博士（地域研究）

学位申請論文

Dynamics of land use systems and environmental management in the Matengo highlands, Tanzania

タンザニア、マテンゴ高地における土地利用システムと環境管理の動態

Stephen Justice Nindi

京都大学大学院アジア・アフリカ地域研究研究科

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Historically, indigenous African options and changes in agricultural land use systems have gone almost completely unnoticed, partly because they were not widely researched and written down or published. Ever since colonial times, most agricultural officials have viewed the agricultural systems and the people in Africa as backward, traditional and without motivation to improve their own subsistence technology. This was perhaps because, although farmers in a few areas accepted innovations, many local farmers rejected the agricultural officers' suggestions (Maack, 1996). And when most capital input to agricultural development failed, local farmers were again accused of being too conservative and their agricultural systems were assumed to be static and unchanging (Meertens *et al.*, 1995).

Certainly, traditional African land uses and environmental management practices may inherently involve some, though not entirely, irrational factors within its systems. However, it is wrong to think that it must always be changed or transformed (i.e. modernised) by external forces. Shigeta (1990) pointed out that contemporary African agricultural land use systems cover a wide range of folk knowledge based on for example "indigenous sciences" (Richards, 1985), "folk knowledge systems" (Fukui, 1987) and "indigenous knowledge systems" (Brokensha *et al.*, 1987). The significance of these systems has been in recent decades re-evaluated as "indigenous knowledge and technology" as a means of sustainable land management, to strengthen resource poor farmers in developing countries by promoting efficient use of available resources (Briggs *et al.*, 1998).

According to Knight (1974) indigenous agricultural land use in Africa was by no means static and changes were common in pre-colonial as well as modern times. He further stressed that the longer the people occupy an environment, the more they learn to interpret and use it with greater facility. Reeberg (2001) contends that the management of land rights in Africa is continuously facing change. Land tenure regimes change and adapt to local circumstances and people jockey for position according to their perception of the circumstances and in anticipation of the future. Blaut (1961) and Knight (1971) referred to such changes or innovations as being scientifically valid and important due to cultural understanding of local environments.

Meertens *et al.* (1995) argued that all aspects of agricultural land use are subject to change and that there are many indicators of dynamics in indigenous African farming systems which contradict the idea of static African agricultural system. The dynamics include changes in crops

varieties, crop yields, soils fertility, inputs (manure, fertilizers, insecticides and so on) and the importance and integration of livestock. Reeberg (2001), in her spatial analysis in dynamics of land use systems in Africa, stressed the relation to changing land use patterns as influenced by a chain of circumstances since time memorial.

The changes of circumstances have been caused by various factors such as political and economic changes, change of natural environment including climate, conflict, rising population density, spread of disease and so on. Although the primary occasions to induce the land use changes may be found easily, the internal innovations made by farmers and the slow changes that have occurred in farming systems have in most cases been unnoticed by outsiders, as Turnell II *et al.* (1993) also pointed out. For understanding the internal changing or its processes, the realities including the historical changes in the rural areas should be comprehended through multidisciplinary approaches. And the information obtained by in-depth studies may become bases of rural development activities in future.

Recently, various activities stood on this thinking have evolved in Africa. The project collaborated by the Sokoine University of Agriculture in Tanzania and JICA (Japan International Cooperation Agency) has also promoted the sustainable rural development based on indigenous agricultural system. The system known as locally *ngolo* or the Matengo pit cultivation in southern Tanzania was focused as a model of integrated study covering various disciplines (JICA, 1998). It was found that the pit cultivation characteristic to the Matengo people is closely related to the land use management system controlled by the society, which is locally called *ntambo*. *Ntambo* literally means a land unit mainly composed of one ridge circumscribed by valleys. *Ntambo* designates also a conventional unit of land ownership mainly operated by extended families (Kakeya, 1996). In view of this, *ntambo* can be seen as a socio-ecological and economic unit that shapes a unique land use pattern in the Matengo society. These results show that land use systems is multifaceted, and should be analyzed from various aspects but at least four different perspectives such as sociological (land tenure or right), ecological (environment), productive (subsistence) and economic (income generation). *Ntambo* forms an interlaced network of interactive systems of land use, land tenure, environmental management and socio-economic organisation within the Matengo local setting. Thus, land use in *ntambo* was taken as a unit of analysis in this study.

