

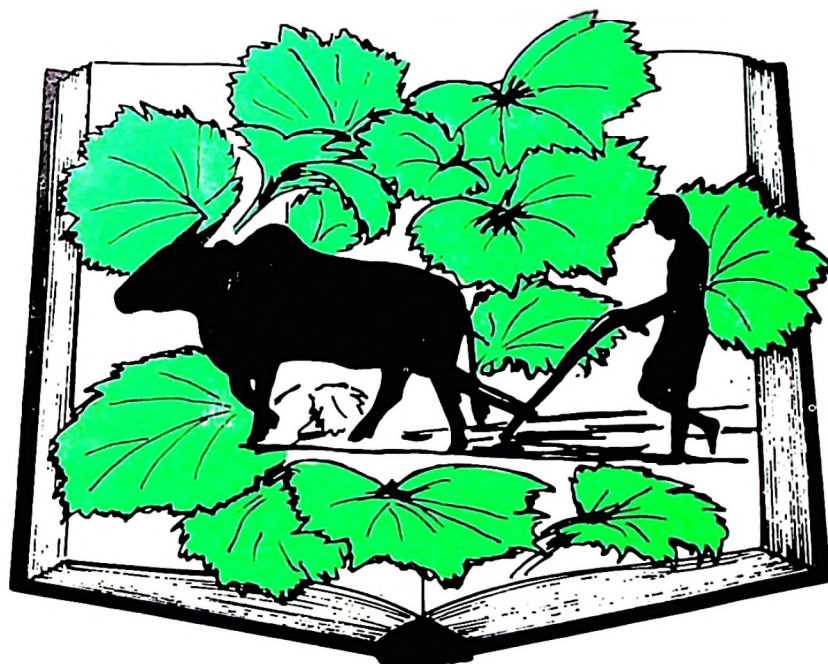
# JORAGRIC

NORWEGIAN CENTRE FOR INTERNATIONAL AGRICULTURAL DEVELOPMENT  
AGRICULTURAL UNIVERSITY OF NORWAY



THE TRADITIONAL HOMEGARDEN AGROFORESTRY SYSTEM OF  
BUKOBA, TANZANIA: DESCRIPTION, CRITICAL CONSTRAINTS  
AND FARM ECONOMIC ANALYSIS OF POSSIBLE SOLUTIONS  
TO FALLING PRODUCTIVITY.

Gabriel H.R. Rugalema



A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE  
DEGREE OF MASTER OF SCIENCE (NATURAL RESOURCE MANAGEMENT)

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7th May, 1992.

- 7 JUN 2001

**DECLARATION**

I, **Gabriel H.R. Rugalema**, do hereby declare that, this thesis is my original work and has never been presented at any other University for any degree award. Any source of information is duly acknowledged.

Signature..... *G. Rugalema*.....  
Place..... *AS-NLH*.....  
Date..... *7th May, 2012*.....

## **DEDICATION**

This work is dedicated to:

My wife Ashura Kokusinga Rugalema so that her  
unfailing love, patience, support and encouragement  
may persist,

and

My parents Ta Gabriel P.M.Rugalema and Ma Anna  
Mukashekya Rugalema for making me what I am.

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My late brother Joseph Kazaura Rugalema for opening my eyes to the academic world.

My friends whose presence make my life 'tick'.

## **ABSTRACT**

A socio-economic study was carried out in the Kyamtware division in Bukoba District, Tanzania. The objectives were: to describe the homegarden agroforestry system found in Bukoba district, to investigate the nature and magnitude of constraints of the farming system and to do a farm economic analysis of possible alternatives to counter falling productivity.

Descriptive statistics, linear regression and one way analysis of variance were the methods used to analyze the data. In the linear regression model banana and coffee yield were dependent (predictor variables) whereas homegarden size, hired labour, cattle keeping, and household size were independent variables.

It was found that homegarden productivity has significantly declined over the years due to; decline in soil fertility and cattle population, outbreak of banana pests and diseases, increase in human population and lack of cash.

Economically, it was found more profitable to rehabilitate the homegarden by reintroducing cattle rather than shift to a completely new farming system based on annual cropping.

Further research into soil fertility restoration, pests and disease management and other aspects of the farming system, is proposed.

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## CHAPTER 1

### INTRODUCTION

The traditional farming system of Bukoba district is a multistorey homegarden agroforestry system that has been successfully practised in the district over the centuries. A homegarden or homestead farm is locally known as Kibanja. The farming system has been characterised by high productivity and high species diversity. High productivity of the system has made Bukoba one of the most densely populated areas of Tanzania and the African continent.

Principal crops grown in the holdings are Banana (*Musa spp*) and Coffee (mainly *Coffea robusta*). Banana is grown for food, brewing and cash, coffee is for cash and social functions. Chewing of boiled and dried coffee beans for example, is an age old tradition of the Bahaya which carries an immense social significance. Several other crops (both perennial and annual) are intercropped with banana and coffee. These include common beans (*Phaseolus vulgaris*), maize (*Zea mais*), cassava (*Manihot esculenta*), yams (*Dioscorea spp*), Taro (*Colocassia esculenta*), and many others, (Appendix 1 is a list of crops and other plants commonly found in Bukoba homegardens).

Livestock is dominated by cattle kept primarily for manure but also for milk production, cash and social/cultural functions such as paying bride wealth.

Various species of trees and shrubs are carefully maintained in the holdings for various uses such as fuelwood, medicine, banana propping, fencing and bark-cloth making.

### **1.1 Statement of the problem**

The traditional Bukoba homegarden is the basic production unit and also the centre of social and cultural activities for farm families. As such its importance and necessity for the survival of the local population in Bukoba district cannot be overemphasised.

Even though the homegarden farming system has sustained the population in Bukoba for centuries, it is not without problems in terms of long term sustainability. Over time the farming system in Bukoba has been pervaded by a host of biological constraints namely; Banana weevils (*Cosmopolites sordidus*), nematodes (*Radopholus goodeyi* and *Radopholus similis*), the panama disease and declining soil fertility. Socio-economically the system is under pressure due to population growth which has led to fragmentation of holdings, Intensity of homegarden management has also decreased and out-migration has become common. Low population of cattle (mainly due to lack of cash, diseases and poor veterinary services) has meant less manure and therefore it has enhanced the problem of soil fertility. The tree component in

homegardens is also under pressure due to fragmentation of homegardens and the need to produce more food. All of these constraints are a threat to the sustainability and stability of the system.

This study attempts to analyze the constraints in the homegarden farming system of Bukoba district and to evaluate the possible alternatives that could be done to counter declining productivity. The study is therefore important to farmers, policy makers and lending institutions for it helps to indicate the advantages and disadvantages of alternatives being proposed.

## **1.2 Objectives**

The objectives of this study are;

- i) to describe the structure and composition of the traditional multistorey homegardens,
- ii) to determine the magnitude of critical constraints in the farming system,
- iii) to analyze possible intervention measures with the view of recommending the most economic and practicable option(s).

### **1.3 Major hypotheses tested**

To investigate the objectives in section 1.3, the following hypotheses were stated.

- i) Crop yields in Bukoba district have declined over the years due to both socio-economic and biological constraints.
  
- ii) As a result of decline in crop yields, there is a significant difference between current crop yields and crop yields in the past (particularly before the onslaught of banana weevils and nematodes).
  
- iii) Intensification (and rehabilitation) of the existing farming system (by the use of traditional inputs) is economically more profitable than shifting to a new farming system based on annual crops (maize/beans).

### **1.4 Some important definitions**

For the purpose of this study the following definitions have been adopted and used as such.

Agroforestry: Young (1983) describe agroforestry as a land-use system in which trees or shrubs are grown in association with agricultural crops, pastures or livestock, and in which there are both ecological and economical interactions between trees and other components.

Homegarden: Fernandes and Nair (1986) define the homegarden as a land use practice involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial crops and livestock within the compounds of individual houses, the whole crop-tree-animal unit intensively managed by family labour.

Multistorey: Refers to the vertical order or arrangement of canopies of various crops, trees and shrubs that are grown in a homegarden.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Background to homegarden agroforestry system

Mixed farming systems have been a traditional way of farming for farmers in different parts of the world. Combinations of trees, crop and livestock activities according to local requirements has always characterised these systems.

Homegarden or homestead agroforestry system is one of those mixed farming systems which has stood the test of time and is practised extensively in tropical and subtropical areas of the world (von Maydell, 1987). Characteristically, homegardens are largely for subsistence, they are ecologically stable and sustainable. In addition they provide continuous or repeated harvests over the whole year and they represent a risk-averse farming system.

Homegardens or homestead farms are found across continents and they have been widely documented in various studies for example, Fernandes *et al.* (1984), Oktingàti and Mongi (1986) Saemorwoto (1987), Oduol and Aluma (1990), Nair and Sreedharan (1987), among others.

#### 2.2 Functions of homegardens

Homegarden as an agroforestry system is valuable for its socio-economic and ecological roles. Its importance lies in its ability to combine the ecological functions of forests with those of providing economic needs of the people.

### **2.2.1 Socio-economic functions**

The importance of homegardens in providing subsistence needs and generating income can not be over-emphasized. Moreover homegardens have social, cultural and aesthetic functions.

Nutritionally homegardens play a key role in supplying food for farm families. In Papua New Guinea for example, homegardens contribute 4-6% of the household energy requirements. According to Saemorwoto (1987) a survey of 40 households in the Philippines found that nearly all the households could meet the recommended daily requirement for vitamin A, vitamin C, and Calcium. Over half of the sample households could obtain a sizeable amounts of their requirements of thiamine, riboflavin and niacin and one in four could meet their protein and energy requirements with the outputs and resources from the homegardens. In Java homegardens have been found to provide more than 40% of the total calorific requirement of the local farming communities (Stoler 1975). Sundkler (1980) pointed out that the homegardens of Bukoba were meeting almost all household calorific requirement in the 1940s and in the 1950s.

In general, a large proportion of the products of homegardens are consumed by farm families themselves. Studies by Stoler (1975), Oktingàti (1985) and Oduol and Aluma, (1990), indicate that the major part of the produce is consumed at home thus providing a high degree of household food security.

Economic returns from homegardens are an important asset of the farming system. Ninez 1985 reported an income of US \$ 28.33 from a small homegarden about 200m<sup>2</sup>. This income although small, contributed almost 10% of the family income in that period. Homegardens of Rwanda have been reported to produce as much as 69.1% of the family cash income, of which 38.3% is from banana, 11.7% from coffee, 5.2% from livestock and 13.9% from other food crops and their products.

Aluma 1987, found that a large **Mvule** tree (*Chlorophora excelsa*) in a Ugandan homegarden can fetch between US \$300-500 for timber and another US \$100-200 for charcoal, this income being over and above that from coffee, banana, minor crops, livestock and other species of trees found in same homegarden.

Homegardens are not only economically important to the farm family but also to the economies of the countries in which they occur. The Chagga homegardens in Tanzania for example, contributed 52% of Tanzania's coffee export in 1982, thus earning the country US \$65 million (Fernandes et al. 1984).

Possibly because of educational and cultural background of most authors, the socio-cultural functions of homegardens have remained largely obscure. In most communities however, homegardens are more than mere production units, they are socially and culturally important to farm families.

Trees in homegardens have got various socio-cultural values ranging from being medicinal to being sacred. Okafor and Fernandes (1987), for example, listed a woody tree species growing in compound farms of Southeastern Nigeria, and is sacred. Sacred trees have also been documented in homegardens of the Far East (Saemorwoto, 1987).

### **2.2.2 Ecological functions**

The multistorey structure of homestead farms plays an important protective role against soil erosion by providing vegetative cover. Available data suggest that higher rainfall erosivity occur beneath trees than in the open, but considerably less soil erosion occur because of the cover of herbaceous plants and litter (Saemorwoto, 1987).

Apart from the protective role, homegarden components are important in the recycling of nutrient and matter in the system thus presenting an excellent opportunity for the efficient use of resources and helping to maintain soil fertility (ibid. 1987; Young, 1983).

## **2.3 Bukoba Homegarden Agroforestry**

### **2.3.1 An Overview**

It is exactly not known when the homegarden agroforestry system became a social, cultural and economic unit of farm families in Bukoba. According to Hyden (1969) the farming system was already well established in Bukoba in the late 19<sup>th</sup> century.

Coffee is indigenous to Bukoba (Mbilinyi, 1969), it was however, commercialized by the Germans in the 19<sup>th</sup> century and banana is said to have been introduced from Far East to East Africa at around 1500AD (Morgan, 1962). It can therefore be speculated that the farming system is some few centuries old.

Today homegardening is the major agricultural production system in Bukoba, covering more than 80% of the total land under cultivation.

A closer look at homegardens reveal that their composition in terms of crops, trees and/or livestock generally vary from one holding to another. Various factors influence homegarden composition, among them are; nature and fertility of soils, size of a holding, size of the household, and individual farmer's preference (Friedrich 1968).

Previous studies indicate that homegarden sizes in Bukoba district are rather small mostly not more than one hectare. Reining (1970) reported an average size of 0.7ha; and Rald (1969) estimated the average size of holding to be 0.69ha. The probability that farm sizes may have since shrunk with time is high, given that the population in Bukoba has continued to grow.

Despite the small size, homegardens of Bukoba plays an important role in the economy of Tanzania. Kagera region produces some 30% of the total coffee crop in Tanzania thus

contributing about 11% of the country's annual foreign exchange earnings. A sizeable part of this coffee is produced in the homegardens Bukoba district.

### **2.3.2 Constraints of production in homegardens**

Studies on the critical factors or constraints limiting productivity of the homegardens in Bukoba have traditionally focused on the respective disciplines of the researchers. As a result most of the problems confronting homegardens have mostly been studied in isolation.

#### Soils

It has been argued that the homestead farms of Bukoba are productive largely because of the intelligent adaptation of the people to the difficult conditions found in the area Ruthenberg (1980). The same author mentioned soils as the major factor limiting crop production in Bukoba. A lot of documented evidences indicate that soils in the district are poor in plant nutrients (Milne 1938, Mitchell 1963, Moberg 1972, Kabwoto 1976, Mkamba 1986, Mkandala *et al* 1989, among others).

Kabwoto (1976) attributes the decline in yields of crops such as tea, banana and coffee to no other factor than poor soils and Mkandala *et al*, (1989) have also shown that poor soil fertility is the major constraint to bean production in Bukoba district. Recent analyses of soils in some parts of Bukoba have revealed that deficiency of both major and micro

nutrients is widespread (Daily News<sup>1</sup>, 1990).

The problem of low soil fertility in Bukoba can be ascribed, at least in part, to the decline in the amount of cattle manure as a cattle population has also declined over the years. Cattle manure has been the major fertilizer and has sustained the farming system over the centuries, particularly for the major crops, banana and coffee. Cory (1957) traced the history of decline in the population of cattle in Bukoba to the year 1891 when the district was hit by rinderpest epidemic. The death toll of cattle during the epidemic is estimated to have been 95% and the cattle population has never appreciably picked up since then.

