practices. Rotation of the factors using the varimax method did not produce better results as compared to the un-rotated solution. Table 24 shows the percentage of respondents indicating a positive attitude towards land productivity (82% of the respondents).

Table 24: Respondents indicating positive attitude towards land productivity

Village/Item	Kitete	Magomeni	Nyameni	Peapea	Total
		% of respondents			
T3-Trees on farm have no effects on crop yield	50	47	47	23	42
T4- If I keep trees on farm crop yield decrease	87	80	97	90	89
T5 - Planting trees on farms increase soil fertility	97	97	100	97	98
T6- Planting trees on farm make the land having low fertility	100	70	97	87	89
T7 - I worry that planting more trees in the future the land will not produce much	90	90	100	93	93
Overall	84	76	88	78	82

4.3.2 Attitude towards commercialization

Results of factor analysis indicated that 57% of the variations were explained by the included items/statements in the factor and the initial Eigen Value was 2.377. Statements T8, T10, T15 and T17 loaded low to the factor with coefficient less than 0.3 (Table 25).

Table 25: Statements and their factor loadings, measuring the attitude towards commercialization

Item	Researchers' Hypothesis	Outcome from	Factor loading
T8- Increase opportunity of extra cash income	Agree	Disagree	-0.267
T9- If there is an opportunity to make extra money I will use it	Agree	Agree	0.459
T10- It took long time to get income	Disagree	Disagree	-0.166
T11- In the future we will grow more crops for sale	Disagree*	Agree	0.628
T12 - Growing as many crops for sale is the best I can do	Agree	Agree	0.729
T13- Trees on farm increase sale of farm produce	Agree	Agree	0.595
T14- Information price helps me decide on what to produce	Agree	Agree	0.373
T15- Reduce cost of inputs (like fertilizer)	Agree	Agree	0.188
T16- Trees on farm provide good building materials	Agree	Agree	0.435
T17- The most important thing for a farm household is to grow all its own food requirement.	Disagree	Agree*	0.285
T18- Frequent change in crops prices is the biggest problem	Agree	Agree	0.586

***Means that there is a difference between researchers' expectations and farmers' actual answers**
[a]Un-rotated factor loading computed from factor analysis

The factor loading of the remaining statements (T9, T11, T12, T13, T14, T16 and T18) were greater than 0.3. This implies that the answers given by the respondents to those statements were correlated to each other and they were used to explain the attitude towards commercialization. With the exception of T8, T11 and T17, the signs of all the other statements conformed to the researchers' prior expectation implying that the researcher's assumption about those statements is accepted by the respondents. Farmers' attitude towards commercialization was high with an overall average of 90% of respondents showing a positive attitude towards commercialization (Table 26). This shows that farmers objective in farming was indicated as to produce cash crops for selling in the future as a means of earning their living. Unlike the results obtained by Senkondo (2000) in Babati that farmers were observed to attach more weight to the production for home consumption and therefore they had a low attitude towards commercialization.

Table 26: Respondents indicating a positive attitude towards commercialisation

Village/Item	Kitete	Magomeni	Nyameni	Peapea	Overall
			% of respondents		
T9- If there is an opportunity to make extra money I will use it	97	90	100	100	96
T11- In the future we will grow more crops for sale	93	90	100	90	93
T12 - Growing as many crops for sale is the best I can do	97	83	98	83	90
T13- Trees on farm increase sale of farm produce	87	70	87	70	78
T14- Information on produce price helps me decide on what to produce for sale	100	90	93	100	95
T16- Trees on farm provide good building materials like timber for selling	83	80	93	100	89
T18- Frequent change in crops prices is the biggest problem for my income	77	93	100	100	92
Overall	91	85	95	91	90

4.3.3 Attitude towards land resource conservation

Results of factor analysis show that items/statements T24, T29, T30, T34 and T37 had low factor loading compared to others (Table 27). The initial Eigen Value was about 3.618 and 63.5% of the variations were explained by the included items/statements in the factor. The factor loading of the remaining items/statements (T19, T20, T21, T22, T23, T25, T26, T27, T28, TT31, T32, T33, T35 and T36) were greater than 0.3. This shows a high loading and was used to calculate factor scores in measuring the attitude towards land resource conservation (Table 27).

Table 27: Statements and their factor loadings, measuring the attitude towards land resource conservation

Item	Researchers 'Hypothesis	Outcome from farmers	Factor loading[a]
T19- The way we are farming now is fine and it can last for ever	Disagree	Agree	0.443
T20- If I keep farming like this I will exhaust the land	Agree	Agree	0.412
T21- In order to make money I have to do something that are not good for the soil	Disagree	Agree	0.372
T22- Trees on farm help to conserve water	Agree	Agree	0.307
T23- Trees on farm help to conserve soil	Agree	Agree	0.367
T24- Everything I do is to make sure the farm gets better all the time	Agree	Not used	-
T25- I will continue to grow more and more trees on the farm	Agree	Agree	0.496
T26- I like to try new things even if I sometimes lose money on it	Disagree	Agree	0.614
T27-We always try new things in our farm like agoforestry	Agree	Agree	0.771
T28- We need to preserve the way our parents farmed	Agree	Agree	0.672
T29- If I had more labour in my family I could grow more trees on farm	Agree	Not used	-
T30- Growing as many trees on farm is the best I can do on this farm although there is shortage of labour	Agree	Not used	-
T31-Improved surrounding condition of the forests	Agree	Agree	0.364
T32- The condition of the forests is not maintained	Agree	Agree	0.549
T33- Trees on farm reduce surface runoff	Agree	Agree	0.541
T34- Planting trees on farm is more efficient land	Agree	Not used	-
T35-I will establish more forests nursery	Agree	Agree	0.419
T36- We need to make changes in our farming practices for the benefit of the future generation	Agree	Agree	0.393
T37- To protect the farm for our children we need to stop agroforestry practices	Disagree*	Not used	-

***Means that there is a difference between researchers' expectations and farmers' actual answers**
[a]Un-rotated factor loading computed from factor analysis

With the exception of T19, T21 and T26, all the items/statements included had the same sign as expected. The results show that about 89% of the respondents in the survey area had a positive attitude towards land resource conservation (Table 28). Discussions with farmers in the study area showed that floods in the area make farmers to have a positive attitude towards land resource conservation.

Table 28: Respondents indicating a positive attitude towards land resource conservation

Village/Item	Kitete	Magomeni	Nyameni	Peapea	Overall
			% of respondents		
T19 - The way we are farming now is fine and it can last for ever	93	83	93	87	89
T20- If I keep farming like this I will exhaust the land	100	97	100	97	99
T21- In order to make money I have to do something that are not good for the soil	100	100	97	100	99
T22- Trees on farm help to conserve water	73	97	97	100	89
T23- Trees on farm help to conserve soil	93	87	93	83	89
T25- I will continue to grow more and more trees on the farm	90	90	100	97	94
T26- I like to try new things even if I sometimes loose money on it	97	87	100	97	95
T27-We always try new things in our farm like agoforestry practice	90	87	97	87	90
T28- We need to preserve the way our parents farmed	77	93	93	93	87
T31-Maintained surrounding condition of the forests	87	83	97	73	85
T32- Inspite of having trees on farm the condition of the forests is	97	93	100	83	93
T33- Trees on farm reduce surface runoff	97	97	90	76	90
T35- I will establish more forests nursery to ensure that trees are	83	47	63	62	64
T36- We need to make changes in our farming practices for the	87	87	100	97	93
Overall	90	87	94	88	89

4.4 Results of the Logistic Regression Model for Selected Predictors

The analysis of socio-economic factors influencing adoption of agroforestry was undertaken using logit model as described in chapter three.Omnibus Tests of Model Coefficients and Hosmer and Lemeshow Test were used to test the goodness of fit of the model. The model was statistically significant ($P = 0.000$) as suggested by Omnibus Tests of Model Coefficients (likelihood ratio test), which give an overall indication of how well the model performs. The results of the logit model are presented in Table 29.

Moreover, the model fits well as indicated by Hosmer and Lemeshow Test which is interpreted differently from the Omnibus test by requiring the value greater than 0.05. The Hosmer and Lemeshow Test was above 0.05 ($P = 0.118$) indicating support for the model (Table 29). Results from the binary logistic equation indicate that the variables influencing adoption of agroforestry was explained by 22.8% and 44% as indicated by Cox and Snell R^2 and Nagelkerke R^2 (pseudo R^2) values respectively (Table 29).This implies that the variables included in the model explain the variation in the probability of adopting agroforestry between 22.8% and 44%. In addition, the model correctly predicted 93.2%of cases overall.

This study found that four variables were significant in explaining the adoption of agroforestry; farm labour force, attitude towards land productivity, attitude towards commercialization and attitude towards land resource conservation. Farm labour force was statistically significant ($P < 0.05$) and positively related with adoption of agroforestry practices. This imply that, when, farm labour force increased by one unit, there was an increase in the probability that the household adopted agroforestry by the amount of the coefficient estimates (Table 29).

Table 29: Results of Logistic Regression Analysis

Variables	**B**	**S.E.**	**Wald**	**df**	**Significance level**
Gender	.254	.929	.074	1	.785
Age	.019	.031	.376	1	.540
Farm labour force	3.073	1.035	8.805	1	.003*
Education level	-1.333	1.555	.735	1	.391
Farm size	.487	.284	2.942	1	.086
Attitude towards land productivity	-1.643	.608	7.300	1	.007*
Attitude towards commercialization	1.203	.510	5.569	1	.018*
Attitude towards Land resource conservation	1.170	.429	7.440	1	.006*
Constant	.727	2.417	.090	1	.764
Performance Indicators for the Logit Model					
Model evaluation (overall) % correct predictions	93.2%				.
Cox & Snell R^2	.228				
Nagelkerke R^2	.440				
	X^2		df		P- value
Likelihood ratio test (Omnibus Tests of Model Coefficients)	30.331		7		.000
Goodness of fit test: Hosmer and Lemeshow Test	12.835		8		.118

***** Significance at 5% level

Similar findings (Buyinzaand Naagula, 2009) revealed that size of family labour force is positively associated with probability to adopt agroforestry technologies. They based their argument on the fact that combining tree resources and food crops on the farm is labour demanding and families constrained with labour force may not be able to practice agroforestry.

The coefficient of attitude towards land productivity was statistically significant ($P < 0.05$) and negatively related with adoption of agroforestry practices. This indicates that respondents with negative attitudes towards agroforestry practices are less likely to use it due to less benefits associated with the practices. Therefore they are less likely to make efforts to establish it. This brings the need to change the negative attitude of farmers in the study area.

Attitude towards land resource conservation was found to have positive relationship with adoption of agroforestry practices and was statistically significant ($P < 0.05$). This suggests that, farmers with higher positive attitudes towards agroforestry practices have stronger views of the technology and they are convinced that the practice contributes more benefits to conservation of land resource than not having it. The study supports the findings of Meghan *et al*. (2008) who found that attitude towards rain forest conservation was positively related to adoption of agroforestry. The authors concluded that more positive attitudes about conservation have positive impacts on farmers' intentions to adopt agroforestry.

The coefficient of attitude towards commercialization was statistically significant ($P < 0.05$) and positively related with adoption of agroforestry practices. This shows that farmers with higher positive attitudes towards adoption of agroforestry in terms of commercialization is expected to produce cash crops for selling rather than for home consumption as a means of earning their living.

Age was not statistically significant but it was positively related with adoption of agroforestry practices. However age was supposed to be treated as age group but in this study it was not taken care as such in the logistic regression analysis. Future research in agroforestry is advocated to consider age group so as to determine how the specific age group influences agroforestry adoption.

4.5 Results of Cost Benefit Analysis of Agroforestry Practices

Cost Benefit Analysis (CBA) was undertaken for each of the selected agroforestry practices common in the four villages surveyed as shown in table 30. The main basic assumption in undertaking this CBA was that farmers aim at maximizing net benefits from the agroforestry practices and based on this assumption; farmers preferred an agroforestry system that had higher measure of economic worth (that is higher NPV).

Table 30: Common Agroforestry Practices in the Surveyed Villages

Kitete	Magomeni	Nyameni	Peapea
Maize/Coconut/*Albizia gummifera* /Livestock	Maize/ Mangoes / *Leucaenea leucocephala*	Maize/Coconut/ Grevillea robusta	Maize/Mangoes/ Bananas
Coconut /Banana /*Leucaenea leucocephala/* Livestock	Maize/Oranges /Coconut	Rice/Coconut /Mangoes	Maize/Sunflower/ Banana/Oranges
Maize / Mangoes /*Albizia gummifera /* Livestock		Maize/Beans/ Oranges	
Maize/Beans *Leucaenea leucocephala* / Livestock			

4.5.1 Technical coefficients used in the analysis

The following technical coefficients were adopted;

(a) Oranges start production 3 to 5 years after planting (Orwa *et al.*, 2009).

b) The time between planting a banana plant and the harvest of the banana bunch is from 9 to 12 months (Abracos, 2011).

c) The tall coconut variety which is widely grown variety starts production 6 to 7 years after planting. Full bearing is attained at 60 years (Orwa *et al.*, 2009).

d) Mango is harvested 3 to 6 years after planting depending on cultivar (Morton and Miami 1987).

e) Maize is harvested 4 months after planting. Only one crop per year is practised in both villages.

f) Rice is a relatively labour intensive crop. It is harvested 3 to 4 months after sowing.

g) The time required for a sunflower to grow from seed depends on the weather conditions in which it is grown. On average sunflowers mature in approximately 100 days (Urbauer, 2013).

h) Grevillea robusta, *Leucaenea leucocephala* and *Albizia gummifera* are harvested 3 to 5 years after planting.

g) The type of herbicides used in control of weeds in maize was TWIGA 2, 4-D which was applied after every two weeks. This information was used in CBA calculations.

4.5.2 Livestock

Livestock were considered only in Kitete village, where a large proportion of farmers kept cows, goats and pigs. On average 3 cows, 3 pigs and 4 goats were kept per household. These numbers were used in CBA calculations.

a) Cow’s milk yield ranged between 1 to 5 litres per cow per day with an average of 1.3 litres per cow which is sold per day.In most dairy units, a lactation length of 305 days is commonly accepted as a standard. However, according to Gillah *et al.* (2012) such a standard lactation length might not work for dairy cows in the urban and peri urban areas of East Africa. For the purpose of this study a lactation period of 205 days was used.

b) Goat milk yield ranged between 1 to 2 litres per animal per day with an average of 1.1 litres which was sold**.** For the purpose of this study a lactation period of 185 days was used.

c) Productive life of pigs, cows and goats was assumed to be 4 years.

d) Piglets were sold as baconers and sows, therefore due to space limitation it was assumed that 5 baconers were sold at six month. For the purpose of this study one sow would farrow 6 piglets and the survival rate per sow was 95% which was adopted from URT (2011). This information was used in CBA calculations.

4.5.3 Costs and Benefits Components

Costs were categorized into two components, common cost and direct costs. Common costs were those which were applicable to the whole range of the components in the mixture. These were labour cost for land preparation and weeding. Weeding was an annual event which occurs in the second year onwards. Due to high weed growth, it was carried out twice a year. Direct costs are those which are specific for each component, for example planting, pruning and tending, harvesting, marketing, pesticides and seedling costs. For tree components, number of seedlings required was corrected by taking the observed survival rate of 85%. This rate was adopted from CDM (2009) in Kilombero and Mufindi Reforestation in Tanzania.

Another classification of cost was done in livestock enterprise which distinguished between investment and operating costs. Investment costs were barn construction, initial costs of livestock and milk utensils. Operating costs were labour, veterinary drugs and annual maintenance of the barn. Benefits were taken as the value of production of the various components for 20 years. Costs and benefits were valued using constant 2012 prices as indicated in chapter three section 3.4.2.2.

4.5.4 Present value calculation for Maize (0.6), Mangoes (0.2) and Leucaenea leucocephala (0.2) in Magomeni village

Maize

Labour input

Land preparation 20.9 man-days/Ha.For 0.6 Ha x 20.9 = 12.5 man days. Labour required: 12.5 man days x 4500 Tshs/man day = 56430 Tshs at constant 2012 prices. This was done every year.

Planting 15.7 man-days/Ha. For 0.6 Ha x 15.7 = 9.4 man days. Labour required 9.4 man days x 4500 Tshs/man day = 42390 Tshs at constant 2012 prices. This was done every year.

Weeding 18.9 man-days/Ha. For 0.6 Ha x 18.9 = 11.3 man days. Labour required 11.3 man days x 4500 Tshs/man day = 50850 Tshs at constant 2012 prices. This was an annual event which was done in the second year onwards.

Harvesting and marketing 15.2 man-days/Ha. For 0.6 Ha x 15.2 = 9.1 man days. Labour required 9.1 man days x 4500 Tshs/man day = 40950 Tshs at constant 2012 prices. These activities were performed every year.

Seedling costs

Seed rate of 30 kg/Ha, For 0.6ha = 30 kg/Ha x 0.6ha = 18 kg. Market price for seed was Tshs 2890 at 2012 constant prices, 2890Tshs/kg x 19kg = 52020 Tshs. This was done in every year.

Herbicides cost

The type of herbicides used in control of weeds in maize was TWIGA 2, 4-D.Quantity of 0.5 ml/2 weeks/ha was applied, for 0.6ha = 0.5 ml/2 weeks/ha x 0.6ha = 0.3 ml/2 weeks. Market price was Tshs 9900 at 2012 constant prices, 9900 Tshs x 0.3ml/2 weeks = 2970 Tshs/ml/ 2 weeks. This was done in every year.

Benefits

Yield reported was 240 Kg/Ha. Market price at constant 2012 prices was Tshs 2200 Benefits were given as 240 Kg/Ha x 0.6 x 2200 Tshs = 316800Tshs.

Mangoes

Labour input

Planting 15.8 man-days/Ha. For 0.2 Ha x 15.8 = 3.2 man days. Labour required: 3.2 man days x 4500 Tshs/man day = 14400 Tshs at constant 2012 prices. This was done in year one.

Pruning and tending 13.9 man-days/Ha. For 0.2 Ha x 13.9 man-days/Ha = 2.8 man days. Labour required 2.8 man days x 4500 Tshs/man day = 12600 Tshs at constant 2012 prices. Pruning and tending were done each year from year 2.

Harvesting and marketing 17.3 man-days/Ha.For 0.2 Ha x 17.3 = 3.5 man days. Labour required 3.5 man days x 4500 Tshs/man day = 15750 Tshs at constant 2012 prices. These activities were performed in the fourth year.

