CONTRIBUTION OF AGROFORESTRY TO HUMAN NUTRITION: A CASE STUDY OF MAJI YA CHAI, KIKATITI AND KISONGO IN ARUSHA REGION, TANZANIA

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A DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUREMENTS FOR DEGREE OF MASTER OF SCIENCE IN MANAGEMENT OF NATURAL RESOURCES FOR SUSTAINABLE AGRICULTURE OF SOKOINE UNIVERSITY OF AGRICULTURE. MOROGORO, TANZANIA

ABSTRACT

In recent years, agroforestry has been frequently reported as a potential farming system for meeting farmer's basic needs. This study examined the contribution of agroforestry to human nutrition in Kikatiti, Maji ya Chai and Kisongo in Arusha, Tanzania. It examined the components and food products found in the area, and their contribution to household nutrition. Research techniques used involved literature review, questionnaires, observations, taking anthropometric measurements and focus group discussion. It involved 115 randomly selected households in four villages. Data were analyzed statistically using the Statistical Package for Social Sciences (SPSS) Programme. Plant and animal species were identified using checklist and taxonomists. The study identified a total of 69 useful plant and animal species in the area used as food and medicine. These species were categorized as 19 vegetables, 27 fruits, 8 roots, 6 legumes, 2 cereals and 7 animals and birds. Agroforestry products played an important role in household nutrition, primary health care and income generation. More than 72% of food and animal products from the agroforestry system were consumed directly in the households. More than 50% of the respondents depended on herbal medicine for their health since these were cheap and readily available. Income from the sales of agroforestry products contributed indirectly to household nutrition. About 37.3% of total income was used to purchase off farm foods. Nutritional status of under fives showed 30% stunting, 14% underweight and 8.7% wasting. The studies revealed causes of poor nutritional status to be level of education, eating habits, women workload and ethnicity besides lack of food. From this study it was concluded that agroforestry contributes to household nutrition through food production, primary health care and cash income. The study recommends more studies to be conducted

on ways of improving and strengthening agroforestry practices and utilization of agroforestry products to all household members.

DECLARATION

I, Idda Amani Makawia, do here declare to the Senate of Sokoine University of Agriculture (SUA) that this dissertation is my original work and has not been submitted for a higher degree in other University.

Signature---Amakawia---

Date 03-10-03

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DEDICATION

To my beloved mother, husband and children

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LIST OF ABBREVIATIONS

AF	Agroforestry
AFP	Agroforestry Products
AIDS	Acquired Immuno Deficiency Syndrome
FAO	Food and Agriculture Organization
FGD	Focused Group Discussion
HIV	Human Immunodeficiency Virus
ICRAF	International Centre of Research in Agroforestry
IDA	Iron Deficiency Anaemia
IDD	Iodine Deficiency Disorders
MASL	Meters Above Sea Level
NTFPs	Non-Timber Forest Products
PEM	Protein Energy Malnutrition
SCAPA	Soil Conservation Agroforestry Programme in Arusha
SD	Standard Deviation
SPSS	Statistical Package for Social Sciences
SUA	Sokoine University of Agriculture
TAS	Tanzanian Shillings
TFNC	Tanzania Food and Nutrition Centre
UNICEF	United Nations Children's Fund
US	United States
US$	United States dollar
VAD	Vitamin A Deficiency
WHO	World Health Organization

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background information

Agroforestry is a land use system that involves deliberate retention, introduction or mixture of trees or wood perennial in crop/animal production to benefit from the resultant ecological, economic and nutritional interactions (Nair, 1989). This is an old land use system that has been practiced for thousands of years by farmers in many parts of the world (Nair, 1993). Characteristically, the system is largely for subsistence and represents a unique system of farming. The multipurpose nature of agroforestry and the food products produced contribute significantly to the fulfilment of nutritional and income needs of the household. One of the best known cases is the Javanese agroforestry system, which provides an excellent example of the diversity and complex structure and functions of the system in Asia. Fruit trees such as guava, rambutam, mangoes and mango stem tend to dominate the system along with other food producing trees such as *Moringa spp* and *Sesbania grandiflora.* Crops such as bananas, cassava, vegetable species like chilli pepper and medicines are derived from agroforestry to supplement food and medicines from other sources. Agroforestry in Asia, produce yields in economically efficient, ecologically sound and biologically sustainable way (Nair, 1993).

In Africa, the system has been practiced successfully for many decades in the highlands where population density is high (Nair, 1985). For instance, the growing of coffee and banana mixed with fodder, shade, fuelwood, poles and timber trees practiced on the slope of Mt. Kilimanjaro is an excellent example of agroforestry practice (O'kting'ati and Mongi, 1986).

In Ghana, agroforestry systems have been reported to have potential contribution to the achievement of self-sufficiency in food production. Other plants dominating the area include *Cannabis sitiva*, *Zingiber officinale*, *Tamarindus indica* and *Adansonia digitata* (Asare *et al.*, 1985).

Agroforestry systems are used in Tanzania in order to meet needs of people in terms of food, fuel wood, fodder, medicines, soil fertility, shade and building materials. Agroforestry practice is well established in Arumeru, where-by farmers undertake their cultivation of various crops in mixtures on the same piece of land and domestic animals and poultry form essential components of the system (Nair, 1993). Homegardens in Arumeru district make possible availability of different types of foods, which are essential to the human body. These food products include; fruits, vegetables, banana, beans, potatoes, cassava, maize, cowpeas, yams, pigeon pea, and green peas. Moreover, the wide diversity of crops in agroforestry systems provides a wide range of edible plants for human consumption (Torres, 1980). Trees and shrubs that are cultivated in the system could also be used as sources of vitamins and other nutrients (Okafor, 1981). On the other hand, fruits and vegetables provide income to the household and diet containing fruits and vegetables improve the nutritional status of the individual household and off-farm population in the area.

1.2 Problem statement and justification

A great deal of research in AF has been carried out over the last two decades producing an enormous amount of information on agroforestry and its role in farms and society. Food and animal products derived form AF practices have many benefits to the farmers and societies when there is a good combination of tree species and food crops. Such combination provides direct benefits to human nutrition, food security and improves household income. Arumeru is well established in agroforestry practices where by valuable food products for humans are produced. It has been claimed that most of the indigenous vegetables and fruits produced in the system are considerably richer in nutrients than introduced temperate ones (Okafor, 1980). This is particularly true of green leafy vegetables such as pumpkin tops, sweet potatoes top, cowpeas and amaranthus, which are nutritionally far better than cabbages, lettuce and cucumber (Levinson, 1991). Even though AF food products have nutritional benefits, these potentials have not been realizes by the people from this area. There is a deliberate need to educate people on the proper farming and use of these food products must be exercised. For instance, AF products like fruits and vegetables are one of the main sources of vitamins and minerals necessary for the development of the human body..

The most important of the vitamins are A and C. Vitamin A deficiency affects roughly 15% of children aged between one and four years in 16 countries, Tanzania being one of them (Levinson, 1991). Levinson further added that, prevalence of vitamin A deficiency is highest in the low-income groups. A serious illness related to vitamin deficiency is measles and is the precipitating factor in roughly 50% of cases of vitamin A blindness. For instance, the observed substandard level of vegetables and fruits, e.g., per capita daily vegetable

consumption in developed countries is 221 compared to 104 g in Tanzania (Nyagwegwe, 1990). .This low consumption may be due to poor education on human nutrition, culture and other factors.

Although the potential for agroforestry to improve nutrition is known, detailed qualitative studies in the area have not been done to assess ways in which AF contributes to improve nutrition. It is therefore important to examine: the available food sources (species), nutritional status of the crops, household intake/consumption trends and possible impact on the well being of children and adults in the household. These are among the key areas of investigation in the proposed study. However, results from this study will form a basis for prescribing remedial intervention strategies to improve the AF system and human nutrition in the study area.

1.3 Objectives of the study

1.3.1 General objective

The overall objective of this study is to assess the contribution of agroforestry to human nutrition in Kisongo, Kikatiti and Maji ya Chai wards in Arumeru district, Arusha Tanzania.

1.3.2 Specific objectives

(i) To identify and assess the types of agroforestry food products found in the study area.

(ii) To assess the contribution of these products to human nutrition.

(iii) To study the influence of cultural factors to the utilization of agroforestry food products.

1.3.3 Research questions

In order to meet the objectives of the study the following research questions were used.

- What are the main components of AF systems?
- What are the AF food and animal products found in the study area?
- What is the contribution of AF food products to human nutrition in the study area?
- Do AF products serve as a source of income in the household?
- What kind of nutritional disorders are present in the study area?
- What is the influence of culture in the utilization of AF food products found in the area?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Overview

Every research problem has an underlying framework or perception of the world. This dictates the way the study is undertaken and functions as guiding principle base and the choices that are made. This perception provides the research with perspective on what AF systems consists of, what components are made up of and what the contribution of the systems to the household/society nutrition (Coward, 1979; and Denzin, 1989). The previous chapter presented the background to the research problem and the study objectives, and research questions for the study. This chapter reviews literature based on the research questions as to what has been done in agroforestry systems and the way the systems contributes to human nutrition in general.

2.1.1 Definition of agroforestry system

Lundgren (1982) and Nair (1989, 1993) summarized several definitions of AF system given by different authors and came up with a new definition. These two definitions of AF stress two characteristics common to all forms of AF and separate them from the other forms of land use, namely:

- The deliberate growing of woody perennial on the same piece of land as agricultural crops and/or animals, either in some forms of spatial mixture or temporal sequence;
- There must be a significant interaction (positive and/or negative) between the woody and non-woody components of the system, either ecological and/or economical.

When promoting AF system one should then stress its potential to achieve certain aims, not only making theoretical and qualitative remarks about the benefits of trees but also, and more importantly, by providing quantitative information (Lundgren, 1982). However, these ideas were later refined through "in-house" discussions at the International Centre for Research in Agroforestry (Nair, 1993), and the following definition of AF was suggested, agroforestry is a collective name of old land use systems and technologies where woody perennials (trees, shrubs, palms, bamboo, etc) are deliberately combined with agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. In agroforestry systems, there are both ecological and economical interactions between the different components (Lundgren, 1982). According to Nair (1993), the implication of this definition is that: -

- an agroforestry system always has two or more species of plants (or plants and animals), at least one of which is woody perennial;
- an agroforestry system always has two or more outputs;
- the cycle of agroforestry system is always more than one year; and
- even the simplest agroforestry system is more complex, ecologically (structural and functional) and economically, than monocropping system.

However, the definition of agroforestry has been revisited (Leakey, 1996). He further, suggested that AF should be considered as dynamic, ecological based, natural resource management system that, through the integration of trees in farm-and rangeland, diversifies and sustains smallholder production for increased social, economic and environmental benefits.

2.2 Components systems

There are three basic sets of components in AF systems that are managed by man, i.e., the trees, crops and animals. In order for a land use system to be regarded as AF system, it should always have a woody perennial (Nair, 1983) with notable exceptions of apiculture and aquaculture. It should include plantation crop mixtures of two woody perennial such as coffee and rubber trees, (Nair and Sreedharan, 1986) or rubber and fruit trees (Penot, 1995) or coffee under shade trees (Escalate, 1995), the herbaceous species crops is also involved. The component of animal is only present in some AF systems. These components can be discussed further as follows.

2.2.1 Crop component

Most of documented AF systems in the tropics indicate similarities in crop components. The set of crop component is mainly composed of food and cash crops. In Nigeria, the dominant staple species associated in AF system includes yams, cassava- (*Manihot spp*), bananas, plantain *(Musa paradisiaca L.*). Maize is usually grown in mixtures with several subsidiary crops such as okra (*Hibiscus esculentus L.*), pumpkin (*Cucurbita pepo*), melon (*Colocynthis vulgaris schrad*) and leafy vegetables (*Amaranthus spp*; *Corchorus olitorius* L.; *Telfairia occidentalis* and *Solanum spp*) (Okafor and Fernandes, 1987).

In Nepal; the major crops associated with AF systems include; maize, various pulses (beans, Soya beans (*Glycine max)* and cowpeas (*Vigna unguiculata*) and finger millet (*Eleusine coracana*). Others include; wheat (*Triticum aestivum*), barley (*Hordeum spp*), and buckwheat (*Polygonum spp.)* and around the trees, various vegetables and bananas are grown for household consumption.

In Papua New Guinea highlands, annual and perennial crops are major crops (Fernandes and Nair, 1986). Food crops include, bananas (mostly triploid cultivaters at 1400-2100 altitude, 0taro sugar cane (*Saccharum officinarum*), maize in high lands, 'pitpit' (*Setaria palmifolia),* while cash crops include coffee. Nair (1986) further reported that, the basic structure of the system is that the mixed vegetable gardens are gradually converted into coffee/ banana gardens and eventually into coffee/casuarina stands.

In Burundi, sweet potatoes, cassava, cocoyams and beans are food crops whereas cash crops are coffee and bananas mainly used to produce local beer (O'kting'ati, 1985). In Arumeru AF systems, main crops reported are banana (*Musa species*), maize (*Zea mays*), beans *(Phaseolus vulgaris*), sweet potatoes (*Ipomoea batatas*), yams (*Dioscorea species)* while cash crops include coffee (*Coffea arabica*), cardamon (*Elettaria cardamomum*) (Fernandes *et al.,* 1984*).* Similarly, the same types of food and cash crops have been reported in other AF systems (Balasubramanian and Egli, 1986) and Rugalema, 1992).

2.2.2 Tree component

In all documented AF systems, different species have been found to be incorporated. Depending upon the climatic condition and altitude, tree species in the system vary considerably in height, physiognomy (forms) and diversification. AF systems are reported to have numerous indigenous trees, which have been deliberately retained and managed for different purposes. Some of the systems are characterized by intensive integration of numerous multipurpose trees and shrubs (Fernandes *et al.*, 1984, Okafor and Fernandes, 1987). The incorporation of a variety of trees in the farming system by farmers mainly depends on their end uses or functions. The most important trees planted in highlands of

many tropical countries are fruit trees, which are the large component in the homegardens (Nair, 1993). Fruit trees may be found integrated with arable crops either in intercropping or boundaries of agricultural fields (Rocheleau *et al.*, 1988).

In the farms of southeastern Nigeria, several trees and shrubs are deliberately planted and managed for variety of products and functions. At least 60 tree and shrub species were found in these farms, many of which provided food products. Okafor cited in Okafor and Fernandes (1987) identifies 171 indigenous woody plants of nutritional importance, out of which about 55% are fruit tree species. Forest foods rarely supply the main part of a family' diet, but tree and forest products have an important role in ensuring adequate and balanced nutrition for rural people. A recent study of Bangladesh villages revealed that nutritional status of preschool children living in villages near forests was considerably better than those children living in villages far from the forests (Hassan 1985). One of the common uses of forest foods, especially fruits and insects, is as snack.

2.2.3 Animal component

This set of component is present only in some AF systems (Nair, 1993). Literature reveals that, all forms of AF systems that incorporate animal components in the tropical countries include more than one type of animal. Although there are broad similarities among the countries with respect to animals tamed in their AF systems, there are also many differences among them. People of Thailand keep animals for food, rituals, religious sacrifices and prestige (Boonkird *et al.*, 1984), while Tanzanian people keep cattle for milk and meat; pigs are kept for meat, sale and/or home consumption (Fernandes *et al.*, 1984). In most cases, cattle as a component of various AF systems contribute to household

nutrition by production of animal protein and minerals (Vergara and Nair, 1985). Cattle have also pastured under coconuts in South Pacific to keep down competing fire-hazardous grassy weeds (Vergara and Nair, 1985). This method was found to be a feasible alternative for fighting fire problem (Fernandes, 1987). By pasturing cattle under those trees also help recycle the biomass and provide nutrient inputs in the form of cattle manure to improve soil fertility and help to increase farm income and employment of farmers (Nair, 1989). Not only domestic animals and poultry are kept in AF systems, but also wild animals such as buffaloes and other fauna are incorporated and grazed in AF systems, e.g., Indonesia (Michon *et al.,* 1986), where they play an important role in pollination, although they represent a major danger for fruits and tuber crops.

2.3 Importance of AF systems

In some areas, agroforestry provides a large proportion of rural households' food needs. These contributions come into two categories:

- The environmental protection role of trees and forests that enhance water and soil conservation to maintain high productivity.
- The commodity contributions, which can supplement normal farm yields or serve as substitute products in the event of crop failures due to floods, droughts or insect infestation. However, the major importance of AF systems is socioeconomic contribution of forestry to household nutrition.

AF systems enable people and society to obtain their needs for food, fuelwood, fodder, shelter, medicinal products and flowers for honey (Okafor, 1987) Additionally, trees that produce marketable wood constitute standing capital which assist to meet basic needs of the family. Nair (1989) reported that, dependency and catastrophes associated with single

crop are overcome or mitigated particularly in the case of irregular rainfall patterns, market fluctuations, pest outbreak where there are difficulties in acquiring imports like pesticides, fertilizer and machinery. AF systems lead to mitigation of the land pressure problems resulting from population growth and lack of resources that would otherwise force poor farmer to marginal land management systems, and causing disasters like deforestation, degradation of soils, floods, drought and desertification (FAO, 1983). However, AF systems combine the practices of agriculture and forestry to provide food and wood without causing deterioration of the ecosystem (O'kting'ati, 1985).