The Royal Tropical Institute (1989) has pointed out that as late as 1960s rinderpest outbreak was still common in the area. Whereas Friedrich (1968) found that 33% of farmers in Bukoba district keep cattle, Rald and Rald (1975), reported cattle keeping being confined to only 20% of the farmers and the Royal Tropical Institute (1989) has reported cattle keeping to be confined to 12% of the farmers. The findings of these studies indicate a falling trend of cattle population in the district.

#### Banana weevil

Banana weevil is reported by most researchers as the worst problem confronting homegardens in Bukoba. Studies by Walker *et al* (1983), Tibaijuka (1984), Royal Tropical Institute (1989) and also reports from Maruku Agricultural Research

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<sup>1</sup> The Daily News (Tanzania) 17.12.1990

Institute (1984) and the Kagera Region Agricultural Office (Tungu 1990) further confirm the severity of banana weevil problem. *Cosmpolites sordidus* is reported to be the most prevalent species although *Temnoschorta nigroplagiata* adults have also been found in the area.

Although banana weevils are said to have been a problem in Bukoba by 1930, it is not until the mid 1970s that extensive damage were experienced (Maruku,1980). According to that report banana weevil had destroyed over 50% of the banana crop in Bukoba district by 1978. Tungu (1990) reported a fall in banana production due to weevils and nematodes in the whole of Kagera region from 601,589 tonnes in 1981 to 427,167 tonnes in 1990. A decrease of 28.99% over a period of nine years. Some studies for example Tibaijuka (1984), have put banana yield reduction due to weevils at a much higher percentage. It is debatable, however, as to what percentage of banana yield reduction can exclusively be attributed to banana weevils.

### Nematodes

The presence of nematodes in Bukoba was ascertained in 1972 when nematode species namely *Radopholus similis*, *Pratylenchus spp.* and *Meloidogyne spp.* were isolated from banana root samples (Walker et al,1983). Initially it was believed that the most important nematode species in banana in Bukoba was *R.similis* it has however, recently been found that the most

important species is *P.goodeyi* (Mbwana<sup>2</sup> 1991, pers.comm). Unlike banana weevil, nematode infestation is widespread in all districts of Kagera region. However, there is no scientific explanation to explain why nematodes are so widespread and not the weevils. Also data on yield losses due to nematodes alone, even in areas where weevil infestation is not acute, is scanty.

#### Homegarden fragmentation

Most common to rural communities in high potential areas, growing population pressure is mostly accompanied by decreasing farm size and declining soil fertility. As population density continue to increase, yields and returns to labour eventually decline to the point at which farmers have to turn to non-agricultural sources of income (Beets 1990). In Bukoba district population pressure and decreasing farm sizes have been known to exist for many decades. As Schmidt (1978) concluded, population in some parts of the district surpassed the areas' carrying capacity some centuries ago, and as a result homegardens are so small that they are can no longer support burgeoning family sizes.

From the foregoing, it is clear that the farming system in Bukoba is severely overburdened by several constraints. It is possibly against this background, that Friedrich (1968) concluded that Bukoba is experiencing agricultural stagnation

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<sup>2</sup> Officer-in-Charge and Nematologist, Maruku Agricultural Research Institute.

while Tibaijuka (1984) concluded that the banana-coffee farming system in Bukoba is facing a total collapse.

**CHAPTER 3**  
**THE STUDY AREA**

**3.1 Location and extent**

Bukoba district is located in the north-western corner of Tanzania, it lies between 1° and 1°25' south and 31°30' and 2° east. It is bordered in the north by Uganda, in the east by Lake Victoria, in the west by Karagwe district and in the south by Muleba district.

The district covers a total area of 11,465km<sup>2</sup>, of which is 5,932km<sup>2</sup> is under water. Bukoba town, the district headquarters is some 1245km from the main port of Dar-es-Salaam. Bukoba district is one of the five districts that make up Kagera region, others are Muleba, Karagwe, Biharamulo, and Ngara. Bukoba is sub-divided into six administrative divisions, namely: Kyamtware, Bugabo, Katelero, Kiziba, Rubale, and Missenye. According to the Tanzanian administrative structure, divisions are sub-divided into Wards and eventually into Villages.

Figure 1 shows the location of Bukoba district.

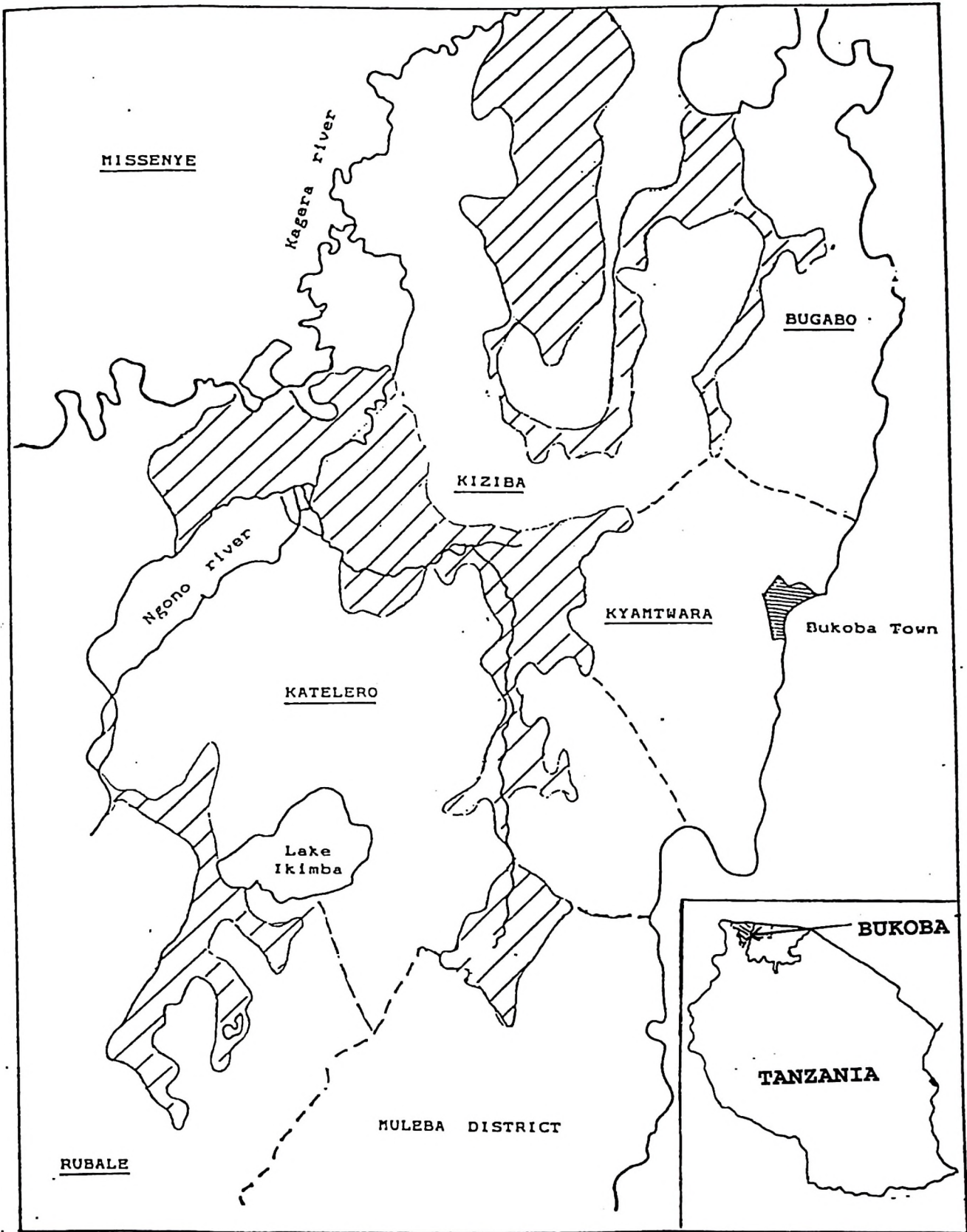
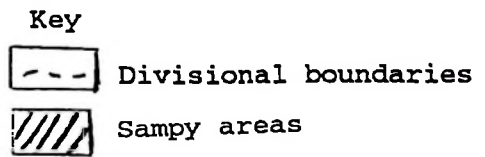


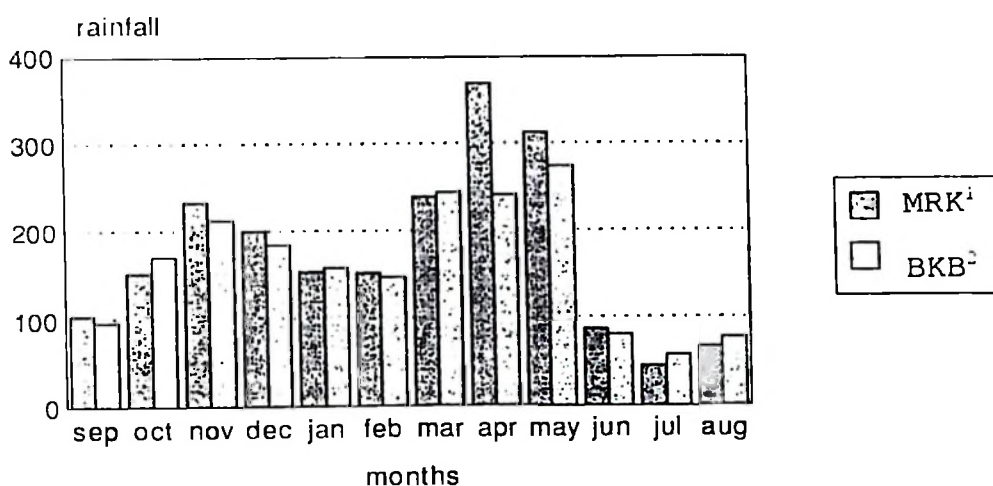
Fig. 1 Map of Bukoba District.



### 3.2 Bio-physical environment

#### 3.2.1 Climate

Bukoba district has a bimodal rainfall pattern, long rains from February to early June and short rains from September to December. The mean annual rainfall range is between 1800mm and 2100mm. Rainfall amount decreases with distance from the shores of lake Victoria. The lake littoral zone where this study was conducted is relatively wet throughout the year with no marked dry season as shown in Figure 1. The mean annual maximum temperatures lie between 25°C-26.5°C. The small annual range of temperature is largely attributed to nearness to the Equator.



MRK<sup>1</sup> = Maruku rainfall average 1961-1985

BKB<sup>2</sup> = Bukoba rainfall average 1980-1988

Fig.2: Monthly rainfall averages (Bukoba district) in mm

Source: Modified from the data by the Royal Tropical Institute (1989)

### 3.2.2 Relief and soils

Bukoba district is hilly consisting of undulating terrain rising up to 1400 metres above sea level. The terrain has flat-topped hills and valleys are dominated by extensive swamps. Ngono and Kagera are the two major rivers in the district.

Soils are derived from the Bukoban system of rocks which is characterised by strata of conglomerates, sandstones, quartzites, and limestones. An age-determination of the Bukoban system of rocks indicated an isotopic age of 800 million years (Morgan, 1962). Major groups of soils in Bukoba are Arenosols, Gleysols, Vertisols, and Ferralsols. Ferralsols are the most important agricultural soils in Bukoba (homegardens are found on these soils). They are deep and thoroughly weathered, but they are also highly leached; thus infertile.

Ferralsols as soils poor in nutrients, the clay fraction consist of mainly Kaolinitic minerals with iron and aluminium oxides. Cation exchange capacity is very low, they are acidic with pH as low as 4 and the C/N ratio tends to be high (Longman and Jenik, 1987).

Soils in the swampy areas of the district are mostly Gleysols and to a lesser extent Vertisols. They are seasonally or permanently water logged, as a result they are poorly drained. If drained, these soils can be successfully cultivated.

### 3.3 Population characteristics

The population of Bukoba district is 389,965 people out of which only 12% live in Bukoba urban, (Bureau of Statistics, 1988). Local population density goes as high as 500 persons/km<sup>2</sup> of cultivated land; (Royal Tropical Institute, 1989). Reining (1955), however, reported local population density of 1250 persons/km<sup>2</sup> of cultivated land making Bukoba district one of the densely populated (rural) areas in Africa.

However, if the population density of Bukoba is calculated basing on land area, it is found to be 70.5 persons/km<sup>2</sup>. But such calculations would be seriously misleading because what is termed total land area in Bukoba include infertile grasslands, rocky hills and wooded or forest land. Therefore it is reasonable to calculate the population density per square kilometre of cultivated land. The population figure by division in Bukoba district is presented in Table 1.

**Table 1 Population figures for Bukoba district by division**

Division	Population	
	1978	1988
Kyamtwara	35,035	33,411
Bugabo	35,358	34,843
Kiziba	65,217	65,737
Katelero	73,496	84,951
Rubale	41,534	59,867
Missenyi	53,850	64,147
<b>Total</b>	<b>333,850</b>	<b>389,965</b>

Source; Royal Tropical Institute, 1989 (after Bureau of Statistics, 1988).

The overall annual growth rate of population in the district during the ten year inter-censal period 1978-1988 was 14.36% implying a modest annual growth rate of approximately 1.44% which is far below the Kagera region and the national averages of 2.7% and 2.8% per year respectively. According to Royal Tropical Institute's (1989) study, this low population growth rate can be attributed to factors such as immigration, district border adjustment and the AIDS epidemic prevalent in Bukoba district. The main ethnic group is the Bahaya, minorities are mostly immigrants, they include the Banyarwanda, Barundi and Baganda.

#### **3.4 Land-use systems**

The people of Bukoba district are primarily agricultural and a majority of those who are economically active are engaged in agriculture. Land use is based on kinship structures which are patrilinear in terms of ownership and inheritance. Such a land use system implies that a father has to subdivide his homegarden to his sons, over generations this leads to fragmentation of homegardens. The district is characterised by intensive smallholder production of subsistence and cash crops, holdings are permanently under banana and coffee.

A typical Bukoba village consists of tens or hundreds of households characterized by banana/coffee homegardens.

A village is usually surrounded by open grasslands which are infertile and dominated by couch grass thus difficult to work with. The grasslands are used for communal grazing, supply of mulch, supply of vegetation for cattle stables to bulk up the

cattle manure, annual plots of legumes mainly Bambara nuts (*Vondzoeia subteranea*) and smallholder tea plantations.

Social division of labour exist and is well pronounced in Bukoba. Much of the farm work is done by women (Swantz, 1977), they combine farm work with household chores, child rearing and, fetching water. Traditionally the Bahaya women do not collect firewood. Men, on the other hand, perform less of cultivation work, in homegardens they are in charge of coffee husbandry practices and banana pruning and detrashing. Because coffee is a man's crop right from planting to selling (of coffee beans), men manage funds from coffee proceeds which they spend on household budget such as buying food, paying school fees and paying development levy. Men also collect firewood and tend cattle.

### **3.5 Infrastructure**

There is a moderately well developed infrastructure of roads (earth roads but passable all the year round) linking Bukoba district to other districts in the region and also to Uganda. Reliable means of transport linking the area to the rest of Tanzania is by steamer and plane services plying between Mwanza and Bukoba across Lake Victoria.