Seedling costs

Number in the mixture = 74 and proportion in the mixture was 0.5.Number/Ha was 74/0.5 = 148 For 0.2 Ha, = 148 x 0.2 = 30 trees. Considering survival rate of 85%, seedlings required were 30 x 1.15 = 34. Seedlings cost 1850 Tshs at constant 2012 prices. Seedling costs = 34 x 1850 Tshs = 62900 Tshs. This was done in the first year.

Benefits

Average yield reported was 100 mangoes/tree/year. Market price at constant 2012 prices was Tshs 50. Benefits were given as 100 Tshs x 30 trees x 50 = 150,000 Tshs. The benefits accrued each year from year four.

Leucaenea leucocephala

Labour input

Planting 15.8 man-days/Ha. For 0.2 Ha x 15.8 = 3.2 man days. Labour required 3.2 man days x 4500 Tshs/man day = 14400 Tshs at constant 2012 prices. This was done in year one and after every four year.

Tending and pruning 13.9 man-days/Ha. For 0.2 x 13.9 Ha = 2.8 man days. Labour required 2.8 man days x 4500 Tshs/man day = 12600 Tshs at constant 2012 prices. These were done in every second year and third year after planting.

Harvesting and marketing 17.9 man-days/Ha. For 0.2 Ha x 17.9 = 3.6 man days. Labour required 3.6 man days x 4500 Tshs/man day = 16200 Tshs at constant 2012 prices. These activities were performed every fourth year after planting.

Seedling costs

Number in the mixture = 66 and proportion in the mixture was 0.5.Number/Ha was 66/0.5 = 132 trees For 0.2 Ha, = 132 x 0.2 = 26 plants. Considering survival rate of 85%, seedlings required were 26 x 1.15 = 30. Seedlings cost 1640 Tshs at constant 2012 prices. Seedling costs = 30 x 1640 Tshs = 49200 Tshs. This occurred in the first year and after every fourth year.

Benefits

Leucaenea leucocephala was mainly used as firewood in Magomeni village. Therefore the benefits were estimated based on the prices of other fuelwood tree species of Tshs 2000. Average number of trees = 26 x 2000, Total benefits were Tshs 52000. These benefits accrued every fourth year.

Table 31 shows summary of NPV calculation for Maize (0.6), Mangoes (0.2) and *Leucaenea leucocephala* (0.2) in Magomeni village. Detailed cash flows calculations are presented in Appendix 5.

4.5.5 Present Value calculation for Maize (0.6), Oranges (0.2) and Coconut (0.2) in Magomeni village

Maize

Calculation for maize refer section 4.5.4.

Coconut

Labour input

Planting 18.6 man-days/Ha. For 0.2 Ha x 18.6 = 3.72 man days. Labour required: 3.72 man days x 4500 Tshs/man day = 16,740 Tshs at constant 2012 prices. This was done in year one.

Pruning and tending 11 man-days/Ha. For 0.2 Ha x 11= 2.2 man days. Labour required: 2.2 man days x 4500 Tshs/man day = 9900 Tshs at constant 2012 prices. These were done each year from year five.

Harvesting and marketing 16.9 man-days/Ha. For 0.2 Ha x 16.9 = 3.38 man days. Labour required: 3.38 man days x 4500 Tshs/man day = 15210 Tshs at constant 2012 prices. These activities were performed in the seventh year onwards.

Seedling costs

Number in the mixture = 89 and proportion in the mixture was 0.6. Number/Ha was 89/0.6 = 148, For 0.2 Ha, = 148 x 0.2 = 30 trees. Considering survival rate of 85%, seedlings required were 30 x 1.15 = 35. Seedlings cost 1750 Tshs at constant 2012 price. Seedling costs = 35 x 1750 Tshs = 61250 Tshs. This was done in the first year.

Benefits

The average yield reported was 51 nuts/tree/year. Market price at constant 2012 prices was Tshs 250, Benefits were given as 51 x 30 x 250 Tshs = 382,500Tshs.

Oranges

Labour input

Planting 15.7 man-days/Ha. For 0.2 Ha x 12.7 = 2.5 man days. Labour required: 2.5 man days x 4500 Tshs/man day = 11250 Tshs at constant 2012 prices. This was done in year one.

Pruning and tending 13.9 man-days/Ha. For 0.2 Ha x 13.9 man-days/Ha = 2.8man days. Labour required: 2.8 man days x 4500 Tshs/man day = 12600 Tshs at constant 2012 prices. These were done each year from year two.

Harvesting and marketing 17.4 man-days/Ha. For 0.2 Ha x 17.4 = 3.5 man days. Labour required 3.5 man days x 4500 Tshs/man day = 15750 Tshs at constant 2012 prices. These activities were performed in year four.

Seedling costs

Number in the mixture = 63 and proportion in the mixture was 0.4. Number/Ha was 63/0.4 = 158 For 0.2 Ha, = 158 x 0.2 = 32 trees. Considering survival rate of 85%, seedlings required were 32 x 1.15 = 37. Seedlings cost 1250 Tshs at constant 2012 price. Seedling costs = 37 x 1250 Tshs = 46250 Tshs. This occurred in the first year.

Benefits

Yield reported was 325 oranges/tree/year. Market price at constant 2012 prices was Tshs 50. Benefits were given as 325 Tshs x 32 x 50 = 520,000 Tshs. The benefits accrued each year from year three.

Table 31 shows summary of NPV calculation for Maize (0.6), Oranges (0.2) and Coconut (0.2) in Magomeni village. Projected cash flow is presented in Appendix 6.

4.5.6 Present Value calculation for Maize (0.5), Coconut (0.3) and Grevillea robusta (0.2) in Nyameni village

Maize

Labour input

Land preparation 20.9 man-days/Ha. For 0.5 Ha, 0.5 Ha x 20.9 = 10.5 man days. Labour required: 10.5 man days x 3000 Tshs/man day = 31500 Tshs at constant 2012 prices. This was done every year.

Planting 13.7 man-days/Ha. For 0.5 Ha x 13.7 = 6.9 man days. Labour required 6.9 man days x 3000 Tshs/man day = 20550 Tshs at constant 2012 prices. This was done every year.

Weeding 18.9 man-days/Ha. For 0.5 Ha x 18.9 = 9.5 man days. Labour required 9.5 man days x 3000 Tshs/man day = 28500 Tshs at constant 2012 prices. This was an annual event done in the second year onwards.

Harvesting and marketing 16.8 man-days/Ha. For 0.5 Ha x 16.8 = 8.4 man days. Labour required 8.4 man days x 3000 Tshs/man day = 25200 Tshs at constant 2012 prices. These activities were performed every year.

Seedling costs

Seed rate of 31.4 kg/Ha, For 0.5 ha = 31.4 kg/Ha x 0. 5 ha = 16 kg. Market price for seed was Tshs 3120 at 2012 constant prices, 3120 Tshs/kg x 16 kg = 48984 Tshs. This occurred every year.

Herbicides cost

Quantity of 0.8ml/ 2 weeks/ha, for 0.5 ha = 0.8ml/ 2 weeks/ha, x 0.5 ha = 0.4 ml/ 2 weeks. Market price for was Tshs 9860 at 2012 constant prices, 9860 Tshs x 0.4 0.4 ml/ 2 weeks = 3944 Tshs/ml/ 2 weeks. This occurred every year.

Benefits

Yield reported was 170Kg/Ha. Market price at constant 2012 prices was Tshs 2400 Benefits were given as 170Kg/Ha x 0.5 x 2400 Tshs/kg = 204 000Tshs.

Coconut

Labour input

Planting 11.9 man-days/Ha. For 0.3 Ha x 11.9 = 3.6 man days. Labour required: 3.6 man days x 3000 Tshs/man day = 10800 Tshs at constant 2012 prices. This was done in year one.

Pruning and tending 14.7 man-days/Ha. For 0.3 Ha x 14.9= 4.5 man days. Labour required: 4.5 man days x 3000 Tshs/man day = 13500 Tshs at constant 2012 prices. These were done each year from year five.

Harvesting and marketing 16.9 man-days/Ha. For 0.3 Ha x 16.9 = 5.1 man days. Labour required 5.1 man days x 3000 Tshs/man day = 15300 Tshs at constant 2012 prices. These activities were performed in the seventh year onwards.

Seedling costs

Number in the mixture = 72 and proportion in the mixture was 0.6. Number/Ha was 72/0.6 = 120, For 0.3 Ha, = 120 x 0.3 = 36 trees. Considering survival rate of 85%, seedlings required were 36 x 1.15 = 41. Seedlings cost 1800 Tshs at constant 2012 prices. Seedling costs = 41 x 1800 Tshs = 74520 Tshs. This occurred in the first year.

Benefits

The average yield reported was 100 nuts/tree/year. Market price at constant 2012 prices was Tshs 150 Benefits were given as 100 x 36 x 150Tshs = 540000 Tshs.

Grevillea robusta

Labour input

Planting 16.2 man-days/Ha. For 0.2 x 16.2 Ha = 3.2 man days. Labour required: 3.2 man days x 3000 Tshs/man day = 9600 Tshs at constant 2012 prices.This was done in year one and after every fourth year.

Tending and pruning 14.7 man-days/Ha. For 0.2 x 14.7 Ha = 2.9 man days. Labour required: 2.9 man days x 3000 Tshs/man day = 8700 Tshs at constant 2012 prices. These were done in every second year and third year after planting.

Harvesting and marketing 19.4 man-days/Ha. For 0.2 Ha x 19.4 = 3.8 man days. Labour required: 3.8 man days x 3000 Tshs/man day = 11400 Tshs at constant 2012 prices. These activities were performed every fifth year after planting.

Seedling costs

Number in the mixture = 49 and proportion in the mixture was 0.4. Number/Ha was 78/0.4 = 130 trees For 0.2 Ha, = 130 x 0.2 = 26 plants. Considering survival rate of 85%, seedlings required were 26 x 1.15 = 23. Seedlings cost 1500 Tshs at constant 2012 prices. Seedling costs = 23 x 1500 Tshs = 34500 Tshs. This occured in the first year and after every fourth year.

Benefits

Grevillea robusta was mainly used as firewood in Nyameni village. Therefore the benefits were estimated based on the prices of other fuelwood tree species of Tshs 1200. Average number of trees = 26 x 1200 Tshs, Total benefits were Tshs 31200. These benefits occurred every fourth year.

Table 31 shows summary of NPV calculation for Maize (0.5), Coconut (0.3) *and Grevillea robusta* (0.2) in Nyameni village. Detailed cash flow calculations are presented in Appendix 7.

4.5.7 Present Value calculation for Rice (0.5), Coconut (0.3) and Mangoes (0.2) in Nyameni village

Rice

Labour input

Land preparation 25.9 man-days/Ha. For 0.5 Ha x 25.9 = 12.9 man days. Labour required: 12.9 man days x 3000 Tshs/man day = 38700 Tshs at constant 2012 prices. This was done every year.

Planting 19.6 man-days/Ha. For 0.5 Ha x 19.6 = 9.8 man days. Labour required 9.8 man days x 3000 Tshs/man day = 29400 Tshs at constant 2012 prices. This was done every year.

Weeding 27.5 man-days/Ha. For 0.5 Ha x 27.5 = 13.8 man days. Labour required 13.8 man days x 3000 Tshs/man day = 41400 Tshs at constant 2012 prices. This was an annual event done in the second year onwards.

Harvesting and marketing 30.8 man-days/Ha. For 0.5 Ha x 30.8 = 15.4 man days. Labour required 15.4 man days x 3000 Tshs/man day = 46200 Tshs at constant 2012 prices. These activities were performed every year.

Seedling costs

Seed rate of 79kg/Ha. For 0.5 ha = 79 kg/Ha x 0.5 ha = 40 kg. Market price for seed was Tshs 3500 at 2012 constant prices, 3500 Tshs/kg x 40 kg = 140,000 Tshs. This occurred every year.

Herbicides costs

Quantity of 1.5ml/ 2 weeks/ha. For 0.5 ha = 1.5ml/ 2 weeks/ha x 0.5 ha = 0.8ml/ 2 weeks. Market price was Tshs 12500 at 2012 constant prices, 12500 Tshs x 0.8 ml/ 2 weeks = 9375 Tshs/ml/ 2 weeks. This occurred every year.

Benefits

Yield reported was 225Kg/Ha. Market price at constant 2012 prices was Tshs 3000, Benefits were given as 225 x 3000 Tshs x 0.5 = 375000 Tshs.

Mangoes

Planting 15.9 man-days/Ha. For 0.2 Ha x 15.9 = 3.2 man days. Labour required: 3.2 man days x 3000 Tshs/man day = 9600 Tshs at constant 2012 prices. This occurred in year one. Pruning and tending 13.7 man-days/Ha. For 0.2 Ha x 13.7 = 2.7 man days. Labour required: 2.7 man days x Tshs/man day = 8220 Tshs at constant 2012 prices. These were done each year from year two.

Harvesting and marketing 17.8 man-days/Ha. For 0.2 Ha x 17.8 = 3.6 man days. Labour required 3.6 man days x 3000 Tshs/man day = 10800 Tshs at constant 2012 prices. These activities were performed in fourth year.

Coconut

Calculation for coconut refer section 4.5.6

Seedling costs

Number in the mixture = 83 and proportion in the mixture was 0.5. Number/Ha was 93/0.5 = 186, For 0.2 Ha, = 186 x 0.2 = 37 trees. Considering survival rate of 85%, seedlings required were 37 x 1.15 = 43. Seedlings cost 1490 Tshs at constant 2012 prices. Seedling costs = 43 x 1490 Tshs = 63742.2 Tshs. This occurred in the first year.

Benefits

Yield reported was 105 mangoes/tree/year. Market price at constant 2012 prices was Tshs 100. Benefits were given as 105 Tshs x 37 trees x 100 = 388500 Tshs. The benefits accrued each year from year four.

Table 31 shows summary of NPV calculation for Rice (0.5), Coconut (0.3) and Mangoes (0.2) in Nyameni village. Detailed cash flow calculations are presented in Appendix 8.

4.5.8 Present Value calculation for Maize (0.5), Beans (0.3) and Oranges (0.2) in Nyameni village

Maize

Calculation for maize refers section 4.5.6.

Beans

Labour input

Planting 27.9 man-days/Ha. For 0.3 Ha x 27.9 = 8.4 man days. Labour required 8.4 man days x 3000 Tshs/man day = 25,200 Tshs at constant 2012 prices. This was done every year.

Harvesting and marketing 30 man-days/Ha. For 0.3 Ha x 30 9 man days. Labour required 9 man days x 3000 Tshs/man day = 27000 Tshs at constant 2012 prices. These activities were performed every year.

Seedling costs

Seed rate of 36 kg/Ha (two crops per year), For 0.3 ha = 36 kg/Ha x 0.3 ha = 10.8 kg. Market price for seed was Tshs 1895 at 2012 constant prices, 1895 Tshs/kg x 2 x 10.8 kg = 40932 Tshs.

Benefits

Yield reported was 160Kg/Ha. Market price at constant 2012 prices was Tshs 1100, Benefits were given as 160 Kg/Ha x 0.3 x 1100 Tshs = 52800Tshs.

Oranges

Labour input

Planting 13.6 man-days/Ha. For 0.2 Ha x 13.6 = 2.7 man days. Labour required: 2.7 man days x 3000 Tshs/man day = 8100 Tshs at constant 2012 prices. This occurred in year one.

Pruning and tending 11.9 man-days/Ha. For 0.2 Ha x 11.9 = 2.4 man days. Labour required: 2.4 man days x 3000 Tshs/man day = 7200 Tshs at constant 2012 prices. These were done each year from year two.

Harvesting and marketing 15.9 man-days/Ha. For 0.2 Ha x 15.9 = 3.18 man days. Labour required 3.18 man days x 3000 Tshs/man day = 9540 Tshs at constant 2012 prices. These activities were performed in fourth year.

Seedling costs

Number in the mixture = 87 and proportion in the mixture was 0.5. Number/Ha was 87/0.5 = 174, For 0.2 Ha, = 174 x 0.2 = 35 trees. Considering survival rate of 85%, seedlings required were 35 x 1.15 = 40. Seedlings cost 1600 Tshs at constant 2012 prices. Seedling costs = 40 x 1600 Tshs = 64000 Tshs. This occurred in the first year.

Benefits

Yield reported was 220 oranges/tree/year. Market price at constant 2012 prices was Tshs 50. Benefits were given as 220 Tshs x 35 x 50 = 385,000 Tshs. The benefits accrued each year from year four.

Table 4.31 shows summary of NPV calculation for Maize (0.5), Beans (0.3) and Oranges (0.2) in Nyameni village. Detailed cash flow calculations are presented in Appendix 9.

4.5.9 Present Value calculation for Maize (0.4), Mangoes (0.2) and Bananas (0.4) in Peapea village

Maize

Labour input

Land preparation 19.5 man-days/Ha. For 0.4 Ha x 19.5 = 7.8 man days. Labour required: 7.8 man days x 4500 Tshs/man day = 35100 Tshs at constant 2012 prices. This was done every year.

Planting 15.6 man-days/Ha. For 0.4 Ha x 15.6 = 6.2 man days. Labour required 6.2 man days x 4500 Tshs/man day = 27900 Tshs at constant 2012 prices. Planting activity was done every year.

Weeding 21.3 man-days/Ha. For 0.4 Ha x 21.3 = 8.5 man days. Labour required 8.5 man days x 4500 Tshs/man day = 38250 Tshs at constant 2012 prices. This was an annual event done in the second year onwards.

Harvesting and marketing 16.9 man-days/Ha. For 0.4 Ha x 16.9 = 6.8 man days. Labour required 6.8 man days x 4500 Tshs/man day = 30600 Tshs at constant 2012 prices. These activities were performed every year.

Seedling costs

Seed rate of 28 kg/Ha, For 0.4 ha = 28 x 0.4 = 11.2 kg. Market price for seed was Tshs 3200 at 2012 constant prices, 3200 x 11.2 kg = 35840 Tshs. This occurred every year.

Herbicides costs

Quantity of 0.9ml/2 weeks/ha, For 0.4 ha = 0.9ml/ 2 weeks/ha x 0.4 ha = 0.4ml/ 2 weeks. Market price was Tshs 9900 at 2012 constant prices, 9900 Tshs x 0.4ml/ 2 weeks = 3960 Tshs/ml/ 2 weeks. This occurred every year.