1.2 Historical changes of land use in the research site

Ngolo was invented by the Matengo themselves in their course of struggle against their local environment. This cultivation practice has, for about 100 years, been highly sustainable on

the account of soil and water conservation and soil fertility improvement and finely adjusted to mountainous ecosystems (Kato, 2001). They have been able to produce most of main foods such as maize and bean from the *ngolo* farms. Coffee, as a cash crop, has been the backbone of the Matengo economy ever since it was introduced in late 1920s and its income subsidizes indigenous farming systems to a great extent (Kato, 2001). The Introduction of coffee farming marked the beginning of the transition to private land holding from the prior communal landholding. Thus, introduction of coffee and cash economy manifest another continuum of changing land use and land ownership systems in this area.

The Matengo highlands are also facing high population pressure in a narrow sloping area of available arable land. By the year 2000 an average population density in Mbinga District was 34 people/km^2, but in the Matengo highlands it hovered to around 100-120 people/km^2 (DALDO, 2001). This situation obliged the Matengo to reduce fallow periods or farm on marginal lands. The open spaces, catchments and other forest resources have largely disappeared. Many of them have been converted into farmlands or residential areas. People who cannot find space for expansion within ntambo/village are moving out to seek land in new areas (JICA, 1998). In these new locations, the immigrants were to certain extent influenced by some physical/natural and socio-economic circumstances to transform their livelihood, including land use systems.

Influence of policies on land use change in this area cannot go without due concern. The giant National Maize Project (NMP) started by the central government in 1975 (URT, 1975) introduced the chemical fertilizers in this area, and the people residing in high populated zones became to use the fertilizer even in the farms for subsistence. T he introduction of agro-chemicals accelerated a division of land and high population density in the mountains. The Structural Adjustment Programs (SAPs) of the mid 1980s, coupled with economic liberalization, forced the Matengo to adjust their livelihood options. The local government intervention through the establishment of by-laws on valley bottom farming, sustainable land use and forest management (Mbinga District Council By Law, 1992) also caused a note of concern to land use change. Aside from all these factors of change, the people's integrity to innovate their local environment forms one of the central premises for land use change in these hillsides.

From the last decade production of both cash and food crops in the Matengo highlands fallen tremendously. This situation is presumably contributed by such factors as poor marketing systems, ecological and pests and diseases, poor credit facilities, population pressure and malpractice of the farming systems. This situation has rendered a poignant test to the livelihood and farming system of the Matengo people. To cope with this situation the Matengo are obliged to

embark on various strategies. In this study, the land use changes after economic liberalisation are focused.

1.3 **Objectives**

Te African farmers have been constantly changing their land use systems, responding to various needs and urgency, accentuated by socio-economic conditions, cultural-political factors and ecological aspects. Farmers' experiments and innovations have also been largely recognised as being one of the bases for land use change. This situation brings in urgency for studying the interaction of multiple factors to understand land use dynamics in Africa. Some of these changes are small and/or take a long time to occur, and some go unnoticed. Linkage of these factors, though complex, is important.

Boserup, in her renowned book *The Conditions of Agricultural Growth* (1965), is amongst the prominent theorists to propose that land use has changed over time across the world. She found population pressure is a major driving force responsible for land use change. However, Meertens *et al.* (1995) argued that though population density indeed as a powerful factor, it is not the only single factor determining change in agricultural land use systems. Other factors such as the influence of economy and technology instead (Hayami and Ruttan, 1971) may determine population density. Lele and Stone (1989) urged the effect of policy and Ruthenberg (1980) added ecology as one of the driving forces whereas Kato (2001) stressed the ingenuity of local people and their culture.

Schmied (1989) falling into the economic perspective trap, noted that one of the most striking changes in East African agricultural land use systems during the last hundred years was the transformation of small self-sufficient cultivators into increasingly market-oriented farmers. Consequently, this brought the necessity to expand land under cultivation, changed the cultivation pattern, created a new farming system and diminished the role of crop grown to meet basic subsistence requirements. However, as it was ascertained by Naveh (1989) that land use changes may not be simple to explain or predict.