### **3.6 Social services**

Bukoba district is well endowed with educational institutions, there are many primary and secondary schools in the area. Health services are offered by both private and public health centres and hospitals of which Bukoba Government Hospital is the biggest.

Off-farm employment opportunities are rather limited due to the small size of Bukoba town. However, there are booming informal trades such as fishing in lake Victoria, clay brick making, pitsawing, masonry, and carpentry.

The tea estate and factory at Rwabikanshe, the Kagera Sugar Company, Maruku Agricultural Research Institute and the Bukop coffee factory are the only institutions which can offer sizeable off farm employment.

## CHAPTER 4

### RESEARCH METHODOLOGY

Bukoba district is divided into two main agroclimatic zones, the eastern zone (also called the lake littoral zone) and the western zone (also known as the hinterland zone).

Of the two zones, the eastern zone was found particularly suited for the study because previous research studies have indicated that constraints limiting productivity in homegardens are more severe than in the western zone.

Two wards, namely Karabagaine and Maruku in Kyamtware division were selected for the study. Constraints largely in terms of time, financial and material resources could not permit the study to cover a larger area than the two wards. In the two wards selected for the study, three villages from each ward (Karabagaine and Maruku) were selected at random. In Karabagaine ward the villages selected were; Nsisha, Kangabusharo and Kiziru, and in Maruku ward Kasha, Nyabukazi and Bujogero villages were selected.

#### **4.1 Data collection**

A list of households for each village was obtained from respective village government office. A table of random numbers was used to select households in each village.

Twelve households per village were picked for the survey.

The questionnaire used in the survey sought to extract information on households, homegarden composition, and major constraints limiting productivity of the homegardens.

Preliminary draft of the questionnaire was done in Norway and it was pre-tested on fifteen households upon arrival in Tanzania in July, 1991. Results from the pre-testing exercise led to adjustments and modification of the questionnaire to accommodate views and comments from target farmers. Hence some questions or parts of questions were dropped out and new ones were incorporated. The questionnaire presented in appendix 2. The source of primary data was the household survey.

The household survey was conducted from mid-August to early November, 1991. All interviews were conducted in Kihaya which is the local language in the study area. This posed no problem because both the researcher, and the three enumerators were conversant with the language. Respondents were a farmer and his wife or one of the two if the other happened to be away, divorced, widowed or separated. In general farmers were cooperative and enthusiastic to answer the questions, each interview lasted slightly longer than one hour. On average two interviews were conducted per working day.

Secondary data was obtained from informal interviews with researchers at Maruku Agricultural Research Institute, village extension workers in the study area, subject matter specialists at Bukoba District Agricultural Office, and the representative of the Tanzania/Netherlands Farming Systems Project at Bukoba.

In addition, literature on the study area was obtained through publications and unpublished reports available at Maruku and at the National Agricultural Library, Sokoine University of Agriculture(SUA), Morogoro.

#### **4.2 Data analysis**

Qualitative data was analyzed by statistical measures of central tendency (means, median), statistical measures of dispersion (range, standard deviation) and percentages.

Quantitative data was analyzed by the use of linear regression. Both simple and linear regression models were used to predict the relationship between homegarden productivity (dependent variable) and its predictor variables.

Regression models were designed as follows:

Simple linear regression

$$Y=a+bx$$

where Y= homegarden productivity (for banana and/or coffee)

a= intercept of the line with Y-axis

b= slope of the line, that is the change of homegarden productivity per unit change of independent variable

x= independent variable

Multiple linear regression

$$Y=a+bx_1+bx_2+\dots+e$$

where the rest of the variables are as above except e which is an unexplained error component.

Predictor or independent variables that were considered to influence homegarden productivity were; Cattle keeping (hence manure), size of homegarden, household labour availability, and hired labour.

A one way analysis of variance (ANOVA) was used to analyze the reported data on present and past yield levels of banana. The analysis was designed to test to test the difference between the two means. The hypothesis tested was stated as  $H_0: \mu_1 = \mu_2$  against the alternative  $H_1: \mu_1 \neq \mu_2$ . The hypothesis was tested at 95% degree of confidence. Only the banana crop yield could be subjected to ANOVA because farmers were able to recall declines in yield over the years.

**Farm Economic Analysis** technique was the major tool used to analyze the current farming system and the alternatives that could be undertaken in Bukoba given the current trend of low production in homegardens. Costs and returns were analyzed using interview data and estimates of crop performances. Monetary units were used as the basis for measuring inputs and outputs in the cost and returns analyses and nominal prices were used throughout.

Two alternatives that were analyzed were (i) intensification (rehabilitation) of the current farming system by the use of cattle manure and (ii) a shift to maize/bean mixed cropping. **The net present value (NPV)** criterion was used i) to test the profitability of the current farming system and of each of the proposed alternatives and ii) to compare the relative profitabilities of these farming systems.

The time horizon of twenty years production period was used and the resulting net cash flow was discounted using three discount rates namely; 20%, 29% and 38% bearing in mind that

the interest rate for medium-term agricultural lending in Tanzania is 29% and the inflation rate is 20% (Bank of Tanzania, 1991). The net present values for each alternative farming system was obtained by summing up its annual discounted net revenues.

**Sensitivity analysis** was done to test stability of the alternative farming systems given the risks and uncertainties that characterise agricultural systems in respect to yield variation and fluctuation of prices of inputs and outputs. Sensitivity analysis was therefore used to investigate the effects of the changes in prices and/or yields on the profitabilities of proposed farming alternatives. For each alternative, the total cost of production was increased by 150%, 100% and 50%. After each increase, the effect on the profitability was examined. The increase in total cost was designed to reflect possible increases in the prices of input factors. In respect to revenue, the total annual revenue was reduced by 50% and then by 75%. The effect on the profitability was then examined. The decrease in total revenue was designed to reflect the possible decrease in yields or in prices of the products.

A 29% discount rate, which reflects the interest rate of agricultural loans in Tanzania, was used in the sensitivity analysis.

Identification of trees and other plant species was done partly through informal interviews with elderly farmers and partly by Regional forestry staff at Bukoba.

## CHAPTER 5

### RESULTS AND DISCUSSION

#### 5.1 Farm (homegarden) characteristics

##### 5.1.1 Homegarden size and household composition

Homegardens in the study area were found to be quite small but intensively cropped. The mean homegarden size was found to be 1.58 acres (0.6ha). Size classes of homegardens are summarized in table 2

**Table 2: Size classes of homegardens**

<u>Size class (acres)</u>	<u>number of homegardens</u>	<u>%</u>
<1	21	29
1-1.9	38	53
2-2.9	12	17
>3	1	1
<u>Total</u>	<u>72</u>	<u>100.00</u>

As shown in table 2 the majority of farmers (82%) had homegardens below 2 acres whereas only 18% had homegardens above 2 acres. A 95% confidence interval revealed that the mean homegarden size was between 1.48 and 1.86 acres or 0.5 to 0.7 hectares. This finding confirms the earlier assertion (see section 2.3.1) that homegardens of Bukoba are small in size. When compared to previous studies in the area for example Friedrich (1968), Moody (1970) and Reining (1970), homegardens have not considerably decreased with time as

decrease in homegarden size is out-migration of people from Bukoba district to other parts of Kagera region and to other parts of Tanzania.

This study found the mean household size in the study area to be 5.22 persons. The smallest household had 1 person while the biggest had 15. A 95% confidence interval showed that the mean household size is between 4.6 and 5.8 people. The findings agrees with a recent study by the Royal Tropical Institute (1990) in which it was found that the mean household size in Bukoba is 5.8 people. Despite that homegarden size has not decreased much over the years, the present size (0.6ha) is small to subsist an average household of about 5 to 6 persons.

#### **5.1.2 Structure and components of homegardens**

In general terms, homegardens surveyed were found to consist of three major components namely; i) the banana-coffee admixture; ii) mixed array of annual crops, tree and shrubs; iii) livestock.

Banana was found to be the most common and predominant crop in all sample homegardens. 97% of homegardens had a banana-coffee mixture and only 3% had no coffee crop. The intensity of admixture was found to vary in space and time and from one homegarden to another. On average banana occupied 80-95% of homegardens; coffee occupied about 20-25% whereas trees and shrubs occupied 2-4%. Root crops (yams, sweet potatoes, taro,

cassava) were found on the edges of homegardens. Beans were sown extensively in all sample homegardens at the onset of short rains in September when the survey was in progress.

Visual observation in sample homegardens revealed that horizontally, land use is organised concentrically around homesteads. The dwelling place (homestead) and cattle stable are centrally located in the homegarden. Close to the homestead, banana stand is dominant, banana trees are abnormally tall probably due to frequent manuring because most household refuse is deposited near the homestead and so is cattle manure (where available). Depending on the season, beans and to a lesser extent maize, are found mixed-cropped in the banana dominated belt. With increasing distance from a homestead banana/coffee mixed stand is found, some trees, shrubs and some annual/biennial minor food crops are also found in this belt. Towards the edges of homegarden the banana crop was found short and less healthy. Some coffee trees were found bushy and overgrown. Deriving from this observation, it can be said that homegardens do have a fertility gradient which decreases as one moves from the centre, at the homestead to the periphery. These findings also indicate that intensity of management of homegardens decrease with distance from homesteads. Similar observations were made in northern Nigeria (Norman, 1974). Under such homegarden management regime, the most important crops are grown near the homesteads where they can be carefully managed while minor crops and tree species with no immediate benefits

are pushed to the periphery. This explains why banana which is a staple crop in Bukoba district is grown close to homesteads.

Vertically, different layers/storeys are evident. Beans, amaranth, cowpea and some other short annuals make up the lowest canopy. The intermediate canopy is made up by such crops and trees such as coffee, papaya, banana and castor whereas the upper most canopy is made up by tall trees which mostly include, *Maesopsis*, *Markhamia*, Oil palm and *Ficus* species.

An inventory of crops and other plants found in Bukoba homegardens is presented in Appendix 1. As shown in the appendix a typical homegarden contain over 30 crop and tree species, these are deliberately planted and maintained to produce food, medicine, cash, fuelwood, and many other services both social, economic and cultural.

Figure 3 shows the lay out of a homegarden in Bukoba.

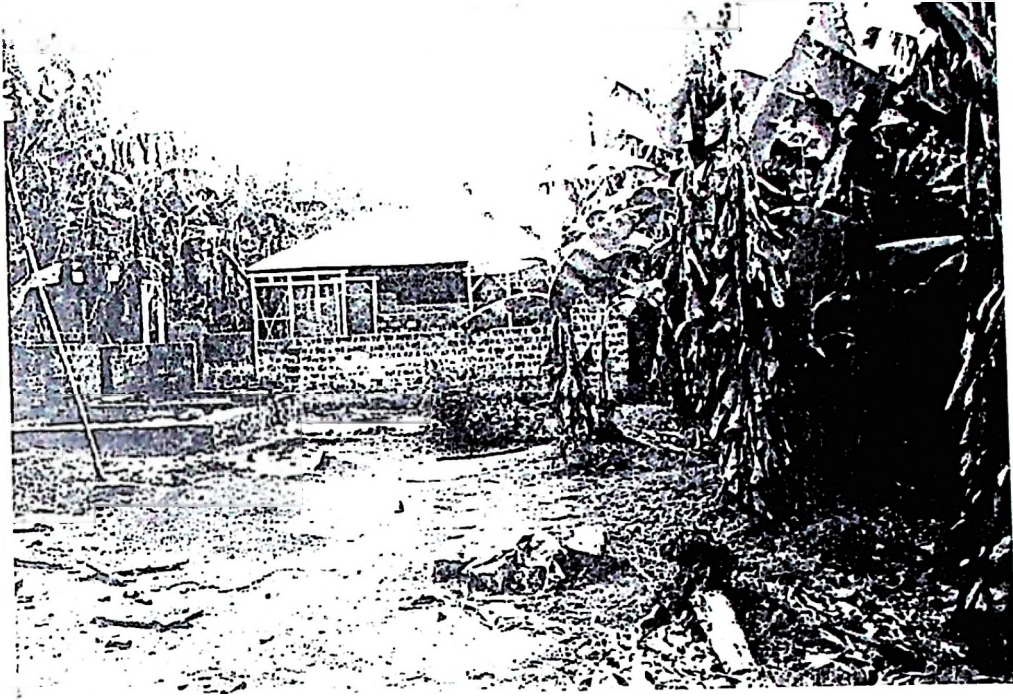


Fig.3: Lay out of a homegarden. Tall banana plants around the homestead (top); mixture of different crops and trees on the periphery (bottom).

Livestock keeping was found to be dominated by cattle. Goat, sheep and local breeds of chicken were found to be small to merit enumeration. Only about 17% (n=12) of the sample households kept cattle, mainly local breeds, the Ankole and Zebu. Three farmers had cross-bred (dairy) cattle. The mean was 5.9 heads per cattle keeping household but this also implies 0.8 heads per capita in the sample villages. When compared to findings by Friedrich (1968), Rald and Rald (1975) and the Royal Tropical Institute (1989) (see section 2.3.1) it is clearly found that cattle keeping in Bukoba has been declining over the past years. Farmers who at present do not keep cattle were asked to give reasons for not keeping cattle. Most of them cited lack of cash, lack of labour to tend cattle and vulnerability of cattle to diseases as the major reasons as summarized in Table 3.

**Table 3: Reasons for not keeping cattle**

<u>Reason</u>	<u>number of respondents</u>	<u>(%)</u>
Shortage of grazing land	2	3
Lack of cash to buy cattle	55	76
Vulnerability to diseases	47	65
Lack of labour to tend cattle	35	49
Difficult to borrow from friends	17	24
Did not inherit any cattle	5	7

From table 3, it is clearly seen that lack of cash to buy cattle and vulnerability to diseases are the two most important factors. Lack of labour even though was mentioned by

almost 50% wouldn't be a strong factor if the two most important limiting factors were to be solved as shown in later paragraphs.

Ninety six percent of farmers keeping cattle reported to graze the cattle in the communal pasture lands in a free range system. Stall feeding was found limited to only three of the cattle keeping respondents.

Cattle is an important integral part of the homegarden farming system in Bukoba. It plays both complementary and supplementary roles . Supplementary role is played through supplementing farmers income in the household, provision of food stuff such as milk, blood and meat which are necessary for household nutrition. Complementary role is played through provision of manure necessary for higher productivity in homegardens. Given the nature of soils in Bukoba district, cattle manure is the most feasible source of soil nutrients. At present households which do not keep cattle are devoid of the complementary and the supplementary roles of cattle. Mostly it is against this background that when farmers who do not keep cattle are willing to keep cattle, 91% replied positively and cited provision of manure as the major reason for willingness to keep cattle (Table 4). The fact that less than half of the respondents mentioned milk as another reason for keeping cattle may be due to the small amount of milk that is produced by local breeds found in the area (approximately 0.9 litres/day).

**Table 4: Reasons for willingness to keep cattle**

<u>Reason</u>	<u>number of respondents</u>	<u>(%)</u>
Manure	70	97
Milk	33	46
Meat	9	13
Cash	20	28

As revealed in table 4, farmers are interested in cattle keeping because of manure which they can use to improve soil fertility and in so doing increase output from homegardens. Cattle can therefore be a strong incentive to farmers in the area.