Benefits

Yield reported was 200Kg/Ha. Market price at constant 2012 prices was Tshs 2300. Benefits were given as 200 x 0.4 x 2300 Tshs = 184000 Tshs. These benefits occurred every year.

Mangoes

Labour input

Planting 15.4 man-days/Ha. For 0.2 Ha x 15.4 = 3.1 man days. Labour required: 3.1 man days x 4500 Tshs/man day = 13950 Tshs at constant 2012 prices. This occurred in year one.

Pruning and tending 13.9 man-days/Ha. For 0.2 Ha x 13.9 = 2.8 man days. Labour required: 2.8 man days x 4500 Tshs/man day = 12600 Tshs at constant 2012 prices. These were done each year from year two.

Harvesting and marketing 17.6 man-days/Ha. For 0.2 Ha x 17.6 = 3.5 man days. Labour required: 3.5 man days x 4500 Tshs/man day =15840 Tshs at constant 2012 prices. These activities were performed in fourth year.

Seedling costs

Number in the mixture = 53 and proportion in the mixture was 0.4. Number/Ha was 53/0.4 = 133. For 0.2 Ha, = 133 x 0.2 = 27 trees. Considering survival rate of 85%, seedlings required were 27 x 1.15 = 30. Seedlings cost 1500 Tshs at constant 2012 prices. Seedling costs = 30 x 1500 Tshs = 45000 Tshs. This occurred in the first year.

Benefits

Yield reported was 110 mangoes/tree/year. Market price at constant 2012 prices was Tshs 150. Benefits were given as 110 x 27 trees x 150 Tshs = 445,500 Tshs. The benefits accrued each year from year three.

Bananas

Labour input

Planting 19.6 man-days/Ha. For 0.4 Ha x 19.6 = 7.8 man days. Labour required: 7.8 man days x 4500 Tshs/man day = 35280 Tshs at constant 2012 prices. This was done in the first year.

Tending and pruning 15.8 man-days/Ha. For 0.4 x 15.8 Ha = 6.3 man days. Labour required: 6.3 man days x Tshs/man day = 28440 Tshs at constant 2012 prices. These were done in every year starting from year two.

Harvesting and marketing 17.2 man-days/Ha. For 0.4 Ha x 17.2 = 6.88 man days. Labour required: 6.88 man days x 4500 Tshs/man day = 30960 Tshs at constant 2012 prices. These activities were performed every year starting from year two.

Seedling costs

Number of clumps in the mixture = 76 and proportion in the mixture was 0.5. Number/Ha was 76/0.5 = 152. For 0.4 Ha, = 152 x 0.4 = 61 clumps. Considering survival rate of 85%, seedlings required were 61 x 1.15 = 70. Seedlings cost 950 Tshs at constant 2012 prices. Seedling costs = 70 x 950 Tshs = 66500 Tshs. This occurred in the first year.

Benefits

Yield reported was 160 bunches/Ha. For 0.4 ha = 160 x 0.4 = 64. Market price at constant 2012 prices was Tshs 1500. Benefits were given as 64 x 1500 Tshs = 96000 Tshs. The benefits accrued each year from year two.

Table 31 shows summary of NPV calculation for Maize (0.4), Mangoes (0.2) and Bananas (0.4) in Peapea village. Projected cash flow calculations are presented in Appendix 10.

4.5.10 Present Value calculation for Maize (0.4), Sunflower (0.2), Banana (0.2) and Oranges (0.2) in Peapea village

Maize and banana

Calculation for maize and banana refer section 4.5.9

Sunflower

Labour input

Planting 9.6 man-days/Ha. For 0.2 Ha x 9.6 = 1.9 man days. Labour required 1.9 man days x 4500 Tshs/man day = 8550 Tshs at constant 2012 prices. This was done every year.

Harvesting and marketing 12.5 man-days/Ha. For 0.4 Ha x 12.5 = 5 man days. Labour required 5 man days x 4500 Tshs/man day = 22500 Tshs at constant 2012 prices. These activities were performed every year.

Seedling costs

The average seed rate was 6.5 kg/Ha, For 0.2 ha = 6.5 x 0.2 = 1.3 kg. Market price for seed was 1800 Tshs at 2012 constant prices, 1800 Tshs x 1.3 kg = 2340 Tshs. This occurred every year.

Benefits

The average yield reported was 113 Kg/Ha. Market price at constant 2012 prices was 3200 Tshs. Benefits were given as 113 Kg/Ha x 0.2 x 3200 Tshs = 72320 Tshs.

Oranges

Labour input

Planting 13.9 man-days/Ha. For 0.2 Ha x 13.9 = 2.8 man day. Labour price was 4500 Tshs at 2012 constant prices. Labour required 2.8 man days x 4500 Tshs/man day = 12600 Tshs at constant 2012 prices. This occurred in year one.

Pruning and tending 11.6 man-days/Ha. For 0.2 Ha x 11.6 = 2.3 man day. Labour price was 4500 Tshs at 2012 constant price. Labour required: 2.3 man days x 4500 Tshs/man day = 10440 Tshs at constant 2012 prices. These were done each year from year two.

Harvesting and marketing 16.1 man-days/Ha. For 0.2 Ha x 16.1 = 3.22 man day. Labour price was 4500 Tshs at 2012 constant price. Labour required 3.22 man days x 4500 Tshs/man day = 14490 Tshs at constant 2012 prices. These activities were performed in fourth year.

Seedling costs

Number in the mixture = 72 and proportion in the mixture was 0.5. Number/Ha was 72/0.5 = 144. For 0.2Ha, = 144 x 0.2 = 29 trees. Considering survival rate of 85%, seedlings required were 29 x 1.15 = 33. Seedlings cost 1350 Tshs at constant 2012 prices. Seedling cost = 33 x 1350 Tshs = 44,550 Tshs. This occurred in the first year.

Benefits

Yield reported was 222 oranges/tree/year. Market price at constant 2012 prices was 50 Tshs/orange. Benefits were given as 222 x 29 trees x 50Tshs = 321,900Tshs.

Table 31 shows summary of NPV calculation for Maize (0.4), Sunflower (0.2), Banana (0.2) and Oranges (0.2) in Peapea village. Detailed cash flow calculations are presented in Appendix 11.

4.5.11 Present Value calculation for Maize (0.5), Coconut (0.3), Albizia gummifera (0.2) and Livestock in Kitete village

Maize

Labour input

Land preparation 23.9 man-days/Ha. For 0.5 Ha x 23.9 man-days/Ha = 11.9 man days. Labour required: 11.9 man days x 4500 Tshs/man day = 53550 Tshs at constant 2012 prices. This was done every year.

Planting 18.6 man-days/Ha. For 0.5 Ha x 18.6 man-days/Ha = 9.3 man days. Labour required: 9.3 man days x 4500 Tshs/man day = 41850 Tshs at constant 2012 prices. This was done every year.

Weeding 20.7 man-days/Ha. For 0.5 x 20.7 man-days/Ha = 10.4 man days. Labour required: 10.4 man days x 4500 Tshs/man day = 46800 Tshs at constant 2012 prices. This was an annual event done in the second year onwards.

Harvesting and marketing 17.5 man-days/Ha. For 0.5, 0.5 Ha x17.5 man-days/Ha = 8.8 man days. Labour required: 8.8 man days x 4500 Tshs/man day = 39600 Tshs at constant 2012 prices. These activities were performed every year.

Seedling costs

Seed rate of 36 kg/Ha. For 0.5 ha = 36 kg/Ha x 0.5 Ha = 18 kg. Market price for seed was Tshs 2790 at constant 2012 prices, 2790 Tshs x 18 kg = 50220 Tshs. This occurred every year.

Herbicides cost

Quantity of 0.7ml/ 2 weeks/ha. For 0.5ha = 0.7ml/ 2 weeks/ha x 0.5ha = 0.4 ml/ 2 weeks. Market price was Tshs 10270 at 2012 constant prices, 10970 Tshs x 0.4 ml/ 2 weeks = 4000 Tshs/ml/ 2 weeks. This occurred every year.

Benefits

Yield reported was 280Kg/Ha. Market price at constant 2012 prices was Tshs 2300. Benefits were given as 2300 Tshs x 0.5 x 280 = 322,000 Tshs.

Coconut

Labour input

Planting 15.9 man-days/Ha. For 0.3 Ha x 15.9 = 4.8 man days. Labour required: 4.8 man days x 4500 Tshs/man day = 21465 Tshs at constant 2012 prices. This was done in year one.

Pruning and tending 17.8 man-days/Ha. For 0.3Ha x 17.8 = 5.3 man days. Labour required: 5.3 man days x 4500 Tshs/man day = 23850 Tshs at constant 2012 prices. These were done each year from year five.

Harvesting and marketing 20.5 man-days/Ha. For 0.3 Ha x 20.5 man-days/Ha = 6.2 man days. Labour required 6.2 man days x 4500 Tshs/man day = 27900 Tshs at constant 2012 prices. These activities were performed in the seventh year onwards.

Seedling costs

Number in the mixture = 56 and proportion in the mixture was 0.6. Number/Ha was 56/0.6 = 93, For 0.3 Ha, = 93 x 0.3 = 28 trees. Considering survival rate of 85%, seedlings required were 28 x 1.15 = 32. Seedlings cost 1980 Tshs at constant 2012 prices. Seedling costs = 32 x 1980 Tshs = 63,360 Tshs. This occurred in the first year.

Benefits

The average yield reported was 112.6 nuts/tree/year. Market price at constant 2012 prices was Tshs 300. Benefits were given as 112.6 x 28 x 300Tshs = 945,840 Tshs.

Albizia gummifera

Labour input

Planting 17.8 man-days/Ha. For 0.2 Ha x 17.8 = 3.6 man days. Labour required: 3.6 man days x 4500 Tshs/man day = 16200 Tshs at constant 2012 prices. This was done in year one and after every four year.

Tending and pruning 19.6 man-days/Ha. For 0.2 x 19.6 Ha = 3.9 man days. Labour required: 3.9 man days x 4500 Tshs/man day = 17550 Tshs at constant 2012 prices. These were done in every second year and third year after planting.

Harvesting and marketing 22.6 man-days/Ha. For 0.2 Ha x 22.6 = 4.5 man days. Labour required: 4.5 man days x 4500 Tshs/man day = 20340 Tshs at constant 2012 prices. These activities were performed every fifth year after planting.

Seedling costs

Number in the mixture = 42 and proportion in the mixture was 0.4. Number/Ha was 42/0.4 = 105, For 0.2 Ha, = 105 x 0.2 = 21 trees. Considering survival rate of 85%, seedlings required were 21 x 1.15 = 24. Seedlings cost 1550 Tshs at constant 2012 prices. Seedling costs = 24 x 1550 Tshs = 37200 Tshs. This was done in the first year and after every four year.

Benefits

Albizia gummifera was mainly used as firewood in Kitete village. Therefore the benefits were estimated based on the prices of other fuelwood tree species of Tshs 2000. Average number of trees = 21 x 2000, Total benefits were Tshs 42,000. These benefits occurred every fourth year.

Livestock

Goats

Labour requirement per year was 91.25man days. Since 8 hours of full time work was equal to one man-day and time taken per day in taking care was 2 hours, (therefore 365 days in a year/8 x 2 hours per day was equivalent to 91.25 man days). Price of labour was 4500 Tshs, 4500 Tshs/man days x 91.25 man days = 410 625 Tshs. This occurs every year.

The average barn construction cost was Tshs 55 900. It occurs in year 1 and replaced in year 11.

The average barn maintenance cost was Tshs 48 500 per year, and occurs each year from year 4 to year 10 and again from year 14 to year 20.

The average cost of animals was Tshs 44,000 x 4 animals = 176,000 Tshs. This cost occurs after every 4 years.

Veterinary drugs were estimated to cost an average of Tshs 7900 per animal x 4 animals = 31600 Tshs.

Milk utensils cost 4000 Tshs. The costs occur in year 1 and in year 10 when they were to be replaced.

Benefits

Selling of kids at one year of age which costed an average of Tshs 27500 x 4 animals = 110 000 Tshs. This occurred in each year.

Price of milk cost an average of Tshs 700/ Litres and on average the amount of milk sold was 1.1 Litres. A lactation period of 185 days was used (refer section 4.5.2).

For 4 animals; 185 days x 1.1 L x 700 Tshs x 4 animals = 569,800 Tshs. This occurred in each year.

Pigs

Labour requirement per year was 91.25man days. Price of labour was 4500 Tshs, 4500 Tshs/man days x 91.25man days = 410,625 Tshs. This occurred every year.

The average barn construction cost was Tshs 54850. It occurred in year 1 and replaced in year 11.

The average barn maintenance cost was Tshs 40,000 per year, and occurs each year starting in year 4 to year 10 and again from year 14 to year 20.

The average cost of animals was Tshs 52,000 x 3 animals = 156,000 Tshs. This cost occurred after every 4 years.

Veterinary drugs were estimated to cost an average of Tshs 7850 per animal x 3 animals = 23,500 Tshs.

Benefits

The benefits include selling of sows which costed an average of Tshs 35,000. Considering survival rate of 95% and 6 piglets in each farrowing; Therefore the benefits was given as 35,000 Tshs x 3 animals x 0.95 x 6 = 598,500 Tshs. This occurred in every fifth year.

Selling of baconers at an average cost of 70,000 Tshs x 5 baconers = 350,000 Tshs. This occurred in each year.

Cows

Labour requirement per year was 91.25man days. Price of labour was 4500 Tshs, 4500 Tshs/man days x 91.25man days = 410625 Tshs. This occurred every year.

The average barn construction costs were Tshs 59,700. It occurs in year 1 and replaced in year 11.

The average barn maintenance costs were Tshs 50,600 per year and occur each year from year 4 to year 10 and again from year 14 to year 20.

The average cost of animals was Tshs 165,900 x 3 animals = 497,700 Tshs. This cost occurs after every 4 years.

Veterinary drugs were estimated to cost an average of Tshs 10,900 per animal x 3 animals = 32700 Tshs.

Milk utensils cost 4500 Tshs. The costs occur in year 1 and in year 10 when they are to be replaced.

Benefits

The benefits accrued include;

Price of milk cost an average of Tshs 800/ Litres and on average the amount of milk sold was 1.3 Litres. A lactation period of 205 days was used (refer section 4.5.2). For 3 animals; 205 days x 1.3 L x 800 Tshs x 3 animals = 639,600Tshs. This occurs in each year.

Selling of heifer which costed an average of Tshs 185,000 x 3 animals = 555,000 Tshs. This occurs after every fifth year.

Selling of bull which costed an average of Tshs 255,000 x 3 animals = 765,000Tshs. This occurs after every fifth year.

Table 31 shows summary of NPV calculation for Maize (0.5), Coconut (0.3), *Albizia gummifera* (0.2) and Livestock in Kitete village. Detailed cash flow calculations for Maize (0.5), Coconut (0.3), *Albizia gummifera* (0.2) are presented in Appendix 12 and Livestock in Appendix 13.

4.5.12 Present Value calculation for Coconut (0.3), Banana (0.5), Leucaenea leucocephala (0.2) and Livestock in Kitete village

Coconut and Livestock

Calculation for coconut and livestock refer section 4.5.11

Banana

Labour input

Planting 12.6 man-days/Ha. For 0.5 Ha, 0.5 Ha x 12.6 man-days/Ha = 6.3 man days. Labour required: 6.3 man days x 4500 Tshs/man day = 28350 Tshs at constant 2012 prices. This was done in the first year.

Tending and pruning 9.8 man-days/Ha. For 0.5Ha, 0.5Ha x 9.8 man-days/Ha = 4.9 man days. Labour required: 4.9 man days x 4500 Tshs/man-days = 22050Tshs at constant 2012 prices. These were done in every year starting from year two.

Harvesting and marketing 15.9 man-days/Ha. For 0.5 Ha, 0.5Ha x15.9 = 7.9 man days. Labour required: 7.9 man days x 4500 Tshs/man-days = 35775 Tshs at constant 2012 prices. These activities were performed every year starting from year two.

Seedling costs

Number of clumps in the mixture = 53 and proportion in the mixture was 0.3 Number/Ha was 53/0.3 = 177. For 0.5 Ha, = 177 x 0.5 = 88 clumps. Considering survival rate of 85%, seedlings required were 88 x 1.15 = 102. Seedlings cost 865 Tshs at constant 2012 prices. Seedling costs = 102 x 865 = 87869 Tshs. This occurred in the first year.

Benefits

Yield reported was 210 bunches/Ha. For 0.5 ha = 210 x 0.5 = 105 Market price at constant 2012 prices was Tshs 1900, Benefits are given as 105 x 1900 Tshs = 199500 Tshs.

Leucaenea leucocephala

Labour input

Planting 15.7 man-days/Ha. For 0.2 Ha, 0.2 Ha x 15.7 = 3.1 man days. Labour required 3.1 man days x 4500 Tshs/man-days = 13,950 Tshs at constant 2012 prices. This was done in year one and after every four year.

Tending and pruning 11.5 man-days/Ha. For 0.2 Ha, 0.2 Ha x 11.5 man-days/Ha = 2.3man days. Labour required; 2.3 man days x 4500 Tshs/man-days = 10350 Tshs at constant 2012 prices. These were done in every second year and third year after planting.

Harvesting and marketing 19.2 man-days/Ha. For 0.2 Ha, 0.2 Ha x 19.2 man-days/Ha = 3.8man days. Labour required 3.8 man days x 4500 Tshs/man-days = 17100 Tshs at constant 2012 prices. These activities were performed every fourth year after planting.

Seedling costs

Number in the mixture = 72 and proportion in the mixture was 0.4. Number/Ha was 72/0.4 = 180 trees, For 0.2 Ha, = 180 x 0.2 = 36 plants. Considering survival rate of 85%, seedlings required were 36 x 1.15 = 41. A seedling costs 820 Tshs at constant 2012 prices.

Seedling costs = 41 x 760 = 31464 Tshs. This occurred in the first year and after every fourth year.

Benefits

Leucaenea leucocephala was mainly used as fodder crop in Kitete village. Therefore the benefits were estimated from the quantities of fodder harvested from the farms and the time saved on fodder collection. It was estimated during the survey that to collect one load of animal fodder (about 40 kgs) from the farm required about 1 hour. On average, each household harvested about 2 loads of fodder (from *Leucaenea* leaves) every week. The average price for a load of animal fodder was about 500 Tshs/load. It was assumed that the production would remain at this level for the whole of the time horizon.

Therefore the benefit/year was estimated as follows:

Number of loads/week/household = 2 loads.