In addition, AF systems have many benefits to the environment, including amelioration of temperature extremes and damage caused by strong winds and raindrops. AF systems however, increase soil fertility and have great efficiency in recycling nutrients, as tree roots capture nutrients from deep soil profiles or from areas away from the annual or perennial crop/plants. Adeyeyo (1980) added that, a large amount of biomass returns to the soil as organic matter through fallen leaves, fruits, flowers and branches. Activities of mycorrhiza or fixed nitrogen, from the air by action of specialized bacteria make trees to capture available nutrients from the soil. Nair (1984) discussed more on the biological benefits of AF as serving as supports for climbers of economic value and plant species diversity, and their spatial arrangement in agroforestry system can deter proliferation of pests and insects, which are harmful.

2.4 Agroforestry and food production

In many countries south of the Sahara the gap between food production and consumption is widening at an alarming rate. According to FAO (1991) reports, the rate of population

growth in this region was 2.5% with a range of growth 1-4% while the rate of food and agricultural production was 1-2% per annum. This means that the amount of food produced is not enough to feed the population. This situation calls for substantial efforts at all levels to increase food production and availability with emphasis on the broadening of the food base by promoting agroforestry systems in rural areas (Nair, 1989).

The development of agroforestry food and animal products is increasingly being regarded as an essential element in improving food consumption and household's nutrition that also make an important contribution to the household food security. These AF products have remarkable seasonal timing for consumption when staples are either scarce, unavailable or are too expensive and thus improve stability of supplies at the farm level. Some of the products are famous for their famine relief characteristics in time of drought, therefore essential in combating nutritional disorders. Such products include; cowpeas, indigenous vegetables and fruits, grain legumes, bananas, root and tubers like yams and nuts. Agroforestry food products also have an important income generating potential, for instance selling of food products is an important source of income especially to women in most of the developing countries (FAO, 1991).

FAO (1989) reported that in 1977, the proportion of vitamins (A and B) derived from vegetables alone was 81% in Africa while that of vitamin C was 43%. Maeda and Salunkhe (1981), Fleuret (1979), and Seenappa *et al.* (1986) have also pointed out the nutritional composition of AF food products in supplying essential nutrients and energy such as vitamins, minerals and carbohydrate. Apart from increasing the quality and quantity of the diet, AF products have also the advantage of adding diversity. Many varieties of AF food

products supply complementarily the nutrient others lack, improve palatability of staples, improve appetite and increase overall consumption (Okigbo, 1985). However, lack of nutrients in the body leads to nutritional disorders (Levinson, 1991).

Although there are different types of agroforestry systems that perform the productive roles, the most typical system is the homegardens since they include different types of tree species and shrubs, herbaceous crops and animals. Several kinds of homegardens are known for their stable yields, very varied products, continuous and repeated harvesting during the year (Soemarwoto, 1987). The author further reported that, the most important function of the homegardens is food production. However, potential functions of these homegardens are as varied as the gardens themselves as they include cash earned from direct sales of produce; cash savings realized by substituting garden produce for purchased vegetables and improved nutrition from types of food or from increased, regular quantities of vitamins, minerals and protein in the household diet (Rocheleau *et al.*, 1988).

Fernandes *et al.* (1984) reported about the Chagga homegardens, which produce about 125 kg of beans (148 $kgha^{-1}$), 280 kg of parchment coffee (422 $kgha^{-1}$) and 275 bunches of banana (404 ha^{-1}) annually. In addition, the Chagga homegardens produce fruits, vegetables and herbs, which are consumed locally. Moreover, farmers are almost self sufficient in fodder, produced primarily from trees, shrubs and banana plants and grasses grown in their gardens used to stall-feed their livestock.

2.5 Agroforestry food and animal products

Agroforestry food and animal products are particularly important in household nutrition and predominantly subsistence economies in rural areas. They generally play a supplementary role in the diet and rarely constitute staple foods. They, however, contribute to the diet diversity and flavour (FAO, 1995). Food and animal products therefore make a significant contribution to household nutrition of the rural population. The vast numbers of these AF products are either direct for consumption or sold to generate income for purchasing off-farm foods or other household expenditures (Arnold, 1995, and FAO, 1995). AF food and animal products are mostly extensively used to supplement other food sources during particular seasons of the year. Many agricultural communities suffer from seasonal food shortage during certain periods of the year when stored food supplies have dwindled and new crops are just beginning- 'hunger periods' (Arnold *et al.*, 1997 and Arnold 1995). Therefore AF food and animal products can be described as life saving in times of disasters such as roots/tubers, vegetables fruits, honey and cereals and legumes can provide essential nutrients in the diet (Arnold, 1995). However, harvesting, processing and preparation of some of these foods is time consuming and thus they have been progressively and rarely consumed by most rural households.

2.6 Contribution of Agroforestry to human nutrition

In general, people in Tanzania still rely on farm and forest products for meeting both their subsistence needs and as a source of income. In many areas people would have difficulty surviving if they had to depend only on cultivated land for food, fuel and cash income. Most rural people depend on AF system for both economic and household nutrition, and in many cases this dependency is increasing with improved living standards and increasing

population (Hines and Eckman, 1993). The indigenous flora and fauna found in AF system contribute to local food systems in two ways (FAO, 1991). AF food products may be produced for direct consumption or might be sold to generate income for food purchase or other expenditures. In this way AF system play direct and indirect roles in production and household nutrition (Makonda; 1997) For example women might rely on sale of AF products, such as fuelwood, pastures as the only available source of income generation. They may therefore use the income to buy food. This is indirect contribution, while consumption of foods produced in the system is direct contribution to household nutrition.

2.6.1 Direct contribution of AF food products to human nutrition

Studies conducted by Walter and Hamilton (1993) reported that at global level, around 75,000 plant species are edible, out of which 12,000 have been used for food, but so far only 2000 have been domesticated. Food products from AF system encompass stems, shoots, tubers, roots, leaves, flowers, fruits cereals, nuts, oil seeds, condiments, spices and mushrooms. Animal food products include honey, bush meat, fish, shells, edible bird eggs, and insects. Moreover, a study conducted by Makonda (1997) in Geita district in Tanzania identified 156 useful plant species and 12 animal species. Out of 156 species, 49 species were used as food and out of 49 species, 39 were fruits and seven were vegetables including edible mushrooms. Furthermore, the same kind of study conducted by Mapolu (2001) in Tabora Tanzania, identified 92 useful plants and 13 animal species used as food.

AF food and animal products play a great role in human nutrition especially at this time when Africa is facing a problem of malnutrition and population growth rate. FAO (1991) estimated that, by year 2000; up to 70 countries, including 49 in Africa would not be able

to produce enough food for them. Although AF products are not to ensure food self-sufficiency of the population, they can at least constitute an important element of sustainable household nutrition. Homegardens as AF system is valuable for its socio-economic, ecological and its nutritional roles. Its importance lies in its' stability to combine ecological function of the forests with those of providing economic and nutritional needs of people (Swaminathan, 1987).

Nutritionally, homegardens play a key role in supplying food for the families. In Papua New Guinea, for instance, various fruits and vegetables are reported to essentially supply the diet with vitamins and minerals and assuring more than 40% of the whole calorific requirements (Swaminathan, 1987). Soemarwoto (1987) surveyed 40 households in Philippines and found that nearly all the households could meet the recommended daily requirements for vitamin A, C and calcium. Similarly, Sommers quoted in Fernandes and Nair (1986), found similar results. The author also reported that, over half of 40 households surveyed could obtain sizable contribution towards their thiamine, riboflavin and niacin requirement and one in four households could meet their protein and energy requirements, from homegardens. Soemarwoto (1987) reported that out of total individual commodities produced by the household, the percentage consumed were fruit 46, coconut 83.7, vegetables 94.7, medicinal plants 95.5 and tuber and roots 97.3. In Bukoba Tanzania, homegarden AF systems are reported to have met almost all-household calorific requirements (Rugalema, 1992).

A considerable number of studies indicate that a large proportion of the products of AF systems are utilized by farm families themselves, thus providing a high degree of

household nutrition (Fonzen and Oberholzer, 1984; O'kting'ati, 1985; Rugalema, 1992). For instance, studies by O'kting'ati (1985) and Oduol (1990), indicated that the major part of the AF produce is consumed at home, thus providing a high degree of household nutritional requirements. Furthermore, AF food and animal products are potential in solving nutritional problems in rural areas of tropical Africa. AF systems can offer an ideal alternative for some nutritional problems (O'kting'ati, 1985) but it cannot be considered as a panacea to cure all evils of nutritional problems nor is it uniformly applicable.

Economic findings from AF systems are an important asset of farming systems. It is well known that most of AF systems practiced in various parts of the tropical countries come under the subsistence category, whereby yields are very low, but for poor people they do significantly contribute to the household nutrition. Therefore, these issues of dependence on AF plants and animal products in relation to household nutrition are discussed in the following sections on the basis of various products from AF system.

2.6.1.1 Vegetables

Leaves, herbs and weeds, either fresh or dried, are one of the most widely consumed AF food products in rural communities (FAO, 1997). Wild and planted vegetables are frequently used as the base for soups, stew and relish, which accompany carbohydrate staples such as stiff porridge (*ugali)* and rice. Its palatability and taste encourage greater food consumption. Vegetables are important part of traditional diets in many parts of Tanzania and contain more riboflavin, a vitamin necessary for good health, than eggs, milk, nuts and fish.

In Lushoto district, Tanzania, Fleuret (1979) reported that green vegetables were valued because they were cheap and accessible and thus an essential part of everyday diet, which accounted for 81% of all side, dishes. The author added that, vegetables had a great economic potential and their promotion would help to alleviate poverty, improve household nutrition and reduce malnutrition. For instance, *Launaea cornuta (mchunga)* is a weed occurring in highly diversified habitats, widely distributed and growing up to an altitude of 2286 meters above sea level. The nutritional value of *L. cornuta* is high considering the level of vitamin C, minerals (Ca, K, and Fe), proteins, crude fat and dietary fibre (Mahunnah, 1993). Furthermore, in Swaziland, Oglea and Grivetti (1985) found 49 species of wild plants leaves were consumed as vegetables and 50% of the adults were reported to consume them more than twice a week. The amount of vegetables consumed per meal ranged from 16-200 g/serving and 10-43 g/serving for the two main vegetable dishes. In upper Shaba in Zaire, Malaise and Parent (1985) found that the leaves of 50 species of trees were used as food. These common vegetable species included *Pterocarpus spp., Myrianthus arboreas, Gnetum spp, Bidens pilosa, Adansonia digitata and Cassia obtusifolia.* They also reported identifying 184 edible wild vegetables in the Zambezian Woodland area of Southern Zaire. According to Mattila *et al,* (1997) varieties of vegetables are utilized on daily basis and most probably make up an important source of mineral and vitamins in otherwise purely staple foods. *Balanites aegyptic* leaves were reported to be rich in calcium (37,000mg./100 g,), *Amaranthus spp* in iron (8.9 mcg/100 g) and β-carotene- (5,716mcg/100g) while *Corchorus spp* in protein (6.7g/100g) and energy (293kJ./100g.).

2.6.1.2 Fruits

In many parts of the world, fruits are an important source of food for many rural communities. Adults tend to ignore the use of fruits while their children fight for their collection and use. Fruits have long been used to compliment or supplement diets. They contain vital nutrients and essential vitamins, which are important especially for growing children, who are prone to malnutrition and related diseases. FAO (1983) listed 40 species of edible fruits of eastern Africa. Seyani (1988) listed about 180 species of edible fruits, 104 species of edible leaves and about 19 species of edible flowers in African flora. Ruffo (1989) listed 16 fruit trees from East Usambara Mountains of Tanzania. The development of fruits is increasingly being regarded as essential element in improving nutrition and especially as vital component of traditional diet (FAO, 1983).

Studies conducted by Maghembe *et al.* (1998) on nutritional analysis of fruits revealed that, *Strychnos cocculoides, Parinari curatellifolia* and *Azanza garckeana* contained more than 30% fat and about 45% crude fibre and total carbohydrates. FAO (1990b, 1992) in similar nutritional analysis reported *Sclerocarya birrea* fruit to contain four times as much vitamin C as sweet oranges while its nuts contain protein over 30% and oil 57% and fruit of *Adansonia digitata* to contain 360mg/100g of vitamin C.

Fruits as a product from AF systems are also used to generate cash for purchasing food or any other household needs. In Zimbabwe; some farmers meet their household food requirements and educational costs for sales of fruits and local brew from *Ziziphus mauritiana* (Kadzere *et al.*, 1997). *Parinari spp.* also provide an abundance of fruits whose

pulp can be used as jam as well as for production of local brew in the rural areas. The nut has product that is almost a substitute of peanut butter.

A study by Nkana and Iddi (1991) reported that the Rangi tribe in Central Tanzania use *Adansonia digitata* fruit pulp to prepare a drink or beverage, which is usually drunk during hot weather.

2.6.1.3 Roots and tubers

Roots and tubers from AF system are described as drought and famine foods not because they can persist under reduced precipitation, but also because they are an important source of water, carbohydrate and some minerals (FAO, 1991; Sene 2000). Missano *et al.* (1994), in their study in Mtwara region found that wild roots were consumed widely by rural people and were being bought by town dwellers as snack when traveling inland. The cassava-like wild starchy roots known locally as 'Ming'oko' were consumed throughout the year particularly during periods of food shortage. This wild yam is said to belong to *Dioscorea species.* Mapolu (2001) in her study of contribution of non-wood forest products to Household Food Security in Tabora district identified 6 species of root and tubers utilized as food. The tubers identified as edible were *Asparagus africana, Commiphora africana, Commiphora mossambicensis, Dioscorea cochleari var.apiculata, Nyphea lotus* and *Pseudeminia comosa.*

Furthermore, a study conducted in Kenya by Kabuye (1986) on edible AF products identified 56 species of root and tubers, which were mostly consumed as snack, thirst quenchers and famine food. Malaisse and Parent (1985) identified more than 40 root

species used for food in upper Shaba. Similarly, Oglea and Grivetti (1985) found that 10% of the root species of AF products were identified as edible, including bulbs or roots and the most frequently used species were bulbs of *Aloe saponaria*, which were good sources of carbohydrates.

2.6.1.4 Honey

Beekeeping industry is highly dependent on flowering plants of which trees/shrubs are mainly components some farmers placed their beehives on the shade trees, especially on cordial (*Cordia africana*), C*roton macrostachys* and *Erythrina burana*, and harvested honey periodically for household consumption and sale. In many parts of the country, honey was collected three times a year (Poschen, 1986). Honey provides important source of non-proteineous animal food product. Honey is nutritionally valuable, especially due to the energy it provides. It is estimated that 100g of honey have 280 calories. Normally, honey is consumed as a side dish accompanying the main dish *(ugali).*It is also used as a life-saving food in terms of famine or natural disasters because it provides energy. At household level, honey is used as a sugar substitute in tea or porridge, as supplementary food for lactating mothers and as appetizer (Kimbi *et al.,* 1998). According to Krell (1996), honey is normally consumed in its unprocessed state in combs as medicine, and is found to be important food for Sandawe people. The same study carried in Iringa region by Kihwele *et al.* (1999) reported the use of honey for food and food storage.

2.6.1.5 Animals

In Africa, all species of wild and domestic animals, from insects to reptiles, from rodents to large animals are used as food resource. FAO (1997) indicated that, most game species are

small animals like rodents, reptiles and insects. Their consumption is linked to their availability and supply as a result there is a great regional variation in meat consumption (FAO, 1991a, 1997). Malaisse (1982) reported that rabbits are major food component for resident of Zimbabwe. About 5 species of rabbit are eaten and they contain 24% of protein. Protein content of grasscutter is found to be 22.3% and that of antelope is 30.4%. In West Africa, bush meat is still a major food item for rural households where it contributes between an estimated 20 and 100% of animal protein consumed (FAO, 1991). In addition, studies by Mabole (1999) reported that 75% of the households in Uganda consume animal products from both wild and domestic animals. The author further added that, 65% of cattle products are locally consumed while only 35% are sold. Poultry and its products are good source of income for women in rural areas of Uganda while men basically own animals like cows and goats.