No respondent farmer reported to be planting trees in the sample homegardens. Such a finding was expected because given the decline of food (banana) production and the fragmentation of homegardens it is only natural that farmers would give more weight to food crops than woody tree species. But as Karani (1986) hypothesizes, removal of trees from homegardens is not likely to be a solution but rather a problem in itself because it may lead to further weakening of banana plants and to the increased incidence of banana weevils.

### **5.1.3 Interaction of components in homegardens**

Components of the homegarden namely; crops, trees and livestock interact in both space and time resulting in an ecosystem specific to homegarden. The use of banana trash for



productive for a long time. Exclusion or absence of one or more components in this system may be expected to result into poor productivity.

#### **5.1.4 Use of inputs in homegardens**

Traditional farm inputs were found to be the major inputs used in homegardens of Bukoba. Very few sample households reported to be interested in using any fertilizers or biocides. Simple or rudimental tools mainly; machetes, hand hoes, fork hoes, spades, axes, and sickles were found widely used in homegarden operations.

##### **5.1.4.1 Labour**

One of the most important input in traditional farming systems is labour particularly household labour, in this study, family labour was found to be the most important labour input in homegardens. Two persons per household were reported to be available for homegarden work. This means an average household of 5.22 members has a work force of two people which seems a reasonable work force in an average sized homegarden. Only twenty three of the sample households (32%) reported that household labour was not sufficient for all farm activities. They were therefore hiring labour from time to time but complained that hired labour is now scarce in their villages. Only three households had permanent paid labourers.

On average labour input in a homegarden was found to be 2 hours per day for men and 3.9 hours for women. Taking a 6 day working week, a man is found to spend an average of 624 hours per year working in a homegarden while a woman spends 1217 hours, almost twice as much. Logically it means man's labour is under utilized. The difference in time spent by both sexes to work in family homegardens can be attributed to the social division of labour that exist in Bukoba district. Responsibilities of men in family homegardens are seasonal while women's responsibilities in homegardens are almost continuous throughout the year.

In cattle keeping households men were found to spend 54 working hours per month (648 hours per year) tending cattle. However, 52% of cattle keeping households reported that tending cattle is mostly done by male children.

A simple regression analysis (table 7) revealed that hired labour accounted for a higher variation in coffee production than in banana. It is important to note however, that most farmers using hired labour have cattle and incomewise they are better off. This means therefore that they hire labour because they can afford to do so. From the results, hired labour is found to be important in coffee production because men (who are in charge of the coffee crop and its proceeds) hire labour for coffee husbandry than for banana which is a women's crop.

#### 5.1.4.2 Chemical fertilizers and biocides

Few farmers (11%) reported to have ever applied fertilizers in their homegardens. Seventy six percent reported to have applied biocides particularly pesticides and nematicides to control the banana weevil and nematodes. Only one farmer reported to have ever applied herbicides in the homegarden. At present no farmer was found to be using any chemical fertilizer or biocides. Farmers were asked to give reasons for not using chemical inputs, the most frequent answer (Table 5 and 6) was that chemical inputs are bad to the soils and the banana crop.

**Table 5: Reasons for not using chemical fertilizers in homegardens.**

<u>Reason</u>	<u>number of respondents</u>	<u>%</u>
Expensive	27	38
Not available	12	17
Destroy soils	60	84
Destroy crops	67	93
No reason	1	1

A threefold explanation can be given to the reasons given by farmers for not using fertilizers in their homegardens. First, the soils where homegardens are found are acidic ferralsols with pH as low as 3.5 (Mkamba 1986), applying acidic fertilizers to such soils results in further acidification of the soil and hence seriously affect crop growth. It is most likely that fertilizer trials with farmers

(which is common in Tanzania). Unfortunately no sample farmer could remember which type(s) of fertilizer(s) that were used. The second possibility is that farmers who tried fertilizers were mainly those who do not keep cattle, their homegardens therefore had low amount of soil organic matter.

Agronomically, ferralsols with high organic matter content react better to chemical fertilizers than ferralsols with little organic matter (Buringh 1979). Thirdly, it is possible that farmers didn't apply the recommended (optimum) rates of chemical fertilizers. Applying a higher dose is detrimental to soils and crops whereas a small dose is not effective.

**Table 6: Reasons for not using biocides**

<u>Reasons</u>	<u>number of respondents</u>	<u>(%)</u>
Not available	20	28
Expensive	29	40
Destroy banana crop	66	92
Destroy soils	56	78
Harmful to human beings	14	19
Ineffective	60	83

Two explanations can be given to substantiate the responses depicted in Table 6 above. First, when banana weevil and nematodes were found to have seriously affected the production of banana in the homegardens, pesticides were envisaged as an initial and quick measure to arrest the problem. The Tanzanian Ministry of Agriculture prescribed Dieldrin for the control of banana weevils. However, instead

of controlling the weevils, dieldrin accelerated the problem, much to the farmers' dismay and complete refrain from using any chemical for pest control.

Trials at Maruku agricultural research institute and other parts of Bukoba district have proved the ineffectiveness of dieldrin to weevils (Mbwana 1991, pers. comm.).

The most logical reason that can be given here is that banana weevils and possibly nematodes have developed resistance to dieldrin.

Second, the distribution of dieldrin to farmers was not backed by any extension service to educate farmers on the use of the pesticides. As a result some farmers, anticipating a quick solution, may have used high doses of the chemical than recommended resulting into destruction of not only the banana crop (phytotoxicity) but possibly killing natural enemies of banana weevils. According to Subijanto (1990), the most common natural predator of banana weevil is a weevil called *Placeus javanus*, certainly we are not sure if this predator existed in Bukoba or not. It is also possible that some of the farmers used small doses which may have made the banana weevil to build resistance.

The dieldrin and fertilizer experience seems to have negatively affected views of the farmers on the use of chemicals in the homegardens of Bukoba.

Recently introduced biocides such as Furadan and Miral are being seriously resisted by farmers even though research trials have proved that these are effective than dieldrin (Sweya 1991<sup>3</sup>, pers. comm.). The prohibitive prices of biocides is another reason which can help explain farmers' refrain to use chemicals. According to Uronu (1991<sup>4</sup> pers.comm;) to obtain the pesticide Furadan for example, a farmer would need 65000 shillings for one hectare of homegarden. Such a big sum seems to be beyond the means of most farmers.

#### **5.1.4.3 Use of organic matter**

Twenty nine percent of sample households reported to be using cattle manure in the homegardens. These included the 12 households keeping cattle, 7 households reported to be buying manure from neighbours and 2 households reported to be collecting manure from communal grazing land. The rest did not use cattle manure, they therefore depended on banana trash, crop residues, household refuse and sometimes on composted banana peelings as sources of soil organic matter. These results imply that nutrient cycling in sample homegardens and undoubtedly in Bukoba district in general is limited to nutrient sources available in the homegarden.

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Arusha.

As banana production has declined so is the use of banana peelings and banana trash. This implies that only a small amount of organic matter is now being recycled.

#### **5.1.4.4 Capital inputs**

No single respondent in the sample villages was using any sophisticated machinery in farm operation. Respondents claimed that they were facing severe scarcity of cash necessary to acquire traditional inputs such as farm yard manure. It was also found that currently no respondent was getting loans/credit from any financial institution or from the Kagera Co-operative Union (KCU). The main reason put forward by most respondents (90%) was that given the stringent conditionalities and bureaucracy it is difficult to secure loans from either the co-operative union (KCU) or governmental financial institutions. Respondents were asked whether they would take farm credit if available, majority (94%) affirmed that they needed farm credit and would take it if available. They pointed out buying cattle for provision of manure as the major investment priority. Logically the response from sample farmers implies that cash is scarce, the scarcity of cash is undoubtedly one of the major limitations of production in homegardens in the study area. Availability of farm credit would likely be a strong incentive for cash poor farmers.

#### **5.1.5 Productivity of homegardens**

The study revealed that an average homegarden of 1.58 acres (0.6ha) produces about 81kg of coffee, 105 bunches of banana

and 120kg of beans per year. Data for cassava, taro, yams, and other minor crops could not be obtained. If converted into per hectare basis, a one hectare homegarden would therefore produce 135kg of coffee, 175 bunches of banana and 200kg of beans per year. Homegardens in which cattle manure is applied were found more productive, the mean yield per hectare was 320 bunches of banana, 264kg of coffee and 272kg of beans. Since cattle manure application is limited to only a small percentage of farmers, average output from homegardens in which manure is not applied were taken as the most representative in further discussion.

A simple linear regression of homegarden productivity with each of its predictor variables showed that cattle keeping account for 71.6% of the variation in banana production and 84.8% of the variation in coffee production (Table 7). This confirms the assertion made earlier that cattle keeping and hence manure, is a necessary input in homegardens and that homegardens in which manure is applied are more productive than those without manure. Other variables were found to account for a smaller percentage of variation except hired labour which accounted for 65.6% of variation in coffee production but accounted for a mere 39.2% of the variation in banana production. As stated before hired labour was found to more important in coffee than in banana production.

A multiple linear regression showed that the four predictor variables (size of homegarden, heads of cattle per household, hired labour, size of the household) accounted for 71.7% and

86.1% of the variation in banana and coffee production respectively. Results of both simple and multiple linear regression are summarized in table 7.

**Table 7: Results of regression analysis**

**a) Simple regression analysis results**

Homegarden production and its predictor variables

Banana	Predictor	R.sq %	t-ratio	p
	Hired labour	39.2	6.84**	0.000
	Homegarden size	7.7	2.62*	0.011
	Household size	0.0	0.79	0.432
	Cattle number	71.2	13.30**	0.000
Coffee	Hired labour	65.6	11.68**	0.000
	Homegarden size	1.9	1.54	0.127
	Household size	1.7	1.48	0.143
	Cattle number	84.8	19.95**	0.000

**b) Multiple linear regression results**

Banana (R.sq 71.7)	Predictor	t-ratio	p
	Hired labour	-0.90	0.372
	Homegarden size	1.76	0.082
	Household size	0.05	0.957
	Cattle number	8.41**	0.000
Coffee (R.sq 86.1)	Hired labour	2.75**	0.000
	Homegarden size	-0.16	0.869
	Household size	0.85	0.398
	Cattle number	10.13**	0.000

Note: \* significant at 95%  
 \*\* significant at 99%

The study found that the average banana output in the past (late 1960s to early 1970s) was 514 bunches per hectare per year whereas at present the mean yield is 175 bunches. This represents a 66% decline in production of banana over a period of about 20 years.

A one way analysis of variance (ANOVA) revealed that there is a highly significant difference between the two means, i.e. the mean yield of banana in the past 20 years and the mean yield of the same crop at present are not equal (calculated F value = 52; p = 0.0000).

According to Schuler (1984) the daily calorie requirements of one man equivalent, i.e. one adult person (15-55 years) is 2500 calories. To obtain this daily calorie requirement, an adult person has to eat 2.1kg of banana per day (1kg of banana provides 1200 calories). Taking an average family reported in this study and assuming that because of children and the elderly, a family of 5.22 persons is equal to 4 man equivalents (M.E). The annual banana requirement for the family is  $4 \times 2.1 \times 365 = 3066\text{kg}$  of banana per year equivalent to about 204 bunches. The present production of 175 bunches per hectare is therefore not sufficient for family subsistence needs let alone income generation.

Also available data from a study by Moody (1970) indicate that banana production in Bukoba then was 3,363.3 kg/ha/year, and coffee was 235kg/ha/year. If a banana bunch is assumed to weigh 15kg (Acland, 1973); then the yield per hectare of a

homegarden was 224 bunches per year. Even though the 1970 study was done on a smaller sample (n=23), the decrease in crop yields is evident.

The above results agrees with the hypothesis that production in homegardens has significantly declined over the last two decades due to various constraints. Banana is the staple and the most cherished crop in Bukoba district. Under present situation of declining homegarden productivity very few homegardens will be able to subsist on their homegardens in the long run.

In this study only about 20% of respondent households felt that their homegardens could subsist them for most part of the year but the general feeling was that there is a shift towards other food crops particularly root crops which are cultivated on the grasslands and on the edges of homegardens. Increased dependency on root crop will lead to short fallow period in the grassland and consequently to poor yield and probably land degradation, it will also lead to decrease in grazing land. Maize cultivation is said to have started in Bugabo division (Royal Tropical Institute 1989). Since Bugabo division was not covered by this study, we defer the discussion of maize cultivation to the section on economic analysis.

### 5.1.6 Household cash income

Sources of household income are summarized in table 8.

**Table 8: Sources of household cash income**

Source of income	number of respondents	%
Coffee sales	68	95
Banana for food	5	7
Beer banana	31	43
Sales of banana beer	34	47
Sales of distilled liquor	5	7
Off-farm income	54	75

As shown in table 8 many households derived their household cash income from coffee sales, this has been the case since coffee was commercialized (Smith, 1987; 1989). Sales of beer banana and banana beer which in the past were not important sources of income were found to contribute cash income to a large number of households. This can be explained as a direct response to the destruction of the most susceptible cooking banana by weevils and nematodes, farmers in Bukoba have increasingly planted beer banana which is considerably resistant to the two pests mentioned above. Undoubtedly this has resulted into an increase in sales of beer banana and banana beer. Cultivation of beer banana may also have been prompted by the farmers need to find alternative source(s) of income in response to poor prices of coffee.

Because of the difficulties in getting data on household cash incomes, the average income was computed basing on the production volume of the three main crops banana, coffee and beans.

Prices at the time of this survey was 50Tshs<sup>5</sup>/kg of coffee, 200Tshs/bunch of banana and 60Tshs/kg of beans. Assuming all crop harvested is sold, an average 0.6ha homegarden therefore produces an income of 47,860.00Tshs. This income is equivalent to 195.35 US \$ per household per year or 9,167.90Tshs (37.42 US \$) per capita per year. The mean off-farm income reported was 20,000shs/year. If this income is added to the farm income the total is 67,860 equivalent to 48 US \$ per capita per year. The average income is certainly low to cater for an average family needs. Logically and in general terms we can assert that farmers in Bukoba district have low incomes.

## **5.2 Constraints underlying productivity in homegardens**

Critical constraints limiting productivity in homegardens were found to affect mainly the two principal crops (banana and coffee) and the livestock component (cattle) as summarized in Table 9.

Soil fertility was mentioned as a limiting factor in both coffee and banana production. Partly, low soil fertility in Bukoba district is due to the soil parent material, nevertheless permanent cropping, lack of constant

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<sup>5</sup> Tanzanian shillings

replenishment of soil nutrients through manuring and leaching due to heavy rains are some of the factors that can be said to have contributed to low fertility.