Number of weeks/year = 52 weeks. Thus loads/year = 104loads

104 loads/household x 500 Tshs/load = 52,000 Tshs

Time saved; The average time spent of fodder collection was about 0.6 hours/day. Since each household was getting about 2 loads of fodder/week, the time saved can be equated to 104 loads/year x 0.6 hours/load = 62.4 hours/year. Therefore; 62.4 hours is equivalent to 7.8 man days.

7.8 mandays x 4500 Tshs/man days = 35100 Tshs

Therefore, the total benefits from fodder are expected to be;

52 000 Tshs + 35100 Tshs = 87100 Tshs

These benefits occur from year three onwards.

Table 31 shows summary of NPV calculation for Coconut (0.3), Banana (0.5), *Leucaenea leucocephala* (0.2) and Livestock in Kitete village. Detailed cash flow calculations are presented in Appendix 14.

4.5.13 Present Value calculation for Maize (0.5), Mangoes (0.3), Albizia gummifera (0.2) and Livestock in Kitete village

Maize, *Albizia gummifera* and livestock

Calculation for Maize, *Albizia gummifera* and livestock refer section 4.5.11

Mangoes

Labour input

Planting 15.7 man-days/Ha. For 0.3 Ha x 15.7= 4.7 man days. Labour required: 4.7 man days x 4500 Tshs/man-days = 33300 Tshs at constant 2012 prices. This occurred in year one.

Pruning and tending 10.8 man-days/Ha. For 0.3 Ha x 10.8 = 3.2 man days. Labour required: 3.2 man days x 4500 Tshs/man-days = 14400 Tshs at constant 2012 prices. These were done each year from year two.

Harvesting and marketing 18.9 man-days/Ha. For 0.3 Ha x 18.9 = 5.7 man days. Labour required 5.7 man days x 4500 Tshs/man-days = 25650 Tshs at constant 2012 prices. These activities were performed in fourth year.

Seedling costs

Number in the mixture = 54 and proportion in the mixture was 0.6.Number/Ha was 54/0.6 = 90 For 0.3 Ha, = 90 x 0.3 = 27 trees. Considering survival rate of 85%, seedlings required were 27 x 1.15 = 31. Seedlings cost 1700 Tshs at constant 2012 prices. Seedling costs =31 x 1700 = 52700 Tshs. This occurred in the first year.

Benefits

Yield reported was 80 mangoes/tree/year. Market price at constant 2012 prices is Tshs 100. Benefits were given as 80 Tshs x 27 trees x 100 = 216,000 Tshs. The benefits accrued each year from year four.

Table 31 shows summary of NPV calculation for Maize (0.5), Mangoes (0.3), *Albizia gummifera* (0.2) and Livestock in Kitete village. Detailed cash flows calculations are presented in Appendix 15.

4.5.14 Present Value calculation for Maize (0.5), Beans (0.3), Leucaenea leucocephala (0.2) and Livestock in Kitete village

Maize, *Leucaenea leucocephala* and livestock

Calculations for maize and livestock refer section 4.5.11 and calculation for *Leucaenea leucocephala* refers section 4.5.12.

Beans (Two crops per year)

Labour input

Planting 19.7 man-days/Ha. For 0.3 Ha x 19.7 = 5.9 man days. Labour 5.9 man days x 4500 Tshs/man-days = 26595 Tshs at constant 2012 prices. This was done every year.

Harvesting and marketing 21.3 man-days/Ha. For 0.3 Ha x 21.3 = 6.4 man days. Labour required 6.4 man days x 4500 Tshs/man-days = 28755 Tshs at constant 2012 prices. These activities were performed every year.

Seedling costs

Seed rate of 34 kg/Ha (two crops per year), For 0.3ha = 34 kg/Ha x 0.3 ha = 10 kg. Market price for seed was Tshs 1200 at 2012 constant prices, 1200 Tshs/kg x 2 x 10 kg = 24000 Tshs.

Benefits

Yield reported was 600Kg/Ha. Market price at constant 2012 prices was Tshs 1600 Tshs Benefits were given as 600 Kg/Ha x 0.3 x 1600 Tshs = 288000 Tshs.

Table 31 shows summary of NPV calculation for Maize (0.5), Beans (0.3), *Leucaenea leucocephala* (0.2) and Livestock in Kitete village. Detailed cash flow calculations are presented in Appendix 16.

4.5.15 Net Present Value (NPV)

Results in Table 31 indicate that the selected agroforestry systems in the villages surveyed had positive net present value per hectare, meaning that the present worth of the benefit stream was greater than the present worth of the cost stream for each system. This implies that agroforestry systems in the surveyed villages were economically viable. The NPV was calculated on per hectare basis because land was the most scarce resource in the study area.

However Maize/Sunflower/Banana/Oranges in Peapea village had the lowest NPV compared to the rest of agroforestry systems in other villages. The possible reason for this may have been low sunflower yield which might be caused by increased bird attack, attracted by the included oranges trees. It can generally be said that, Kitete village was observed to have greater NPV than the rest of the villages which might be due to inclusion of livestock components in agroforestry system.

Table 31: Summary of the calculated NPV, BCR, IRR and Switching value of the agroforestry systems (values x 1000Tshs, at constant 2012 prices)

Agroforestry systems	NPV	BCR	IRR %	Switching value %[1] Benefits	Costs
Nyameni village					
Maize/Coconut / Grevillea robusta	2100.87	2.1	93	50	108
Rice / Coconut / Mangoes	3913.89	2.2	73	50	117
Maize / Beans / Oranges	1971.23	1.7	98	60	150
Kitete village					
Maize /Coconut /*Albizia gummifera* / Livestock	6990.04	1.4	73	28	40
Coconut / Banana /*Leucaenea leucocephala/* Livestock	6849.47	1.4	56	29	41
Maize / Mangoes /*Albizia gummifera /*Livestock	4279.31	1.2	72	19	24
Maize/ Beans /*Leucaenea leucocephala* / Livestock	3311.42	1.2	65	11	16
Peapea village					
Maize / Mangoes / Bananas	2440.99	1.9	84	48	93
Maize / Sunflower / Banana / Oranges	1381.34	1.5	83	33	50
Magomeni village					
Maize/Mangoes/*Leucaenea leucocephala*	1571.26	1.4	61	17	85
Maize / Oranges / Coconut	1596.62	1.3	47	35	54
Overall	3309.68	1.6	73	32	65

%1 Percent by which cost will have to increase or benefit will have to decrease before the systems's NPV fall to zero.

On the other hand the contribution of livestock to NPV varied noticeably on different systems in Kitete village, the inclusion of livestock component in agroforestry systems was found to contribute on average of 76.5% of the calculated NPV (Table 32). This shows that farmers without livestock in their agroforestry systems have chances of improving their income by including livestock. It was also noted that, the agroforestry system remained economically viable when livestock systems were removed (Table 32).

The BCR of the selected agroforestry systems in all villages was greater than one (Table 31), implying that all the systems are beneficial in all villages at 10% discount rate. However the highest BCR 2.2 and 2.1 was observed in Nyameni village for Rice/Coconut/Mangoes and Maize/Coconut/Grevillea robusta systems respectively. The lowest BCR 1.2 was observed in Kitete village for Maize/Beans/*Leucaenea leucocephala*/Livestock system and Maize/Mangoes/*Albizia gummifera*/Livestock system. The same trend was observed in the value of NPV within Kitete village indicating that the systems are less beneficial than the rest of the systems.

Results in Table 31 shows the maximum interest rate (IRR) for each village that agroforestry systems can pay for the resources used if the system was to recover its investment and operating expenses in twenty years time and still break even. The IRR in all the systems was much higher than the World Bank's rate of 10% indicating the worth of investing in the selected agroforestry systems in all villages.

Some studies on agroforestry projects suggest that such projects can be economically viable in using resources. In assessing the land use option in Tanzania, Mwakaje *et al.* (2010) noted the high returns of about USD 482 385 from agroforestry system compared to USD 434 761 and 337 542 for agricultural intensification and woodlot plantation, respectively. Moreover, in evaluating the economic analysis of agroforestry systems in Uluguru Mountains area in Tanzania Senkondo (1992) found that the systems were economically viable at 10% as opportunity cost of capital. The findings by Franzel (2004) revealed that agroforestry practices of improved fallows in Zambia had significant financial benefits, for example in the first year the NPV increases from $US 115 to $US 129 per hectare. The author concluded that the benefits of improved fallows could spread over a 2 to 3 year period or longer.

Table 32: Contribution of livestock in agroforestry systems NPV in Kitete village at 10% discount rate ('000 Tshs constant 2012 prices)

Agroforestry systems	NPV with livestock	NPV without livestock	% contribution of livestock
Maize /Coconut /*Albizia gummifera* / Livestock	6990.039	3765.402	64.9
Coconut / Banana /*Leucaenea leucocephala/* Livestock	6849.476	3659.636	65.2
Maize /Mangoes /*Albizia gummifera* /Livestock	4279.309	1101.847	79.5
Maize/ Beans / *Leucaenea leucocephala* / Livestock	3311.423	124.579	96.4
Average			76.5

In assessing the agroforestry system versus shifting cultivation in Viet Nam, Mai (1999) for example found that the agroforestry system had positive NPV of about 9.1 million than shifting cultivation at 10% discount rate and 10 years rotation. The author noted the BCR of agroforestry was about 6.01, twice the one of shifting cultivation and the IRR was about 86%. In India, the planting of sugarcane with poplar agrisilviculture based system was found to be economically efficient, with a BCR of about 3.0 at a discount rate of 10% and 8 year rotation (Dwivedi *et al.*, 2007).

It is therefore worth to invest in agroforestry practices in Kilosa District since the present worth of the benefit stream was greater than the present worth of the cost stream for each system in the surveyed villages. Thus agroforestry practice is economically viable in use of resources in the District.

4.5.16 Sensitivity analysis

The prices can fluctuate considerably over long time period, especially if overall output increases due to increase in agroforestry system adoption, thus reduce the farmers' benefits. This will lead to a decline in the planned NPV. To deal with these uncertainties, the present study computed sensitivity analysis by using switching values for decline in benefits as a result of decline in output prices and increase in costs as a result of changes in real prices of inputs. Switching value is the value an element of project would have to reach as a result of a change in an unfavorable direction before the project no longer meets the minimum level as indicated by NPV (when NPV drops to zero) (Senkondo, 1992).

The results as shown in table 31 indicate that the system to be economically unviable the costs have to increase by an average of 65%, when computed at 10% discount rate, holding all other factors constant. Benefits have to fall by an average of 32% before the systems become economically unviable. This implies that agroforestry systems in the surveyed villages will remain viable over a wide range of changes in costs except in terms of benefits, holding all other factors constant.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

This chapter presents conclusions and recommendations emerging from the major findings of the study.

5.1 Conclusions

The study identified two different agroforestry systems in the sampled villages. In Nyameni, Magomeni and Peapea villages the system was mainly agrosilvicultural, where the main components were trees and agricultural crops. In Kitete village agrosilvopastoral system (woody perennials, herbaceous crops and animals) was observed due to inclusion of large herd size. In all villages, mixed intercropping, boundary planting and homegardens are the various agroforestry arrangement observed. On average mixed intercropping arrangement was more common compared to other technologies in both villages.

The study also observed that the main motive that makes respondents to practice agroforestry system was to obtain fruits followed by provision of firewood. This implies that respondents appreciate the contribution of agroforestry in improving nutritional status as well as meeting the diverse needs to uplift their socio-economic status. However agroforestry systems in the sampled villages were constrained with a number of problems. The main production constrains were, inadequate land, lack of agroforestry training and education, poor extension services as well as lack of seed and seedlings.

The results show that a substantial number of respondents have a positive attitude towards commercialization. This shows that farmers objective in farming was indicated as to produce cash crops for selling in the future as a means of earning their living. Further, considerable number of respondents had a positive attitude towards land resource conservation indicating that respondents appreciate the contribution of environmental services provided by agroforestry practices. Moreover, a substantial number of respondents had a positive attitude towards land productivity.

Based on the logistic regression analysis, factors that significantly influence adoption of agroforestry practices in the study area were, farm labour force, attitude towards land productivity, attitude towards commercialization and attitude towards land resource conservation at $P < 0.05$. A change in these factors will have influence in the uptake of agroforestry practices.

The selected agroforestry systems in the sampled villages were found to be economically viable when evaluated at 10% discount rate. It is therefore worth to invest in agroforestry practices in Kilosa District since the present worth of the benefit stream was greater than the present worth of the cost stream for each system in the surveyed villages.

5.2 Recommendations

In view of the major findings of the study and the above conclusions, the following recommendations can be made.

i) Strengthening education, training and agroforestry extension programs

There is a need for the government and other development agencies to intervene by providing information and training to farmers who are ignorant of the benefits of engaging in agroforestry farming. For example information related to proper spacing of trees, which will optimise the benefits from agroforestry and reduce competition for nutrients, light and water.

ii) Improving benefits from agroforestry practices

High attitude towards agroforestry practices was found to be important in adoption of the practice. High attitude towards agroforestry practices were due to the respondents' perception that investment in agroforestry practices was associated with more benefits than costs. This suggests the need for agroforestry disseminators to improve the benefits of the practice so as to enhance high attitude towards agroforestry practices and the willingness to invest in it. Inclusion of more valuable tree species like fruits and firewood trees in the farm plot would likely make agroforestry more profitable and therefore increasingly encourage farmers to invest in it.

iii) Resolving Land tenure problem

The issue of land tenure should be solved by the village leaders so as to give room for farmers to practice agroforestry. In addition, land should be well distributed to make sure that all people have an access to land for agroforestry practices.

iv) Strengthening and improving supply of tree seedlings

The government and project interventions are needed to supply tree seedlings and promoting tree planting as well as providing technical assistance. The supply of seedlings could be improved by; increasing availability of tree seeds for seedlings production from current suppliers, enhance community in establishing group or village based tree nurseries and increasing training of individual farmers on nursery establishment and management techniques so as to enable them to establish their own nurseries to sustain year to year supply of seedlings.

v) Increasing the efficiency of agroforestry

The government and project donors should disseminate technology development in agroforestry through breeding, selection of crops and tree species for specific suitable characteristics. Characteristics such as drought tolerance, short maturity, and disease resistance should be considered. Moreover, improvements in the market for example on demand and access to markets for agroforestry products will improve the marketability of agroforestry products. In addition, establishment of rural financial institutions is important to address farmers' credit needs on loan terms with low interest rate. All these are needed so that the gain from agroforestry system can be made.

REFERENCES

Abracos, E. (2011). How bananas are grown. [http://www.bananalink.org.uk/how-bana nas-are-grown] site visited on 15/08/2013.

Adekunle, V. A. (2009). Contribution of agroforestry practice in Ondo State Nigeria to environmental sustainability and sustainable agriculture production.Federal University of Technology. *Journal ofNigeria Africa Focus* 22: 27 – 40.

Ajayi, C. O. (2007). User acceptability of sustainable soil fertility technologies: Lessons from farmers' knowledge, attitude and practice in Southern Africa. *Journal of Sustainable Agriculture* 30 (3): 21 – 40.

Better, D. R. (1988). Planning optimal economic strategies for Agroforestry systems. *Journal of Agroforestry Systems* 7: 17 – 31.

Blandon P. (1985). Agroforestry and Portfolio Theory. *Journal of Agroforestry Systems* 3: 149 – 239.

Body, H.K., Westfall, P. and Stasch, S.F. (1981), cited by Ishengoma G. C. (2002). Accessibility of Resources by Gender: The Case of Morogoro region in Tanzania. In: Gender, Justice, Citizenship and Development. (Eds.) Mukhopadhyay, M. and Singh, N. Paper presented at CODESRIA conference on African Gender in the New Millenium, Cairo, April 2002. 354pp.

Buake, M.S. (2005). Socio-Economic Factors Influencing Agroforestry Practices in the BekwaiForest District of Ghana; A Thesis for the award of Master of Philosophy Degree at University of Cape Coast, pp. 16-30.

Buyinza, M. and Naagula, A. (2009). Predictors of Agroforestry Technology Adoption and Land Conservation Strategies in the Highlands of South Western, Uganda. *Online Journal of Earth Sciences*, 3(2): 46-55.

Cacho, O. and Hean, R. (2004). *Dynamic Optimization* for *Evaluating Externalities in Agroforestry Systems*. In: Alavalapati, J. R. R. and Mercer, E. D. (Eds), Valuing Agroforestry systems, methods and applications. Kluwer Academic Publishers, Netherlands, pp. 139 – 163.

Cary, J. W. and Wilkinson, R. L. (1997). Perceived profitability and farmers' conservation behavior. *Journal of Agricultural Economics* 48(1): 31 – 21.

Clean Development Mechanism (CDM), (2009). Reforestation in grassland in Kilombero andMufindi,Tanzania.[http://www.greenresources.no/Portals/0/Carbon/Final%20 VCS%20PDD%20ufpmfp.pdf] site visited on 24/07/2013.

Dykstra, P. D. (1984). Mathematical programming for natural resource management. McGraw-Hill, New York. 318pp.

Dwivedi, R. P., Kareemulla, K., Singh, R., Rizvi, R. H. and Chauhan, J. (2007). Socio-economic analysis of agroforestry systems in Western Uttar Pradesh.*Indian Journal of Research Extension Education* 7(3): 18 – 22.

Enete, A. A. and Amusa, A. T. (2010). *Determinants of Women's Contribution to Farming Decisions in Cocoa Based Agroforestry Households.* Field Actions Science Reports No. 4. Ekiti State, Nigeria. 5pp.

FAO (2005). *State of the Worlds Forests Realizing the Economic Benefits of Agroforestry:* Experiences lessons and challenges. Part II Selected current issues in the Forest Sector, Rome, Italy. 97pp.

Filius, A.M. (1983). Economics aspects of agroforestry.*Agroforestry Systems* 1(1): 29 – 39.

Franzel, S. (2004). *Financial Analysis of Agroforestry Practices: Fodder Shrubs in Kenya, Woodlots in Tanzania and Improved Fallows in Zambia.* In: Alavapati, J.R.R. and Mercer, D. E. (Eds.), Valuing Agroforestry Systems. Kluwer Academic Publishers, Dordrecht, The Netherlands. pp. 1-38.

Gama, B. M., Matata, P., Otsyina, R. M., Kitalyi, A. and Nyadzi, G. I. (2012). *Contribution of Agroforestry to Natural Resources Management, Food Security and Climate Change Mitigation*.Millennium Village Project, UNDP, Third RUFORUM Biennial Meeting, Tabora, Tanzania. 2139pp.