2.6.1.6 Medicinal plants

Medicinal plants are important in primary health care systems, particularly in rural areas. Local communities have developed interests and often sophisticated knowledge systems about the use of a vast variety of plants for medicinal purpose (FAO, 1995). Chandrasekharan (1998) reported that 75% of the world population particularly in developing countries depends on traditional medicine. In Africa, reliance on such medicines is due to high costs of conventional medicines and the inaccessibility of modern health care facilities, but also because traditional medicine is often deemed as a more appropriate method of treatment (Marshal, 1998). In Tanzania, medicinal trees and herbs are the main source of medicine for traditional healers and 80% of rural people (Mahunnah, 1993). In Malawi, sale of traditional medicine is one of the main commercial activities in

urban areas (Maliehe, 1992).The Maasai pastoralists have used woody plants and other aromatic plant parts as herbs to cure illness and diseases of domestic animals since prehistoric times. They treat their children using different types of plants that have been shown to have fungicidal, anti-protozoal, bactericidal and antiviral properties (Ole Lengisugi and Mziray, 1996). Therefore, in any case the contribution of medicinal plants to household nutrition through health care and income generation is substantial requiring development in future.

2.6.2 Indirect contribution of AF products to household nutrition

Agroforestry contributes indirectly to household economy through the generation of income and employment from sale of harvested goods and processed products such as honey, timber, fibre and extracted products (Okafor, 1987). In some cases, the income earned from AF products is used to purchase food and in some cases it is invested in agricultural inputs and livestock. According to FAO (1991), income from AF products also often contributes to other needs, such as housing, health care, education, construction and clothing. Incomes from selling AF products contribute greatly to national economies. Taylor (1996) reported that rural economies in many countries benefit from AF products trade. AF systems constitute one or more of cash crops such as coffee, rubber, cocoa, cashew nuts and pyrethrum (Okafor, 1987). According to Mauro (1995), Xapuri villagers in Brazil earn an average annual income of US$ 960 per household from sale of nuts and rubber extracts. In West Bengal, many village communities derive as much as 17% of their annual household income from selling AF food and animal products. It is estimated that in the 1960's, the "shamba" system in Kenya accounted for about 18 million kg (200,000 bags) of maize which formed about 16% of the total national production (Oduol, 1986).

Similarly, it is further reported that 38% of the potatoes produced in the country were grown in the "shamba" system. Oduol (1986) also reported that family income was greatly improved, as farmers saved cash that could have been spent on food. Soemarwoto documented (1987) that the Lima homegarden of Peru, with average size of 0.02ha, produced an income of US$ 28.33 in five months. This income although small, is reported to have added almost 10% to the family income, which was used for purchasing off farm products. Other sources of income were sales of banana and other crops. However, in 1983, coffee accounted for 11.7% of the total cash income in the Gisaka-Migongo region in Rwanda. Banana, during this year contributed 38.3%, food crops and their products (13.9%) and livestock (5.2%) (6and Price, 1983). In a study carried out in Tabora region, Moshi, (2000) reported that an individual beekeeper could earn approximately US$ 1488 per annum from a sale of honey and beeswax. Many studies reported in this section revealed that, most of the income obtained from selling AF products were used to buy household requirements such as food, medicines and clothes; and was sometimes used for school fees and farm inputs.

2.7 Nutritional status of household

This is an outcome of many interrelated factors, which include environmental, biological, food quality and quantity, cultural factors and education. In many cases to state nutritional status of a certain community or nation, children are used as an indicator due to the fact that they are the most vulnerable group. According to FAO (1991), various diet-related health problems have cropped up in recent years, thus affecting high population in developing countries. Nutritional disorders in children are common in Africa and Tanzania is no exception. The main cause was found to be lack of some food nutrients in the body

such as protein, vitamins and minerals. Population in the developing countries receives micronutrients from indigenous vegetables and fruits (Okafor, 1981). Micronutrients include minerals and vitamins that are easily found from agroforestry products. The importance of micronutrients has now been realized over the last two decades (WHO and UNICEF, 1993). Food nutrients other than protein, energy and fat include vitamins and minerals, such as vitamins A, C, iodine, zinc, copper and selenium, are important for the whole range of vital functions in the human body. However, lack of these nutrients in the body leads to nutritional problems.

2.7.1 Malnutrition

This refers to a number of diseases, each with a specific cause which related to deficiency of one or more nutrients (e.g. protein, iodine or calcium). Each disease is characterized by cellular imbalance between the supply of nutrients and energy on the other hand and the body demands for them to ensure growth, maintenance and specific functions. Malnutrition occurs in many forms and persists in all countries of the world in spite of a general improvement in food supplies and heath conditions, and the increased availability of education and social services (FAO, 1996). About 174 million under-five children in the developing world are malnourished as indicated by low weight for age, and 230 million are stunted. Over 800 million people still cannot meet basic needs for energy and protein, more than two thousand million people lack essential micronutrients, and hundreds of millions suffer from diseases caused by unsafe food or by unbalanced food intake (FAO, 1996).

2.7.2 Factors influenciug nutritional status

Nutritional status is influenced by wide range of factors that may lead to inadequate or excessive nutrient intake or may impair nutrient utilization. According to FAO (1999), the following factors mostly affect nutritional status: -

(i) Food security

(ii) Knowledge, care and nutrition

(iii) Health

However, the factors are often interacting with each other. It is well recognized that poverty is the major cause of malnutrition. FAO (1997) reported that, acute and chronic under- nutrition and most of Micronutrient deficiencies primarily affect poor and deprived people who do not have access to adequate food. It affects people who live in unsanitary environment without access to sufficient and clean water, lack of appropriate education and information.

When poverty engulfs the family, the youngest are the most affected and most vulnerable. Their rights and survival, growth and development are at risk. Poverty is the main underlying cause of millions of preventable deaths and the reason why children are malnourished (UNICEF, 2001). In addition, poor and uneducated parents lack the information needed to provide optimum care for their children, increasing the risks of childhood illness and childhood mortality. Studies by FAO (1997) reported that, children born with mothers with no formal education are more likely to contract respiratory infections, diarrhoea, measles and other preventable diseases and are less likely to receive

needed care. For instance, in Tanzania, 80% of children who died before the age of five died at home without ever going to hospital (UNICEF, 2001).

2.7.2.1. Household food and nutrition

In sub-Saharan Africa where 70% of the population lives in rural area, crop and animal production, fisheries and forestry activities are a direct source of food and provide income with which to buy food. Increased and diversified production of food for family consumption is prerequisite for improved household nutrition. With regard to infant/ child nutrition, extent of breast feeding is important, and hygienic preparation and handling of food are crucial for diseases prevention and proper child growth (FAO, 1997).

The basic diet of Tanzania has a cereal base with variation across tribal groups (FAO, 1993). Maize, sorghum, millet and rice are dominant cereals in Tanzania. In the northern part of Tanzania, Kilimanjaro, Arusha and southern highlands, bananas and plantains assume a very important role in the diet, while consumption of cassava is high along the coastal regions (Rocheleau, 1988). The author further added that consumption of vegetables, legumes, and fruits of all kind is high but intake of meat; fish and dairy products is low. Therefore, overall food consumption is low and that the main cases of nutritional disorders are those of marasmus and marasmic kwashiorkor. Although the diet is mixed and varied, diets are often bulky for the young children. Cassava and banana are reported to be a good source of starch and are very poor in other nutrients. Despite that they are used as a base diet for children, resulting in malnutrition (Mosha, 1988).

2.7.2.2. Knowledge, care and nutrition

Malnutrition can occur even when a household has access to adequate amount of nutritious foods as well as access to sanitation and health services. This will not bring improvement unless households are able to take advantage of them that is sufficient knowledge and ability to care the vulnerable individuals. These are of critical importance (TFNC, 1992). More studies by TFNC (1992) revealed that, care consists of time, attention and support provided in the household mainly by mothers in the community. These are important to meet physical, mental and social needs of growing children and other family members.

FAO (1997) reported that, it is important to ensure that women's access to resources, knowledge and education are permissible in order to care better for their children. FAO (1997) recommended that, legislation to improve women's status in society and legal access to land and other productive resources is essential for future nutritional well being of family members.

2.7.2.3 Women workload

Overworking resulting from the time and the energy expended in taking the numerous tasks creates or amplifies conditions of inadequate children's food intake by reducing the frequency of meals. During the peak, period of farming the number of daily meals can be low and the care with which the food is prepared can be reduced during this time (Katani, 1999). Also, due to too much work, women might not be able to produce enough food for their family. A study conducted by Ricci (1996) looked at the relationship between maternal use of time and children's health and nutritional status and found that at two years of age, toddlers began to receive less intensive care, freeing the principal caretakers, mostly

mothers, for economic activities. The author further added that, participation of mothers in economic activities outside the household could have a negative effect on child nutrition, depending on the age of child. A study conducted by Wandel and Holmboe (1992) in Rukwa, Tanzania on women's work in agriculture and child nutrition reported that, women spent less time cooking and feeding their children during the peak labour seasons.

2.7.2.4 Diseases

The quality and quantity of food consumed determine the nutritional status of individuals. Inadequate feeding, especially for young children, or inadequate weaning foods and low intake of animal protein by growing children, are the major direct causes of malnutrition. The origin of such behaviour is sometimes deep rooted in social and cultural systems of the community (TFNC, 1992).

Poor nutrition predisposes to infection and in areas of limited food consumption, malnutrition follows after an episode of infection (Levinson, 1991). The prevalence of infectious disease is very high in Tanzania. Diarrhoea, malaria, respiratory diseases, and intestinal parasites like hookworms, measles and infection with human immunodeficiency virus HIV/AIDS have a major impact on nutritional status. The interaction of infection and inadequate food consumption cause growth retardation in children. Therefore, effective public health, improvement of environmental sanitation, better sources of drinking water, malaria control, observing balanced diets, good methods of cooking foods and immunization will result in a better fight against malnutrition (Mosha, 1988)).

2.7.3 Types of nutritional disorders

2.7.3.1 Vitamin A Deficiency (VAD)

This is a nutritional disorder due to inadequate intake or utilization of vitamin A. Deficiency may be secondary, resulting from various body states that interfere with vitamin A absorption and utilization (FAO, 1992). However, vitamin A deficiency may also be a complication of host diseases like Protein Energy Malnutrition (PEM), diarrhoea, measles, gastroenteritis, infectious diseases and intestinal parasites. In a retrospective study of the causes of blindness in children attending school for the blind in Tanzania, Levinson (1991) reported that, vitamin A deficiency was the most important cause of blindness. Moreover, vitamin A deficiency may lead to reduction in quality of life, thus, causes social implications for an individual who cannot support himself/herself. This deficiency could also induce infections due to the lowered resistance to diseases and fatality rate, which is high in children of underfive years of age. The problem can be solved by consumption of AF food products rich in vitamin A, such as fruits and vegetables like mangoes, pawpaws, passions, guavas, watermelons, pumpkin tops, carrots, red palm oil and yellow maize. Other sources include animal products chiefly butter, milk, liver, fish liver oils and eggs.

In arid regions; a seasonal deficiency of vitamin A is common. Preservation of green vegetables (on seasons) by good methods was found to prevent the problem (FAO, 1992). Studies revealed that human body could store vitamin A for a couple of months. On the other hand, it means that when children eat a lot of mangoes and papaya during the season, they can store enough vitamin A for several months (Ritchie, 1983).

2.7.3.2 Iodine Deficiency Disorders (IDD)

People who are on iodine deficient diets develop an enlargement of the thyroid gland, which is known as goitre (Levinson, 1991). Normally, the human body contains 40mg of iodine (TFNC, 1984). Further studies by TFNC (1984) revealed that, goitre in Tanzania is attributed to primary deficiency of iodine in the soil, water, food and the possible goitrogenic effect from the high consumption of brassicas. Goitre is known to occur in highland areas far from the sea. There are reports, however, of presence of goitre along the coast (Rufiji) (Levinson, 1991). In a report on the prevalence and geographic distribution of endemic goitre in East Africa, Levinson (1991), showed a distribution in the northwestern part of the country bordering Rwanda and Burundi, the coastal area of Rufiji, the central area around Dodoma, the southern highlands area, highland area on the eastern shore of Lake Tanganyika and in Arusha district at the base of mount Meru. However, there may be a high prevalence of goitre in other parts of the country, where surveys have not been done. Consumption of seafood products and cereals are the possible goitre fighting products (FAO, 1991).

2.7.3.3 Iron Deficiency Anaemia (IDA)

Anaemia is a result of iron deficiency in the body. This is a problem in developing and developed world, affecting about 1000 million people, including 370 million women of childbearing age. In a developing country like Tanzania, IDA is primarily a problem of women and young children. Among the causes of anaemia is low dietary iron consumption (FAO, 1980, 1991). Studies also reveal that, adequate amount of iron are not available in the body because it is not absorbed from the digestive tract. Vitamin C (ascorbic acid), which is easily found in AF fresh foods are essential in the absorption of iron (Ritchie,

1983). However, a well varied diet with fresh fruits and vegetables help to prevent anaemia.

Anaemia may also be precipitated by pathological non-losses due to hookworm or other parasitic infections, or red cell destruction by malaria parasites (Pelletier *et al.*, 1995). The author further reported that iron deficiency anaemia is likely to develop in adult, males with 5000 eggs/gram faeces and women and children with 2000 or more eggs/gram faeces. Therefore, hookworm causes intestinal blood loss and is termed to be part of nutritional problem. The authors further conducted studies and revealed that, infant anaemia is associated with retardation of physical and cognitive development and tends to reduce resistance to infections. In adult, it is associated with fatigue and reduced work capacity, impairs reproduction function and causes about 20% maternal death because it predisposes the body to hemorrhage and infection. Pregnant women anaemia results in retardation of foetal growth, low birth weight and increases rates of prenatal mortality. Food products which are good sources of iron include wild dark green vegetables, pumpkin leaves, sweet potato tops, cassava tops, whole grain wheat products, legumes, apricots, raisins. Others include meat, liver, heart, kidney and eggs (Ritchie, 1983).

2.7.4 Measures of nutritional status in childhood

The nutritional status of children is analyzed and evaluated in comparison with the common used U.S National Center for Health Statistics Standard that is recommended by the World Health Organization (WHO). Height and weight data as well as the information on the child's age are used to construct indices of physical growth that describe the

nutritional status of a child. Height for age, weight for-height and weight for age indices, each provide different information about the nutritional status of children.

Height for age is a measure of linear growth whereby children who are more than two standard deviations below (-2SD) the median of the reference population are considered stunted, a condition reflecting the cumulative effect of chronic malnutrition. (Christian and Greger, 1988)

The weight for height describes current nutritional status of children. This includes children who are below -2SD from the median of the reference population who are considered to be 'wasted' a condition reflecting acute or recent nutritional deficiency (Christian and Greger, 1988).

Furthermore, weight for age is the composite index of weight for height and height for- age and thus does not distinguish between acute malnutrition (wasting) and chronic malnutrition (stunting). A child can be underweight for his/her age because she or he is stunted, wasted or both. Children whose weight for age is below-2SD from the median of the reference population are classified as 'underweight and below –3SD are severely underweight (Christian and Greger, 1988). According to UNICEF (2001), it was found that the situation of malnurtition in Tanzania is:- underweight (27%), wasting (6%) and stunting (42%) both moderate and severe, respectively.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Overview

This chapter presents the research procedures and methodology used in the collection and analysis of data of this study. It describes the sampling frame and procedure and the sample size that was employed in collecting primary data and rationale for the technique. The chapter also describes the study methodology; the data collection exercises; data analysis techniques; reliability and validity of the data and concludes by providing the limitations of the study

3.2 Description of the study area

3.2.1 Location

Maji ya Chai, Kisongo and Kikatiti are wards of Arumeru district in the Arusha region of Tanzania. Arusha region is located in northeastern Tanzania. It is found within latitude 2°06' to3°S and longitude 36° 04' to 37° E. The district lies between longitudes 36^0 15'-36^0 55' E of the Equator and latitudes 3^0 00'-3^0 40'S. Arumeru district lies on the slope of Mt. Meru (the second highest mountain in Tanzania after Kilimanjaro) (Mkeya, 1994). It rises up to 14,000 ft above sea level in Arusha region. Arumeru district is one of five districts of Arusha region. The district is located to the northeastern of the region, bordering Kilimanjaro region to the east, Kiteto and Simanjiro to the south and Monduli district to the west and south. With land area of approximately 3000km^2, it has a population of 516,814 people of whom 51% are female and 49% are male. More than 90% of these live in the rural areas. The population is increasing at the rate of 2.8% annually (Bureau of Statistics,

2002). The area has bimodal rainfall pattern with long rains from March to May and short rains from October to December. The mean annual rainfall varies from 800mm below 800 m above sea level (m.a.s.l.) to 2000 m.a.s.l. Mean annual temperatures decrease with increasing altitude from 22°C between 800 m and 1000 m to 18 °C between 1000 m and 2000 m. a.s.l.

The study was conducted in Arumeru district (Fig.1) because it is one of the districts in Arusha, which has a long experience in agroforestry systems and so provided more practical information. Also, the area is selected due to easy accessibility and convenience to the researcher.