**Table 9: Constraints underlying productivity in homegardens**

	constraint	frequency %	n
a) Banana	Banana weevil	88	63
	Nematodes	31	22
	Land scarcity	64	46
	Labour scarcity	47	34
	Lack of manure	71	43
	Poor soil fertility	82	59
	Panama disease	72	52
b) Coffee	Pests/diseases*	29	21
	Low producer prices	53	38
	Lack of inputs**	11	8
	Land scarcity	69	50
	Labour scarcity	50	36
c) Cattle***	Diseases*	58	7
	Lack of vet.services	67	8
	Lack of labour	42	5

NOTE:

- \* unspecified
- \*\* include sprayers and chemical inputs
- \*\*\* cattle keepers were the respondents

Banana

From table 8 it is clear that banana weevil is viewed by the farmers as the most pressing problem of banana production in Bukoba district.

Weevils damage banana plants by feeding on the banana corm, they tunnel the corms and cause weakening of banana plants which eventually fall down even when there is no strong wind. Banana stools with bunches have to be propped, and fruit quality is greatly reduced.

Nematodes, though equally devastating were not considered as a problem by majority of farmers. This is probably due to the fact that nematodes are microscopic, it is therefore difficult for farmers to point out nematodes (which they have never seen) as a threat to the banana crop. It is also possible that farmers can not differentiate crop damage due to nematodes from that caused by weevils.

Nematodes destroy the banana crop through the destruction of the root system. They burrow, feed and reproduce inside the roots, the root system and eventually the corm rots away. Like in weevil damage, banana plants damaged by nematodes commonly fall down unless propped.

Old farmers attributed the outbreak of banana weevil to the introduction of the sunflower crop (*Heliothis annuus*) (Obwonza in Kihaya language) during the British colonial period. Sunflower was resisted and it is not grown in Bukoba today but it may be of great interest to researchers to validate or invalidate the farmers' claim.

Agronomically banana weevil is seldom a serious problem on fertile soils and in well managed farms (Acland 1971), it is however, a serious threat on infertile and neglected farms. The serious outbreak of banana weevil in Bukoba district in the mid 1970s could be attributed to the gradual decline of soil fertility over the years. The same explanation might be given for the outbreak of nematodes.

Panama disease caused by *Fusarium oxysporum* f.sp. *cubense* was reported to be a relatively new problem but fast spreading in Bukoba district. Whereas cooking banana have considerable resistance, beer banana especially Jamaica sweet is very susceptible to panama disease (Valmayor 1990), same phenomenon has been experienced in Bukoba. Panama disease destroy the crop by attacking the leaves which eventuall dry. Photosynthesis is therefore interferred, consequently banana plants dies.

### Coffee

The major problems of coffee were found to be scarcity of land, low producer prices and scarcity of labour.

The fact that Tanzanian farmers are usually paid artificially low producer prices is well known and it has been documented widely (Uma Lele 1984; Coulson 1982). As a result of being underpaid, farmers have no incentive to invest in coffee production. Visual assessment of most sample homegardens during the survey indicated that coffee trees were bushy and old. Tibaijuka (1984) observed a similar trend and reported that about 30% of coffee trees are so old to be productive. The logical implication is that the coffee crop in Bukoba is either stagnant or declining. The coffee industry in Bukoba district has faced booms and depressions over the last century, farmers respond to increases in price by producing more coffee and vice-versa (Smith, 1987; 1989). At present farmers are paid 50 shillings per kilogramme of dried, unmilled coffee which is only 10% the world market price.

Under the present state of the economy of Tanzania, annual earnings from coffee can not subsist an average household for a month. In this case farmers find no incentive to produce more coffee. A higher price of coffee would be an incentive to farmers.

Scarcity of land as a constraint to coffee production in Bukoba as pointed out by sample farmers may be explained in the light of continued fragmentation of homegardens due to population pressure and also decline of banana for food in the district. In such a situation the basic priority of a farm family is to produce enough food for the household.

Only about 30 percent of respondent cited pests and diseases as limiting factors to coffee production. Agronomically *Coffea robusta* suffers from few pest and disease attack (Acland, 1971). Coffee pests and diseases can therefore be said to be minor constraints of coffee in the study area.

### Cattle

Results summarized in table 8 shows that (respondent farmers felt that the most pressing constraints were lack of veterinary services, prevalence of cattle diseases and lack of labour. Only three out of twelve cattle keeping farmers reported to have a regular contact with livestock and veterinary extension staff. If veterinary services could be improved, possibly the problem of cattle diseases may be lessened. Some previous studies have documented that long calving interval (approximately 25.5 months), high weaning

loss (30%), high sterility among cows and poor husbandry of cattle are also common constraints to cattle keeping in Bukoba ( Friedrich, 1968; KILIP, 1988). The prevalence of the above constraints help to explain why cattle population has remained low.

#### **5.2.1 Farmers response to constraints**

Farmers response to a host of constraints underlying homegarden productivity varied from one respondent to another depending on the resource endowments at the disposal of a farmer. Generally stated no respondent reported to be taking any serious measures to improve homegarden productivity.

In respect to banana crop, 68% of the respondents practised cultural method of banana control, mainly trapping the weevil. Only about 10% were in contact with village extension workers and these were trying weevil control measures prescribed by extension agents. These measures were chopping up of old banana pseudostems and covering the corms with earth. The rest 22% were not doing anything substantial to control weevils.

The decline of homegarden productivity in Bukoba district due to the onslaught of constraints so far discussed has resulted in general responses which can itemized and discussed as follows:

## Out-migration

Out-migration has always been pointed out as a response to land scarcity in densely populated areas of the tropics (Beets, 1990). Out-migration has been a way of life for people in densely populated parts of Bukoba district over the decades (Royal Tropical Institute, 1989; Smith, 1987). Under current situation of land shortage and decline in homegarden productivity, people are migrating to other parts of the district particularly the south-western part (Katerelo and Rubale divisions) and also to other parts of Kagera region where there is still some room for expansion and where banana weevil and nematode infestation is minimal. The other destination of migrants is the urban centres of Tanzania, this is particularly common for the youth. It is highly debatable if out-migration is a panacea for the problems confronting farmers in Bukoba district. Whereas migration to urban areas directly affects farm labour supply, migration to other rural areas within the region amount to exporting problems to new areas. First, migrants take young banana stools with them to plant in new plots and in so doing they unconsciously spread crop diseases, banana weevils and nematodes. Second the supply of arable land is limited, with increasing population the land is increasingly become scarce. This will lead to cultivation of marginal land which is even more infertile and more prone to degradation.

### planting of beer banana

The planting of beer banana as a response particularly to the onslaught of banana weevil in Bukoba district has been prompted partly by the fact that beer banana is less susceptible to weevil damage, and partly due to low producer prices of coffee. This supports results of this survey indicating that sales of banana beer and beer banana has become an important source of household income. Beer banana varieties are on the other hand, susceptible to Panama disease, consequently, planting of beer banana may not be a viable solution. Since beer banana is normally not eaten, food supply at household level is likely to be severely affected by increasingly planting beer banana in homegardens.

### Dependency on root crops

The destruction of cooking banana by weevil and nematodes has resulted into shortage of the most cherished food in Bukoba and therefore more dependency on hitherto minor crops (cassava, yams, taro, and sweet potatoes). Cultivation of these crops is traditionally a woman's responsibility, overdependence on root crops and grains will mean more workload to women. Also because cultivation of root crops dictate a high degree of crop rotation and/or long fallow period, it is unlikely that it can be successful in Bukoba where arable land is scarce.

### Neglect of homegardens

The need to have alternative sources of livelihood and also due to migration an increasing number of homegardens are being neglected. As stated earlier neglected homegardens are breeding grounds for banana weevil and nematodes.

Figure 5 shows homegardens with different resource endowment hence different management levels.

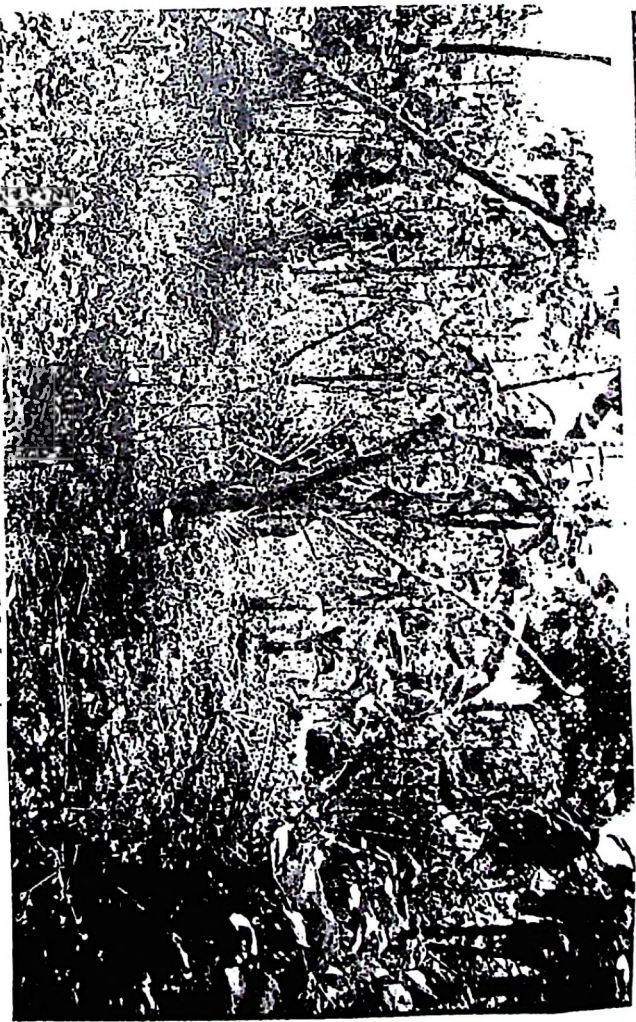


Fig. 5: Homegardens under different management levels. Well kept and manured (left); well kept, no manure (top right); neglected (bottom right). Note, all the three homegardens are infested by panama disease (see banana leaves) and by banana weevils and nematodes.

The constraints so far discussed can be summarized in a cause and effect model (figure 6).

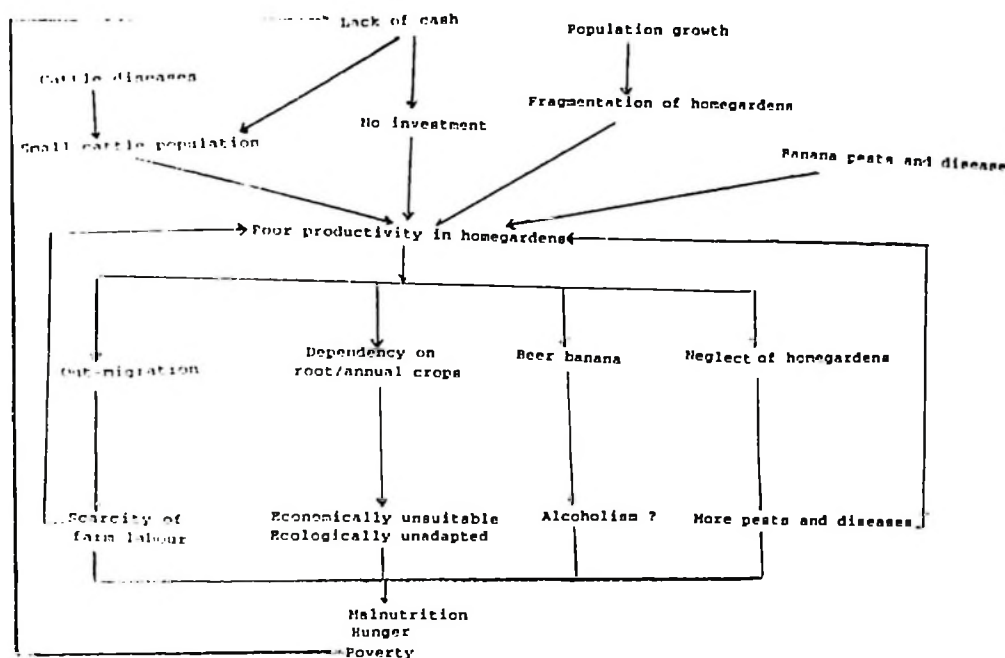


Fig.6: The cause and effect model

As shown in figure 6, it can be said that various constraints are responsible for low productivity in homegardens. Farmers have responded to these constraints in a variety of ways the main ones being; out-migration, dependency on root/annual crops, growing beer banana and neglecting homegardens. The likely results of these responses are; scarcity of farm labour due to migration, soil degradation due to the absence of multi-storey canopy cover, lower economic returns, more crop pests and diseases, and probably alcoholism due to over drinking of banana beer and liquor. Finally, and if no alternative measures are taken to redress the situation, malnutrition, hunger and poverty will be rampant.

### **5.3 Farm Economic analysis**

In view of the agricultural crisis facing farmers in Bukoba district practical alternatives to increase crop yields need to be sought. In order to justify if any alternatives are needed, banana production trend over the last 20 years was analyzed basing on the data obtained from the survey.

As stated earlier (section 5.1.5), banana production in homegardens of Bukoba district has dropped from an average annual yield of 514 bunches per hectare in the early 1970s to 175 bunches in the early 1990s. It was found that intervention in the current homegarden farming system is desirable and economically justified (table 10 and 11).

Two alternatives, one based on rehabilitation of the existing farming system and the other based on a new farming system with maize and beans as the major crops were therefore analyzed to compare their respective profitabilities.

In rehabilitating the existing farming system, the most important undertaking was thought to be the improvement of soil fertility. This was necessitated by the fact that results of this study indicate that well maintained homegardens particularly those applying cattle manure were more productive than otherwise. Evidences from literature indicate that banana weevils and nematodes are common practically in all areas of the world where banana/plantain is an important crop. However, the damage from these pests is rarely serious if soil fertility and good husbandry are maintained (Acland, 1971; Ilaco, 1981; Subijanto, 1990).

Shifting to a new farming system based on maize and beans was considered for analysis because 44% of the respondent farmers mention that they would turn to maize production in the event of banana yields falling to a level which can't sustain families. Only 35% of respondent farmers indicated they were reluctant to turn to maize cultivation, 6% preferred to emigrate to new areas whereas 15% were optimistic that the future of their homegardens is not bleak.

Maize cultivation has also been suggested in a study by the Royal Tropical Institute (1990) which indicated that maize cultivation was becoming common in some parts of Bukoba district notably in Bugabo division.

The Kagera Regional Crop Development Office (Tungu, 1990) has also suggested the cultivation of maize as a means of crop diversification. In this case maize was considered to be grown mixed with beans (mixed cropping).

In both alternatives inflation rate of 20% and medium term lending interest rate of 29% were used because these are the prevailing rates in Tanzania. Inflation was assumed to remain constant. A 20 year project duration was adopted and nominal prices were used throughout. Market prices prevailing in 1991 were used, therefore the base year for all the prices is 1991. Year 1 was taken to be the first year of the project. It was assumed that returns flows at the end of each year.

### **5.3.1 The current farming system**

The current farming system was analyzed in the light of falling banana production. Even though production of coffee in homegardens has been falling too, it was difficult to obtain a reliable trend.