In such a circumstance where explanation of land use change needs multiple and flexible concepts, the borrowing of a devise that organizes plural explanation is imperative. Kull (1998) suggests that when such state of affairs exists, critical examination of a practical range of choices available for land use change such as ecological, political-economic, cultural, market, perceptual, and social factors are prerequisite. The range of choice is assumed to contribute to providing a framework for combining factors that are dynamic (Berry, 1993) - in the sense that they are

constantly changing, moulded through the processes explained in political-economic, ecological, social and other theories (Reenberg, 2001).

The framework of this study explored the importance of the natural environment (ecology), socio-political and economic infrastructures, peoples' ingenuity, demographic and technology, factors of equal importance to bringing land use change. It was thought necessary to pursue new interrelated links between these factors that could better handle the complexity of factors rather than to treat each of them in isolation. This was precisely so because all these factors are assumed to be interrelated in the dynamics of land use systems (Meertens *et al.*, 1995). Thus, a system approach rather than single location causality was borrowed to understand the dynamics of land use change in Matengo highlands.

Since changes in land use in the Matengo highlands are closely related to changes in *ntambo* land management, the concept of *ntambo* was used as a focal point of this study. As a geographical concept, *ntambo* is a unit of land that is bordered by small (river) valleys and is normally located in mountain slopes. However, since totality of livelihood in rural setting depends on use of land, it is certainly that *ntambo* land management also entails social-cultural significance that reflects the land tenure system. To deepen our understanding of the dynamics of land use system issues, the *ntambo* were analysed in terms of genealogy, demographic characteristics, landholding and land use patterns and soil properties.

In analysing changes in land use and environmental management in the *ntambo*, techniques like household interviews and physical measurements of different land uses were adopted. Topographical and aerial photographs and satellite imageries were analysed to trace land use change. The aim was to understand the process of land use change, including the people's life within the *ntambo* to extrapolate it impact to a wider geographical area and to suggest feasible approaches to improve the system.

In order to determine the effect of topography and to obtain a diachronic perspective of land use change, two contrasting sites were selected for the study. Kindimba village represented the mountainous area, the original settlement of the Matengo while the rolling hills, the areas of new settlement, and therefore sparse in population having more natural vegetation, was symbolized by Kitanda village. These two sites were compared and contrasted in order to determine the effect of time and other factors on changing land use systems and the state of the natural environment. Appendix 1 presents a framework of current dynamics of in land use in the study area.

CHAPTER TWO

OVERVIEW OF THE STUDY AREA

2.1 The Profile of Mbinga District

2.1.1 Geographical location and landforms

Mbinga district is one of the five administrative districts of Ruvuma Region, located in the southwestern part of the United Republic of Tanzania. Other districts are Songea Rural and Urban, Tunduru and newly formed Namtumbo district. Mbinga district borders Songea Rural district to the east, Lake Nyasa/Malawi to the west, Ludewa district (Iringa Region) to the north and Mozambique to the south (Fi. 1.). The district lies between longitudes 34° 24'E and 35° 28'E and latitudes 10° 15'S and 11° 34'S. The district is characterised by highlands reaching an elevation of about 2000 m and a series of low-level at lower elevations between 900 and 1500 m above sea level.