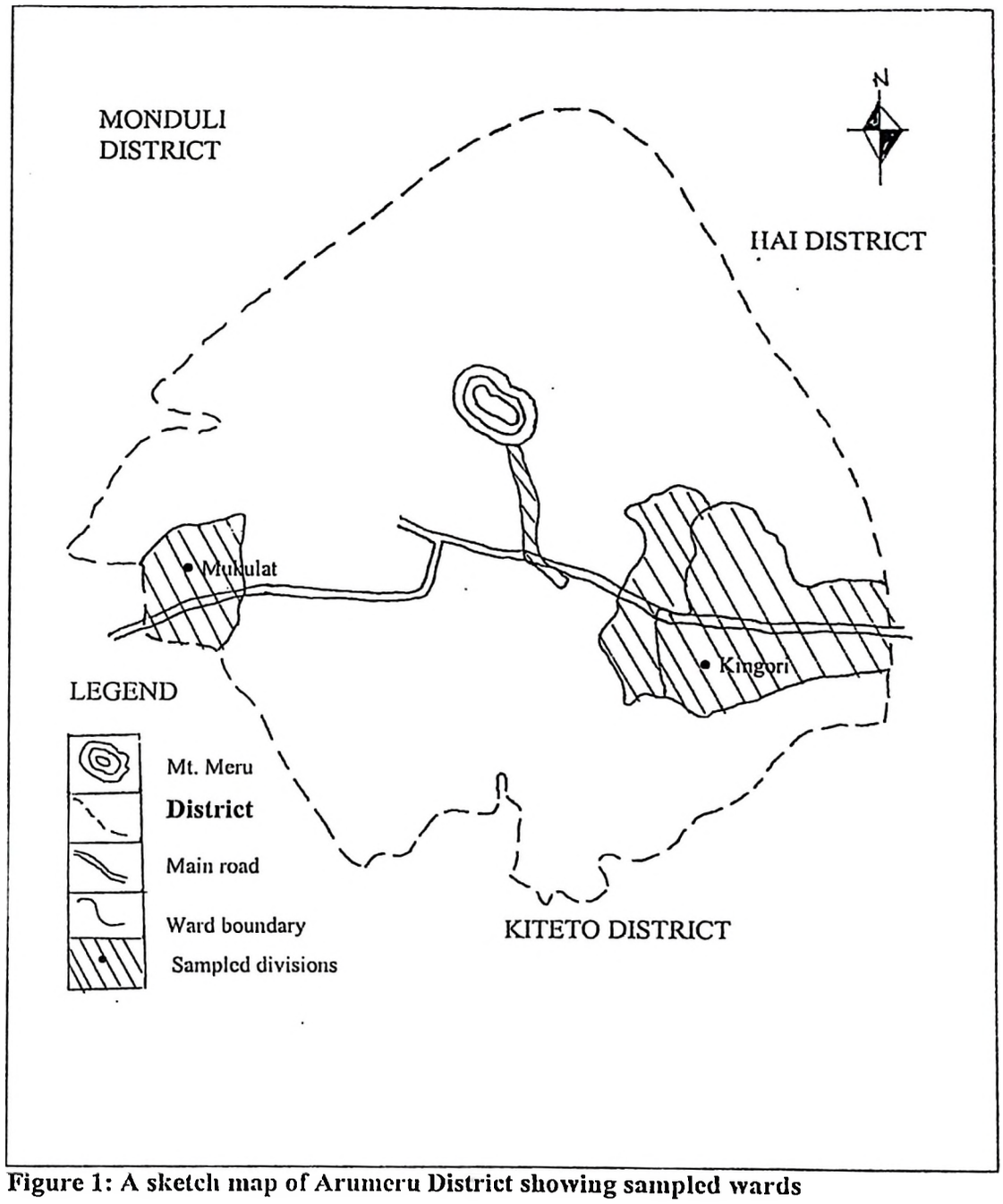

Figure 1: A sketch map of Arumeru District showing sampled wards

3.3 Research design

Purposive sampling design was used to select divisions, wards and villages. Random sampling design was used to select households as sampling units. A household in this respect is defined as a group of people who eat from a common pot, share a dwelling house and have the unit command from the head of the household who is the decision maker from the smallest unit of the village (Mbeyale, 1999).

3.4 Sampling procedure / sample size

A multi-stage sampling technique was used. This technique is convenient for studying large and diverse populations. The sampling stages or phase was at wards, villages and finally the households that are sampling units of the study. At each stage, random sampling method was used in order to obtain a true representative sample of the population intended. Three wards were selected, two from east and one from west of the district. The three wards were considered very important because it was anticipated that agroforestry practices and human nutrition varied from one area to another. In this study, samples were collected from eastern to western part of the district due to the fact that agroforestry practice appeared to be more intensive in the eastern part than in western part. This was important in finding out the contribution of agroforestry food products to human nutrition. Also, it was convenient for comparing the nutritional status between the two locations. Further sampling was done in village offices to get the key informants in each village that has to represent the village population in the discussion of this study.

Sampling was based on Body's formula n/N x 100=C, where C represents a figure greater or equal to 5% of the village households, N is total number of households in village, and n

is the number of selected households (Body *et al.;* 1981). A fixed number of households was selected and calculated using Body's formula resulting in 5% or closest to 5% (as long as it was above5%) of total households in the village. The entire sample consisted of 115 respondents. These sampled households were used to assess the contribution of agroforestry to human nutrition in the study area. Table 1 shows distributions of villages in the study area.

Table 1: Location of villages in Maji ya Chai, Kikatiti and Kisongo

District	Division	Ward	No. villages	Villages	Sampled households
Arumeru	Kingori	Maji ya Chai	1	Maji ya Chai	39
		Kikatiti	1	Seela	31
	Mukulat	Kisongo	2	Loovikuny	24
				Engorora	21
Total	2	3	4	4	115

3.5 Instrumentation and data collection

The data presented in this study was obtained from primary as well as secondary sources. Primary data was collected through well-structured questionnaire (Appendix 1). Physical measurements of children under-five years of age (anthropometric measurements), were taken and personal observation where information was noted in the researcher's notebook and informal discussion with villagers were done. Data collection was in two stages: -

3.5.1 Preliminary survey

This was conducted in some villages before an intensive study was done on selected villages. Preliminary survey was very important in obtaining general information about the villages and for familiarization and the introduction of the study objectives to the village

government. The questionnaire was pretested to correct the anomalies and thus help to gather information during the actual survey.

3.5.2 Basic data collection phase

This was an important part of the study where various techniques were used together to collected data and information, which included interviewing, group discussion and observation. The fieldwork of this study aimed at exploring information on the types of AF food products produced in the study area and their contribution to human nutrition. The fieldwork further intended to explore the cultural factors, which influenced the utilization of AF food products, types of trees and their function in the farms and different uses of trees found in each farm. In addition, the fieldwork intended to solicit peoples' views on the importance of agroforestry food products to their household nutrition.

3.5.3 Anthropometric measurements

Anthropometric measurements of 90 children in this study were taken. These included weight and height of children. Child's age and sex were also recorded. The weights of children below 24 months of age were taken using Salter scale. The scale (with weighing pant) was adjusted to zero before each child was weighed. With light clothing and without shoes on, the child was picked and left to hang freely supported by the pant. One reading was taken for every child to the nearest 0.1 kg. For the children above 24 months a digital bathroom scale (Seca, Inc., Colombia and MD) was used. With light clothing and barefooted, the child stood on the scale. One reading was taken for every child to the nearest 0.1 kg. The supine length of the children below 24 months of age was taken using length board. The board was laid horizontally on a flat surface and the child was laid on it

with the head positioned firmly against the fixed head board and eyes looking up. The knees were extended and feet flexed at right angle to the lower legs. The upright sliding foot piece was moved to obtain firm contact with the heels. One reading was taken for every child to the nearest 0.1 cm. For the children above 24 months of age, the length board was vertically propped on a flat surface and the child (without shoes) stood on it. The heels, buttocks, shoulders and the back of the head were put to touch the board upright and the head held straight and looking ahead and the hand hung loosely at the sides. The head piece was lowered gently to obtain contact with the head. One reading was taken for every child to the nearest 0.1 cm. Moreover, mothers of the children were requested to present their children's clinic cards from which the date of birth and child's sex were obtained. Child's age was calculated by subtracting date of interview from date of birth.

3.5.4 Determination of nutritional status

Each child's anthropometric measurements were compared to the growth reference curves developed by United States National Centre for Health Statistics and Centre for Disease Control and Prevention. World Health Organization has recommended the use of this growth curves internationally (WHO, 1983). The Centre for Disease Control and Prevention Epi info Programme (Epi INFO Version 6, CDC, Atlanta) was used to compute weight for height and weight for age. These nutritional status indices were expressed in terms of standard deviation (SD) scores or Z-scores.

3.6 Research tools and techniques

3.6.1 Interviewing

This technique was used to collect data and information based on the interaction between two people, answering questions and filling in the questionnaires. The questionnaire was designed to capture information on AF products and contribution to human nutrition. The questionnaire included semi-structured and open ended questions covering the objectives of the study. The data and information gathered was based on respondents' intuition, experience and inspiration of day to day practices. The respondents shared their personal views, agreement and disagreements on the information discussed. In the process of interviewing, it was learnt that the lesser the interview was unstructured, the more it allowed for freer exchange between the interviewee and interviewer, leading to acquisition of more information on the object. The approach made it possible to build understanding through the combination in both qualitative and quantitative manner.

3.6.2 Group discussion

The Focused Group Discussion (FGD) methodology was used to collect data from the selected areas. The reason for using this method was to get more diverse information about the agroforestry practice in the study area. The group comprised of four elderly males and female from each of villages under investigation. Experience showed that, normally, the elderly people would always have long experiences on matters of their particular area, and for that matter, on the agroforestry practices. The FGD was used to obtained information about agroforestry food products produced in the area, how the products used and off farm products, which are always used in the study area. The questions posed included: what types of food crops were included in the system? What tree species were used as

food/fruits? What type of vegetables was found in the area? What were off farm products normally used in this area? What were the common diseases for children of under-five years of age? Other question included was why have you decided to practice agroforestry system at farm? Moreover, the FGD aimed at getting the informants views on what could be the future plans to improve the production and use of agroforestry food products in the study area.

3.6.3 Observation

This technique was used in order to learn and to discuss with peasants on how the agroforestry practice contribute to their daily diet/ meal and what were cultural factors in utilization of agroforestry food products in their households. This observation was guided by unstructured interview, visiting the farms and finding out the different species of trees, vegetables, root/tubers and crop practice in the system. The technique also helped in collecting complementary data, validating information gathered through literature review and other means. Furthermore, the technique helped in understanding the advantages and disadvantages of agroforestry practices in relation to human nutrition. However, the observation technique was not enough to provide enough information on AF food products in the area. As such, it was supplemented by informal discussion.

3.7 Validity and reliability of the data

The research findings were mostly obtained through immersing oneself in the culture of the people of the study. Throughout the data collection period the researcher became part of local people; the process enabled, among other things, to understand how those people practiced agroforestry, what were the benefits of the system were with respect to human

nutrition? Efforts were made to listening, speaking skills and attitude to ensuring that the local people expressed freely in giving ideas. However, the validity rests on the fact that several methods were used in combination with triangulation and cross checking facts.

3.8 Data processing and presentation

The processing of data started in the field. Bernhard (1994a and b) draws a distinction between jottings, the diary, the log and the notes when working with the observation, semi or unstructured interviewing without a tape recorder. The author further emphasized that it is important to go through the jottings the same day in order to preserve the details. Moreover, the collected data needed to be coded and entered in the computer prior to analysis. Both qualitative and quantitative data need to be analyzed using the appropriate computer software for social research data analysis, e.g. statistical package for social sciences (SPSS). Descriptive statistics such as measures of central tendency mainly means and frequencies, percentage and measures of dispersion need to be determined. Descriptive statistics were used to determine frequencies such as the occurrence of various qualitative responses that included the description of agroforestry system and human nutrition. Data collected from farm inventories was analyzed to indicate the composition of various species and their uses. Special attention was on the species used as food. Cross tabulation was used to analyse the respondents' sampled characteristics, i.e., education level, tribe, age of under-five, AF food and animal products and eating habits.

Z- Scores of Weight for Age (WA), Height for Age (HA) and Weight for Height (WH) were used to deduce the nutritional status of children in the study area in comparison with the standard reference (WHO, 1983). Whereas, children whose Z-scores were below -

2.0SD of the reference population were categorized as malnourished (nominated as wasted, underweight, or stunted), those whose Z-scores were above-2.SD of the reference population were categorized as well nourished (nominated as normal).

3.9 Limitations and Delimitation

(i) In the course of conducting the fieldwork and during the data interpretation, this study hit some setbacks. The main problems encountered during the fieldwork were in methods of collecting data, unreliable transport, postponement of appointments, some difficulties observed when taking measurements from children since they related the researcher with a doctor.

(ii) There were passive resistant informants during the fieldwork. It was observed to be common with respondents from the western part of the district (Mukulat division), who pretended to be polite and loyal to the authorities, particularly to animal revenue collectors. The researcher was at times associated with SCAPA officers, which as a result made the informants to try to supply the information that they believed SCAPA officers wanted to hear. Conducting the interviews in privacy helped to minimize this suspicion.

(iii) The study faced the problem of recall data. Data collection depended on the respondent's memory. As a result, there was a notable difficulty on the part of the respondents to give correct amount of some categories of data such as household's production data and income. The researcher tried to minimize this problem by asking some questions more than once in different ways to get this information correctly.

(iv) Conversion of units was also a problem since some respondents used local units for example tins (*debe or kopo*), bags, etc., which were not standardized. Also, they tended to mix units for example, acre and hectares. Actual observation was employed by researcher as well as triangulation to minimize invalidity brought about by incorrect data.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 Overview

This chapter represents and analyses data in the context of the research questions and objectives advanced in this study. Quantitative and qualitative means of analysis were used. Percentages, frequencies, tables, figures/graphs and level of significance were used in elaborating the findings. Village level data was the focus of this study, which involved four villages as described in chapters one and three.

4.2 Production system

4.2.1 Land tenure and ownership pattern

People in Arumeru district own and use land on individual family basis. Land tenure is based on the inheritance systems where land is divided among sons. Land therefore belongs to men who are also heads of households. However, some widows and unmarried women can own plots, which are mainly acquired by buying. Though women have no right to own land they have the user- right by virtue of marriages. Women however, constitute the majority of subsistence farmers; they work to provide the families with food and other household needs.

There is land shortage in the district and the farmland is highly fragmented with holdings ranging from 0.1 ha near the highway to 2 ha at higher elevation. The majority of farmers have less than a hectare (average of 0.8 ha). Consequently, land conflicts have risen. This severe land shortage and the fact that nearly all-available land is intensively cultivated, hamper efforts to increase production and satisfy demand of food. Homegardening as the

AF practice in the district is used as a remedy to this problem. However, renting and purchasing land occurs in lowland areas, where lands seem to be plenty, an opportunity which is in favour of few rich farmers (Mkeya, 1994).

4.2.2 Farming systems and crop production

The majority of small-scale farmers are practicing agroforestry systems (Semu *et al.*, 1992). Family labour is the main production force. The main crops produced by small scale farmers in the study area included pyrethrum, sugarcane, banana, Irish potatoes, maize, beans, cassava, sorghum, sweet potatoes, yams, green peas, pigeon peas, cowpeas, chick peas and Lima beans. Farm production in many societies around the mountain areas was based on subsistence homegarden, which entail mixture of crops like coffee, banana and some vegetable crops (Mkeya, 1994). Most of the crops are permanent and are grown to facilitate efficient use of potential land both horizontally (multistoried) and vertically and in space and time. The sustainability however, is in terms of its ability to produce a diverse of products (for both subsistence and generating income) at a long time horizon. However, agroforestry practices are more intensive in the eastern part of district (Maji ya Chai and Kikatiti wards) than in western part of district (Kisongo ward). The land use pattern is summarized in Table 2.

Table 2: Land use in Arumeru District

Land use/ activities	Area (ha)	Total area %
Agriculture	51,575	17.81
Grazing	58,762	20.29
Pasture/ fodder	9,876	3.41
National parks	16,650	5.75
Forests	16,178	5.59
Water	40,117	14.06
Unsuitable	90,583	33.09

Source: Mkeya (1994)

4.2.3 Soils

According to Soil Conservation and Agroforestry Programme in Arusha (SCAPA) (1998), soils of Arumeru district are of volcanic origin, and are generally classified as andosols. The most fertile land with high rainfall is on the moderate and steep slopes of Mt. Meru and associate hills. These areas are densely populated with most land under cultivation. Soils are mainly of volcanic ash, hence highly susceptible to soil erosion. The plains, with low rainfall are used as rangelands with considerable livestock populations.