Since it was found that there has been a 66% fall in homegarden banana production over the last two decades, we assumed that if no intervention is done production will continue to fall at a constant rate of 3.3% per hectare per year. It was also assumed that coffee production will remain constant at 135kg/ha/year but producer prices will increase to 310 shs/kg equivalent to 60% of the world market price. Neither milk nor cattle manure production was considered because cattle is confined to only a small percentage of farmers (17%). In the same token, man-days spent tending cattle were not considered. It was assumed that traditional farm tools would be bought twice over a 20 year period (a combined price for tools is 20000shs).

### 5.3.2 Intensification of the current farming system

In this case (project) the improvement of homegarden productivity mainly by improving soil fertility was considered. Cattle manure was taken to be the most important input in the system. The life span of the project was considered to be 20 years after which farmers would be required to cut down banana and coffee trees to counter the ageing effects of plantations. The analysis was based on one hectare of homegarden.

Some factors of the current farming system were considered as follows:

#### Cattle

It was assumed that farmers would get heifer loans from the Kagera Smallholder Dairy Extension Project (KASDEP), a project which is distributing Fresian/Zebu crossbred heifers in Kagera region. Otherwise farmers could loan from the Kagera Co-operative Union (KCU) to buy the heifers, hoping that co-operatives will be restructure as per the new Co-operative Act of 1990. Crossbred heifers are better than indigenous zebu because apart from being able to resist diseases they produce more milk than zebu or ankole cattle which are common in Bukoba. An in-calf heifer costs 65,000 shillings. Loan repayment would begin in the second year of the project, equal annual payments will be paid for five years. Construction of cattle shed (stable) was assumed to cost 25,000shs and be reconstructed on the tenth year. Milk production was expected to be 1250 litres per cow per year over and above the milk consumed by a calf. A farm

family would keep a maximum of two cows and thus would get 2500 litres per year from the third year to the end of the project. A litre of milk costs 80 shillings. A calving interval of 1 year is assumed so that each year a calf will be produced. Cows would be grazed in communal pasture land but supplementary feeding by fodder grass is expected. Farmers could plant fodder grass along the edges of homegardens. Any extra cow or bull calf (culls) will be sold at 50,000shs each at a two year interval effective from the fourth year. We assumed 2 culls to be sold at a two year interval. Manure production was reflected in increased crop yield. Finally, it is expected that the Kagera Indigenous Livestock Improvement Project (KILIP) will continue to offer veterinary and livestock extension services as at present.

### Banana

Optimum plant population for a hectare of homegarden was considered to be 600 banana stools. It is assumed that a homegarden will be properly managed thus be able to produce 400 bunches (6 tonnes) per year from the third year. In the present study it was found that the best homegarden was producing 465 bunches per hectare, so the target of 400 bunches may not be difficult to achieve. Production of banana was assumed to increase from the current production of 175 bunches per hectare to 250 and 400 bunches per year in the second and third year respectively. Production would then remain constant over the remaining years of the project life. A bunch of banana in Bukoba costs 200shs.

## Coffee

Optimum plant population of coffee in a homegarden is 300 coffee trees. It was assumed that farmers will not neglect the coffee crop (as it is the case at present) because the Tanzania government has promised to increase producer prices for coffee to be closer to the world market prices (Tanzania News, 1992). Further, it was assumed that production will reach a target of 300 kilogramme of dried, unmilled coffee per year from the fourth year of the project. Production of coffee was assumed to increase from the present yield of 135kg/ha to 200, 250, 300kg/ha/year in the second, third and fourth year of the project. Production would then remain constant until the end of the project. It was assumed that the government would honour its promise thus pay high producer prices for coffee. We assumed that coffee farmers will be paid 60% of the world market price equivalent to 310 shillings per kilogramme.

## Beans

Currently the production of beans is 200kg/ha. It was assumed that production will increase to 300kg/ha from the second year of the project. Beans cost 60shs per kilogramme.

### Labour

The current study found that 1841 man-hours are available for work in a 0.6ha homegarden per year. This implies 3068 man-hours per hectare per year. 648 man-hours were found available for tending cattle. 8 man-hours were considered as 1 man-day. Male and female labour were valued equally and child labour was not considered. The average pay for daily labour in the sample villages was 200shs, each man day was valued at this price which is higher than the government rate of 159shs per day.

### Land

Land value was not included in the economic analysis because either of the alternatives would be undertaken in the same piece of land.

### Tools

Traditional tools; machete, hoes, sickles, secateurs etc; were assumed to be worn-out and replaced after every 8 years. All necessary tools were assumed to be bought first in year 1 at a combined cost of 20,000shs.

### Pest and disease control

It is assumed that cultural control measures of pest and disease control will be practised. This would entail, proper husbandry practices, weevil trapping, selection of planting material from uninfected stools, eradication of infected plants, and chopping and covering banana stem bases with earth.

### Other inputs

We assumed that fertilizers and pesticides will not be used. Results from this study has also indicated that most respondent farmers are not keen to apply chemicals in homegardens.

#### **5.3.3 The maize-beans farming system.**

In this case (project) it is assumed that farmers in Bukoba would shift to this new farming system as a result of continued onslaught of banana pests and diseases and also due to poor profitability of coffee.

Factors of this new farming system were considered as follows:

#### Labour

Labour demand for maize was derived from secondary sources based on labour inputs at research stations researching on maize in Tanzania. This data was found to fit well with data found in literature (Acland, 1971; Ilaco, 1981). Because maize and beans would be grown in the same season and harvested at around the same time, 250 man-days per hectare per year were considered enough for all agronomic practices except year 1 when extra 30 man day would be needed for clearing homegardens of all present crops and trees. In practise however, a farmer would most probably clear only a portion of a homegarden for maize production at least in the beginning of the adoption of the maize-beans farming system. Each man-day was valued at 200shs.

### Inputs

Fertilizers would be used. According to Samki and Harrop (1984), recommended fertilizer rates for Bukoba district are; 50kgN/ha and 40kgP<sub>2</sub>O<sub>5</sub>/ha for maize and 50kgP<sub>2</sub>O<sub>5</sub>/ha for beans. Therefore a farmer would buy 2 bags of Triple Super Phosphate (TSP) fertilizer (50kg each) and a 50kg bag of Nitrogen fertilizer. TSP cost 1,700shs whereas Calcium Ammonium Nitrate (CAN) cost 1,500shs per 50kg bag. Seed maize would be bought each year from Tanseed (Tanzania Seed Company) at 500shs per 15kg bag. The recommended seed rate is 15kg/ha. Seed beans will be obtained from previous crop.

### Tools

Tools would be bought in year 1 at a combined cost of 20,000 shillings and replaced in year 7 and year 14.

### Yield

Because maize mono cropping and/or maize/beans mixed cropping is hitherto not common in Bukoba, maize yield was assumed to be as high as 1.5 t/ha/year which is the average maize yield at farm level in Tanzania. Bean yield was assumed to be 400kg/ha/year. In this farming system, bean yield was taken to be higher than in homegardens, first because of the use of fertilizers and second because the shading effect of maize canopy is much smaller than canopies of homegardens.

#### **5.3.4 Results of the farm economic analysis**

Results of the farm economic analysis (Table 10) indicated that the current farming (NRHG) with a falling trend in banana production is not profitable, it has a negative returns and so are its net present values. The two alternatives however, were found to be profitable since all their net present values are positive for all three discount rates. Gross returns, costs, net returns and discounted net returns of alternative farming systems are presented in appendices 3a-3h.

The relative sizes of net present values showed that rehabilitation (intensification) of the current farming system in Bukoba district is more profitable than changing to maize/bean mixed cropping (M/B). The rehabilitated farming system was found more profitable regardless of the coffee prices (RHG<sup>1</sup> and RHG<sup>2</sup> respectively). Milk contributed the largest share of revenues followed by banana and coffee while maize contributed the largest share of revenues for the maize/beans farming system. Results of the economic analysis are presented in table 10.

**Table 10: Summary of Profitability Results**

Farming system	Net returns (20 years)	NPV at 20%	NPV at 29%	NPV at 38%
RHG <sup>1</sup>	75198504	6165962	2908541	1609976
RHG <sup>2</sup>	47961580	3891040	1830340	1007379
NRHG	-3235593	-228088	-102750	-56630
M/B	12785030	1109767	559274	335760

Source: Derived from tables of itemized costs and returns from each farming system (appendices 3a-3h).

NOTE: RHG<sup>1</sup>= Rehabilitated homegarden assuming producer price for coffee is raised to 310shs/kg.

RHG<sup>2</sup>= Rehabilitated homegarden assuming producer price for coffee remain at 50shs/kg.

NRHG=Unrehabilitated homegarden with a constant annual decline of banana production of 3.3% per hectare and coffee price at 310shs/kg.

M/B= Maize and beans mixed cropping.

The fact that the net present values rehabilitated homegarden are greater than the maize/beans mixed cropping supports the hypothesis that rehabilitation of the current farming system is more profitable than shifting to a new farming system based on annual crops. The results conform with the view that keeping cattle as an integral part of the farming system is more rewarding not only because of provision of manure but also for cash and milk for household consumption. If data on the yield of minor crops and ecological and economic benefits of the tree subsystem of homegardens could be obtained and valued, the profitability of homegarden farming system could have been much higher.

The results of the sensitivity analysis (Table 11) indicated that the profitability potentials of RHG<sup>1</sup> and RHG<sup>2</sup> are very stable. The farming system remained profitable even when (i) its total cost was increased by 150% or (ii) its total

revenues were decreased as much as 50% regardless whether the producer price for coffee was increased or remained at the present level of 50shs/kg. The farming system remained stable until its total cost was increased by 50% and a simultaneous drop in total revenue by 50%.

The maize/bean farming system was found to be very unstable just when (i) its total cost was doubled or (ii) its total revenue was halved.

The current farming system was found to be unstable throughout implying that under current situation of decreasing homegarden productivity, the farming system is economically not profitable.

**Table 11: Summary of the Sensitivity Analysis Results**

<u>Variations</u>	Effects on farming systems NPVs at 29% discount rate			
	RHG <sup>1</sup>	RHG <sup>2</sup>	NRHG	M/B
1. No variations	2908541	1830340	-102750	559274
2. 150% increase in TC	1244830	166629	(-)	-352813
3. 100% increase in TC	1759400	721200	(-)	-48784
4. 50% decrease in TR	899700	360600	(-)	-24392
5. 50% increase in TC and 50% decrease in TR	-209441	-758541	(-)	-632450
6. 75% decrease in TR	-104420	-374271	(-)	-316225

Note: TC=Total cost; TR=Total revenue; (-)=negative value

### 5.3.5 Some implications of shifting to a new farming system

#### Soils and fertilizer application

Given the acid soils of Bukoba district, fertilizer application will necessarily cause a need for liming. It is also most likely that fertilizer application will upset the delicate balance of mineral nutrients in the soil by fixing some of the nutrients. Use of acidic fertilizers such as Sulphate of Ammonia would be particularly dangerous because of long-term acidifying effects. Any cropping system highly dependent on chemical fertilizers is not suited for soil conditions in Bukoba.

#### Nutrient requirements

Maize is a relatively "heavy feeder" crop requiring large amounts of soil nutrients especially Nitrogen. Just for comparison, nutrients removed by a maize crop of 1500kg/ha/yr are 75kgN, 30kgP<sub>2</sub>O<sub>5</sub> and 60kgK<sub>2</sub>O. A banana crop of 400 bunches/ha/yr removes 12kgN, 3kgP<sub>2</sub>O<sub>5</sub> and 40kgK<sub>2</sub>O whereas a coffee crop producing 300kg/ha/yr removes 4.5kgN, 0.75kgP<sub>2</sub>O<sub>5</sub>, and 7.2kgK<sub>2</sub>O (Ilaco, 1981). These figures imply that maize removes more nutrients than banana and coffee together. Without a stable and reliable availability of chemical fertilizers, we are doubtful if annual crop cultivation, maize in particular, will be successful given the infrastructural and agro-ecological setting of Bukoba district.

### soil conservation

Bukoba district (particularly the lake coast) receives over 2000 millimetres of rainfall per year. Trees and crops in homegardens play an important role in reducing soil erosion and, to some extent, leaching. Through mulching and litter fall soil organic matter is constantly replenished. A change from the current agroforestry system to annual crops will entail exposing soils to hazards of erosion, leaching and hardening.

### Food security and quality

The homegarden agroforestry is essentially an adaption to risk aversion due to the possibility of harvesting something all year round. If it happens that annual cropping replaces the homegarden agroforestry in Bukoba, it has to be known that farmers will be adopting a more risky system especially in the event of poor or very poor rains.

Availability of fruits in homegardens afford a certain degree of supply of vitamins and minerals in local diets. Cultivation of annual crops alone will result in a relatively poorer diet, lacking vitamins and minerals unless these are bought or brought from outside the farm.

It is certain that if the homegarden agroforestry is replaced by a cropping system based on annuals, ecological, social and cultural benefits of homegardens will be foregone.

## CONCLUSIONS AND RECOMMENDATIONS

**6.1 Conclusion**

The homegarden agroforestry system has been a traditional farming system in Bukoba and has sustained the local populations over the centuries.

Crops of which banana and coffee are the most important, are intensively integrated with trees and livestock all of which are managed on the same piece of land. Trees and shrubs are used for shade, timber, poles, medicinal purposes and for other social-cultural functions. The most important use of livestock (cattle) is provision of manure. Horizontally, homegarden components are arranged into distinct belts. Vertically, different canopies can be distinguished whereby crops such as beans occupy the lowest canopy, banana, coffee, papaya, and castor occupy the intermediate canopy while tall trees such as *Maesopsis*, *Markhamia*, and Oil palm occupy upper most canopy.

Declining of homegarden productivity seem to have been influenced by the gradual decline of soil fertility mainly as a result of decrease in cattle population, the serious outbreak of banana weevils, nematodes and later panama disease, fragmentation of homegardens due to population growth and lack of cash. As a result, homegardens can no longer subsist farm families for the most part of the year. The actual decline in banana yield is 66% over the last 20

years. Incomes are too low to support modest investment to improve productivity in homegardens.

Farmers' responses to these problems has been out-migration, a shift towards cultivation of root crops, planting of beer banana and decrease in homegarden management intensity. These responses however are likely to offer short term and partial solutions.

The farm economic analysis has indicated that the current homegarden system is not economically profitable but if soil fertility is restored by application of manure the farming system profitable. In view of the farm economic analysis, it is more economically viable to rehabilitate the current farming system by re-introducing cattle than shifting to maize/beans mixed cropping. Ecologically, the homegarden farming system is more adapted to Bukoba district than the maize/beans system.

Since banana is the staple crop and it is the worst affected particularly by pests and panama disease, measures to redress the situation are urgently needed otherwise food imports will be required to fill the gap between actual yields and actual food requirements.

Given the results of the present study, we are recommending that the current homegarden agroforestry system should be rehabilitated instead of shifting to a new farming system.

It is necessary that the Tanzanian government has to strengthen extension services so that farmers in Bukoba district can be advised about good crop and livestock husbandry practices. As of today crop, and livestock husbandry is done in the old traditional ways. Establishment of demonstration farms will undoubtedly be useful for farmers. The government should also facilitate credit availability to the farmers. Review of the coffee prices as already promised by the government is a necessary step.