Gao, J. (2012). Residents perceptions of agroforestry landscapes: Implications for agritourism. Dissertation for Award of MSc Degree at University of Missouri, pp. 60- 82.

Gillah, K. A., Kifaro, G. C. and Madsen, J. (2012). Urban and peri urban dairy farming in East Africa: A review on production levels, constraints and opportunities. *Livestock Research for Rural Development* Volume 24 Article No.198. [www.Irrd.org/Irrd24/11/gill24198.htm] site visited on 12/09/2013.

Hanes, N. and Lundberg, S. (2008). E-learning as a Regional Policy Tool: Principles for a Cost-benefit Analysis. [http://rusc.uoc.edu] site visited on 13/3/2013.

Hardaker, J. B., Huirne, R. B. M. and Anderson, J. R. (1997). *Coping with Risk in Agriculture.*Wallingford, UK: CAB International, 274pp.

Hazell, P., Poulton, C., Wiggins, S. and Dorward, A. (2007). *The Future of Small Farms for Poverty Reduction and Growth*. Discussion Paper No. 42. International Food Policy Research Institute, Washington, DC. 38pp.

Hess, S., Beukering, V. P., Kayharara, G., Geofrey, V. and Haider, W. (2008). *Livelihoods in the Uluguru Mountains of Tanzania:* Survey report and choice model. Institute for Environmental Studies (IVM), Vrije Universiteit Amsterdam, The Netherlands. 90pp.

Hosmer, D. W. and Lemeshow, S. (2000). *Applied Logistic Regression.* (Second Ed.), John Wiley and Sons, Inc., New York. 392pp.

Hussain, T., Sarwar, K. G., Ali Khan, S., Masood, N., Ashfaq, M. and Sarwer, N. (2012). Farmers' agro forestry in Pakistan, farmers' role-trends and attitudes. *Journal of Social Sciences* 4(1): 29 – 35.

Irshad, M., Khan, A., Inoue, M., Ashraf, M. and Sher, H. (2011). Identifying factors affecting agroforestry system in Swat, Pakistan. *African Journal of Agricultural Research* 6(11): 2586 – 2593.

Kabwe, G. (2010). Uptake of agroforestry technologies among smallholder farmers in Zambia. Thesis for Award of PhD Degree at Lincoln University, 234pp.

Kalaba, F. K., Chirwa, P., Syampungani, S., Oluyede, C. and Ajayi. T. T. (2010). *Contribution of Agroforestry to Biodiversity and Livelihoods Improvement in Rural Communities of Southern African Regions*. Tropical Rainforests and Agroforests under Global Change, Environmental Science and Engineering, Springer Verlag, Berlin Heidelberg. pp. 461 – 476.

Kalabisova, J. and Kristkova, Z. (2010). Valuing socio economic factors of farmers' households and economic effects of agroforestry system. *Economics and Informatics* 2(4): 1 – 22.

Kalineza, H. M., Mdoe, N. S. Y. and Mlozi, M. R. S. (1999). *Factors Influencing Adoption of Soil Conservation Technologies in Tanzania*: A Case Study in Gairo. Sokoine University of Agriculture, Morogoro, Tanzania. pp. 76 – 84.

Kessy, J. F. (1993). *The Economics of Rehabilitating Denuded Areas in Tanzania*.The Case of Legho Mulo Project, Moshi, Tanzania. 140pp.

Khanal, S. (2011). Contribution of agroforestry in biodiversity conservation and rural needs fulfillment. A Case Study from Kaski District. Dissertation for Award of MSc Degree at Tribhuvan University Institute of Forestry Pokhara, Nepal. 82pp.

Kitalyi, A., Otsyina, R., Wambugu, C. and Kimaro, D. (2013). *Characterisation of Global Heritage Agroforestry Systems in Tanzania and Kenya Agro Forestry and Development Alternatives*. Tanzania. 76pp.

Kofi, F. A., Joyce, A., Rose, D. A., Mensah, K. A., Samuel, A., Agyei, E. B., Nyarko, A. O. and Parahoe, M. (2003). *The Potential and Constraints of Agroforestry in Forest Fringe Communities of the Asunafo District Ghana.*[http://www.tropenbos.org/file.php/297/agroforestry.pdf] site visited on 14/9/2013.

Kwayu, J. E., Sallu, M. S. and Paavola, J. (2013). *Farmer participation in the Equitable Payments Watershed Services in Morogoro, Tanzania.* Paper No. 42. Sustainability Research Institute, Morogoro, Tanzania. 38pp.

Kweka, D. (2004). *The Role of Local Knowledge and Institutions in the Conservation of Forest Resources in the East Usambara.* Young Scientist Programme, UNESCO, Biosphere. 33pp.

Lambert, O. and Ozioma, F.A. (2011). Adoption of Improved Agroforestry Technologies among Contact Farmers in Imo State, Nigeria" Asian Journal of Agriculture and Rural Development 2(1): 1-9.

Leakey, R. R. B. (1996). Definition of agroforestry revisited. *Agroforestry Today* 8(1): 5 – 7.

Lilieholm, R. J. and Reeves, L. H. (1996). Incorporating economic risk aversion in agroforestry. *Agroforestry Systems* 13: 63 – 71.

Lulandala, L.L.L. (2011). *Guideline for Putting Agroforestry High on the Development Policy Agenda in Tanzania.*FAO Project on Sustainable Forest Management in a Changing Climate, Tanzania. 18pp.

Magayane, F. T. (1995). Farmers' adaptive effort to soil erosion and land productivity decline: The Case of Uluguru Mountains Tanzania. Thesis for Award of PhD Degree at University of Illinois, Urbana Champaign, pp. 18-103.

Mai, T. P. (1999). Socio-economic analysis of shifting cultivation versus agroforestry system in the upper stream of lower Mekong Watershed in Dak Lak Province. Thesis for Award of PhD Degree at National University Hcmc College of Economics Vietnam, pp. 1- 62.

Mbwambo, J. S., Saruni, P. L. and Massawe, G. S. (2013). Agroforestry as a solution to poverty in rural Tanzania.Lessons fromMusoma Rural District, Mara Region, Tanzania. *Kivukoni Journal* 1(2): 15-30.

Meghan, M. M., Swisher, E. and Alavalapati, J. (2008). Agroforestry adoption and maintenance: Self-efficacy attitudes and socio-economic factors. *Agroforestry System* 73: 99 – 108.

Mercer, D. F. and Miller, R. P. (1998).“Socioeconomic Research in Agroforestry Progress, Prospects and Priorities”, *Agroforestry Systems* 5:177-93.

Morton, J. F. and Miami, F. L. (1987). Mangifera indica In: Fruits of warm climates [http://www.hort.purdue.edu/newcrop/morton/mango_ars.html] site visited on 21/8/2013.

Muneer, S. (2008). Factors affecting adoption of agroforestry farming system as a mean for sustainable agricultural development and environment conservation in Arid Areas of Northern Kordofan State, Sudan.*Journal of Biological Sciences* 15(1): 1 – 24.

Mwakaje, A. G., Kahyarara, G., Mung'ong'o, C. G. and Kauzeni, A. (2010). *The Potential of Reducing Emissions from Deforestation and Degradation REDD for Rural Development in Tanzania:* Cases From Babati, Hai and Kilosa Districts Final Report No. 2. Tanzania, 84pp.

Nair, P. K. R. (1990). *The Prospects for Agroforestry in the Tropics.* Technical Paper No. 131.World Bank, Washington, DC, USA, 77pp.

Neupane, P. R., Sharma, R.K. and Thapa, B. G. (2002). Adoption of agroforestry in the hills of Nepal: A logistic regression analysis. *Agricultural Systems* 72: 177–196.

Nkonya, E., Schroeder, T. and Norman, D. (1997). Factors affecting adoption of improved maize seed and fertilizer in Northern Tanzania. *Journal of Agricultural Economics* 48(1): 1 – 12.

Oino, P. and Mugure, A. (2013). Farmer oriented factors that influence adoption of agroforestry practices in Kenya: Experiences from Nambale District, Busia County. *International Journal of Science and Research* 2: 450 – 456.

Orwa, C., Mutua, A., Kindt, R., Jamnadass, R. and Simons, A. (2009). Agroforestry tree Database. [http://www.worldagroforestry.org/af/treedb/] site visited on 11/8/ 2013.

Pallant, J. (2007). *The Outline of Factor Analysis and the Utilised SPSS Practice:* A step by step guide to data analysis using SPSS for windows. (3rd Ed.), Open University Press, Maidenhead. 15pp.

Parwada, C., Gadzirayi, C. T., Muriritirwa, W. T. and Mwenye, D. (2010). Adoption of agroforestry technologies among smallholder farmers: A case of Zimbabwe. *Journal of Development and Agricultural Economics* 2(10): 351 – 358.

Place, F., Adato, M., Hebinck, P. and Omas, M. (2005). *The Impact of Agroforestry-Based Soil Fertility Replenishment Practices on the Poor in Western Kenya.* Research Report No. 142. IFPRI, New York. 166pp.

Ray, G. L. (2001). *Extension Communication and Management*. Naya Prokash. pp. 145 – 162.

Rodgers, E. M. (1962). *Diffusion of Innovations*. Free Press, Glencoe. New York. 367pp.

Rogers, E.M. (1995). *Diffusion of Innovations* (4thEd.), The Free Press, New York, USA. 519 pp.

Rogers, E. M. (2003). *Diffusion of Innovations.*(Fifth Ed.), The Free Press, New York. 500pp.

Senkondo, E. M. M. (1996). The use of linear programming in planning smallholder agroforestry strategies. The case of Uluguru Mountains, Tanzania. *Eastern Africa Social Science Research Review* 12(2): 25 – 36.

Senkondo, E. M. M. (2000). *Risk Attitude and Perception in Agroforestry Decisions in Tanzania*. Mansholt Studies No. 17. Wageningen. 213 pp.

Senkondo, E. M. M., Msangi, A. S. K., Xavery, P., Lazaro, E. A. and Hatibu, N. (2004). Profitability of rainwater harvesting for agricultural production in selected semi-arid areas of Tanzania. *Journal of Applied Irrigation Sciences* 39 (1): 1 – 15.

Senkondo, E. M. M. (1992). Farming System analysis of alternative Agroforestry Systems in Tanzania: The case of Uluguru Mountains Area, Morogoro. Thesis for Award of MSc Degree at University of Norway, pp. 45 – 51.

Senkondo, E. M. M., Mdoe, N. S. Y., Hatibu, N., Mahoo, H. and Gowing, J. (1998). Factors affecting the adoption of rain water harvesting technologies in Western Pare Lowlands of Tanzania. *Journal of Agriculture Science* 1(1): 81 – 89.

Senkondo, E. M. M., Mlangwa, J. E. D., Mdoe, N. S. Y. and Turuka, F. M. (2011). Determinants of demand for private veterinary services in Tanzania. *Journal of Agricultural Economics and Development* 8: 14 – 38.

Simon, M. M., Mdoe, N. S. Y. and Senkondo, E. M. M. (2011). Adoption of rotational woodlot technologies in Semi-Arid Areas of Tanzania.The Case of Tabora Region. *Journal of Agricultural Economics and Development* 8: 107 – 128.

Singh, V.S. and Pandey, D. N. (2011). *Multifunctional Agroforestry Systems in India: Science Based Policy Options Climate Change and CDM Cell Rajasthan State Pollution Control Board.* Occasional Paper No. 4. RSPCB, India. 33 pp.

Tabachnick, B. G. and Fidell, L. S. (2007). *Using Multivariate Statistics*. (5th Ed.), Pearson Education, Boston. 1024pp.

Thangata, P. H. and Alavalapati, J. R. R. (2003). Agroforestry adoption in southern Malawi: the case of mixed intercropping of Gliricidia sepium and maize. Southern economics Forestry Workshop, Malawi, 18-20 Aprial, 1999. 71pp.

Umeh, G. N. (2012). Distribution of agroforestry species in the Southeast Nigeria. *Journal of Agricultural Science* 4(3): 271 – 274.

Urbauer, T (2013). How long does a sunflower seed need to grow? [http://www.ehow.com/facts_7182776_long-sunflower-seed-need-grow_.html] site visited on 22/9/2013.

URT (2006).National population policy, Ministry of Planning, economy and empowerment. [http://www.tanzania.go.tz/pdf/Idadi%20Eng.pdf] site visited on 13/9/2013.

URT (2011). Ministry of Livestock and Fisheries Development. Investment Opportunities Livestock industry. [http://www.mifugo.go.tz/ documents_storage/Livestock%20 Investment%20Opportunities.pdf] site visited on 22/9/2013.

URT (2012). *Population and Housing Census by Sex and Number of Households*. Tanzania. [http://www.nbs.go.tz/sensa/popu2.php] site visited on 15/9/2013.

Valentin, M., Marius, P., Andrei, P. and Delia, G. (2009). Methodological Approaches in Realizing and Applying Cost Benefit Analysis for the Investment Projects. *Journal of Annals of the University of Oradea. Economic Science* 2(1): 156-162.

Wahl, N., Jamnadass, R., Baur, H., Munster, C. and Liyama, M. (2009). *Economic Viability of Jatropha CurcasL. Plantations in Northern Tanzania Assessing Farmers Prospects via Cost-benefit Analysis*. ICRAF Working Paper No. 97. World Agroforestry Centre, Nairobi, Kenya. 62pp.

Wijayanto, N. (2011). Species identification and selection to develop agroforestry at Lake Toba Catchment Area.*Biodiversitas Journal* 12(1): 52 – 58.

Wise, M. R. and Cacho, O. J. (2002). Tree-crop interactions and their environmental and economic implications in the presence of carbon sequestration payments**.** Working Paper CC11, ACIAR Project ASE England. [http://www. une. edu.au/febl/Economics/carbon/] site visited on 12/3/2013.

World Bank (2010). Looking for a world free of poverty. [http://data.worldbank.org/ indicator/FR.INR.LEND] site visited on 31/03/2013.

APPENDICES

Appendix 1: Household Questionnaire

A. General Identification Variables

Date.......................... Region…………….... District........................

Village name...................Ward......................... Division……………..

B. General Household Head Information

1. Name...................................

2. Age of the head of household............. years.

3. Gender of the head of household 1 = Male 2 = Female………. [ ]

4. Marital Status 1. Unmarried 2. Widower 3. Married 4. Divorced [ ]

5. Ethnic groups of the household: 1. Kaguru 2. Sagara 3. Vidunda [ ] 5. Others (specify)……………………..

6. How many years did you spend to school of the following level of education

i) Primary education ……………….. (years)

ii) Secondary education ……………….. (years)

iii) University ……………………….. (years)

iv) Informal education……………….. (years)

v) Adult education……………….. (years)

vi) Others (specify)…………………..

7. Households composition

How many people regularly live in this household…………….

Household age groups	**Number**	**Number of people working in the farm**	**If part time indicate months worked**
Infants 0-5 years			
Children 6-10 years			
Youth 11-17 years			
Adult male 18 -60 years			
Adult female 18 -60 years			
Over 60 years (older)			

8. What are your main sources of labour force?

1) Family 2) Hired 3) Both [ ] Number if hired…………………..

9. Occupation of the head of the household (circle)

   1. Livestock farmer
   2. Mixed farmer
   3. Wage employment
   4. Typical farmer
   5. Off farm income generating activities (not employment)
   6. Others (specify)…………………………..

10. Are you a member of any farmer group association? 1. Yes 2. No [ ]

    If yes give the name……………………………….

11. Are you regularly participating in any agroforestry training/meetings?

1. Yes 2. No [ ]

If yes, what are the changes after getting training?

……..…………………………………………………………

Land availability and use

12. Give the total land owned by your household…………………….. (acres)

13. Ownership of the land; 1. Own………. 2. Rented……… 3. Borrowed……… [ ]

14. If rented/borrowed for how long…………..years

15. If rented/borrowed who owns it…………… his/her residence……………….

16. If is a rented one how much did you pay per plot………………………Tsh

17. If rented/borrowed would planting of perennial crops change the ownership? 1. Yes 2. No [ ]

Comment on this; Answer………………………………………………………….

18. How many acres of cultivated land do you have? (field devoted to agroforestry)

Plot number	**Location**	**Crops grown**	**Total area (acres)**	**Estimated distance from household**
1				
2				
Total				

19. Can you get more land for cultivation if you wish? 1.Yes 2. No [ ]

If yes how?..

20. What activities are going to be given priority if additional land is made available?

Activity	**Rank 1 first priority**
1.Maize production	
1.Rice production	
2.Beans production	
3. Sweet potatoes production	
4. Coconut production	
5. Sunflower production	
6. Fruit trees production	
7. Livestock production	
9. Agroforestry practices	
10. Others (specify)………….	

INFORMATION ON TREE COMPONENTS AND AGROFORESRTY PRACTICES

21. Who collects firewood: 1. Women 2. Men 3. Children [ ]

22. Where do you get firewood ………………….., estimated distance………..km

23. How often do they collect firewood?..................... per week

24. Do you buy firewood or charcoal? 1.Yes 2. No [ ]

25. If yes at what price? Tshs………. per bundle of firewood , Tshs………per sack/bag of charcoal

26. Are you aware about agroforestry 1. Yes 2. No [ ]

27. Do you practice agroforestry 1. Yes 2. No [ ]

28. Do you practiceagroforestry continuously? For how many years?................... years

29. What kinds of trees are planted in your farm and how many?

Plot	**Name of tree**	**Number per acre**	**Function/Use**	**Total number**
1				
2				
Total				

NOTES: For function, use the following Key and can put more than one entry. Circle the entry. Fuelwood = 1, Fodder = 2 , Fruits = 3 Timber and poles = 4, Fence = 5, Boundary = 6, Shade=7, Windbreak = 8, Fodder banks = 9, Soil erosion control = 10, Soil fertility and food security =11, Traditional = 12, Religious = 13, Others specify and give a number

30. Are there naturally growing trees in your farm which you manage and harvest?

    1. Yes 2. No [ ]

If yes describe its uses………………………………………………………………

31. What are the costs of planting trees per acres?.................................. Tshs

32. Biotic components (systems) and arrangement (technologies) of agroforestry

Plot number	Ownership	Components	Arrangement
1			
2			

FARMERS' ATTITUDES TOWARDS AGROFORESTRY

33. Circle one number based on whether you strongly agree (SA), agree (A), Undecided (UD), disagree (DA), strongly disagree (SD) with the statement.