4.2.4 Vegetation

The slopes of Mt. Meru are surrounded by both indigenous and planted forest. The southern side on the steep slopes of Mt. Meru has a well-developed montane forest belt, while some catchments forests are protected as national, district or village reserves. State owned forest plantations have replaced indigenous forests in some areas. Despite the existing legal or community protection, forestry reserves are being depleted through encroachment for agriculture, indiscriminate burning and lumbering (SCAPA, 1998). According to Semu *et al.* (1992), the dominant indigenous species include *Cordia africana*, *Olea capensis, Albizia spp., Combretum spp., Croton spp* , and *Acacia spp. Grass* and herb species include: Maasai love grass, *African foxtail*, *Tripsacum laxum* (Guatemala), *Pennisetum purpureum* (elephant grass), *Canna edulis*, *Desmodium spp* and Devell's horse whip.

4.2.5 Water sources

There are seven major perennial rivers in the district, the major of which also flow through Arusha district. These include Nduruma, Ngaramtoni, Maji ya Chai, and Tengeru. Others

are Makumira, Themi and Kikuletwa. All of them originate from the forests surrounding Mt. Meru and contribute to economic development as they are utilized intensively for irrigation projects in the district (SCAPA, 1998).

4.2.6 Inhabitant and eating habits

The district is inhabited by two main ethnic groups the Waarusha on the west of Mt. Meru and the associated plains and the Wameru on the eastern slopes of the mountain, hence the district bears a combination of names of the two tribes. The Waarusha are an offshoot of the Maasai who have adopted a more settled pattern of farming unlike the Maasai who are mostly nomadic pastoralists. Most of Wameru are found in Maji ya Chai and Kikatiti while Waarusha are found in Kisongo ward.

The local people in the study area have varying eating habits depending on the availability of food. Three meals per day are taken when food is plenty and only one or two are taken when food is scarce. The morning meal (breakfast) is normally tea accompanied with bites made from wheat flour, roots or the meal of the previous night. The types of food that are normally eaten as lunch/dinner differ from the eastern to the western part of the district. In the eastern part, they normally eat stiff porridge (*ugali*) in Swahili) made from maize flour. *(Ugali)* is normally taken with green vegetables as relish, meat, fish or legumes. A number of green vegetables are commonly consumed. Since they are producing banana and rice they normally consume bananas and rice for dinner, which is accompanied with meat stew, vegetables, fish and legumes.

In the western part, they normally eat stiff porridge, made from maize and accompanied

with legumes. In their dinner, they normally eat "Loshoro" (in Arusha language) made out of maize, banana and milk. Sometimes they eat maize mixed with beans (*Kande*). Maize in the western part act as their staple food while bananas are dominant meals of people living in the eastern part of the mountain.

4.2.7 Socioeconomic activities

The Waarusha were originally pastoralists. In recent years, they have settled to become agropastoralists practicing mixed farming. The pastoral system of the Waarusha is defined according to the mode of association between livestock and cultivation. In general, they have adopted an integrated system of crops and livestock on permanent settled villages. Together with farming, few people are involved in beekeeping and craft works, and some are employed by several institutions in the district.

The historical production system of the Wameru is based on subsistence agriculture with large emphasis in crop production. Through interaction with the Waarusha, Wameru have developed interest in livestock production. Livestock numbers are not comparable to those of the Waarusha, instead become part of Wameru social system, especially on the northern area of Mt. Meru. However, the recent and fast adoption of improved livestock, especially dairy cows, stall-feeding is becoming a common practice.

4.3 Household and sample characteristics

The respondent's gender, age, marital status, level of education, household size and occupation were used to describe sample characteristics (Table 3). The word household, peasant and respondent have been used interchangeably in the document.

Table 3: Characteristics of respondents surveyed in Arumeru district

Characteristics	Number	%
Sex		
Male	68	59
Female	47	41
Marital status		
Single	2	2
Married	99	86
Divorced	3	3
Widow	10	9
Level of Education		
No education	21	18
Able to read and write	78	68
Primary education	2	2
Secondary education	7	6
Religion		
Christian	76	68
Moslem	8	7
Pagan	24	21
traditional	4	4
Ethnic group		
Meru	47	41
Arusha	44	38
Others	24	21
Main occupation		
Farming and livestock keeping	69	59
Farming and selling labour	8	7
Farming and petty trading	23	20
Farming and employment	16	14
Land ownership		
Inheritance	86	75
Purchase	25	21
Given by government	4	4
Age classes		
19-30	23	20
31-40	41	36
41-50	33	28
> 50	18	16
Household classes	72	63
2-6	38	33
7-12	5	4
13-20		

4.3.1 Age distribution

The age distribution of respondents is shown in Table 3. Most of the respondents (64%) were aged between 31-50 years, which is considered as the middle age. Indicating that this middle age respondents were the ones who dealt with AF practice, since they posses plots through inheritance or other means and were therefore able to settle with their families. There were only 16% of respondents who were above 50 years. At this age, majority did not contribute much labour to farms and they often lived with their sons who were married. The age and experience of an individual may play an important role in indigenous knowledge and practices. Old farmers are more knowledgeable, hence they contribute more effectively to information on AF products found in the area, and its contribution to human nutrition.

4.3.2 Household size

The size of the family is between 1 to 20 people, with an average of 12 members per household. According to Table 3 the majority (63%) of households had 2 to 6 people and 33% had 7 to 12 people while only 4% had more than 13 people. Family size is an important factor in determining the nutritional status of a family and also the extent to which labour is available in practicing AF systems.

4.3.3 Main occupation

The main occupation of the respondents is subsistence farming and livestock keeping (Table 3). Among the respondents, 59% were farmers and livestock keepers, 20% were farmers and petty traders, 14% were farmers and employees and 7% were farmers and casual labourers. Out of 115 respondents interviewed, 98% practice agroforestry system.

Therefore, the nutrition and economy of people in the area depend mainly on AF food and animal products.

4.3.4 Ethnic groups

Results from Table 3 show that, main tribes in the study area are Meru and Arusha, who accounted for 41 and 38% of the respondents, respectively. Other tribes account for only 21%. These are from neighbouring regions of Kilimanjaro and Singida. The diversity of the respondents is an important factor in studying the utilization of AF food and animal products in relation to nutritional status of people in the area.

4.3.5 Land ownership and acquisition

Table 4, gives status of land ownership and acquisition in the study area, whereby 98% of the respondents owned land and 2% did not.

Table 4: Land ownership and acquisition

Information	Respondents	
	Number	%
Land ownership		
Own land	113	98
Do not own land	2	2
Mode of land acquisition		
Inheritance	86	75
Purchase	25	21
Government allocation	4	4

The issue of women owning land is sensitive. Sixteen percent said women could own land but the majority 84% indicated women could not own land. It was traditional for men both in Meru and Arusha to own land and cattle, but few exceptions exist for other tribes found in the area where women can own both land and cattle. However, women can have ownership of land or cattle through outright purchase, through inheritance or by government land allocation. Table 4 shows that, most of the respondents (75%) acquired land through inheritance, purchase (21%) and by government allocation (4 %).

In the study area, land was scarce and the majority of farmers interviewed had a land with an average size of 0.7ha. The average land size in this study concurs with that reported by Mkeya (1994). As a result, scarcity of land has forced 80% of respondents to rent from other areas, where they practiced monocropping or intercropping.

4.4 Agroforestry practice in the study area

The common AF practices in the study area include homegarden, fodder banks, livestock pastures and trees, agriculture and crop production. Homegardens were the most common and 98% of farmers interviewed were practicing this type of AF system on their small pieces of land. Homegardens are usually located close to homesteads, and are regarded as an extension of the home. This system is common on private lands surrounding individual houses with definite fence in which several tree species are cultivated together with annual and perennial crops, often with inclusion of small livestock (Lundgren 1982). Common crops integrated within include trees, coffee, bananas, fruits, tuber, roots, climber crops, vegetables, legumes/pulses and cereals. Live fences surrounding homegardens were used as fodder banks. Common tree and plant species planted are *Setaria splendida*, *Dracaena*

afromontana, *Pennisetum purpureum*, *Eriobotrya japonica*, *Dracaena usambaresis* and *Croton macrochyus*, are among the common species planted and used as animal fodder. Trees also served as shade for goats, cows and sheep when they were left to feed themselves on these portions. However, only few farmers possessed enough land for their animals due to land scarcity. Seventy six tree species found in the area of which 57.8% were indigenous and 42.3% were exotic species. Moreover, 27.6% of these tree species are fruit trees that are mostly consumed by children (Appendix 3).

4.5.0 Components of AF system found in the study area

4.5.1 Trees

Trees are some of the components in AF systems. Tree establishment in the study area was not meant for income generation only but rather for other purposes like shade, fruits, windbreaks fodder, water retention, poles, local medicine, soil fertility, live fence and prevention of soil erosion. Currently, most farmers are aware that they could get money from selling wood products and non-wood products. In this case both, men and women are involved in tree planting and management. A total of 76 tree species were identified in the study area (Appendix 3). All species were scientifically identified, most (58%) of the species are indigenous while 42 % were exotic. The study revealed that, 28% of the species has been used for food. This implies that the households in the study area are knowledgeable on AF trees and utilize them for household subsistence. Similar study by Walter and Hamilton (1993) represent that, at global level, around 75,000 plant species are edible. About 12,000 plant species are useful for food, so far only 2000 has been domesticated Okafor cited in Okafor and Fernandes (1987) identifies 171 indigenous woody plants of nutritional importance, out of which about 55% are fruit tree species.

Other studies conducted on the importance of trees in household nutrition revealed the same. For instance Makonda, (1997) identified 156 useful species in Geita district, Tanzania while Mapolu (2001) identified 92 useful plants used as food in a similar study conducted in Tabora region, Tanzania. Therefore, it suffices, to say that useful tree plants play an important role in the household nutrition.

Meanwhile, about 50.7% of respondents had more than ten of both indigenous and exotic tree species in their farms, while only 40.3% of them had less and greater than 10 species of both exotic and indigenous tree species (Table 5). This suggests that indigenous trees in the study area are well protected due to the fact that 44% of the respondents indicated to use indigenous species for medicines. This concurs with results reported by Mahunnah, (1993), that medicinal trees and herbs were the main source of medicine for traditional healers and 80% of the rural people Moreover, the same study conducted in Malawi appreciated the sale of traditional medicine and other tree products as one of the main commercial activities in rural and urban area In addition, majority of household heads acknowledged that, those trees were good sources of income when their products were sold, such as timber (27%), poles (30) and pastures and fodder (15%). Therefore, those were among the motivations making people in the study area to conserve the indigenous species.

Table 5: Tree species found in each household visited

Number of trees in each household	% of households involved
Indigenous and exotic <10	7
Indigenous and exotic >10	50.7
Exotic <10, indigenous >10	1.7
Exotic <10, indigenous >10	40.6

4.5.2 Animals

Animals are among the component in AF system indicated in the surveyed area. About 7 species of animals are incorporated in the system; with an average of 2 species of animals in each household visited. These included cows, goats, sheep, rabbits, pigs, chicken and ducks, that are used for different purposes such as food, income, religious sacrifice, gift, squaring off conflicts, payment of dowry and ploughing. Most (37%) of the animals were cows while only 7.7% of animals were pigs (Fig.2). This suggests that a cattle keeping is of more importance in the area than other types of animals. This concurs with the research results presented by Nair (1993), that all forms of AF systems that incorporate animal in the tropical countries include more than one type of animal. The author urgued that, although there are similarities among the countries with respect to animals tamed in their AF systems, there are also many differences among them. For instance, people of Thailand keep animals for food, rituals, religious sacrifices and prestige while in Botswana they are kept for income, food, draught and bridal gift.

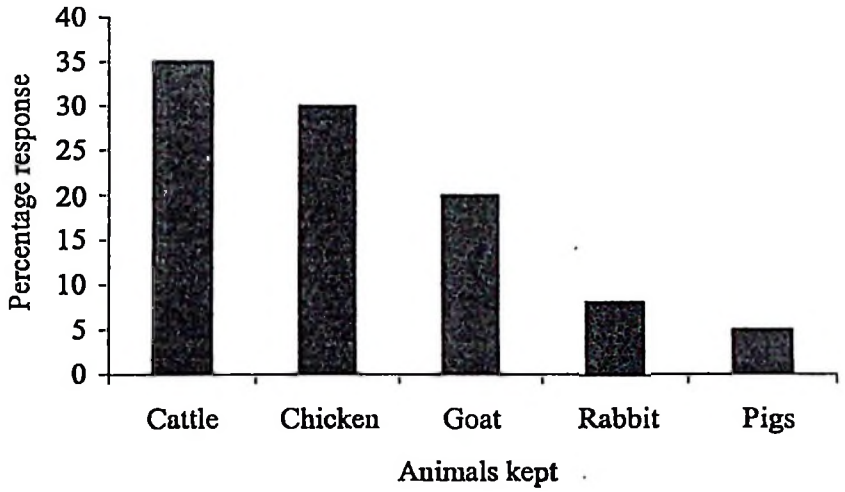

Figure 2: Percentage of animals kept in Arumeru, district

In this study, most (85%) of the respondents utilized animal products, such as milk, meat, ghee and eggs in their daily diets. Cattle as a component of various AF systems in the area contributed to household nutrition by production of animal protein and minerals (Vergara and Nair, 1985). Due to the problem of land in the eastern part of the district, 57 % of the respondents practiced zero grazing whereby all animals were fed in their houses. Only 42% practiced extensive grazing in the western part of the district due to the fact that, people possessed rangeland for their animals. Zero grazing enabled proper collection of manure, which was used in the system to improve soil fertility.

According to Kasembe *et al.* (1993), manure provides cheap resource of plant nutrients, which do not involve the use of foreign exchange. Manure supplied almost all the nutrient elements required by plants. Besides the provision of food products, and manure, animals contributed about 31% of household income (Fig.3). Kayumbu *et al.* (1998) also reported

in his study on AF and its resources that, livestock keeping was the most income generating activity in Arumeru district.

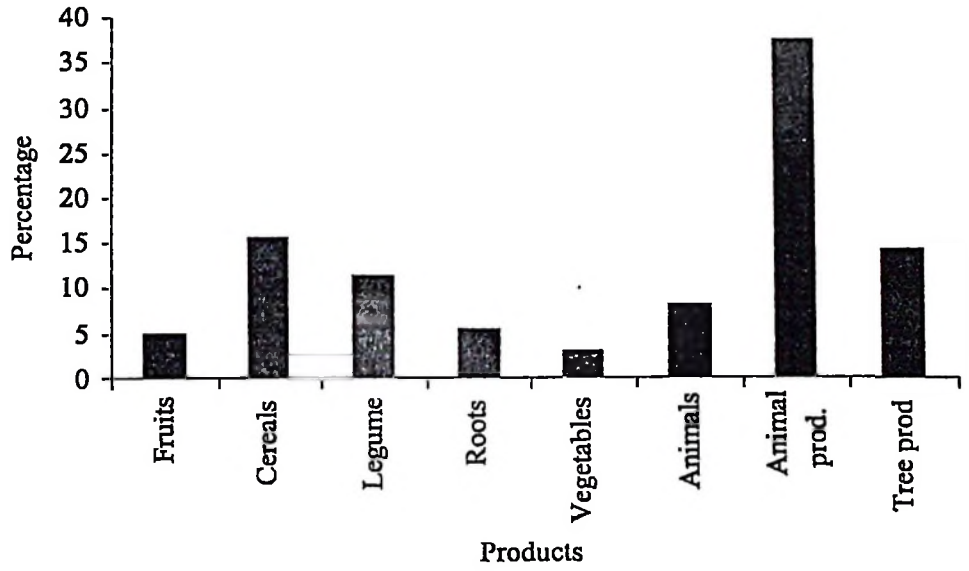

Figure 3: Indirect contribution of AF products to household income

4.5.3 Crops

The set of food crops found in the study area included banana (*Musa species*), maize *(Zea mays*), beans *(Phaseolus vulgaris*), sweet potatoes (*Ipomoea batatas*), yams (*Dioscorea species*), vegetables, pulses (soya beans (*Glycine max)* and cowpeas (*Vigna unguiculata),* pigeon peas (*Cajanus cajan*). Cash crops included coffee (*Coffea arabica*) and cardamon (*Elettaria cardamomum*). Similarly, the same types of food and cash crops were reported in other AF systems, e.g., Balasubramanian and Eglia (1986) and Rugalema (1992). Dominant root/ tuber crops found in the area included cocoyams and cassava (*Manihot esculetum Crantz*). Maize is usually grown in mixtures with several subsidiary crops such as okra (*Hibiscus esculentus L.*), pumpkin (*Cucurbita pepo*), cucumber and leaf vegetables (*Amaranthus spp; Corchorus olitorius L.; Telfairia occidentalis*, and *Solanum spp*),

legumes and some pulses. According to Okafor and Fernandes (1987), major crops associated with AF systems included; maize, various pulses, wheat (*Triticum aestivum*), barley (*Hordeum spp),* and buckwheat (Polygonum spp.) and around the trees, various vegetables and bananas were grown for household consumption.

Most (52%) of the respondents indicated concentrating mostly in the production of cereals, legumes vegetables, roots and pulses whereas 38% based on production of the cereals, legumes and roots (Table 6). This suggests that cereals, pulses/ legumes, roots and vegetables are dominant crops in the study area. However, 76% of the respondents declared that they consumed all species of crops produced in the AF system. Furthermore, production, sales and consumption of AF products varied from one village to another as indicated in (Appendix 6-9).