## 6.2 Research needs

The following should be priority areas for further research;

- i) integrated pest and disease management so that cultural, biological and chemical methods of pest and disease control complement one another in the control of weevils, nematodes and panama disease in banana crop.
  
- ii) biological control of the banana weevils by its natural predator *Plaesius javanus* which is used successfully in Indonesia, and also for the control of nematodes by the use of parasitic and toxin producing fungi, *Paecilomyces lilacinus* and *Penicillium anaticum*, whose use is also being explored in the Philippines.
  
- iii) the possibility of some other plants in homegardens being alternative hosts to pests and diseases of banana and coffee.
  
- iv) breeding of banana and coffee cultivars resistant to pests and diseases.
  
- v) the possibility of incorporating fast growing and/or nitrogen fixing trees and fodder grass along the boundaries of homegardens. This will help in soil fertility improvement, supply of fuelwood and supply of fodder grass to livestock.

- vi) extensive soil analyses so that a clear picture of which nutrients are lacking and in which village is given. This will enable recommendations on soil improvement to be made based on specific and practical than general and often theoretical grounds.
- vii) determination of carrying capacity of communal grazing land so as to avoid overgrazing and related land degradation effects should more farmers keep cattle.
- viii) the possibility of zero grazing and its impact on household labour.

### **6.3 Limitations of the study**

Collection of primary data depended on the farmers memory. Under such circumstances it is possible that the data collected may not be very accurate.

The study covered only a small part of Bukoba district, this gives little room to comparison of the situation between the area covered by the study and the rest of Bukoba and other districts in Kagera region.

Given limited time for research it was not possible to obtain data on each every output from homegardens. Therefore the analysis and discussion was limited to the three major crops (banana, coffee and beans). This means woody tree products and yield of minor crops whose data was not immediately available could not be analysed.

#### **Introduction**

Homegarden agroforestry system has been a traditional way of farming in Bukoba district over the centuries. It is a purely mixed cropping system whereby a variety of trees and crops are maintained in the same piece of land. The basic primary production is banana which is the main food crop and coffee which is the main cash crop. Crops, trees and livestock are managed by small farmers to produce food, timber, poles, medicine, fuelwood, manure, fodder, bark-cloth and for many other functions/uses.

Until recent years the homegarden farming system was very productive hence sustaining a high population of up to 1250 people/sq.km of cultivated land. With time however, the farming system has succumbed to a host of constraints which has adversely affected the productivity. The constraints include; banana diseases and pests, declining cattle population and therefore poor soil fertility, population growth hence fragmentation of homegardens, low cash income thus low investment in homegarden productivity, poor management and general neglect of homegardens.

This study was aimed at describing the components of homegardens, assessing the magnitude to which stated constraints have affected homegarden productivity and to do the economic analysis of intervention measures to counter falling productivity.

## **The Study Area**

The study area is located in North-Western Tanzania on the shores of Lake Victoria. Rainfall is of bimodal pattern ranging between 1800mm to 2200mm per annum. The terrain is undulating with flat topped hills and valleys are characterized by extensive swamps. Agricultural soils are predominantly acidic, infertile ferralsols.

Population growth rate between 1978-88 was 14.36% or 1.44% per year which is only half of the national average of 2.8% per year. The area is characterized by intensive smallholder production of subsistence and cash crops, holdings are small in size but intensively cropped.

## **Review of Literature**

Homegardens are widely distributed throughout the world and has been widely documented (Saemorwoto 1987; Fernandes et al 1984). Characteristically homegardens are largely for subsistence and they represent a risk-averse farming system (Oduol and Aluma, 1990).

In Bukoba, the homegarden agroforestry was already well established in the late 19<sup>th</sup> century (Hyden 1969), it has since been the dominant agricultural system in the district. Various constraints afflicting the homegarden farming system in Bukoba has attracted attention of researchers of various backgrounds. Poor soils has always been pointed as a major constraint (Milne 1938; Moberg 1972; Kabwoto 1976; Mkamba 1986; Mkandala et al 1989).

Banana pests became serious in the seventies and are reputed to have caused tremendous loss of yield of banana (Tibaijuka 1984; Walker 1983; Maruku A.R.I 1980; Mbwana, 1991 personal communication). Population pressures and fragmentation of homegardens has led to low productivity per unit of land (Reining 1955; Schmidt 1978).

### **Methodology**

The questionnaire survey was conducted in six randomly selected villages in Kyamtvara division in the eastern agro-climatic zone of Bukoba district. In every village, the village register was used as a sampling frame. From each village register, a list of 12 heads of households was drawn at random for interview.

Descriptive statistics was used mainly to analyze qualitative data. Linear regression analysis (both simple and multiple regression models) were used to analyze the relationship between homegarden and its predictor variables. This implies that banana and coffee were taken as dependent variables whereas cattle keeping (manure), hired labour, household composition and homegarden size were taken as independent variables. One way analysis of variance (ANOVA) was used to test the difference between the mean banana yield in the past (before the serious onslaught of banana weevils and nematodes) and the mean banana yield at present.

Economic analysis was used to evaluate the profitability of the current farming system, and also to evaluate the proposed alternatives so as to compare their respective profitabilities (net present values). Sensitivity analysis was done to test the stability of net present values of the current farming system and the proposed alternatives.

### **Results and discussion**

The study revealed that homegardens of Bukoba district are small (average 0.6ha) The small size of homegardens is due to population pressure and scarcity of arable land in the area. Household size is 5.22 people, implying 0.11 ha of homegarden per capita which is small by any rural standards.

The multistorey structure is portrayed by different crops and trees. Beans and herbs occupy the lowest storey (the under growth), coffee, banana, papaya, castor oil and some other woody species occupy the intermediate storey whereas tall woody species such as Markhamia and Maesopsis occupy the upper most store. Such a structure is important in nutrient recycling and in protecting and conserving soil.

Livestock (cattle) is confined to only 17% of respondent farmers, major reasons for not keeping cattle are lack of cash and high incidence of diseases. Willingness to keep cattle if cash is obtained, is immense. The necessity of cattle lies in the provision of manure.

Family labour is the major input, 384 man-days per year are spent in homegarden husbandry. Women work almost twice as much as men, men's labour is therefore under utilized.

Chemical fertilizers and biocides are not used by farmers because they are expensive but above all farmers have a strong negative feeling that biocides and fertilizers are harmful to soils and crops. Farmer's negative attitude towards fertilizers and biocides is attributed to the use of these chemicals in the past. Unfortunately there was no success in improving soil fertility or in the control of banana weevils and nematodes.

A hectare of homegarden produces 135kg of coffee, 175 bunches of banana and 200kg of beans. Harvests from other crops and trees could not be quantified due to lack of data. Homegardens in which farm yard manure is applied are more productive, the average production is 320 bunches of banana per hectare per year. This explains the importance of cattle in the farming system and the farmers' quest to own cattle. Household cash income is low, if all what is produced (banana, coffee, beans) is sold a household would earn 67,860Tshs. Off-farm income is low averaging to only 20,000Tshs equivalent to 48.15 \$ (US) per capita. Cash income is the major factor limiting investments in homegardens.

Constraints of the banana crop are banana weevils, poor soil fertility, lack of manure and scarcity of arable land for homegarden expansion. Nematodes, even though are as destructive as banana weevils are not mentioned by farmers as major constraints probably because they are microscopic.

Coffee production is hampered mainly by low producer prices therefore farmers have not no incentive to produce the crop. Land scarcity and labour scarcity are also found to limit coffee production. Coffee is more labour demanding than banana and given the increased need for food, coffee is given low priority compared to banana.

Cattle keeping is limited by lack of cash, labour scarcity, prevalence of diseases and poor veterinary and livestock extension services.

Farmers have responded to constraints by migrating to other areas, planting of beer banana which is less susceptible to weevils and nematodes, tendency towards dependency on root crops and general neglect of homegardens. These responses offer only partial and short-term solutions.

The economic analysis revealed that the current farming system is not economically profitable in the long run (net present values were negative for three discount rates). Also it was found that rehabilitation of homegarden by restoration of soil fertility (through cattle keeping) is more profitable than changing to a Maize/beans mixed cropping system.

## Conclusions and Recommendations

The findings and discussion presented in this study indicate that:

- i) The multistorey homegarden agroforestry system is important in soil conservation and nutrient cycling. It ensures the supply of different foods over the year and it is socially, culturally and economically important to the farm family.
- ii) Over the years the farming has succumbed to a variety of constraints, Both biological and socio-economic constraints have led the decline productivity in homegardens. Production of banana crop alone has fallen by 66% from the early seventies to date.
- iii) It is possible to rehabilitate the current state of falling homegarden productivity by restoration of soil fertility and good crop and livestock husbandry. Economically and undoubtedly ecologically, it is profitable to rehabilitate the current farming system by re-introducing livestock rather than change to a new one based on annual cropping.

It is therefore recommended that the current farming system should be rehabilitated to enable it to sustain the population in Bukoba district.

## **Research needs**

In order to improve the productivity of homegardens, there is a need to address the following:

- i) integrated pest and disease management.
- ii) biological control of banana weevils and nematodes by using natural enemies.
- iii) Pest and disease problems in relation to possible alternative hosts in homegardens.
- iv) Soil analyses to determine nutrient balance and dynamics in homegardens.
- v) Inclusion of nitrogen fixing plants and fodder grass especially along the boundaries of homegardens.

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## Appendix 1

An inventory of plant species commonly found in homegardens of Bukoba and their functions/uses.

Common name	Venercular name	Scientific name	Uses/functions
Musizi	Omuhumula	<i>Maesopsis emlinii</i>	Timber, fuelwood, goat fodder, poles
Ficus	Omujuju	<i>Ficus sp.</i>	Sacred, canoe/vat making, fuelwood
Ficus	Omusomoro	<i>Ficus exasperata</i>	Scrubbing (sand paper-like leaves)
Ficus	Ombugu	<i>Ficus natalensis</i>	Bark-cloth making, fuelwood
Ficus	Omutoma	<i>Ficus sp.</i>	Shade, live fence, fuelwood,
Oil palm	Omuneshhe	<i>Elaeis guinensis</i>	Edible oil
Raphia	Omhunge	<i>Raphia monbuttorum</i>	Weaving thread (for mats and baskets)
-	Omuziru	<i>Pseudolachnostylis spp.</i>	Fruit, fuelwood
-	Omuqango	<i>Senecio multicoymbosa</i>	Fruit, fuelwood
Markhamia	Omuqambya	<i>Markhamia platcalyx</i>	Medicinal (for cattle), fuelwood
Dracena	Omulamula	<i>Dracena afromontana</i>	Building/propsing poles, boundary marker
Mango	Omunembe	<i>Mangifera indica</i>	Grave/boundary marker
Tangerine	Omuchensa	<i>Citrus sp.</i>	Fruit, fuelwood
Orange	Omuchunkwa	<i>Citrus sp.</i>	Fruit, fuelwood
Lemon	Omundimu	<i>Citrus limon</i>	Fruit, fuelwood, medicinal
Guava	Ompera	<i>Psidium guajava</i>	Fruit, medicinal, fuelwood
-	Omulinzi	<i>Erythrina abyssinica</i>	Boundary marker
Cinamon	Omulalasinzi	<i>Cinamon zeylenicum</i>	Spice, shade, fuelwood
Castor	Omujuuna	<i>Ricinus communis</i>	Banana propsing poles, medicinal
Cassia	Omwita njoka	<i>Cassia hirsuta</i>	Snake repellent
Sodom's apple	Omutobatobo	<i>Solanum incanum</i>	Medicinal, poisonous to cattle, weed
Jack fruit	Omfenensi	<i>Artocarpus heterophyllus</i>	Fruit, fuelwood
Avocado	-	<i>Persea americana</i>	Fruit, fuelwood
Tobacco	Etaaba	<i>Nicotiana spp.</i>	Medicinal, cigarrrete and snuff making
Bamboo	Omushekeyanda	<i>Arundinalia tolange</i>	Propsing and building poles, fuelwood, distillation pipes for liquor (enkonyagi)
-	Omuhoiko	<i>Baphiopsis spp.</i>	Medicinal
-	Omuqshulajwi	<i>Cyperus dives</i>	Medicinal
Ginger	Etangawizi	<i>Zingiber officinale</i>	Spice
Pineapple	Enanazi	<i>Ananus cosmosus</i>	Fruit
Cabbage	Ekabeji	<i>Brassica spp.</i>	Vegetable
Banana	Engemu	<i>Musa spp.</i>	Food, fruit, beer, cash
Coffee	Omuqumwani	<i>Coffea robusta</i>	Cash, social functions (chewing), fuelwood

Appendix 1 continued.

Common name	Veneclular name	Scientific name	Uses/functions
Colocasia (taro)	Ebikwala	<i>Colocasia spp.</i>	Food
Yams	Ebilai	<i>Dioscorea spp.</i>	Food
Maize	Ebicholi	<i>Zea mays</i>	Food (eaten as green maize, often roasted)
Beans	Empelege/Ebiimba	<i>Phaseolus vulgaris</i>	Relish, vegetable (leaves)
Dolichos bean	Enkuku	<i>Dolichos lablab</i>	Relish
Pigeon pea	Entendaigo	<i>Cajanus cajan</i>	Relish
Cassava	Ekilibwa/Ekigando	<i>Manihot spp.</i>	Food, vegetable (leaves)
Cow pea	Obukaiga/Obukole	<i>Vigna unguiculata</i>	Relish, leafy vegetable
Tomato	Omunyanya	<i>Lycopersicon esculentum</i>	Vegetable
Bitter tomato	Entongo/Entura	<i>Solanum spp.</i>	Vegetable
Passion fruit	Omutunda	<i>Passiflora edulis</i>	Fruit
Sugar cane	Ekiqusha	<i>Saccharum officinalum</i>	Fruit (chewed mainly by children)
Amaranthus	Omulili	<i>Amaranthus spp.</i>	Leafy vegetable
Cleome	-	<i>Cleome viscosa</i>	Leafy vegetable
Night shade	Eshwiga	<i>Solanum nigrum</i>	Fruit
-	Entutunu	<i>Physalis spp.</i>	Spongy endocarp
Luffa	Ekiqunjuzo	<i>Luffa aegyptiaca</i>	Medicinal, weed
-	Ekitatelante	<i>Leonotis nepetifolia</i>	weed, chicken and rabbit fodder
Gallant soldier	Kataihwa mbazi	<i>Galinsoga parviflora</i>	Spice
Pepper	Omguruma	<i>Capsicum annuum</i>	Food
Potato	Amanumbu	<i>Solanum spp.</i>	Food
Sweet potato	Entuma/Ebitakuli	<i>Ipomea batata</i>	Food
Pumpkin	Omwongu	<i>Curcubita moschata</i>	Food, vegetable (leaves)
Gourd	Olushusi	<i>Mormodica spp.</i>	Containers for local beer
Vernonia	Ombirizi	<i>Vernonia amygdalina</i>	Medicinal

Appendix 2

QUESTIONNAIRE FOR FARMERS.

Interviewer code number.....

Respondent code number.....

Village.....