Statement	SA	A	UD	D	SD
1. I worry that the land will not produce much when tree are on farm	5	4	3	2	1
2. Reduce chance of complete crop failure (Increase crops yield)	5	4	3	2	1
3. Trees on farm have no effects on crop yield	5	4	3	2	1
4. If I keep trees on farm crop yield decrease	5	4	3	2	1
5.Frequent change in crops prices is the biggest problem for my income	5	4	3	2	1
6. The most important thing for a farm household is to grow all its own food requirement	5	4	3	2	1
7. Planting trees on farms increase soil fertility	5	4	3	2	1
8. Planting trees on farm make the land having low soil fertility	5	4	3	2	1
9.Maintained/ improved surrounding condition of the forests	5	4	3	2	1
10. Inspite of having trees on farm the condition of the forests is not maintained	5	4	3	2	1
11. Trees on farm reduce surface runoff	5	4	3	2	1
12. Planting trees on farm is more efficient land use	5	4	3	2	1
13. Increase opportunity of extra cash income from selling of agroforestry seeds	5	4	3	2	1

14. If there is an opportunity to make extra money I will use it	5	4	3	2	1
15. It took long time to get income	5	4	3	2	1
16. Trees on farm increase sale of farm produce	5	4	3	2	1
17. Information on produce price helps me decide on what to produce for sale	5	4	3	2	1
18. Reduce cost of inputs (like fertilizer)	5	4	3	2	1
19. Reduction of risks associate with growing crops alone on the farm	5	4	3	2	1
20. Trees on farm provide good building materials like timber for selling	5	4	3	2	1
21. Trees on farm provide good building materials like poles for selling	5	4	3	2	1
22. The way we are farming now is fine and it can last for ever	5	4	3	2	1
23. If I keep farming like this I will exhaust the land	5	4	3	2	1
24. In order to make money I have to do something that are not good for the soil	5	4	3	2	1
25. Trees on farm help to conserve water	5	4	3	2	1
26. Trees on farm help to conserve soil	5	4	3	2	1
27. If I had more labour in my family I could grow more trees on farm	5	4	3	2	1
28. Growing as many trees on farm is the best I can do on this farm although there is shortage of labour	5	4	3	2	1
29. Everything I do is to make sure the farm gets better all the time	5	4	3	2	1
30. I like to try new things even if I sometimes loose money on it	5	4	3	2	1
31. We need to preserve the way our parents farmed	5	4	3	2	1
32. We always try new things in our farm like agoforestry practice	5	4	3	2	1
33. I will continue to grow more and more trees on the farm	5	4	3	2	1
34. I worry that planting more trees in the future the land will not produce much	5	4	3	2	1
35. I will establish more forests nursery to ensure that trees are available on the farm	5	4	3	2	1
36. We need to make changes in our farming practices for the benefit of the future Generation	5	4	3	2	1
37. To protect the farm for our children we need to stop agroforestry practices	5	4	3	2	1

34. How do you finance your farming activities/ source of loan / credit?

i) Bank

ii) Money lenders

iii) Personal saving

iv) Family member support

v) Cooperatives

vi) Others (specify)…………………………………………..

35. Do you sell any agroforestry products in the market? 1. Yes 2. No [ ] If yes, what is the selling price ?

Agroforestry products	**Quantity**	**Selling price**	**Comments on output**
Firewood			
Charcoal			
Fodder			

Timber			
Fruits			
Medicine			
Others (specify)			

36. Do you sell any food or cash crops in the market? 1. Yes 2. No [ ] If yes, what isthe is the yield and the selling price?

Food / Cash crop	**Yield per year**	**Selling price**	**Comments on yields/output**
Maize			
Rice			
Beans			
Sweet potatoes			
Cassava			
Sunflower			
Coconut			
Others (specify)			
Total			

Livestock information

37. Do you purchase livestock 1. Yes 2. No [ ], If yes, indicate the following

Typeof livestock	**Number**	**Purchase price**

38. Do you use fodder trees in feeding your livestock Yes = 1 No =2 [ ]

39. How do you keep your cattle (tick)

1. Zero grazing 2. Semi grazing 3. Open grazing 4. Communal grazing 5. Others (Specify)

40. If yes, please name tree species you use in feeding your livestock

Tress species	**Type of livestock**

Note: Please indicate whether you feed them together

41. Indicate labour use per month and time spent infeeding/ looking after livestock

Type of livestock	**Type of labour used** 1. Family 2. Hired 3. Communal	**Gender** 1.Male 2. Female 3. Both	**Number of people**	**Time taken/day**	**Price of labour (Ths/month)**
Cattle					
Goats					
Pigs					
Chicken					
Others (specify)					

42. How much do you spend in the following

	Amount (Tshs)	When constructed	Expected life	Maintenance cost
Goats house				
Pigs house				
Cattle house				
Others (specify)				

43. Please indicate inputs purchased for livestock

Type of livestock	Inputs	Amount used	Price/unit)

44. Livestock and livestock products

Plot number/name	Products	Amount produced	Amount consumed	Amount sold	Price/unit)
1.	Milk				
2.	Dam				
3.	Kid				
Others (specify)					

Farm machinery and equipment

45. What kind of farm machinery/tool/equipment do you own?

Machinery/tool/equipment	Number	Initial price	Year of purchase

Labour for farm work and purchased inputs

46. Is there any period with critical labour shortage 1. Yes 2.No [ ]

47. If yes which months of the year 1. …………………… 2. ………………

48. Labour use and time of operations (**NOTE**: Put F if done by female, M if male and B if both).

Plot number/name	**Operation**	**Month**	**Days/hours**	**M, F or B**
1	Land preparation Planting Weeding Pruning			
2				
3				

49. Is your household labour able to accomplish all the above itemized farming activities especially in critical labour demand periods. 1. Yes 2. No [ ]

50. If no, what do you do to solve the problem of shortage of household labour in those periods

1. Use hired labour, 2. Leave some planted area unattended, 3. Increase working hours (give hours increased) ………………….., 4. Others (specify)………………..……… [ ]

51. If hired labour is used, indicate activities, number of people and labour price

Labour type	**Activities done (use key)**	**Number of people**	**Price of labour (Ths/ acre)**	**Give the total workdone (acre) by hired labour**	**Type of crop**
Hired labour					

Key: 1. Land preparation 2. Spraying 3. Cultivation/ ploughing 4. Sowing/planting/transplanting 6.Weeding 7. Fertilizer application 8. Pruning, 9. Harvesting and processing 10.Storage, 11.Marketing 12. Irrigation 13.Others (specify)…………….

52. If you pay them in kind explain**……………………………………………………..**
53. Source of seed and seedlings

Component	**Crops/trees**	**Source**	**Quantity used per acre**	**Price/Kg or seedling**

54. Fertilizer and other purchased inputs use

Crop	**Fertilizer/herbicide type**	**Quantity**	**Price/kg**

55. Purchased inputs for livestock including feeds and drugs

Livestock type	**Purchased input**	**Quantity**	**Price/unit or payment**

General questions

56. Which year did you get the first information on Agroforestry?........................... year
57. Who gave you that information?
    1. Village leaders 2. Extensionist 3. Fellow friends 4. Others (specify)……………….

52. Do you know any existing agroforestry programme in your area ? a) Yes b) No ( )

If yes, which one ? ....

53. What is your opinion about it ? ....

54. Do you get advice from extension workers 1. Yes 2. No [ ]

If yes, what is their frequency visit …………………………..per month/week/year

55. What are the motivating factors that make you to practice Agroforestry? (mention)

1. ……………… 2. ……………… 3. …………… 4. ……………………

56. What are limiting factors that hinder you to plant many trees? (mention)

1. ……………… 2. ……………… 3. ………………………… 4. …………..

57. Do you have either of the following indigenous agroforestry tree species in your farm? (circle) 1. *Lonchocarpus capassa* 2. *Vitex keniensis,* 3. *Pseudolachnostylis maprouneifolia,* 4. *Lannea schimperi* 5. *Combretum adenogonium*

58. What are the reasons for planting or retaining the mentioned trees?

……………………………………………………………………………..

59. If you have not been planting or retaining either of the mentioned trees give reasons?

....

60. Do you have a nursery 1. Yes 2. No [ ]

If yes, how do you raise it? ....

61. Do you participate in any nursery activities? 1. Yes 2. No [ ]

62. Do you train fellow farmers on issues related to nursery activities?

1. Yes 2. No [ ]

Appendix 2: Checklist of Probe Questions for Key Informants

1. When did agroforestry start in this village? ....

2. Can you mention different institutions that could contribute in developing agroforestry practices in this village?

3. How many people are using it? …………………………..

4. Do they like it? ....

5. Which tree species are common in the agroforestry found in this village?

6. What are the rotation ages for the tree species of the agroforestry in this village?

7. What are the prices of timber per cubic metre?

8. What are the best suited combination of trees and crops in this village? 1)………………2)…………………3)…………………4)……………………………

9. Give reasons for their suitability…………………………………………………..

10. What are the problems related to agroforestry practices?

11. What would you recommend to the government so as to enhance technology transfer and subsequent adoption in the district?

Appendix 3: Dominant Agroforestry Mixtures in the Surveyed Villages

Agroforestry mixture in Magomeni	**Percent**
Maize/ *Mangifera indica* /*Leucaenea leucocephala*	14.3
Coconut / Maize /*Citrus cinensis* / *Eucalyptus spp*	3.3
Maize/*Citrus cinensis*/Coconut	18.7
Maize /*Acacia polyacantha*/Simsim	3.3
Maize /*Mangifera indica* /Coconut /*Pterocarpus angolensis*	3.3
Maize / *Mangifera indica* / Pigeon peas /Sugar cane / Cassava	3.3
Maize / *Milicia excels*	3.3
Maize / Simsim/ Sunflower / *Lonchocarpus capassa*	3.3
Maize /*Citrus cinensis* /*Mangifera indica*	3.3
Maize/ Beans / *Albizia gummifera*	3.3
Maize/Coconut / Banana	10.3
Maize/*Albizia gummifera* / *Acacia polyacantha*	3.3
Maize/Coconut /*Mangifera indica*	3.3
Maize/*Flueggea virosa* / *Senna siamea*	3.3
Non adopters	20.0
Total	**100.0**

Agroforestry mixture in Nyameni village	**Percent**
Maize/ Coconut/*Grevillea robusta*	23.3
Maize / Simsim / Pigeon peas / Cassava/ *Mangifera indica*	3.3
Maize/ Banana / *Mangifera indica*	3.3
Maize/ Banana / *Mangifera indica* / *Citrus sinensis* / Sugar cane	3.3
Maize/ Banana /Pigeon peas /Cow pea /*Senna siamea*	3.3
Maize /Banana/ Pigeon peas /Cow pea /Coconut / Sugar cane/ *Senna siamea*	3.3
Maize / Banana / Pineapple / *Mangifera indica* /Sugar cane	3.3
Maize /Banana / Sugar cane / Coconut	3.3
Maize / *Citrus sinensis* / Bananas	13.3
Rice /Coconut / *Mangifera indica*	16.7
Maize / *Citrus sinensis* /Beans	20.0
Non adopters	3.3
Total	**100.0**

Agroforestry mixture in Peapea village	Percent
Maize /*Stereospermum kunthianum* /*Tamarindus indica*	3.3
Banana / Maize / Coconut / *Mangifera indica*	3.3
Coconut / *Mangifera indica* / *Elaeis guineense*	3.3
Maize /*Mangifera indica* /Banana	20.0
Maize /*Acacia polyacantha* /*Leucaenea leucocephala*	3.3
Maize /Banana/ *Mangifera indica* /*Elaeis guineense* / Coconut	3.3
Maize / Coconut / *Citrus limonia*	3.3
Maize / *Lonchocarpus capassa*/ *Acacia Senegal*	3.3
Maize/Pigeon peas /*Lonchocarpus capassa*/ Coconut	3.3
Maize/ Rice/ Cassava / *Annona senegalensis*	3.3
Maize / Simsim / *Acacia polyacantha* / *Senna siamea*	3.3
Maize / Sunflower / *Citrus cinensis/* Banana	22.0
Maize / Sunflower /*Citrus cinensis*	4.7
Maize / Sunflower /Pigeon peas/*Leucaenealeucocephala*	6.7
Maize/ Sunflower /*Stereospermum kunthianum* / *Lonchocarpus capassa*	3.3
Maize /Sunflower/*Citrus sinensis*	10.0
Total	**100.0**

Agroforestry mixture in Kitete village	Percent
Banana / *Leucaenea leucocephala* /Coconut	3.3
Banana / *Citrus limonia* /Coconut/ *Flueggea virosa*	3.3
Maize / /Beans/ *Leucaenealeucocephala /Livestock*	13.3
Maize /Rice/ *Acacia polyacantha/ Pentas pururea*	3.3
Maize/ Pigeon peas /*Lannea schimperi* /*Senna siamea*	3.3
Maize / Banana / Sunflower /Cow pea / Coconut /*Lonchocarpus capassa* / *Flueggea virosa*	3.3
Maize /Coconut / *Albizia gummifera/Livestock*	13.2
Maize / *Mangifera indica* /*Albizia gummifera/Livestock*	20.0
Maize /Pigeon peas /*Mangifera indica/ Pentas pururea*	3.3
Maize/ Simsim / *Lonchocarpus capassa*	3.3
Maize /Simsim /Bananas/*Senna siamea/ Pentas pururea*	3.3
Maize/ Simsim/ Sunflower / *Acasia polyacantha*	3.3
Maize /Simsim /*Lonchocarpus capassa* / *Cedrella odorata*/*Flueggeavirosa*	3.3
Bananas/ Coconut / *Leucaenealeucocephala/Livestock*	16.7
Non adopters	3.3
Total	**100.0**

Appendix 4: Attitudinal Statements towards Agroforestry Practices

Statements/Items towards Land Productivity

T1- I worry that the land will not produce much when tree are on farm

T2 - Reduce chance of complete crop failure (Increase crops yield)

T3-Trees on farm have no effects on crop yield

T4- If I keep trees on farm crop yield decrease

T5 - Planting trees on farms increase soil fertility

T6- Planting trees on farm make the land having low fertility

T7 - I worry that planting more trees in the future the land will not produce much

Statements/Items towards Commercialization

T8- Increase opportunity of extra cash income from selling of agroforestry seeds

T9- If there is an opportunity to make extra money I will use it

T10- It took long time to get income

T11- In the future we will grow more crops for sale

T12 - Growing as many crops for sale is the best I can do

T13- Trees on farm increase sale of farm produce

T14- Information on produce price helps me decide on what to produce for sale

T15- Reduce cost of inputs (like fertilizer)

T16- Trees on farm provide good building materials like timber for selling

T17- The most important thing for a farm household is to grow all its own food requirement

T18- Frequent change in crops prices is the biggest problem for my income

Statements/Items towards Land Resource Conservation

T19 - The way we are farming now is fine and it can last for ever

T20- If I keep farming like this I will exhaust the land

T21- In order to make money I have to do something that is not good for the soil

T22- Trees on farm help to conserve water

T23- Trees on farm help to conserve soil

T24- Everything I do is to make sure the farm gets better all the time

T25- I will continue to grow more and more trees on the farm

T26- I like to try new things even if I sometimes loose money on it

T27- We always try new things in our farm like agoforestry practice

T28- We need to preserve the way our parents farmed

T29- If I had more labour in my family I could grow more trees on farm

T30- Growing as many trees on farm is the best I can do on this farm although there is shortage of labour

T31- Maintained/ improved surrounding condition of the forests

T32- Inspite of having trees on farm the condition of the forests is not maintained

T33- Trees on farm reduce surface runoff

T34- Planting trees on farm is more efficient land use

T35- I will establish more forests nursery to ensure that trees are available on the farm

T36- We need to make changes in our farming practices for the benefit of the future

T37- To protect the farm for our children we need to stop agroforestry practices

Appendix 5: Present Value calculation for 1 hectare Maize (0.6), Mangoes (0.2) and *Leucaenea leucocephala* (0.2) in Magomeni village (values x 1000 Tshs, using constant 2012 prices)

Year	1	2	3	4	5	6	7	8	9	10
Cost										
Maize										
Planting	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4
Harvesting and marketing	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9
Common labour cost										
Land preparation	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1
Weeding	101.7	101.7	101.7	101.7	101.7	101.7	101.7	101.7	101.7	101.7
Mangoes										
Planting	14.4	0	0	0	0	0	0	0	0	0
Pruning	0	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Harvesting and marketing	0	0	0	15.8	15.8	15.8	15.8	15.8	15.8	15.8
Leucaenea leucocephala										
Planting	14.4	0	0	14.4	0	0	14.4	0	0	14.4
Pruning	0	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Harvesting and marketing	0	0	0	16.2	0	0	16.2	0	0	16.2
Total labour cost	266.9	263.3	263.3	309.7	279.1	279.1	309.7	279.1	279.1	309.7
Herbicides cost										
Maize	3	3	3	3	3	3	3	3	3	3
Seed cost										
Maize	52.1	52.1	52.1	52.1	52.1	52.1	52.1	52.1	52.1	52.1
Mangoes	62.9	0	0	0	0	0	0	0	0	0
Leucaenea leucocephala	49.2	0	0	43.8	0	0	43.8	0	0	43.8
Total cost	434.1	318.4	318.4	408.6	334.2	334.2	408.6	334.2	334.2	408.6
Benefits										
Maize	316	316	316	316	316	316	316	316	316	316
Mangoes	0	0	0	150	150	150	150	150	150	150
Leucaenea leucocephala	0	0	0	52	0	0	52	0	0	52
Total Benefits	316	316	316	518	466	466	518	466	466	518
Net Benefits	-118.1	-2.4	-2.4	109.4	131.8	131.8	109.4	131.8	131.8	109.4