Table 6: Crops produced in the study area

Crop production	%of total respondents
Cereals + legumes+roots+vegetables+pulses	52
Legume+ cereals+vegetables+roots	38
Cereals + legumes+vegetables	8
Cereals + legumes+roots+vegetables+oils	2

4.6.0 Contribution of AF to human nutrition

AF products in the study area contributed to human nutrition through supply of food products throughout the year; improve nutrition through utilization, exchange through barter system and indirectly through cash generation. AF products identified as food in the study area were vegetables, fruits, animal products, honey, roots/tubers, legumes/pulses and cereals. Around 98% of respondents practiced homegarden as the farming system; this

means that AF practice in the study area was important system for food production. However, the productions of different types of foods depended much on the size of land available. The average size land the study area per household in the study area as indicated in previous sections is about 0.7ha. This suggests that farmers had to grow all the crops needed in the same piece of land.

4.6.1 AF food products in the study area

4.6.1.1 Vegetables

A total of 19 species of vegetables have been identified to be consumed in the study area as a form of sauce or relish. This was taken together with the staple foods, most commonly maize, banana and rice (Appendix 4). In Swaziland, Oglea and Grivetti (1985) reported identifying 49 species of plant leaves consumed as vegetables. The present study showed that the most commonly utilized vegetables were Amaranthus (84%), and *Galinsoga parviflora* (72%), spinach (65%), cowpea tops (62%), *Gynandropsis gynandra* (58%), *Launaea cornuta* (45%) and cassava leaves (43%). Vegetables were picked throughout the year but mostly during the rainy season. These vegetables are consumed fresh providing the body with vitamins and minerals. Amaranthus and spinach for example are rich in vitamin C and iron while cowpeas tops are rich in calcium and iron. To ensure availability of vegetables throughout the year, 35% of the respondents have special gardens for vegetables in the AF system, whereby they irrigated during the dry season.

It was observed that the cultivated vegetables were mixtures of different species. This mixture improved taste and palatability since they are mixed during cooking; this indicates that mixing different vegetables during cooking increases chances of consuming more and

different nutrients, which are important in the body. According to Malaisse and Parent (1985) and FAO (1990) studies, vegetables were found to be an excellent source of vitamins and minerals. For example, leaves of *Balanites aegyptiaca* were rich in calcium (37g/100g,) and *Amaranthus spp* are rich in iron (8.9mcg/100g) and β-carotene (5716mcg/100g). Therefore, the results showed that vegetables played an important role in the provision of relish and nutrients in daily diet throughout the year.

Most (70%) of respondents had at least three different vegetable species incorporated in AF system that are either planted or locally grown. With average production of 423 kg/ year in each households' farm; 77% of total production of vegetable is consumed in households and 23% are sold (Table 7).

Table 7: Production, sales, consumption and purchased of products in the study area

Products	Production (kg)	Sales (kg)	Consumption (kg)	% consumed	Purchase (kg)
Cereals	81113	12174	68939	85	5562
Roots	12446	3808	8638	69	815
Vegetables	13866	3154	10712	77	2175
Fats/oils	833	0	833	100	0
Legumes/pulses	18079	2956	15123	84	0
Animal-products	75421	19932	55489	74	5747
Fruits	40772*	9727*	9797*	76*	4490*
Animals	1203**	130**	-	-	-
Tree products	1131.5***	1131.5***	-	-	-
Total	244864.5	53012.5	169531	69.2	18789

*Number of fruits ** Number of animals *** Number of trees

This implies that, at least 1kg of vegetables is consumed per day (i.e., 170g per individual). On the other hand, it was observed that, all members of the household consumed vegetables as relish for staple foods. This concur with results reported by Fleuret (1979)

that green vegetables are valued food because they were cheap and accessible and thus were essential part of everyday diet, which accounted for 81% of all side dishes. The amount of vegetables consumed per meal ranged from 16-200g/serving and 10-43g/serving for the two main vegetable dishes. This amount of vegetables consumed as stated by Fleuret (1979) is almost the same as that reported in the study area. This implies that even though vegetables are normally utilized in small quantities on a daily basis, they played an important role in human nutrition in rural communities.

Besides the use of vegetables as food, women sold the surplus to generated income. Among households, the income from sales of vegetables contributed 3.3% of total income in the household (Fig. 2).This supports the results from a study conducted by FAO (1991) on vegetables that green vegetables have a great economic potential and their promotion will help to alleviate poverty, improve household nutrition and thus reduce malnutrition. A study done by Fleuret (1979) in Tanzania also revealed that, green vegetables were available on sale in all markets in Usambara district by women.

4.6.1.2 Fruits

A total of 27 fruit species were identified to be edible in the study area (Appendix 5). In a similar study in eastern Africa, FAO (1983) listed 40 species of edible fruits. Ruffo (1989) listed 16 fruit trees from east Usambara Mountains of Tanzania. Results from Table 8 show that, commonly utilized fruits included *Carica papaya* (62%), *Persea americana* (60%), *Psidium guajava* (58%), *Mangifera indica* (46%) and *Cordia monoica* (37%). Similarly, Campbell (1993) reported that the most frequently consumed fruits and valued fruit species in Zimbabwe were *Diospyros mespiliformis, Strychnos cocculoides, Azanza girkiana and*

Parinari curatelifolia. The fruits were consumed as snacks, dietary staples and used in making beverages, most particularly mixed fruit juices.

Table 8: Average production and consumption of fruits in the study area

Product	Average production (Number)	% consumed
Carica papaya	76*	62
Persea americana	116*	60
Psidium guava	106*	58
Mangifera indica	143*	46
Cordia monoica	118*	37

*Number of fruits

The study also revealed that most of the fruits were consumed as snacks by children and adults while in the field, tendering crops, herding animals and walking to school. Similarly, Oglea and Grivetti (1985) in Botswana noted that most fruits were consumed away from the homestead, when walking or working and children consumed the greatest quantities of fruits. Most of these fruits were eaten directly at harvest.

Nutritional analysis of some of the fruits has been conducted and showed them to be rich in nutrients. FAO (1990) for instance, reported *Sclerocarya birrea* fruits to contain four times as much vitamin C as sweet oranges. Its nut was rich in protein, (over 30%) and also contained 57% oil. Similar studies conducted by FAO (1992b) reported the fruit of *Adansonia digitata* to contain 369mg/100mg of vitamin C.

The study found that, the average production of fruits which were incorporated in AF system in the surveyed area was 40,772 fruits /year, with average of 355 fruits in each

household. Of the fruits produced 76% are consumed at the household level, whereas only 24% of fruits are sold (Table 8). More than 20% of fruits were sold of which income obtained contributed about 5.1% of total household income in surveyed wards (Fig. 2). However, fruits contribute about 3.9% of total food production in the study area. Therefore, it suffices to suggest that fruits are important AF products, which contributed to household nutrition. Hines and Eckman (1993) surveyed on multipurpose trees in Tanzania concluded that the significance of fruits was nutritional rather than economical, as most was consumed at homes and not sold.

4.6.1.3 Roots / tubers

Respondents mentioned four species of root/tuber crops that are utilized in the study area (Table 9).

Table 9: List of roots and tubers identified by respondents in surveyed area

Common name	Local name	Scientific Name	% consumed
Cassava	mihogo	*Manihot spp*	*76*
Sweet potatoes	Viazi	*Ipomoea batatas*	*67*
Yams	maduma	*Dioscorea spp*	*43*

The most commonly consumed roots and tuber are *Manihot spp* (76%), *Ipomoea batatas* (67%) and *Dioscorea spp* (43%). Malaisse and Parent (1985) identified more than 40 species of roots used as food in upper Shaba. Similarly, Kabuye (1986) also identified 57 species of roots and tubers utilized as food in semi arid regions of Kenya. The survey found that roots/tubers had different uses. For instance, *Manihot spp* and *Ipomoea batatas* were used as snacks while *Dioscorea spp* were used as main dish. However, some of respondents indicated that they used local potatoes as food substitute for the period of

hunger. Most (86%) of Wameru interviewed responded to be utilizing *Musa spp* in their daily meals.

The average production of tubers /roots as revealed in this study is 195kg /year in each farm. Roots and tubers contributed 6% of total produce in the surveyed households. However, 38% of respondents indicated the sale of roots/tubers for income, which is found to be contributing about 5.5% of total household income from AF products (Fig. 3). This study proved that tubers/roots played a major role in household nutrition because 69% of the production is consumed in the households. Similar findings have been reported in different studies by Missano *et al.* (1994) that roots/tubers are consumed widely by rural people and were bought by town dwellers as food or sometimes snack. Furthermore, FAO (1991) argues that roots and tubers are important foods because of their richness in carbohydrates, minerals and water. Although various studies indicate roots and tubers to be rich in nutrients and also as important source of food during the drought period, this study showed them to be least frequently utilized. The study revealed that, the low frequency of consumption of roots and tubers was due to the fact that their cultivation and processing is too laborious.

4.6.1.4 Cereals and legume

Other crops that were incorporated in AF system in the surveyed area included cereals and legumes. These crops are important due to their availability and consumption throughout the year. Two common species of cereals identified in the study area included maize and paddy. Although the species were incorporated in the system with trees it has been discovered that, the average production per year was about 413 kg/year/farm. Of these 85%

of produce was consumed at household level (Table 8). About 22% of respondents sold at least 15% of their cereal produce to solve household problems, such as buying other foods, agricultural inputs, medicine and paying school fees. However, income from sales of cereals contributed about 11.2% of household income (Fig. 3). On the other hand, 25% of respondents reported that cereals produced in their farms were not sufficient for their household requirements. This is supplemented with purchases. The study revealed that, in western part of the district every meal contained cereals as one of the main ingredients. The common consumed foods included *loshoro* (which is made up of maize, milk and some banana), (*Kande*) and *(ugali*) vegetables, legumes and meat acted as relish or sometime they did without them. For this fact, cereals were of great need in western compared to eastern part. Cereals are good sources of carbohydrates, minerals and vitamin B (FAO, 1991). FAO (1991) further added that, the principal carbohydrates eaten are chiefly obtained from cereals, potatoes and bananas. Furthermore, cereals contained approximately 70% of carbohydrate that provided the body with energy. In addition, a total of six species of legumes were identified in the study area (Table 10). The most commonly consumed species are *Phaseolus vulgaries* (76%), *Phaseolus radiata* (59%) and *Cajanus cajan* (45%). Since land was scarce as explained in previous sections, legumes were intercropped with cereals on the same plot.

Table 10: Cereals and legumes/pulses identified in the surveyed area

Common name	Local name	Scientific name
Cowpeas	Kunde	*Vigna unguiculata*
Pigeon peas	Mbaazi	*Cajanus cajan*
Greenpeas	Choroko	*Phaseolus radiata*
Beans	Maharage	*Phaseolus vulgaris*
Lima bean	Ngwara	*Dolichos lablab*
Maize	Memba	*Zea mays*
Paddy	mpunga	*Oryza sativa*

Around 89% of respondents indicated that plots were not sufficient to meet their family requirements. Therefore, they hired land to solve the problem. Legumes are annual crops, which accounted for an average of 194 kg/year/farm. Families consumed almost the total production. Species like Lima beans, chickpeas and green peas are mainly for generating income. Legumes (lima beans and chickpeas) are good sources of plant protein and minerals. Besides its nutritive value, respondents were producing them only for generating income instead of household consumption. This study revealed that income from selling legumes, which are not consumed by respondents, contributed about 11.4% of total household income (Fig. 3). Therefore, selling AF products provides an answer to household financial problems. This study thus suggests that legumes are important food for promotion of household nutrition as it has been found to contribute 5.4% of total produce studied in the area (Fig. 3).

4.6.1.5 Animals and honey

Animals are another group of important AF products that provide household food and nutrition through direct consumption. The range of species consumed in the study area included poultry, insects, cattle, goats, sheep and rabbits and their products such as eggs, milk and honey. Animal products offered an important part of the diet, in most cases providing nutritionally important source of protein, minerals and some vitamins. In the study area, where Meru and Arusha ethnic groups were dominant, there was high consumption of milk and meat. However, the consumption of meat and milk was more pronounced in the western part of the district .where Waarusha tribe resides; 64% of respondents (Waarusha) consumed meat or milk in one of their meals. Meru people from the eastern part have high rate of meat consumption. Fifty two percent of respondents

consumed meat daily. On the other hand, 30% of respondents reduced their frequency of eating meat due to high prices. Instead, the frequency of legume and vegetables consumption increased.

Honey is a valued AF product found in the study area, where, 24% of respondents harvested honey twice a year. Honey in the study area is eaten directly with some plant materials, regarded as medicine for healing wounds, used as jam, sugar for soft drinks and acted as food preservative. This concur with results reported by Kihwele *et al.* (1999), that in Singida and Dodoma honey is collected three times a year. The author further added that, honey provided an important source of non-proteineous animal food product. For instance, Wahazabe indicated honey mixed with nuts is very nutritious food for infants and children.

Beekeeping is a source of food in the surveyed area and also acts as a source of income through the sale of honey. About 46% of total production of honey was sold in each harvest despite the fact that respondents complained of unreliable market for the product, obsolete processing machinery and storage facilities. The study also revealed that production of honey and its products is out on small scale basis, whereby beehives made up of log and bark hives are commonly used. According to Kihwele *et al.* (1999), honey and beeswax are the principal products of beekeeping, the bulk of which is produced by traditional beekeepers in rural areas; suffering from inadequate market, out of date processing machinery and storage facilities. It was very exciting to find that women are involved in beekeeping together with other income generating activities.

4.6.2 Indirect contribution of AF products to human nutrition

4.6.2.1 Income from AF products

Table 11 represents results on average production and sales of AF products per household in the study area. These results showed that households could earn an average of 79,126 TAS per annum from AF products. Results also showed that, animal and tree products constituted 38 and 16%, respectively of the income earned by households through selling AF Products (AFP). Therefore, animal and tree products contributed more income than other AFP. Various studies indicated income from AFP played an important role in supplementing household income. In some cases income earned from AF products was used to purchase food or is invested in agricultural inputs and livestock. According to FAO (1991), income also often contributed to other securities such as housing, health care, education, construction and clothing. These results are in the same line with those reported by Kayumbu *et al.* (1998), that animal keeping was the most income generating activity in Arumeru district. Animal products (milk and eggs) in this study show a high percentage due to the fact that, 98% of respondents had at least chicken and cows. This meant that majority of respondents receive milk and eggs. This could be a result of the traditional customs of the study area that each household should keep one type of animal to produce manure for the farms. Manure is one of the products that are benefiting from animals. According to Kasembe *et al.* (1993), manure provides cheap sources of plant nutrients, which do not involve the use of foreign exchange. Semu *et al.* (1992) reported that, in AF systems sustainability may be enhanced with external inputs like farmyard manure through composting that was essential to improve the system; given that animal keeping, tree planting and soil conservation in Arumeru district are closely related.

Table 11: Average production and sales of AF products in the study area

Product	Production (kg)	Product sold(kg)	Income(Tshs)
Cereals	413	211	12205
Roots	165	50	4278
Fruits	225 *	60 *	4010
Vegetables	158	56	2253
Fats/oils	11.5	-	-
Animal products	516	327	29426
Animals	12**	1**	6669
Pulses/legumes	194	67	8910
Tree products	58***	8.5 ***	11175
Total			76126

*Number of fruits **Number of animals ***Number of trees

Nutritionally, the results (Table 12) shows that, 37.3% of income from selling AFP was used to purchase foods stuffs which are either produced in the system but are not sufficient for some households, or off farm products. For instance, the study revealed that 59% of respondents purchased Irish potatoes because they did not produce the product. Around 39% purchased banana due to insufficient production for household consumption, whereas 47 and 44%, respectively purchased vegetables and fruits, either due to drought or need of varieties, which were not found on their farms. Findings of a study done in Lima homegardens of Peru, which were reported by Soemarwoto (1987), showed that, with average size of 0.02ha, farmers generated an income of US$ 28.33 in five months. This income although small was reported to have added almost 10% to the family income, which was used for purchasing off farm products. Other sources of income were sales of banana and other crops. However, in 1983, coffee accounted for 11.7% of the total cash income for families in the Gisaka Migongo region in Rwanda. Banana during this year contributed 38.3%, food crops and their products 13.9% and livestock 5.2% (and Price, 1986).

Table 12: Average off farm products purchased per household

Products	Income used (Tshs)	% of income used
Fruits	1362.6	1.7
Cereals	9985	12.6
Legume/pulse	1827.7	2.3
Roots	5474.3	6.9
Vegetables	2929.6	3.7
Animal products	8015	10.1
Total	29594.2	37.3

4.6.2.2 Income from non-farm activities

To generated income, especially when returns from farm activities are low, farmers practiced non-farm activities. These included casual labour, petty trade, employment and selling local brew. Almost half of the farmers interviewed engaged in non-farm activities. The proportion of farmers involved in non-farm activities fluctuated due to the fact that not all farmers engage in non-farm activities throughout since some of them did so only when the situation in farm activities worsened. Average annual income from off-farm activities were.55,787 Tshs. The income obtained in off farm activities has been indicated to supplement household needs.