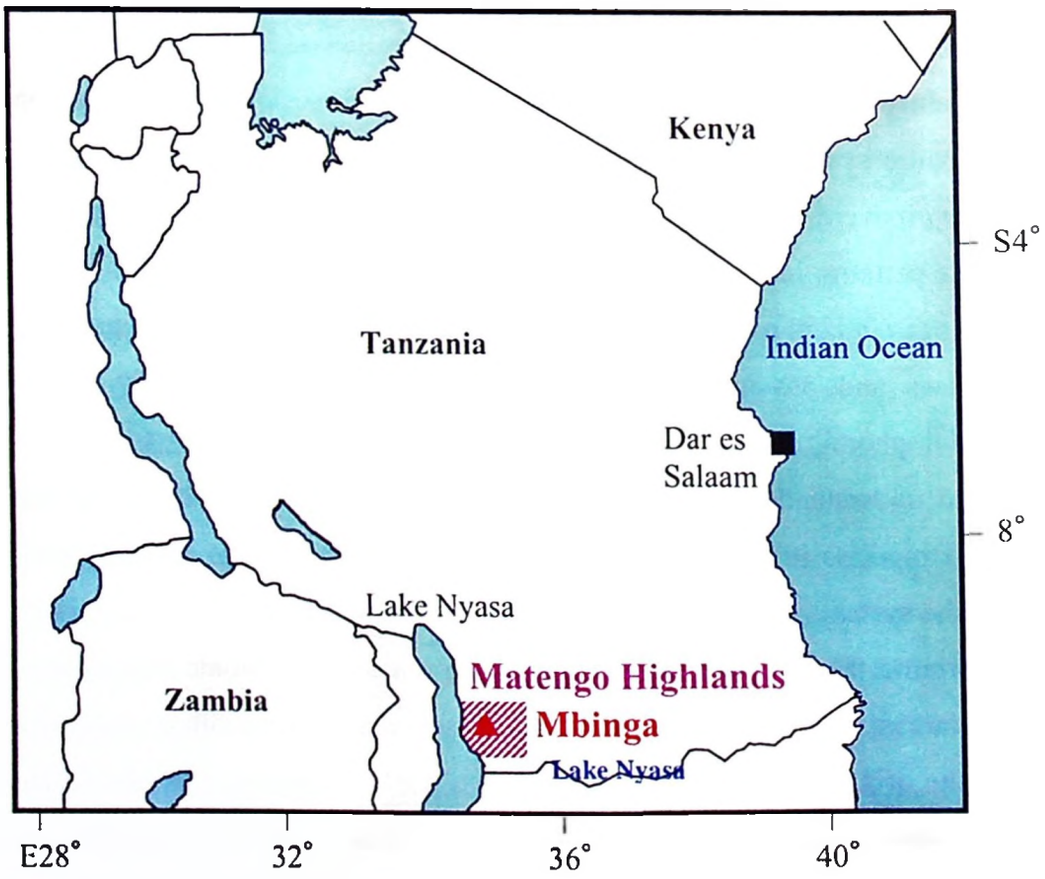

Fig. 1. Map of Tanzania showing location of Matengo highlands in Mbinga district

The district covers a total of 11,396 km^2 of which 2,979 km^2 (26%) was covered by waters mainly of Lake Nyasa (Malawi). Another 2,526 km^2 (22%) was covered by forest (largely *Miombo* woodland vegetation and forest reserves and woodlots). Arable land covered 5,891 km^2 (52%) out

of which 943 km^2 was under cultivation. The remaining area was used for alternative land use options such as grazing (Mbinga District Socio-Economic Profile, 1992-1996).

Mainly three agro-ecological zones epitomized Mbinga district (Fig. 2). The zones were, the Matengo Highlands, the Lower Plateau and the Lake Shore Zone, which differ from each other in terms of topography, vegetation, and soil (JICA, 1998). The Matengo highlands were further subdivided into four sub-zones, the Mountain Area, Hagati Plateau, North and South Rolling Hills.