Appendix 5 continue

Year	11	12	13	14	15	16	17	18	19	20
Cost										
Maize										
Planting	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4
Harvesting and marketing	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9
Common labour cost										
Land preparation	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1
Weeding	101.7	101.7	101.7	101.7	101.7	101.7	101.7	101.7	101.7	101.7
Mangoes										
Planting	0	0	0	0	0	0	0	0	0	0
Pruning	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Harvesting and marketing	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8
Leucaenea leucocephala										
Planting	0	0	14.4	0	0	14.4	0	0	14.4	0
Pruning	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Harvesting and marketing	0	0	16.2	0	0	16.2	0	0	16.2	0
Total labour cost	279.1	279.1	309.7	279.1	279.1	309.7	279.1	279.1	309.7	279.1
Herbicides cost										
Maize	3	3	3	3	3	3	3	3	3	3
Seed cost										
Maize	52.1	52.1	52.1	52.1	52.1	52.1	52.1	52.1	52.1	52.1
Mangoes	0	0	0	0	0	0	0	0	0	0
Leucaenea leucocephala	0	0	43.8	0	0	43.8	0	0	43.8	0
Total cost	334.2	334.2	408.6	334.2	334.2	408.6	334.2	334.2	408.6	334.2
Benefits										
Maize	316	316	316	316	316	316	316	316	316	316
Mangoes	150	150	150	150	150	150	150	150	150	150
Leucaenea leucocephala	0	0	52	0	0	52	0	0	52	0
Total Benefits	466	466	518	466	466	518	466	466	518	466
Net Benefits	131.8	131.8	109.4	131.8	131.8	109.4	131.8	131.8	109.4	131.8

Appendix 6: Present Value calculation for 1 hectare Maize (0.6), Oranges (0.2) and Coconut (0.2) in Magomeni village (values x 1000 Tshs, using constant 2012 prices)

Year	1	2	3	4	5	6	7	8	9	10
Cost										
Maize										
Planting	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4
Harvesting and marketing	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9
Common labour cost										
Land preparation	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1
Weeding	101.7	101.7	101.7	101.7	101.7	101.7	101.7	101.7	101.7	101.7
Oranges										
Planting	11.3	0	0	0	0	0	0	0	0	0
Pruning	0	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Harvesting and marketing	0	0	0	15.8	15.8	15.8	15.8	15.8	15.8	15.8
Coconut										
Planting	16.7	0	0	0	0	0	0	0	0	0
Pruning	0	0	0	0	8.7	8.7	8.7	8.7	8.7	8.7
Harvesting and marketing	0	0	0	0	0	0	21.1	21.1	21.1	21.1
Total labour cost	266.1	250.7	250.7	266.5	275.2	275.2	296.3	296.3	296.3	296.3
Herbicides cost										
Maize	3	3	3	3	3	3	3	3	3	3
Seed cost										
Maize	52.1	52.1	52.1	52.1	52.1	52.1	52.1	52.1	52.1	52.1
Coconut	61.3	0	0	0	0	0	0	0	0	0
Oranges	46.3	0	0	0	0	0	0	0	0	0
Total cost	428.8	305.8	321.6	330.3	330.3	351.4	351.4	351.4	351.4	351.4
Benefits										
Maize	316	316	316	316	316	316	316	316	316	316
Coconut	0	0	0	0	0	0	382.5	382.5	382.5	382.5
Oranges	0	0	0	52	52	52	52	52	52	52
Total Benefits	316	316	316	368	368	368	750.5	750.5	750.5	750.5
Net Benefits	-112.8	10.2	-5.6	37.7	37.7	16.6	399.1	399.1	399.1	399.1

Appendix 6 continue

Year	11	12	13	14	15	16	17	18	19	20
Cost										
Maize										
Planting	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4	42.4
Harvesting and marketing	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9
Common labour cost										
Land preparation	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1	53.1
Weeding	101.7	101.7	101.7	101.7	101.7	101.7	101.7	101.7	101.7	101.7
Oranges										
Planting	0	0	0	0	0	0	0	0	0	0
Pruning	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Harvesting and marketing	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8
Coconut										
Planting	0	0	0	0	0	0	0	0	0	0
Pruning	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
Harvesting and marketing	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1
Total labour cost	296.3	296.3	296.3	296.3	296.3	296.3	296.3	296.3	296.3	296.3
Herbicides cost										
Maize	3	3	3	3	3	3	3	3	3	3
Seed cost										
Maize	52.1	52.1	52.1	52.1	52.1	52.1	52.1	52.1	52.1	52.1
Coconut	0	0	0	0	0	0	0	0	0	0
Oranges	0	0	0	0	0	0	0	0	0	0
Total cost	351.4	351.4	351.4	351.4	351.4	351.4	351.4	351.4	351.4	459.2
Benefits										
Maize	316	316	316	316	316	316	316	316	316	316
Coconut	382.5	382.5	382.5	382.5	382.5	382.5	382.5	382.5	382.5	382.5
Oranges	52	52	52	52	52	52	52	52	52	52
Total Benefits	750.5	750.5	750.5	750.5	750.5	750.5	750.5	750.5	750.5	750.5
Net Benefits	399.1	399.1	399.1	399.1	399.1	399.1	399.1	399.1	399.1	291.3

Appendix 7: Present Value calculation for 1 hectare Maize (0.5), Coconut (0.3) and Grevillea robusta (0.2) in Nyameni village (values x 1000 Tshs, using constant 2012 prices)

Year	1	2	3	4	5	6	7	8	9	10
Cost										
Maize										
Planting	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6
Harvesting and marketing	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
Common labour										
Land preparation	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5
Weeding	28.5	57	57	57	57	57	57	57	57	57
Grevillea robusta										
Planting	9.6	0	0	9.6	0	0	9.6	0	0	9.6
Pruning	0	8.7	8.7	0	8.7	8.7	0	8.7	8.7	0
Harvesting and marketing	0	0	0	0	11.4	0	0	0	11.4	0
Coconut										
Planting	10.8	0	0	0	0	0	0	0	0	0
Pruning	0	0	0	0	13.5	13.5	13.5	13.5	13.5	13.5
Harvesting and marketing	0	0	0	0	0	0	15.3	15.3	15.3	15.3
Total labour	126.2	143	143	143.9	167.9	156.5	172.7	171.8	183.2	172.7
Herbicides cost										
Maize	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Seed cost										
Maize	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9
Coconut	74.5	0	0	0	0	0	0	0	0	0
Grevillea robusta	34.5	0	0	34.5	0	0	34.5	0	0	34.5
Total cost	288	195.8	195.	231.2	220.7	209.3	260	224.6	236	260
Benefits										
Maize	204	204	204	204	204	204	204	204	204	204
Coconut	0	0	0	0	0	0	540	540	540	540
Grevillea robusta	0	0	0	0	31.2	0	0	0	31.2	0
Total Benefits	204	204	204	204	235.2	204	744	744	775.2	744
Net Benefits	-84	8.2	8.2	-27.2	14.5	-5.3	484	519.4	539.2	484

Appendix 7 continue

Year	11	12	13	14	15	16	17	18	19	20
Cost										
Maize										
Planting	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6
Harvesting and marketing	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
Common labour cost										
Land preparation	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5
Weeding	57	57	57	57	57	57	57	57	57	57
Grevillea robusta										
Planting	0	0	9.6	0	0	9.6	0	0	9.6	0
Pruning	8.7	8.7	0	8.7	8.7	0	8.7	8.7	0	8.7
Harvesting and marketing	0	0	11.4	0	0	0	11.4	0	0	0
Coconut										
Planting	0	0	0	0	0	0	0	0	0	0
Pruning	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
Harvesting and marketing	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3
Total labour cost	171.8	171.8	184.1	171.8	171.8	172.7	183.2	171.8	172.7	171.8
Herbicides cost										
Maize	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Seed cost										
Maize	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9
Coconut	0	0	0	0	0	0	0	0	0	0
Grevillea robusta	0	0	34.5	0	0	34.5	0	0	34.5	0
Total cost	224.6	224.6	271.4	224.6	224.6	260	236	224.6	260	224.6
Benefits										
Maize	204	204	204	204	204	204	204	204	204	204
Coconut	540	540	540	540	540	540	540	540	540	540
Grevillea robusta	0	0	31.2	0	0	0	31.2	0	0	0
Total Benefits	744	744	775.2	744	744	744	775.2	744	744	744
Net Benefits	519.4	519.4	503.8	519.4	519.4	484	539.2	519.4	484	519.4

Appendix 8: Present Value calculation for 1 hectare Rice (0.5), Coconut (0.3) and Mangoes (0.2) in Nyameni village (values x 1000 Tshs, using constant 2012 prices)

Year	1	2	3	4	5	6	7	8	9	10
Cost										
Rice										
Planting	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4
Harvesting and marketing	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2
Common labour cost										
Land preparation	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7
Weeding	41.4	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8
Mangoes										
Planting	9.6	0	0	0	0	0	0	0	0	0
Pruning	0	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Harvesting and marketing	0	0	0	10.8	10.8	10.8	10.8	10.8	10.8	10.8
Coconut										
Planting	10.8	0	0	0	0	0	0	0	0	0
Pruning	0	0	0	0	13.5	13.5	13.5	13.5	13.5	13.5
Harvesting and marketing	0	0	0	0	0	0	15.3	15.3	15.3	15.3
Total labour cost	176.1	205.3	205.3	216.1	229.6	229.6	244.9	244.9	244.9	244.9
Herbicides cost										
Rice	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
Seed cost										
Rice	140	140	140	140	140	140	140	140	140	140
Coconut	74.5	0	0	0	0	0	0	0	0	0
mangoes	63.7	0	0	0	0	0	0	0	0	0
Total cost	463.7	354.7	354.7	365.5	379	379	394.3	394.3	394.3	394.3
Benefits										
Rice	338	338	338	338	338	338	338	338	338	338
Coconut	0	0	0	0	0	0	540	540	540	540
mangoes	0	0	0	388.5	388.5	388.5	388.5	388.5	388.5	388.5
Total Benefits	338	338	338	388.5	726.5	726.5	1266.5	1266.5	1266.5	1266.5
Net Benefits	-125.7	-16.7	-16.7	23	347.5	347.5	872.2	872.2	872.2	872.2

Appendix 8 continue

Year	11	12	13	14	15	16	17	18	19	20
Cost										
Rice										
Planting	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4	29.4
Harvesting and marketing	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2	46.2
Common labour cost										
Land preparation	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7	38.7
Weeding	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8	82.8
Mangoes										
Planting	0	0	0	0	0	0	0	0	0	0
Pruning	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2	8.2
Harvesting and marketing	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8
Coconut										
Planting	0	0	0	0	0	0	0	0	0	0
Pruning	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
Harvesting and marketing	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3
Total labour cost	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9	244.9
Herbicides cost										
Rice	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4	9.4
Seed cost										
Rice	140	140	140	140	140	140	140	140	140	140
Coconut	0	0	0	0	0	0	0	0	0	0
mangoes	0	0	0	0	0	0	0	0	0	0
Total cost	394.3	394.3	394.3	394.3	394.3	394.3	394.3	394.3	394.3	394.3
Benefits										
Rice	338	338	338	338	338	338	338	338	338	338
Coconut	540	540	540	540	540	540	540	540	540	540
mangoes	388.5	388.5	388.5	388.5	388.5	388.5	388.5	388.5	388.5	388.5
Total Benefits	1266.5	1266.5	1266.5	1266.5	1266.5	1266.5	1266.5	1266.5	1266.5	1266.5
Net Benefits	872.2	872.2	872.2	872.2	872.2	872.2	872.2	872.2	872.2	872.2

Appendix 9: Present Value calculation for 1 hectare Maize (0.5), Beans (0.3) and Oranges (0.2) in Nyameni village (values x 1000 Tshs, using constant 2012 prices)

Year	1	2	3	4	5	6	7	8	9	10
Cost										
Maize										
Planting	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6
Harvesting and marketing	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
Common labour cost										
Land preparation	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5
Weeding	28.5	57	57	57	57	57	57	57	57	57
Beans										
Planting	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
Harvesting and marketing	27	27	27	27	27	27	27	27	27	27
Oranges										
Planting	8.1	0	0	0	0	0	0	0	0	0
Pruning	0	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Harvesting and marketing	0	0	0	9.5	9.5	9.5	9.5	9.5	9.5	9.5
Total labour cost	166.1	193.7	193.7	203.2	203.2	203.2	203.2	203.2	203.2	203.2
Herbicides cost										
Maize	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Seed cost										
Maize	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9
Oranges	64	0	0	0	0	0	0	0	0	0
Beans	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9
Total cost	323.8	287.4	287.4	296.9	296.9	296.9	296.9	296.9	296.9	296.9
Benefits										
Maize	204	204	204	204	204	204	204	204	204	204
Oranges	0	0	0	385	385	385	385	385	385	385
Beans	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8
Total Benefits	256.8	256.8	256.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8
Net Benefits	-67	-30.6	-30.6	344.9	344.9	344.9	344.9	344.9	344.9	344.9

Appendix 9 continue

Year	11	12	13	14	15	16	17	18	19	20
Cost										
Maize										
Planting	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6	20.6
Harvesting and marketing	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
Common labour cost										
Land preparation	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5	31.5
Weeding	57	57	57	57	57	57	57	57	57	57
Beans										
Planting	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2	25.2
Harvesting and marketing	27	27	27	27	27	27	27	27	27	27
Oranges										
Planting	0	0	0	0	0	0	0	0	0	0
Pruning	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2	7.2
Harvesting and marketing	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
Total labour cost	203.2	203.2	203.2	203.2	203.2	203.2	203.2	203.2	203.2	203.2
Herbicides cost										
Maize	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
Seed cost										
Maize	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9
Oranges	0	0	0	0	0	0	0	0	0	0
Beans	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9	40.9
Total cost	296.9	296.9	296.9	296.9	296.9	296.9	296.9	296.9	296.9	296.9
Benefits										
Maize	204	204	204	204	204	204	204	204	204	204
Oranges	385	385	385	385	385	385	385	385	385	385
Beans	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.8
Total Benefits	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8	641.8
Net Benefits	344.9	344.9	344.9	344.9	344.9	344.9	344.9	344.9	344.9	344.9

Appendix 10: Present Value calculation for 1 hectare Maize (0.4), Mangoes (0.2) and Bananas (0.4) in Peapea village (values x 1000 Tshs, using constant 2012 prices)

Year	1	2	3	4	5	6	7	8	9	10
Costs										
Maize										
Planting	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9
Harvesting and marketing	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6
Common labour cost										
Land preparation	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1
Weeding	38.3	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5
Mangoes										
Planting	14	0	0	0	0	0	0	0	0	0
Pruning	0	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Harvesting and marketing	0	0	0	15.8	15.8	15.8	15.8	15.8	15.8	15.8
Banana										
Planting	35.3	0	0	0	0	0	0	0	0	0
Pruning	0	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4
Harvesting and marketing	0	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9
Total labour cost	181.2	242	242	257.8	257.8	257.8	257.8	257.8	257.8	257.8
Herbicides cost										
Maize	4	4	4	4	4	4	4	4	4	4
Seed costs										
Maize	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8
Mangoes	45	0	0	0	0	0	0	0	0	0
Banana	66.5	0	0	0	0	0	0	0	0	0
Total cost	332.5	281.8	281.8	297.6	297.6	297.6	297.6	297.6	297.6	297.6
Benefits										
Maize	184	184	184	184	184	184	184	184	184	184
Mangoes	0	0	0	445.5	445.5	445.5	445.5	445.5	445.5	445.5
Banana	0	96	96	96	96	96	96	96	96	96
Total Benefits	184	280	280	725.5	725.5	725.5	725.5	725.5	725.5	725.5
Net Benefits	-148.5	-1.8	-1.8	427.9	427.9	427.9	427.9	427.9	427.9	427.9

Appendix 10 continue

Year	11	12	13	14	15	16	17	18	19	20
Costs										
Maize										
Planting	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9
Harvesting and marketing	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6
Common labour cost										
Land preparation	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1
Weeding	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5
Mangoes										
Planting	0	0	0	0	0	0	0	0	0	0
Pruning	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6	12.6
Harvesting and marketing	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8	15.8
Banana										
Planting	0	0	0	0	0	0	0	0	0	0
Pruning	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4
Harvesting and marketing	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9
Total labour cost	257.8	257.8	257.8	257.8	257.8	257.8	257.8	257.8	257.8	257.8
Herbicides cost										
Maize	4	4	4	4	4	4	4	4	4	4
Seed costs										
Maize	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8
Mangoes	0	0	0	0	0	0	0	0	0	0
Banana	0	0	0	0	0	0	0	0	0	0
Total cost	297.6	297.6	297.6	297.6	297.6	297.6	297.6	297.6	297.6	297.6
Benefits										
Maize	184	184	184	184	184	184	184	184	184	184
Mangoes	445.5	445.5	445.5	445.5	445.5	445.5	445.5	445.5	445.5	445.5
Banana	96	96	96	96	96	96	96	96	96	96
Total Benefits	725.5	725.5	725.5	725.5	725.5	725.5	725.5	725.5	725.5	725.5
Net Benefits	427.9	427.9	427.9	427.9	427.9	427.9	427.9	427.9	427.9	427.9

Appendix 11: Present Value calculation for 1 hectare Maize (0.4), Sunflower (0.2), Banana (0.2) and Oranges (0.2) in Peapea village (values x 1000 Tshs, using constant 2012 prices)

Year	1	2	3	4	5	6	7	8	9	10
Cost										
Maize										
Planting	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9
Harvesting and marketing	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6
Common labour cost										
Land	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1
Weeding	38.3	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5
Bananas										
Planting	35.3	0	0	0	0	0	0	0	0	0
Pruning	0	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4
Harvesting and marketing	0	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9
Oranges										
Planting	12.6	0	0	0	0	0	0	0	0	0
Pruning	0	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4
Harvesting and marketing	0	0	0	14.5	14.5	14.5	14.5	14.5	14.5	14.5
Sunflower										
Planting	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Harvesting and marketing	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Total labour	210.9	270.9	270.9	285.4	285.4	285.4	285.4	285.4	285.4	285.4
Herbicides										
Maize	4	4	4	4	4	4	4	4	4	4
Seed costs										
Maize	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8
Oranges	44.6	0	0	0	0	0	0	0	0	0
Sunflower	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Bananas	66.5	0	0	0	0	0	0	0	0	0
Total cost	297.6	313	313	327.5	327.5	327.5	327.5	327.5	327.5	327.5
Benefits										
Maize	184	184	184	184	184	184	184	184	184	184
Oranges	0	0	0	321.9	321.9	321.9	321.9	321.9	321.9	321.9
Sunflower	72	72	72	72	72	72	72	72	72	72
Bananas	0	96	96	96	96	96	96	96	96	96
Total Benefits	256	256	256	577.9	577.9	577.9	577.9	577.9	577.9	577.9
Net Benefits	41.6	-57	-57	250.4	250.4	250.4	250.4	250.4	250.4	250.4