4.6.3 Nutritional status in the study area

Most (78%) of households interviewed had under-five children, whereby their anthropometric measurements were taken to study the nutritional status of people in the area (Table 13). The results indicated that 30% were stunted, 14% underweight and 8.9% were wasted. These results were almost the same as those reported by UNICEF (2001) that, rate of stunting in Tanzania was 42%, underweight 27% and wasting 6%. This meant that 53% of children assessed had at least one of the nutritional problems. Although the previous section (4.3) of this study revealed that 98% of respondents practiced

homegardens, this was contrary to many studies, which indicated that, where homegardens were practiced intensively, they provided household with variety of food products that supplied essential nutrients in the body (Okafor, 1987). These results indicate that, there is improper consumption of the AFP in the study area.

Table 13: Nutritional status in the study area

Village	% Sample		%Stunting		% Wasting		%Underweight		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Maji ya Chai	24	27	5	21	2	8	3	13	10	42
Seela	27	30	26	22	2	7	5	19	13	48
Engorora	17	18	9	53	2	12	2	12	13	77
Loovikuny	22	24	7	32	2	9	3	14	12	55
Total	90		27	30	8	8.9	13	14	48	53

Results from this study showed that, there is a significant difference between the nutritional status in western and eastern part of the district. In the eastern part, the nutritional status of children was better off compared to the situation in the western part. This might be due to the fact that, AF system in the eastern part seemed to be more intensive than in the western. The eastern part had more varieties of food products such as vegetables, fruits, animal products and cereals. This showed that their diets contained more of vitamins, proteins, minerals and carbohydrates that were essential for prevention of malnutrition. Children received more of minerals and vitamins, since they ate fruits and vegetables, elders rarely ate vegetable and fruits. Vitamins facilitate the absorption of fats and carbohydrates and some minerals, e.g., vitamin C facilitates the absorption of iron. This concurs with results reported by Seenappa *et al.* (1986), that AF food products were very important in supplying essential nutrients, which were important in the body. AF products in the eastern part also

contributed to human nutrition through generation of income and employment from sale of harvested goods and processed products such as honey, timber, fibre and extracted products. This income was used to supplement household needs such as food and medicines (Okafor, 1987). This study suggests that, AF food and animal products have significant contribution to household nutrition given that more than 60% of AF produce is consumed at household level. Therefore, occurrence of malnutrition in surveyed area might have been results of factors other than lack of food, such as level of education, eating habits, ethnicity, women workload, poor methods of cooking and storage of foods.

4.6.3.1 Common diseases in the surveyed area

According to the field survey (Table 14) there are four common diseases, which were mentioned frequently. The surveyed data also showed that the average frequency of attack of most of diseases according to respondents was three times a year. Around 41% of the children experienced diarrhoea and 31% coughing problem. Diarrhoea and coughing are thus the chronic problems in the study area. According to UNICEF (2001) reported that children who are poor and malnourished are more likely to contract respiratory infections, diarrhoea, measles and other preventable diseases.

Table 14: Common diseases in the study area

Villages	Sample		Diarrhoea		Fever		Cough		Malaria	
	No.	%	No.	%	No.	%	No.	%	No.	%
Maji ya Chai	24	27	4	17	5	21	12	50	3	12
Seela	27	30	9	33	6	22	7	26	5	18
Engorora	17	18	9	53	-		5	29	3	18
Loovikuny	22	24	15		68-		4	18	3	14
Total	90		37	41	11	12	28	31	14	16

Furthermore, the study (Table 15) observed that more than 81% of the households with under-fives, kept food for their children for later use, whereas 40% of respondents kept this food in containers with no lids and 41% kept in flask containers. When respondents were asked if they warmed food before feeding their children 33% of them responded that they warmed the food before feeding the child and 55% did not. This could be the reason why diarrhoea I s common in the study area

Table 15: Handling of food for child in the study area

Questions	Responses %	
	Yes	No
Do foods remain for later use?	81	9
Where food kept? Container with no lid/ flask	40	41
Is food warmed before use?	33	55

4.6.4 Results from cross tabulation

4.6.4.1 Education level of the head of households against underweight children

Tables 16, shows that most (54%) of children from households headed by persons with no education were underweight. Only 7% were found from households with primary education. Education is associated with higher socio-economic status. However, this study suggested that education has a strong positive impact on nutritional status as supported by results from Pearson Chi-square that showed significance at $P< 0.05$. With education an individual could easily adopt nutritional innovations introduced in the society. This has also the ability to make proper combination of available foods to have quantity and quality required by the body.

Table 16: Level of education and undernourished children

Education head	Total sample		No. of undernourished
	Number	%	%
No education	16	18	54
Primary education	70	74	7
Secondary education	4	4.4	25

4.6.4.2 Ethnicity against stunting of children

Table 17 showed that 37.8% of children from Arusha tribe were stunted as compared to children from Meru (30.3%) and other tribes (15%), respectively.

Table 17: Ethnicity and stunting of children in surveyed area

Ethnicity/Tribe	Total sample		%Stunting
	No.	%	
Meru	33	37	30.3
Arusha	37	41	37.8
Others	20	22	15

This indicated that there is strong relationship between tribe and nutritional status (height against age). This was also supported by result from Pearson Chi-square, which proved to be significant ($P<0.01$). This suggested that eating habits of people had strong effect on their nutrition. Respondents from Waarusha tribe had a tendency of consuming cereal based foods. Most of them were made of maize (*loshoro*) or maize mixed with beans (*kande*). Some vegetables were mostly consumed in the rainy season otherwise they had to purchase due to the fact that the area is usually very dry. The study also revealed that 45% of fruits consumed by the Waarusha people were purchased from the market because they had limited varieties of fruits in their farms, a fact that made children to consume fruits only twice a week (market days). In addition, 74% of Waarusha respondents indicated that,

they did not have special foods for their under-five children. Instead, they ate with adults regardless of their age. Due to the big family size as indicated in previous sections, the quantity and quality of food consumed by under fives were not sufficient for body requirement. It is well known that, under fives need more nutrients as they are growing and have many activities which make the body demand more of the nutrients.

Furthermore, the study revealed that 36% of respondents from Waarusha tribe never attended school. Consequently, though they had some food products from AF system, they also lacked the knowledge of proper combination of foods to produce a balanced diet. This resulted in malnutrition. In addition, discussion with village leaders and health officers indicated that there were traditional beliefs that hindered utilization of some foods by children. For instance, in Waarusha tribe, children were not provided with meat because people believed that only milk was enough for young children. Children in this area were only provided with *loshoro*. On the other hand, within the family, some children were not allowed to eat meat due to some customs. Furthermore, families with high economic status considered vegetables as inferior food products, which led to lack of important nutrients for their children. Poor methods of preparation of foods, such as vegetables led to loss of nutrients such as vitamins and minerals. Boiling was the main method used for cooking foods in the study area. This method led to loss of nutrients that were soluble in water, i.e., vitamins B and C. According to TFNC (1992) malnutrition can occur even when a household has access to adequate amount of nutritious foods as well as access to sanitation and health services. This will not bring improvement unless households are able to take advantage of them, i.e., sufficient knowledge and ability to care the vulnerable individuals.

Moreover, data from this study revealed that those children between ages of one to three years were the most affected group. This might be true for the reason that, most women are very busy in farm and income generating activities and had less time for their children (Table 18). It has been found that most of the women who are engaged in petty trade, take their children with them, whereby they feed them either with fruits only or they provide them with snacks for their lunch. Thus, children receive the real meal once per day, i.e., dinner. The results confirm findings from survey by Mbago (1992), which showed that the prevalence of moderate and severe forms of malnutrition was high in children aged 13 to 36 months. Furthermore, a study that looked at the relationship between maternal use of time and children's health and nutritional status found that at the age of two years, toddlers begin to receive less intensive care, freeing the principal caretakers, mostly mothers, for economic activities. Participation of mothers in economic activities outside the household could have a negative effect on child nutrition, depending on the age of child. Another study, in Rukwa region of western Tanzania, reported that women spent less time in cooking and feeding their children during the peak labour seasons (Wandel, 1992). Although this study was carried out in a high activity season, findings from Rukwa are relevant to this study.

Table 18: Sex and economic activities of households with under fives in the study area

Sex	Farming		Farming and labour		Farming and trade		Total	
	No.	%	No.	%	No.	%	No.	%
Male	19	76	4	16	2	8	25	28
Female	35	54	15	23	15	23	65	72
Total	54	60	19	21	17	19	90	100

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Overview

This chapter outlines the major conclusions drawn out of the findings and analysis on this study: contribution of agroforestry to human nutrition in Kikatiti, Maji ya Chai and Kisongo in Arusha, Tanzania. Conclusions were drawn based on the main questions that were the core of the study. Nevertheless, it is important to mention here that the selected methodology for this study enabled this research to adequately look into the research problem.

5.2 Conclusions

From this study, it can be concluded that AF products contributed significantly to human nutrition. They supplement diet, contribute to health care and generate cash. The study also concluded that AF products contributed indirectly to household economy through reduced household expenditure because most of the products are found freely accessible in AF system. The AF products identified to be consumed in the study area were vegetables, fruits, roots and tubers, medicinal plants, meat, milk, honey, cereals and legumes. These vast numbers of products were all obtained in the AF system practiced in the area.

This study revealed that respondents in the study area depended heavily on AF products for household requirements throughout the year, which, also play an important role during times, of food shortage. Crops, which were incorporated in the system, were widely utilized in each household surveyed. The average household production of cereals was 413kg/year. About 78% of respondents in the study area used cereals in their daily diet.

Around, 85% of total production was consumed at the household level, and only 15% was sold. Legumes acted as good source of plant protein in the study area. Six species of legumes were incorporated in the system with an average production of 165kg/year. About 84% of total production was consumed at the household level. Minerals and vitamins were obtained from fruits and vegetables, which were highly produced in the study area. Vegetables were planted or naturally grew in the area. About 19 species of edible vegetables were identified with *Amaranthus spp* and *Galinsoga parviflora were* commonly consumed throughout the year. About 77% of total production (158kg) was consumed in the household.

Many (27) varieties of fruits were found in the area, which made an average production of 355 fruits/year in each household. *Carica papaya* and *Persea americana* were the mostly consumed species. Children consumed about 76% of the total production of fruits since adults regarded fruits as special foods for children.

Roots and tubers were also incorporated in the system whereby eight varieties were identified with the average production of 195 kg/year. The most consumed species was *Manihot spp* (76%). Therefore, AF food products contributed significantly to household nutrition in the study area because more than 69% of products produced in the AF system were consumed at household level. It was only the surplus that was sold.

Medicinal plants played an important role in family health care in the study area because the village hospital was located far away in most cases more than 8 km. For instance, there was one dispensary in Mukulat division where villages are very scattered. Also,

respondents seemed to have strong belief that certain diseases were cured by traditional medicines that were cheaper than hospital drugs. Medicinal plants have positive impacts to health of people in the study area.

In addition, AF products contributed significantly to household economy in income generation. The study showed an average of 76,126 TAS per year was acquired in each household from sales of AF products. Around 37.3% of total income from sales of AF products per annum was used to purchase foods. Animal products and cereals indicated to be main sources of income contributing 37.8% and 15.7% of the total household income, respectively. Therefore, income from AF products supplements other income from petty trades, employment and casual labour.

The nutritional status of children in the study area was 30% stunted, 14% underweight and 8.7% wasted. AF food and animal products were the main source of ingredients used to prepare children's food and had different and important nutrients. For instance, fruits and vegetables were rich in vitamins and minerals while milk, eggs and legumes were rich in protein and minerals. These were essential nutrients for growth of children. The study revealed that the prevalence of malnutrition was more pronounced in Kisongo ward than Kikatiti and Maji ya Chai wards due to the fact that AF system was more intensive in Kikatiti and Maji ya Chai than Kisongo ward. Intensive, thus intensive AF system provided more varieties of foods throughout the year. The study indicated prevalence of malnutrition was due to factors other than lack of foods, such as level of education, women workload, eating habits and traditional beliefs. For instance, it has been observed that, in Arusha tribes, children are not provided with meat because people believe that only milk is enough

for young children. Children in this area were only provided with "loshoro". This was a product of maize, some banana and milk. On the other hand, within the family some kids were not allowed to eat meat due to the fact that some believed if they did, children would experience bad things. Families with high economic status considered vegetables as inferior product. This led to lack of important nutrients for their children. Poor methods of preparation of foods, e.g., vegetables led to loss of nutrients like vitamins and minerals. Boiling was the main method used for cooking foods; the method that led to loss water-soluble nutrients.

5.3 Recommendations

It was observed that AF products contributed greatly to household nutrition and economy through subsistence, primary health care and income. However, there was ignorance on the importance of some of products like vegetables and fruits. Therefore, it is highly recommended that, health and nutrition institutes such as TFNC need to initiate more programmes, which will educate people in rural areas of the importance of some food products, methods of preparing foods which conserve nutrients and proper combination of ingredients to have balanced diet. Also heath institution should put more emphasis on educating people especially rural women on sanitation methods to avoid preventable diseases such as diarrhoea.

There was scarcity of some of important AF products, which resulted from overexploitation of these resources like medicinal trees, fruits and some vegetables. Therefore, it is recommended that agroforestry research centres in Tanzania put emphasis on domestication and conservation of genes of these useful plants to enable sustainable

supply in future. Moreover, AF centers in Tanzania need to bc well equipped, committed and strengthened into issues of this nature

More research also is needed in the study area to improve processing and storage techniques and technologies, which result in poor quality food products and loss of nutrients.

Most of the rural people although utilize all products from AF system, utilize limited amounts which do not satisfy body requirements. Therefore, there is the need to mount aggressive promotion activities and campaigns to promote the use of promising AF products in amounts that will satisfy nutritional needs in the body

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APPENDICES

Appendix 1: Household Questionnaire

Name of Enumerator.....
Date.....Questionnaire No.....

Village.....Division..... Ward.....

Village identification number.....
Section A: Background information

1. Name of the head of the household .....
2. Respondent sex
   - 01 Male
   - 02 Female
3. Age.....years
4. Marital status
   - 01 Single
   - 02 Married
   - 03 Divorced
   - 04 Widow
5. For male number of wives
   - 01 One
   - 02 Two
   - 03 Three
   - 04 Four
6. Religion
   - 01 Christian
   - 02 Moslem
   - 03 Pagan
   - 04 Traditional
   - 05 Others (specify).....
7. Tribe
   - 01 Meru
   - 02 Maasai
   - 03 Arusha
   - 04 Others (specify) .....
8. Educational level
   - 01 No education
   - 02 Able to read and write
   - 03 Primary education
   - 04 Adult education
   - 05 Secondary education
   - 06 Others(Specify) .....
9. Occupation
   - 01 Peasant
   - 02 Farmer
   - 03 Petty Trader
   - 04 Civil servant
   - 05 Others (specify) .....

10. Family members

Age	Number	Male	Female
0-5 years			
>5-18 years			
>18-55 years			
Over 55 years			

11. Household main economic activities and source of income

Activity	Yes/No	Who involved	How often	Purpose
Farming				
Employment				
Beekeeping				
Small Business				
Others				

Section B: Types of agroforestry systems and food products

12. Since when have you been residing at this village?.....
13. Do you own land?
    - 01 Yes
    - 02 No
14. How many acres approximately..... Acres
15. How did you get this land?
    - 01 Inheritance
    - 02 Purchase
    - 03 Given by village government
    - 04 Others (specify) .....
16. Does the available land satisfy your annual household food requirements?
    - 01 Yes
    - 02 No
17. If no, what do you do to fill the deficit?
    - 01 Purchase foods
    - 02 Collect wild foods
    - 03 Sell labor
    - 04 Petty trading
    - 05 Others (Specify) .....
18. What forms of agroforestry systems do you practice on your farm?
    - 01 Home garden
    - 02 Intercropping
    - 03 Crops/trees and livestock
    - 04 Others (Specify) .....

19. What species do you prefer for

Item	Species	Local name	Seasons and quantity	Location on the farm	Number on The farm		Role in farming system
					<10	>10	
Foods	1.						
	2.						
Trees	1.						
	2.						
Medicine	1.						
	2.						
Fruits	1.						
	2.						

20. Which species of the following agroforestry food crops do you grow on your farm?

Item	Species	Local name	Quantity/Year	Subsistence/scale	Location on the farm
Cereal/grains	1.				
	2.				
Root/tubers	1.				
	2.				
Vegetables	1.				
	2.				
Nuts	1.				
	2.				
Fat/oils	1.				
	2.				
Legumes	1.				
	2.				
Pulses	1.				
	2.				