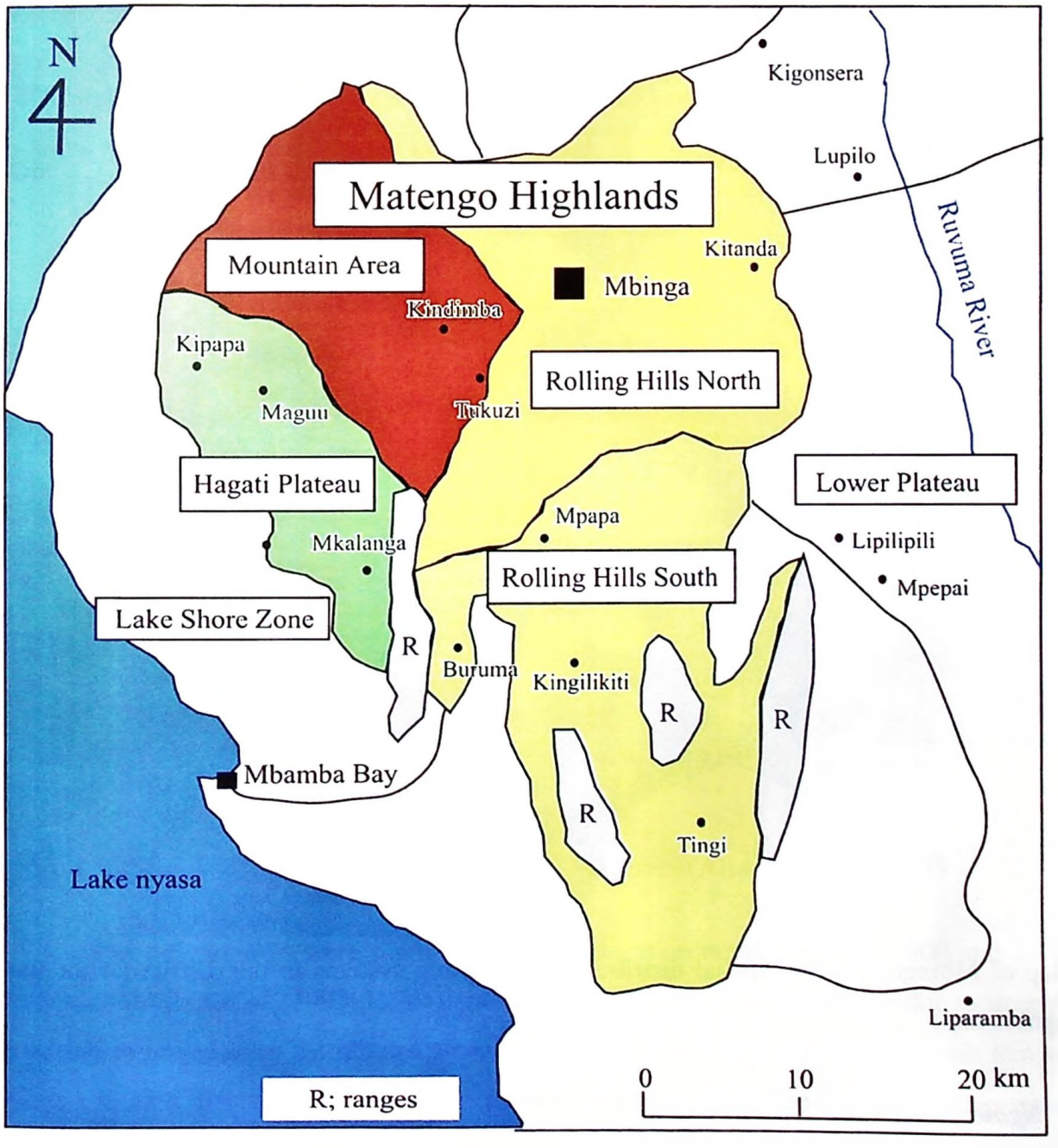

Fig. 2. Agro-ecological zones of Mbinga district (After JICA, 1998:24)

Kindimba village was located in the mountain area whereas Kitanda was in the rolling hills south sub-agroecological zones of the Matengo highlands. Mchau (1993) asserts that these agro-ecological zones greatly influence land use systems in Mbinga District. Fig. (3) presents an over view of land use in Mbinga district.