Appendix 11 continue

Year	11	12	13	14	15	16	17	18	19	20
Cost										
Maize										
Planting	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9
Harvesting and marketing	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6	30.6
Common labour cost										
Land preparation	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1	35.1
Weeding	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5	76.5
Bananas										
Planting	0	0	0	0	0	0	0	0	0	0
Pruning	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4	28.4
Harvesting and marketing	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9	30.9
Oranges										
Planting	0	0	0	0	0	0	0	0	0	0
Pruning	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4
Harvesting and marketing	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5
Sunflower										
Planting	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6	8.6
Harvesting and marketing	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Total labour	285.4	285.4	285.4	285.4	285.4	285.4	285.4	285.4	285.4	285.4
Herbicides cost										
Maize	4	4	4	4	4	4	4	4	4	4
Seed costs										
Maize	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8
Oranges	0	0	0	0	0	0	0	0	0	0
Sunflower	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Bananas	0	0	0	0	0	0	0	0	0	0
Total cost	327.5	327.5	327.5	327.5	327.5	327.5	327.5	327.5	327.5	327.5
Benefits										
Maize	184	184	184	184	184	184	184	184	184	184
Oranges	321.9	321.9	321.9	321.9	321.9	321.9	321.9	321.9	321.9	321.9
Sunflower	72	72	72	72	72	72	72	72	72	72
Bananas	96	96	96	96	96	96	96	96	96	96
Total Benefits	577.9	577.9	577.9	577.9	577.9	577.9	577.9	577.9	577.9	577.9
Net benefit	250.4	250.4	250.4	250.4	250.4	250.4	250.4	250.4	250.4	250.4

Appendix 12: Present Value calculation for 1 hectare Maize (0.5), Coconut (0.3), *Albizia gummifera (0.2)* and Livestock in Kitete village (values x 1000 Tshs, using constant 2012 prices)

Year	1	2	3	4	5	6	7	8	9	10
Cost										
Maize										
Planting	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9
Harvesting and marketing	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6
Common labour cost										
Land preparation	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6
Weeding	46.8	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6
Coconut										
Planting	21.5	0	0	0	0	0	0	0	0	0
Pruning	0	0	0	0	23.9	23.9	23.9	23.9	23.9	23.9
Harvesting and marketing	0	0	0	0	0	0	27.9	27.9	27.9	27.9
Albizia gummifera										
Planting	16.2	0	0	16.2	0	0	16.2	0	0	16.2
Pruning	0	17.6	17.6	0	17.6	17.6	0	17.6	17.6	0
Harvesting and marketing	0	0	0	20.3	0	0	20.3	0	0	20.3
Total labour cost	219.6	246.3	246.3	265.2	270.2	270.2	317	298.1	298.1	317
Herbicides costs										
Maize	4	4	4	4	4	4	4	4	4	4
Seed cost										
Maize	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2
Coconut	63.4	0	0	0	0	0	0	0	0	0
Albizia gummifera	37.2	0	0	37.2	0	0	37.2	0	0	37.2
Total cost	374.4	300.5	300.5	356.6	324.4	324.4	408.4	352.3	352.3	408.4
Benefits										
Maize	322	322	322	322	322	322	322	322	322	322
Coconut	0	0	0	0	0	0	945.8	945.8	945.8	945.8
Albizia gummifera	0	0	0	42	0	0	42	0	0	42
Total Benefits	322	322	322	364	322	322	1309.8	1267.8	1267.8	1309.8
Net Benefits	-52.4	21.5	21.5	7.4	-2.4	-2.4	901.4	915.5	915.5	901.4

Appendix 12 continue

Year	11	12	13	14	15	16	17	18	19	20
Cost										
Maize										
Planting	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9
Harvesting and marketing	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6
Common labour cost										
Land preparation	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6
Weeding	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6
Coconut										
Planting	0	0	0	0	0	0	0	0	0	0
Pruning	23.9	23.9	23.9	23.9	23.9	23.9	23.9	23.9	23.9	23.9
Harvesting and marketing	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9
Albizia gummifera										
Planting	0	0	16.2	0	0	16.2	0	0	16.2	0
Pruning	17.6	17.6	0	17.6	17.6	0	17.6	17.6	0	17.6
Harvesting and marketing	0	0	20.3	0	0	20.3	0	0	20.3	0
Total labour cost	298.1	298.1	317	298.1	298.1	317	298.1	298.1	317	298.1
Herbicides costs										
Maize	4	4	4	4	4	4	4	4	4	4
Seed cost										
Maize	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2
Coconut	0	0	0	0	0	0	0	0	0	0
Albizia gummifera	0	0	37.2	0	0	37.2	0	0	37.2	0
Total cost	352.3	352.3	408.4	352.3	352.3	408.4	352.3	352.3	408.4	352.3
Benefits										
Maize	322	322	322	322	322	322	322	322	322	322
Coconut	945.8	945.8	945.8	945.8	945.8	945.8	945.8	945.8	945.8	945.8
Albizia gummifera	0	0	42	0	0	42	0	0	42	0
Total Benefits	1267.8	1267.8	1309.8	1267.8	1267.8	1309.8	1267.8	1267.8	1309.8	1267.8
Net Benefits	915.5	915.5	901.4	915.5	915.5	901.4	915.5	915.5	901.4	915.5

Appendix 13: Projected cash flow for Livestock in Kitete village (4 goats, 3 cows and 3 pigs per household) (values x 1000 Tshs, using constant 2012 prices)

Year	1	2	3	4	5	6	7	8	9	10
Cost										
Labour cost	1231.9	1231.9	1231.9	1231.9	1231.9	1231.9	1231.9	1231.9	1231.9	1231.9
Barn construction	170.5	0	0	0	0	0	0	0	0	0
Barn maintenance	0	0	0	139.1	139.1	139.1	139.1	139.1	139.1	139.1
Cost of animals	829.7	0	0	0	829.7	0	0	0	829.7	0
Veterinary drugs	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9
Milk utensils	8.5	0	0	0	0	0	0	0	0	8.5
Total cost	2328.5	1319.8	1319.8	1458.9	2288.6	1458.9	1458.9	1458.9	2288.6	1467.4
Benefits: Selling										
Kids	110	110	110	110	110	110	110	110	110	110
Sows	0	0	0	0	598.5	0	0	0	598.5	0
Baconers	350	350	350	350	350	350	350	350	350	350
Heifer	0	0	0	0	555	0	0	0	555	0
Bull	0	0	0	0	765	0	0	0	765	0
Milk	1236.4	1236.4	1236.4	1236.4	1236.4	1236.4	1236.4	1236.4	1236.4	1236.4
Total Benefits	1696.4	1696.4	1696.4	1696.4	3614.9	1696.4	1696.4	1696.4	3614.9	1696.4
Net Benefits	-632.1	376.6	376.6	237.5	1326.3	237.5	237.5	237.5	1326.3	229

Year	11	12	13	14	15	16	17	18	19	20
Cost										
Labour	1231.9	1231.9	1231.9	1231.9	1231.9	1231.9	1231.9	1231.9	1231.9	1231.9
Barn construction	170.5	0	0	0	0	0	0	0	0	0
Barn maintenance	0	0	0	139.1	139.1	139.1	139.1	139.1	139.1	139.1
Cost of animals	0	0	829.7	0	0	0	829.7	0	0	0
Veterinary drugs	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9	87.9
Milk utensils	0	0	0	0	0	0	0	0	0	0
Total cost	1490.3	1319.8	2149.5	1458.9	1458.9	1458.9	2288.6	1458.9	1458.9	1458.9
Benefits:Selling										
Kids	110	110	110	110	110	110	110	110	110	110
Sows	0	0	598.5	0	0	0	598.5	0	0	0
Baconers	350	350	350	350	350	350	350	350	350	350
Heifer	0	0	555	0	0	0	555	0	0	0
Bull	0	0	765	0	0	0	765	0	0	0
Milk	1236.4	1236.4	1236.4	1236.4	1236.4	1236.4	1236.4	1236.4	1236.4	1236.4
Total Benefits	1696.4	1696.4	3614.9	1696.4	1696.4	1696.4	3614.9	1696.4	1696.4	1696.4
Net Benefits	206.1	376.6	1465.4	237.5	237.5	237.5	1326.3	237.5	237.5	237.5

Appendix 14 : Present Value calculation for 1 hectare Coconut (0.3), Banana (0.5), *Leucaenea leucocephala (0.2)* and Livestock in Kitete village (values x 1000 Tshs, using constant 2012 prices)

Year	1	2	3	4	5	6	7	8	9	10
Cost										
Leucaenea leucocephala										
Planting	13.9	0	0	13.9	0	0	13.9	0	0	13.9
Pruning	0	10.4	10.4	0	10.4	10.4	0	10.4	10.4	0
Harvesting and marketing	0	0	0	17.1	0	0	17.1	0	0	17.1
Common labour cost										
Land preparation	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6
Weeding	46.8	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6
Coconut										
Planting	21.5	0	0	0	0	0	0	0	0	0
Pruning	0	0	0	0	23.9	23.9	23.9	23.9	23.9	23.9
Harvesting and marketing	0	0	0	0	0	0	27.9	27.9	27.9	27.9
Banana										
Planting	28.4	0	0	0	0	0	0	0	0	0
Pruning	0	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1
Harvesting and marketing	0	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8
Total labour cost	164.2	215.5	215.5	236.1	239.4	239.4	287.9	267.3	267.3	287.9
Seed cost										
Leucaenea leucocephala	31.5	0	0	31.5	0	0	31.5	0	0	31.5
Coconut	63.4	0	0	0	0	0	0	0	0	0
Banana	87.9	0	0	0	0	0	0	0	0	0
Total cost	347	215.5	215.5	267.6	239.4	239.4	319.4	267.3	267.3	319.4
Benefits										
Leucaenea leucocephala	0	0	0	87.1	87.1	87.1	87.1	87.1	87.1	87.1
Coconut	0	0	0	0	0	0	945.8	945.8	945.8	945.8
Banana	0	199.5	199.5	199.5	199.5	199.5	199.5	199.5	199.5	199.5
Total Benefits	0	199.5	199.5	286.6	286.6	286.6	1232.4	1232.4	1232.4	1232.4
Net Benefits	-347	-16	-16	19	47.2	47.2	913	965.1	965.1	913

Appendix 14 continue

Year	11	12	13	14	15	16	17	18	19	20
Cost										
Leucaenea leucocephala										
Planting	0	0	13.9	0	0	13.9	0	0	13.9	0
Pruning	10.4	10.4	0	10.4	10.4	0	10.4	10.4	0	10.4
Harvesting and marketing	0	0	17.1	0	0	17.1	0	0	17.1	0
Common labour cost										
Land preparation	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6
Weeding	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6
Coconut										
Planting	0	0	0	0	0	0	0	0	0	0
Pruning	23.9	23.9	23.9	23.9	23.9	23.9	23.9	23.9	23.9	23.9
Harvesting and marketing	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9	27.9
Banana										
Planting	0	0	0	0	0	0	0	0	0	0
Pruning	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1	22.1
Harvesting and marketing	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8
Total labour cost	267.3	267.3	287.9	267.3	267.3	287.9	267.3	267.3	287.9	267.3
Seed cost										
Leucaenea leucocephala	0	0	31.5	0	0	31.5	0	0	31.5	0
Coconut	0	0	0	0	0	0	0	0	0	0
Banana	0	0	0	0	0	0	0	0	0	0
Total cost	267.3	267.3	319.4	267.3	267.3	319.4	267.3	267.3	319.4	267.3
Benefits										
Leucaenea leucocephala	87.1	87.1	87.1	87.1	87.1	87.1	87.1	87.1	87.1	87.1
Coconut	945.8	945.8	945.8	945.8	945.8	945.8	945.8	945.8	945.8	945.8
Banana	199.5	199.5	199.5	199.5	199.5	199.5	199.5	199.5	199.5	199.5
Total Benefits	1232.4	1232.4	1232.4	1232.4	1232.4	1232.4	1232.4	1232.4	1232.4	1232.4
Net Benefits	965.1	965.1	913	965.1	965.1	913	965.1	965.1	913	965.1

Appendix 15: Present Value calculation for 1 hectare Maize (0.5), Mangoes (0.3), *Albizia gummifera (0.2)* and Livestock in Kitete village (values x 1000 Tshs, using constant 2012 prices)

Year	1	2	3	4	5	6	7	8	9	10
Cost										
Maize										
Planting	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9
Harvesting and marketing	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6
Common labour cost										
Land preparation	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6
Weeding	46.8	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6
Mangoes										
Planting	33.3	0	0	0	0	0	0	0	0	0
Pruning	0	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
Harvesting and marketing	0	0	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6
Albizia gummifera										
Planting	16.2	0	0	16.2	0	0	16.2	0	0	16.2
Pruning	0	17.6	17.6	0	17.6	17.6	0	17.6	17.6	0
Harvesting and marketing	0	0	0	20.3	0	0	20.3	0	0	20.3
Total labour cost	231.4	260.7	286.3	305.2	286.3	286.3	305.2	286.3	286.3	305.2
Herbicides costs										
Maize	4	4	4	4	4	4	4	4	4	4
Seed cost										
Maize	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2
Mangoes	52.7	0	0	0	0	0	0	0	0	0
Albizia gummifera	37.2	0	0	37.2	0	0	37.2	0	0	37.2
Total cost	375.5	314.9	340.5	396.6	340.5	340.5	396.6	340.5	340.5	396.6
Benefits										
Maize	322	322	322	322	322	322	322	322	322	322
Mangoes	0	0	0	216	216	216	216	216	216	216
Albizia gummifera	0	0	0	42	0	0	42	0	0	42
Total Benefits	322	322	322	580	538	538	580	538	538	580
Net Benefits	-53.5	7.1	-18.5	183.4	197.5	197.5	183.4	197.5	197.5	183.4

Appendix 15 continue

Year	11	12	13	14	15	16	17	18	19	20
Cost										
Maize										
Planting	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9
Harvesting and marketing	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6
Common labour cost										
Land preparation	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6
Weeding	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6
Mangoes										
Planting	0	0	0	0	0	0	0	0	0	0
Pruning	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4	14.4
Harvesting and marketing	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6	25.6
Albizia gummifera										
Planting	0	0	16.2	0	0	16.2	0	0	16.2	0
Pruning	17.6	17.6	0	17.6	17.6	0	17.6	17.6	0	17.6
Harvesting and marketing	0	0	20.3	0	0	20.3	0	0	20.3	0
Total labour cost	286.3	286.3	305.2	286.3	286.3	305.2	286.3	286.3	305.2	286.3
Herbicides costs										
Maize	4	4	4	4	4	4	4	4	4	4
Seed cost										
Maize	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2	50.2
Mangoes	0	0	0	0	0	0	0	0	0	0
Albizia gummifera	0	0	37.2	0	0	37.2	0	0	37.2	0
Total cost	340.5	340.5	396.6	340.5	340.5	396.6	340.5	340.5	396.6	340.5
Benefits										
Maize	322	322	322	322	322	322	322	322	322	322
Mangoes	216	216	216	216	216	216	216	216	216	216
Albizia gummifera	0	0	42	0	0	42	0	0	42	0
Total Benefits	538	538	580	538	538	580	538	538	580	538
Net Benefits	197.5	197.5	183.4	197.5	197.5	183.4	197.5	197.5	183.4	197.5

Appendix 16: Present Value calculation for 1 hectare Maize (0.5), Beans (0.3), *Leucaenea leucocephala* (0.2) and Livestock in Kitete village (values x 1000 Tshs, using constant 2012 prices)

Year	1	2	3	4	5	6	7	8	9	10
Cost										
Maize										
Planting	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9
Harvesting and marketing	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6
Common labour cost										
Land preparation	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6
Weeding	46.8	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6
Leucaenea leucocephala										
Planting	13.9	0	0	13.9	0	0	13.9	0	0	13.9
Pruning	0	10.4	10.4	0	10.4	10.4	0	10.4	10.4	0
Harvesting and marketing	0	0	0	17.1	0	0	17.1	0	0	17.1
Beans										
Planting	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6
Harvesting and marketing	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8
Total labour cost	251.2	294.5	294.5	315.1	294.5	294.5	315.1	294.5	294.5	315.1
Herbicides costs										
Maize	4	4	4	4	4	4	4	4	4	4
Seed cost										
Maize	322	322	322	322	322	322	322	322	322	322
Leucaenea leucocephala	31.5	0	0	31.5	0	0	31.5	0	0	31.5
Beans	24	24	24	24	24	24	24	24	24	24
Total cost	632.7	644.5	644.5	696.6	644.5	644.5	696.6	644.5	644.5	696.6
Benefits										
Maize	322	322	322	322	322	322	322	322	322	322
Leucaenea leucocephala	0	0	0	87.1	87.1	87.1	87.1	87.1	87.1	87.1
Beans	288	288	288	288	288	288	288	288	288	288
Total Benefits	610	610	610	697.1	697.1	697.1	697.1	697.1	697.1	697.1
Net Benefits	-22.7	-34.5	-34.5	0.5	52.6	52.6	0.5	52.6	52.6	0.5

Appendix 16 continue

Year	11	12	13	14	15	16	17	18	19	20
Cost										
Maize										
Planting	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9	41.9
Harvesting and marketing	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6	39.6
Common labour cost										
Land	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6	53.6
Weeding	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6	93.6
Leucaenea leucocephala										
Planting	0	0	13.9	0	0	13.9	0	0	13.9	0
Pruning	10.4	10.4	0	10.4	10.4	0	10.4	10.4	0	10.4
Harvesting and marketing	0	0	17.1	0	0	17.1	0	0	17.1	0
Beans										
Planting	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6	26.6
Harvesting and marketing	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8
Total labour cost	294.5	294.5	315.1	294.5	294.5	315.1	294.5	294.5	315.1	294.5
Herbicides										
Maize	4	4	4	4	4	4	4	4	4	4
Seed cost										
Maize	322	322	322	322	322	322	322	322	322	322
Leucaenea leucocephala	0	0	31.5	0	0	31.5	0	0	31.5	0
Beans	24	24	24	24	24	24	24	24	24	24
Total cost	644.5	644.5	696.6	644.5	644.5	696.6	644.5	644.5	696.6	644.5
Benefits										
Maize	322	322	322	322	322	322	322	322	322	322
Leucaenea leucocephala	87.1	87.1	87.1	87.1	87.1	87.1	87.1	87.1	87.1	87.1
Beans	288	288	288	288	288	288	288	288	278.4	278.4
Total Benefits	697.1	697.1	697.1	697.1	697.1	697.1	697.1	697.1	687.5	687.5
Net Benefits	52.6	52.6	0.5	52.6	52.6	0.5	52.6	52.6	-9.1	43