21. Which species are mostly consumed in this household? .....
22. Which species are mostly consumed by children of under five-years of age?
23. What type of cropping system are you using on your farm?
    01 Intercropping
    02 Single cropping
24. Why? .....

25. What domestic animals do you keep?
    01 Cattle
    02 Goats
    03 Chicken/Ducks
    04 Others (Specify) .....
26. For what purposes do you keep the above-mentioned animals?
    01 Family consumption needs
    02 Generating income
    03 Manure
    04 All of the above
    05 Others (specify) .....

27. Which system do you use in keeping your livestock?
    01 Zero grazing
    02 Extensive grazing
28. Why?.....
29. How much do you get per year by selling agroforestry products from your farm?

Item	Production/Year	Amount of money
Fruits		
Vegetables		
Fuel wood		
Pasture		
Timber		
Herbs		
Crops		
Honey		
Milk		
Butter		
Manure		
Animals		
Others		

30. Who decides when/what to sell from agroforestry products?
    01 Father
    02 Mother
    03 Father and Mother
    04 Children
    05 Other (specify) .....
31. How frequently do you sale?
    01 Daily
    02 Weekly
    03 Monthly
    04 Others (specify) .....
32. How do you spend the money from selling agroforestry products?
    01 Buying other foods
    02 Buying farm inputs
    03 Paying school fees
    04 All of the above
    05 Paying for medical services
    06 Others (specify) .....
33. What are the food items used in your households that are outside from your farm? Mention.....
34. Who mostly benefit from agroforestry food products within the household?
    01 Men
    02 Women
    03 Children
    04 All members
35. Do you think that agroforestry food products from your farm contribute to your family nutrition?
    01 Yes
    02 No
36. Why? .....

37. What kinds of foods do you always experience a problem in your household?
38. What is your current production of agroforestry food products as compare to past ten years?
    01 Decreased
    02 Increased
    03 Same/constant
    04 Fluctuates
39. What do you think is the reason for the above answer?.....

40. What problems are you experiencing in the course of practicing agroforestry?

Problems
Marketing of products
Small plot area
Shading effect
Fodder/Pasture
Others

Section C. Nutritional status

41. Under-five characteristics

Name	Sex	Weight	Height	Age
1				
2				

Complementary Foods

43. Mention the type of food(s) that you normally give to your child / children as complementary food and frequency per day.

Food /meal name	Frequency	Ingredients	Origin (Purchased/Produced / gift)
1. Morning		1	
		2	
2. Afternoon		1	
		2	
3. Evening		1	
		2	

42. If the child does not eat everything, what do you do to the remaining food?
    01 Keep it for later use
    02 Discard the remainder
    03 Other
43. Where do you keep the food which remains_____
44. If kept for later use do you warm the food before feeding the child again?
    01 Yes
    02 No
45. If No why not? .....
46. Are there foods, which are restricted to be fed to children in your household?
    01 Yes
    02 No

47. If Yes which type of foods and restrictions

Food type restriction	Reason

48. Which diseases affect your children frequently?

01 Fever
02 Diarrhea
03 Dysentery
04 Cough
05 Any other

Appendix 2: Checklist Questionnaire

The checklist questionnaires were addressed to forestry officer/extensionists, and health officer to get the overview information on the situation of agroforestry systems contribution of agroforestry to human nutrition.

A. Forestry officer/Extensionists

1. Name of interviewee
   Name of ward
   Name of village
2. Sex of the officer/extensionists----------
3. What is your age? ----------
4. What is your education level? ----------
5. For how long have you been working in this village? ----------
6. What forms of agroforestry practices are carried out in this village? ----------
7. Do you provide seedlings to villagers?
   1=Yes
   2=No
8. What kind of Tree species do they prefer most? And why do you think they prefer most?

Tree species	Uses

9. Base on your experience, how do people in this area manage/use their trees?
---
10. What do you think should be enhance to make agroforestry more sustainable?---------

B. Health officer

1. Name of interviewee
   Name of ward
   Name of village
2. Sex of the officer ----------
3. What is your age? ----------
4. What is your education level? ----------
5. For how long have you been working in this village? ----------
6. Base on your experience in this village, how much of agroforestry food products are consumed in the households?---------- ---------

8. What is the situation of nutritional status of children particularly in this village?------ ----------
9. What are the common foods from agroforestry system consumed in most households?----------
10. What are the common diseases for under fives in this village?----------
11. What do you think are the causes of such diseases ?----------
12. What is the contribution of agroforestry food products to household nutrition?----------
13. How many health centers do you have in this village? ----------
14. What is the trend of villages to attend clinic especially for under- fives?

C. SCAPA OFFICER/WORKERS

1. Name of interviewee
   Name of ward
   Name of village
2. Sex of the officer ----------
3. What is your age? ----------

4. What is your education level? ----------
5. For how long have you been working in this village? ----------
6. For how long you have been working in this village/ward
7. What can you comment about the responses of villagers in planting trees?----------

8. What form of agroforestry you encourage people to adopt?-why?----------
9. How much SCAPA accepted by the people in this area?----------
10. What is the problem you encountered in the course of implementing your objectives?

Appendix 3: Tree species found in the surveyed area

Family	*Scientific name*	Vernacular name (Arusha &Meru)	Remarks
Mimosoideae	*Albizia gummifera*	Asangupesi	Indigenous
Anacardiaceae	*Mangifera indica*	Mwembe	Exotic
Anacardiaceae	*Schinus molle*	Mpilipili	Exotic
Annonaceae	*Annona muricata*	Mstafeli	Exotic
Annonaceae	*Annona squamosa*	Mtomoko	Exotic
Apocynaceae	*Rauvolfia coffra*	Msesewe	Indigenous
Araliaceae	*Cussonia kirkii*	Oldimaroi	Indigenous
Bombacaceae	*Adansonia digitata*	Mesera	Indigenous
Boraginaceae	*Cordia africana*	Mringaringa	Indigenous
Boraginaceae	*Cordia monoica*	Oseki	Indigenous
Burseraceae	*Commiphora africana*	Osilalei	Indigenous
Caesalpiniodeae	*Tamarindus indica*	Masamburai	indigenous
Caesalpinioideae	*Senna siameg*	Mjohoro	Exotic
Capparidaceae	*Cadaba farinosa*	Ngamalog	Indigenous
Caricaceae	*Carica papaya*	Mpapai	Exotic
Combretaceae	*Combretum molle*	Ol maroroi	Indigenous
Combretaceae	*Terminalia brownii*	Olbugoi	Indigenous
Cupressaceae	*Juniperus procera*	Nderakwa	indigenous
Cupressaceae	*Cupressus lusitanica*	Mtarakwa	Exotic
Dracaenaceae	*Dracaena usambarensis*	Isare	Indigenous
Ebenaceae	*Euclea divinorum*	Ekeni	Indigenous
Euphorbiaceae	*Croton macrostachyus*	Mfurufuru	Indigenous
Euphorbiaceae	*Croton megalocarpus*	Marabai	indigenous
Euphorbiaceae	*Manihot glaziovii*	Mpira	Exotic
Gramineae	*Arundinaria alpina*	Ireko	Indigenous
Lauraceae	*Persea americana*	Mparachichi	Exotic
Meliaceae	*Tricilia emetica*	Mtimaji	indigenous
Meliaceae	*Azadirachta indica*	Mwarobaini kamili	Exotic
Meliaceae	*Ekebergia capensis*	Mkuna	Indigenous
Meliaceae	*Melia azedarach*	Mwarobani nusu	Exotic
Melianthaceace	*Bersama abyssinia*	Iranguwe	Indigenous
Mimosoideae	*Albizia schimperiana*	Nduruka	Indigenous
Mimosoideae	*Acacia tortilis*	Oldepesi	Indigenous
Mimosoideae	*Acacia xanthophloea*	Elerai	Indigenous
Mimosoideae	*Acacia nilotica*	Ol giloriti	Indigenous
Mimosoideae	*Acacia mellifera*	Eiti	Indigenous
Mimosoideae	*Acacia mearnsii*	Muwati	Exotic
Mimosoideae	*Acacia lahai*	Meleki	exotic
Mimosoideae	*Acacia hockii*	Endawasi	Indigenous
Mimosoideae	*Leucaena leucocephala*	Mlusina	Exotic
Moraceae	*Ficus thonningii*	Oreteti	indigenous
Moraceae	*Artocarpus spp*	Mfenesi	Exotic
Moraceae	*Morus nigra*	Mforsadi	exotic
Moraceae	*Melia excelsa*	Mvule	Indigenous
Myrtaceae	*Callistemon citrinus*	Bottlebrush	Exotic
Myrtaceae	*Eucalyptus camaldulensis*	Mkaratusi	Exotic
Myrtaceae	*Eucalyptus citriodora*	Mkaratusi	Exotic
Myrtaceae	*Syzygium cuminii*	Mzambarau	Exotic
Myrtaceal	*Psidium guajava*	Mpera	Exotic

Olacaceae	*Ximenia americana*	Olama	Indigenous
Oleaceae	*Olea capesis*	Mshiyo	Indigenous
Oleaceae	*Olea europaea*	Lorieni	Indigenous
Papilionoideae	*Cajanus cajan*	mbaazi	Exotic
Papilionoideae	*Erythrina abyssinica*	Olowani	Indigenous
Papilionoideae	*Pterocarpus angolensis*	Mninga	Indigenous
Papilionoldeae	*Erythrina abyssinica*	Olowani	indigenous
Podocarpaceae	*Podocarpus falcatus*	Owiriwiri	Indigenous
Proteaceae	*Gravillea robusta*	Meresi	Exotic
Proteaceae	*Faurea salgina*	Ol garian	Indigenous
Rhamnaeceae	*Ziziphus mucronata*	Oloilahi	Indigenous
Rosaceae	*Prunus africana*	Kondekonde	indigenous
Rosaceae	*Eriobotrya japonica*	Mtangawizi	Exotic
Rosaceae	*Prunus persica*	Peach	Exotic
Rubiaceae	*Vangueria madagascariensis*	Loshoro	Indigenous
Rutacea	*Fagaropsis angolensis*	Olmoirijoi	indigenous
Rutaceae	*Calodendrum capense*	Isau	Indigenous
Rutaceae	*Citrus reticulata*	Mchenza	exotic
Rutaceae	*Citrus medica*	mfurungu	exotic
Rutaceae	*Citrus limon*	Mlimao	Exotic
Rutaceae	*Citrus paradisi*	Mbalungi	exotic
Rutaceae	*Citrus sinensis*	Mchungwa	exotic
Rutaceae	*Zanthoxylum chalybeum*	Oluisuki	Indigenous
Sapindaceae	*Dodonaea angustifolia*	Iwuwu	Indigenous
Sapindaceae	*Dodonaea angustifolia*	Ol getinai	Indigenous
Sapindaceae	*Pappea capensis*	Orimigomi	Indigenous
Ulmaceae	*Trema orientalis*	Mwefu	Indigenous

Appendix 4: Vegetables Identified in the survey area

Scientific Name	Local name	Common name
Amaranthus cruentus	Mchicha	Amaranthus
Amaranthus spp	Mchicha, spinach	Amaranthus
Brassica spp	Kabichi	Cabbage
Curcubita moschata	Majani ya maboga	Pumpkin leaves
Galinsoga parviflora Or *Solanum nigram*	Mnafu	Night shaole
Gynandropsis gynandra	Mgagani	
Hibiscus esculentus L.	*Bamia*	Occra
Ipomea batata	Tembele	Potato tips
Launaea cornuta	Mchunga	Wild spinach
Lycopersicon esculentum	*Nyanya*	Tomato
Oxygonum sinuatum	Mbigili	
Solanum spp.	*Nyanya chungu*	Bitter tomato
Sonchus oleraceus	Mchunga	Wild spinach
Vigna unguiculata	*Majani ya kunde*	Cowpea tips
Manihot spp	Kisamvu	Cassava leaves

APPENDIX 5: List of fruits identified by respondents in the survey area

Scientific name	Local name	English name	Family name
Adansonia digitata	Mesera	Baobab	Bombacaceae
Annona muricata	Mstafeli	Soursop	Annonaceae
Annona squamosa	Topetope	Sugar apple	Annonaceae
Artocarpus heterophyllus	Mfenesi mfuu	Jackfruit	Moraceae
Arundinaria alpina	Ol moloi	Mountain bamboo	Gramineae
Azanza garckeana	Emotoo	Snot apple	Malvaceae
Carica papaya	Mpapai	Pawpaw	Caricaceae
Citrus aurantifolia	Mndimu	Lime	Rutaceae
Citrus limon	Mlimao	Lemon	Rutaceae
Citrus medica	Mfurungu	Citron	Rutaceae
Citrus reticulata	Chenza	Tangerine	Rutaceae
Citrus sinensis	Mchungwa	Orange	Rutaceae
Cordia monoica	Oseki	Sandpaper	Boraginaceae
Mangifera indica	Mwembe	Mango	Anacardiaceae
Morus nigra	Mforsadi	Black mulberry	Moraceae
Pappea capensis	Ol dimigomi	Pappea	sapindacea
Persea americana	Mparachichi	Avocado pear	Lauraceae
Piliostigma thonningii	Mchikichi	Camel's foot tree	Caesalpinioideae
Pithecellobium dulce	Mkwaju	Madras thorn	Mimosoideae
Prunus persica	Pichesi	Peach	Rosaceae
Psidium guajava	Mpera	Guava	Myrtaceae
Syzygium cordatum	Mzambarau	Water berry tree	Myrtaceae
Tamarindus indica	Mkwaju	Tamarind	Caesalpinioideae
Temimnalia catappa	Mkungu	Tropical almond	Combretaceae
Vangueria madagascariensis	Loshoro	wild medlar	Rubiaceae
Vitex keniensis	Muuru	Meru oak	Verbenaceae
Ximenia americana	Olama	Wild plum	Olacaceae
Colocynthis vulgaris scharad	Tikiti Maji	Water melon	

APPENDIX 6: Average production, sales and consumption in Maji ya Chai village

Products	Harvest (kg)	Sales (kg)	Income Tshs	Consumption (kg)	Purchase (kg)	Income Tshs
cereals	433	124	177150	353	45	20500
Roots	226	83	22195	143	30	10760
Vegetables	78	11	41530	67	22	4840
Legumes	169	53	45900	116	30	1248
Fruits	175*	60*	13805	115*	40*	5940
Animal products	455	321	111480	134	426	72864
Animals	12**	12**	53500	-	-	
Tree products	14***	14***	56700		-	
Oils/fat	8.15	-	-		8.15	
Total			522260			110,752****

* Number of fruits
** Number of animals
*** Number of trees
****21% of total income from sales of AF products used for purchasing foods

APPENDIX 7: Average production, sales and consumption in Seela village

Products	Harvests (kg)	Sales (kg)	Income (Tshs)	Consumption (kg)	Purchased (kg)	Income (Tshs)
cereals	473	215	21500	258	137	21700
Roots	190	85	8500	105	88	8750
Vegetables	319	109	32900	210	79	7900
Legumes	228	83	29100	155	50	15150
Fruits	879*	132*	46700	747*	102*	4110
Animal products	821	593	103140	228	382	64600
Animals	14**	14**	113000	-	-	-
Tree products	59***	59***	57000	-	-	-
Oils/fat	24	-	-	24	-	-
Total			411840			122210****

* Number of fruits
** Number of animals
*** Number of trees
****30% of total income from sales of AF products used for purchasing foods

APPENDIX 8: Average production, sales and consumption in Engorora village

Products	Harvests (kg)	Sales (kg)	Income (Tshs)	Consumption (kg)	Purchased (kg)	Income (Tshs)
cereals	917	300	30000	617	182	26600
Roots	144	53	5300	91	94kg	37500
Vegetables	240	32	3200	208	76kg	7600
Legumes	336	127	47900	209	26kg	7800
Fruits	409*	53*	1060	356*	144kg	5460
Animal products	715	405	62340	310	207kg	34700
Animals	18**	5**	90000	15***	-	-
Tree products	18***	18***	24000	-		
Oils/fat	22	-	-	22	-	-
Total			263800			119660****

* Number of fruits

**Number of animals

*** Number of trees

****45% of total income from sales of AF products used for purchasing food

APPENDIX 9: Average production, sales and consumption in Loovikuny village

Products	Harvests (kg)	Sales (kg)	Income (Tshs)	Consumption (kg)	Purchased (kg)	Income (Tshs)
cereals	529	225	22500	304	123	21700
Roots	97	53	5300	44	72	13415
Vegetables	167	90	9000	77	47	4700
Legumes	206	97	38500/=	109	44	13200
Fruits	537*	208*	2960/=	329	136	4180
Animal products	613	277	54360/=	336	267	44620
Animals	32**	5**	63000	27 ***	-	-
Tree products	14***	14***	18000	-	-	-
Oils/fat	15	-	-	15	-	-
Total			213620			101815****

* Number of fruits
** Number of animals
*** Number of trees

****48% of total income from sales of AF products used for purchasing foods