**A: INFORMATION ON HOUSEHOLD**

1. Respondent's (a) gender 1 Male 2 Female  
(b) Status in the household  
1 Head of household  
2 Not head of household  
(c) level of education
  
2. Household size and composition  
1 children below 16 years  
2 adults 16 to 60 years  
3 aged >60 years
  
3. Estimated size of the homegarden.....acres.
  
4. Is the husband or wife having formal employment?  
If so what kind of job.....
  
5. What are the major sources of family income  
1 coffee sales  
2 banana sales (food)  
3 banana sales (beer)  
4 sales of local brew  
5 others (specify)
  
6. Can you estimate the proportion of the income generated by each source you have mention in question 5?.....

**B. STRUCTURE AND COMPOSITION OF HOMEGARDEN**

7. Major food crops in the homegarden....(name them)
8. Main cash crops in the homegarden.....
9. Do you keep livestock Yes/No.  
    If Yes go to 10. If No go to 11
10. What kind of livestock and how many do you keep
  1. Cattle
  - 2 Sheep/Goat
  - 3.Chicken
11. Why don't you keep any livestock
  - 1 shortage of grazing land
  - 2 lack of cash to buy animals
  - 3 vulnerability to diseases
  - 4 others (specify)
12. Can you identify trees growing in your homegarden and their uses (use separate sheet of paper)
13. What are the other plants that you maintain in your homegarden and why.....
14. What was the condition of the homegarden when you first acquired it
  - 1 fully developed (inherited)
  - 2 not developed (forest/fallow)

15. What kind of organic matter do you use in your homegarden
- 1 cow manure
  - 2 compost
  - 3 mulch
  - 4 household refuse
  - 5 others (specify)
16. Have you ever used fertilizers in the homegarden  
Yes/No
17. Do you use inorganic fertilizers in your holding  
Yes/No If Yes go to 17. If No go to 18
18. Which type of fertilizer and why that type
19. Give reasons as to why you don't use fertilizers
- 1 not available
  - 2 lack of cash
  - 3 don't prefer
  - 4 other reasons (specify)
20. Have you ever used any pesticides Yes/No
21. Do you use pesticides to control pests in you homegarden Yes/No. If No go to 21
22. Give reasons as to why you don't use pesticides
- 1 not available
  - 2 expensive
  - 3 harmful to crops
  - 4 harmful to human beings
  - 5 other reasons (specify)
23. Do you get agricultural credit from any financial institution Yes/No  
If No go to 24 and 25
24. Why don't you take any credit
- 1 difficult to get
  - 2 not willing to take credit
  - 3 other reasons (specify)

25. Were you to take credit what investment priority would you consider

**D: LABOUR REQUIREMENT AND UTILISATION**

26. How many persons in the household are actively and mostly engaged in farm work.....
27. Do you collect firewood from outside the homegarden  
Yes/No If Yes go to 28, 29 and 30
28. How far is the place you collect firewood.....km
29. How long does it take to collect firewood.....hours
30. Who collects firewood..... and how often.....trips per week
31. How do you feed your livestock  
1 stall feeding (zero grazing)  
2 private pasture  
3 communal pastureland
32. How much do you spend feeding livestock.....days/month
33. Can you tell the time used to do the following activities and how many persons perform each task  
1 sowing beans....weeks/year....persons  
2 weeding the holding...weeks/year..persons  
3 detrashing and pruning  
banana.....weeks/year....persons  
4 harvesting  
coffee....weeks/year....persons  
5 harvesting  
beans.....weeks/year....persons

34. Is the household labour sufficient for all farm activities Yes/No If No go to 35, 36 and 37
35. Where do you get extra labour
- 1 hire
  - 2 relatives
  - 3 cooperative group
  - 4 others (specify)
36. If you use hired labour, how many labourers do you need per year.....labourers
37. What kind of payment do you offer
- 1 cash.....shs per work piece or per month
  - 2 in kind.....(specify)

**E: PRODUCTIVITY OF THE HOLDING (HOMEGARDEN)**

38. How many bunches of banana do you harvest per week from your homegarden
39. Is banana production constant throughout the year Yes/No If No go to 43
41. How many bunches do you harvest during the peak period.....bunches
42. Is the banana production enough for your household food requirement Yes/No  
If No go to 43. If Yes go to 44
43. Where do you get extra food.....
44. Do you sell extra to the market?.....bunches per month
45. How much coffee do you harvest per year from you homegarden.....kg

**F: CONSTRAINTS LIMITING HOMEGARDEN PRODUCTIVITY**

45. What do you consider to be the constraints limiting your homegarden productivity....name

1.....

2.....

3.....

4.....

46. Of the constraints you have just mentioned which one(s) do you consider to be most critical....

47. Do you remember when did the constraint(s) mentioned in 46 above become so critical...years (approximately)

\*If constraints are many take one by one (use back side)

48. Of the two crops major crops (banana and coffee) which one do you think is hard hit by the problems you have mentioned

49. How was productivity before the advent of the problems

Banana harvest during peak period

.....bunches/week

Coffee production was .....kg/year

50. Assessing your homegarden now would you say it is:

1 in very good state

2 in good state

3 average state

4 in poor state

5 very poor state

51. Would you plant other food crops than banana  
Yes/No Yes go to 52 No go to 53

52. Which crops.....

53. Why.....

54. In general how do you view the future of your  
homegarden

1 bright

2 same as now

3 bleak

55. Any additional information or comments.....

THANK YOU VERY MUCH YOUR PATIENCE AND COOPERATION

**Appendix 3a: Estimated yield and Gross Returns Per Hectare of Rehabilitated Homesteads in Bukoba, Tanzania.**

Year	Expected Yield			Expected milk (l/yr)	Sales of Culls	Gross Returns (sh)
	Banana*	Coffee**	Beans***			
1	175	135	200	1250		226620
2	250	200	300	1250		330750
3	400	250	300	2500		648600
4	400	300	300	2500	248800	811100
5	400	300	300	2500		1176800
6	400	300	300	2500		1220900
7	400	300	300	2500	358300	1760400
8	400	300	300	2500		1680400
9	400	300	300	2500	516000	2534300
10	400	300	300	2500		2420300
11	400	300	300	2500	743000	3624900
12	400	300	300	2500		3485400
13	400	300	300	2500	1069900	5253600
14	400	300	300	2500		5019700
15	400	300	300	2500	1540700	7565600
16	400	300	300	2500		7228100
17	400	300	300	2500	2218600	10893600
18	400	300	300	2500		10410000
19	400	300	300	2500	3194800	15687100
20	400	300	300	2500		14990200

**Note:**

- \* bunches
- \*\* kilograms
- \*\*\* kilograms
- l/yr = litres of milk per year
- sh = Shilling (Tanzanian)

**Appendix 3b: Estimates of Labour and Capital Input Requirement To Rehabilitate a Hectare of Homegarden.**

Year	Labour* (man-days)	Helper	Stable	Tools	Loan repayment	Total cost (sh)
1	465			20000		111600
2	465	65000	25000		21176	155096
3	465				21176	182066
4	465				21176	214151
5	465				21176	252746
6	465				21176	298781
7	465					333405
8	465					399900
9	465			103200		601080
10	465		154800			730470
11	465					690000
12	465					829095
13	465					995100
14	465					1194120
15	465					1432665
16	465					1719570
17	465			443720		2506925
18	465					2476125
19	465					2971350
20	465					3565620

NOTE:

\* Sum of 384 man-days for homegarden husbandry and 81 man-days for tending cattle.

Appendix 3c: Discounted Net Returns for a Hectare of Rehabilitated Homegarden.

Year	Gross returns	Costs	Net returns	NPV at 20%	NPV at 29%	NPV at 38%
1	226620	221600	5020	4183	3892	3637
2	330750	155096	175654	121974	105550	92236
3	648600	182066	466534	269983	217312	177330
4	811100	214151	596949	287909	215558	164579
5	1176800	252746	924054	371377	258643	184626
6	1220900	298781	922119	308818	200100	133523
7	1760400	333407	1426993	398274	240020	149692
8	1680400	399900	1280500	297844	166977	97318
9	2534300	601080	1933220	374658	195449	106520
10	2420300	730470	1689830	272908	132483	67424
11	3624900	690990	2933910	394904	178088	84819
12	3485400	829095	2656305	298037	125112	55782
13	5253600	995100	4258500	398170	155435	64729
14	5019700	1194120	3825580	298013	108264	42081
15	7565600	1432665	6132935	398028	134311	48450
16	7228100	1719570	5508530	298011	93645	31949
17	10893600	2506925	8386675	378239	110704	35224
18	10410000	2476125	7933875	298314	96793	23802
19	15687100	2971350	12715750	398003	100454	27975
20	14990200	3565620	11424580	298182	69690	18279
Total	96968368	21769864	75198504	6165962	2908541	1609976

**Appendix 3d: Estimated Yield and Gross Returns Per Hectare  
of Maize/Beans Mixed Cropping System.**

Year	Expected Yield (kg/ha)		Gross Returns (sh)
	Maize	Beans	
0	1200	300	90000
1	1500	400	136800
2	1500	400	163400
3	1500	400	197600
4	1500	400	235600
5	1500	400	279300
6	1500	400	340100
7	1500	400	405500
8	1500	400	490200
9	1500	400	589000
10	1500	400	706800
11	1500	400	874400
12	1500	400	1016500
13	1500	400	1219800
14	1500	400	1463000
15	1500	400	1755600
16	1500	400	2103300
17	1500	400	2528900
18	1500	400	3034300
19	1500	400	3642300
20	1500	400	4370000

**Appendix 3e: Estimates of Labour and Capital Input Requirement for a Hectare  
Of Maize/Beans Mixed Cropping System.**

Year	Labour man-days	Tools (sh)	Fertilizers (bags) TSP	CAN	Seed maize (bags)	Total costs (sh)
1	250	20000	2	1	1	66480
2	250		2	1	1	79776
3	250		2	1	1	95832
4	250		2	1	1	114950
5	250		2	1	1	137936
6	250		2	1	1	165374
7	250	71660	2	1	1	270259
8	250		2	1	1	238220
9	250		2	1	1	285864
10	250		2	1	1	342936
11	250		2	1	1	411622
12	250		2	1	1	493896
13	250		2	1	1	592775
14	250	256780	2	1	1	968285
15	250		2	1	1	853449
16	250		2	1	1	1024322
17	250		2	1	1	1229054
18	250		2	1	1	1475015
19	250		2	1	1	1770020
20	250		2	1	1	2124105

**Appendix 3f: Discounted Net Returns for a Hectare of Maize/Beans Mixed Cropping System**

Year	Gross Returns	Costs	Net Returns	NPV at 20%	NPV at 29%	NPV at 38%
1	136800	93480	43120	35931.9	33426.6	31244.8
2	163400	79776	83624	58068.5	50249.7	43911.0
3	197600	95832	101768	58893.1	47403.5	38682.0
4	235600	114950	120650	58189.5	43566.7	33263.2
5	279300	137936	141364	56814.2	39567.8	28244.5
6	340100	165374	174726	58515.7	37915.5	25300.3
7	405500	270259	135241	37745.8	22747.5	14186.8
8	490200	238220	251980	58610.6	32858.2	19150.5
9	589000	285864	303136	58747.8	30647.0	16702.8
10	706800	342936	363864	58764.0	28526.9	14518.2
11	874400	411622	462778	62289.9	28090.6	13374.3
12	1016500	493896	522604	58636.2	24614.6	10974.7
13	1219800	592775	627025	58626.8	22886.4	9530.8
14	1463000	968285	494715	38538.3	14000.4	5441.9
15	1755600	853449	902151	58549.6	19757.1	7127.0
16	2103300	1024322	1078978	58372.7	18342.6	6258.1
17	2528900	1229054	1299846	58623.1	17158.0	5459.4
18	3034300	1475015	1559285	58629.1	19023.3	4677.9
19	3642300	1770020	1872280	58602.4	14791.0	4119.0
20	4370000	2124105	2245895	58617.9	13700.0	3593.4
Total	25552400	12767370	12785030	1109767	559274	335760

**Appendix 3g: Discounted Net Returns for a Hectare of Rehabilitated Homegarden  
(If Price of Coffee is unchanged at 50sh/kg).**

Year	Gross returns	Costs	Net returns	NPV at 20%	NPV at 29%	NPV at 38%
1	184500	221600	-37100	-30915	-28760	-26883
2	255950	155096	100854	70033	60603	52958
3	536100	182066	354034	204879	164909	134568
4	649400	214151	435249	209921	157168	119998
5	778000	252746	525254	211100	147019	104946
6	932900	298781	634119	212366	137604	91820
7	1126596	333405	793191	221380	133415	83206
8	1345900	399900	946000	220040	123358	71896
9	1615700	601080	1014620	196633	102578	55906
10	1937300	730470	1206830	194903	94615	48153
11	2324900	690000	1634900	220058	99238	47249
12	2790000	829095	1960905	220014	92359	41179
13	3349100	995100	2354000	220099	85921	35781
14	4018300	1194120	2824180	220004	79924	31066
15	4823100	1432665	3390435	220039	74251	26784
16	5786000	1719570	4066430	219994	69129	23585
17	6944300	2506925	4437375	200126	58573	18637
18	8333400	2476125	5857275	220234	71459	17572
19	10000200	2971350	7028850	220003	55528	15463
20	11999800	3565620	8434180	220132	51448	13495
Total	69731448	21769864	47961580	3891040	1830340	1007379

**Appendix 3h: Discounted Net Returns for a Hectare of Non-Rehabilitated Homestead**

Year	Gross Returns	Costs	Net Returns	NPV at 20%	NPV at 29%	NPV at 38%
1	90780	112160	-21380	-17816.0	-16573.8	-15491.9
2	107442	110592	-3150	-2187.4	-1892.8	-1654.1
3	127028	132864	-5836	-3377.3	-2718.4	-2218.3
4	150715	159360	-8645	-4169.5	-3121.7	-2383.4
5	178287	191232	-12945	-5202.6	-3623.3	-2586.4
6	210978	229248	-18270	-6118.6	-3964.6	-2645.5
7	249648	275328	-25680	-7167.3	-4319.4	-2693.8
8	296055	330240	-34185	-7951.4	-4457.7	-2598.1
9	351192	396288	-45096	-8739.6	-4559.2	-2484.8
10	415188	475392	-60204	-9722.9	-4720.0	-2402.1
11	492197	570224	-78427	-10556.3	-4760.5	-2266.5
12	586507	848595	-262088	-29406.3	-12344.3	-5503.8
13	693895	821760	-127865	-11955.4	-4667.1	-1943.5
14	822348	986112	-163764	-12757.2	-4634.5	-1801.4
15	971346	1183104	-211758	-13743.1	-4637.5	-1672.9
16	1157977	1420032	-292055	-14177.2	-4454.9	-1519.9
17	1376667	1703808	-327141	-14754.1	-4318.3	-1374.0
18	1636005	2044800	-408795	-15370.7	-4987.3	-1226.4
19	1937700	2453760	-516060	-16152.7	-4076.9	-1135.3
20	2302263	2944512	-642249	-16762.7	-3917.7	-1027.6
Total	14154218	17389812	-3235593	-228088	-102750	-56630