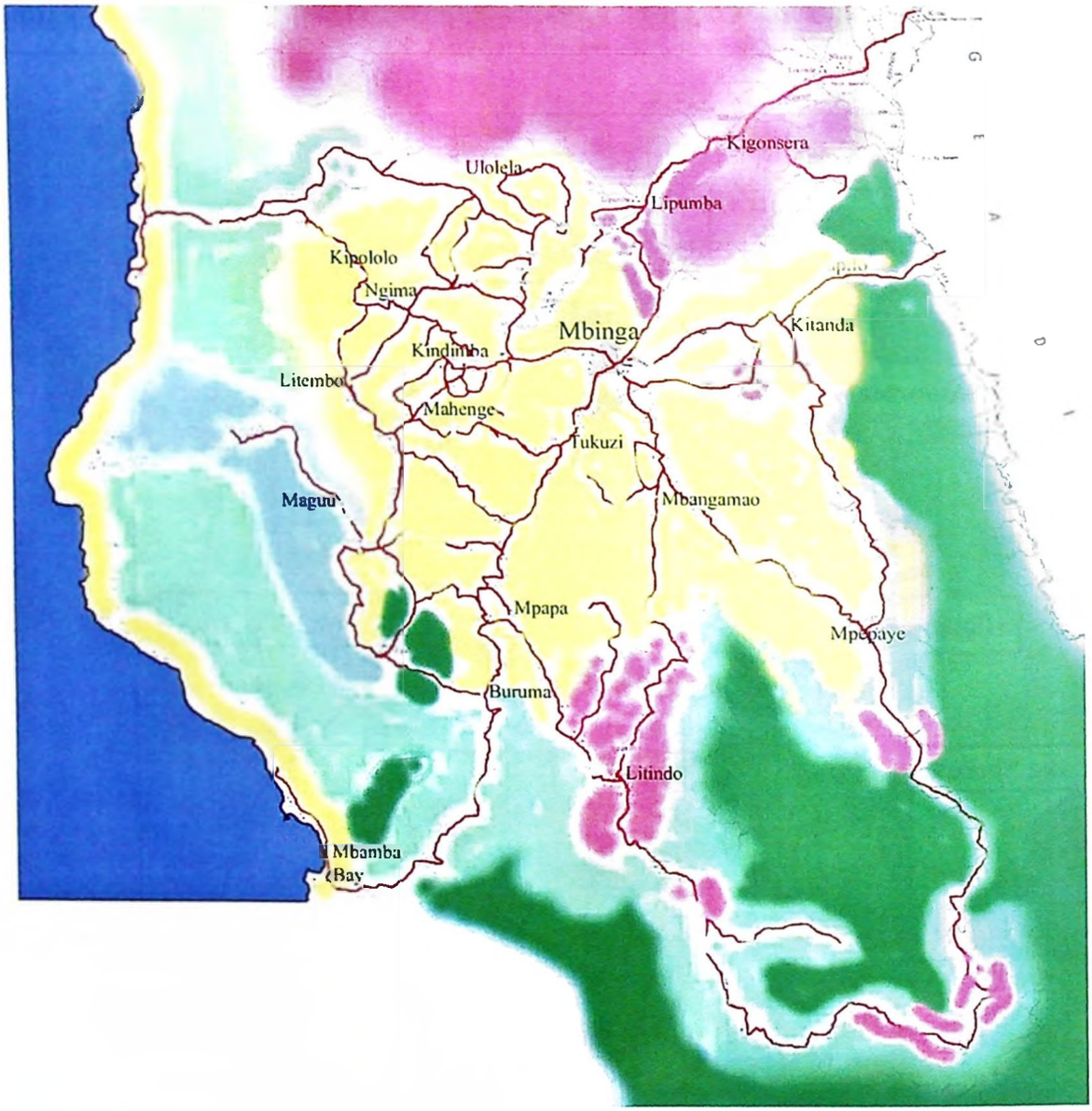

Fig. 3. Map of Mbinga showing spatial distribution of farming systems in the district (After Itani, Juichi, unpublished)

JICA (1998) reports that mountains and high hills characterise the Matengo highlands (Fig. 4.). The mountainous landscape is highly dissected by deep slope gradients, generally exceeding 45%. The longitudinally steep and U-shaped valley bottoms with perennial streams were landscapes typical in the Mountain Area cone (Kimaro *et al.*, 1996; Magogo *et al.*, 1996). The Mountain Area forms the highest parts of the Matengo highlands with elevation ranging from 1,400 to about 2,000 m above sea level, and a maximum relief intensity exceeding 500m (JICA, 1998). The landscapes of rolling hills are moderately dissected.

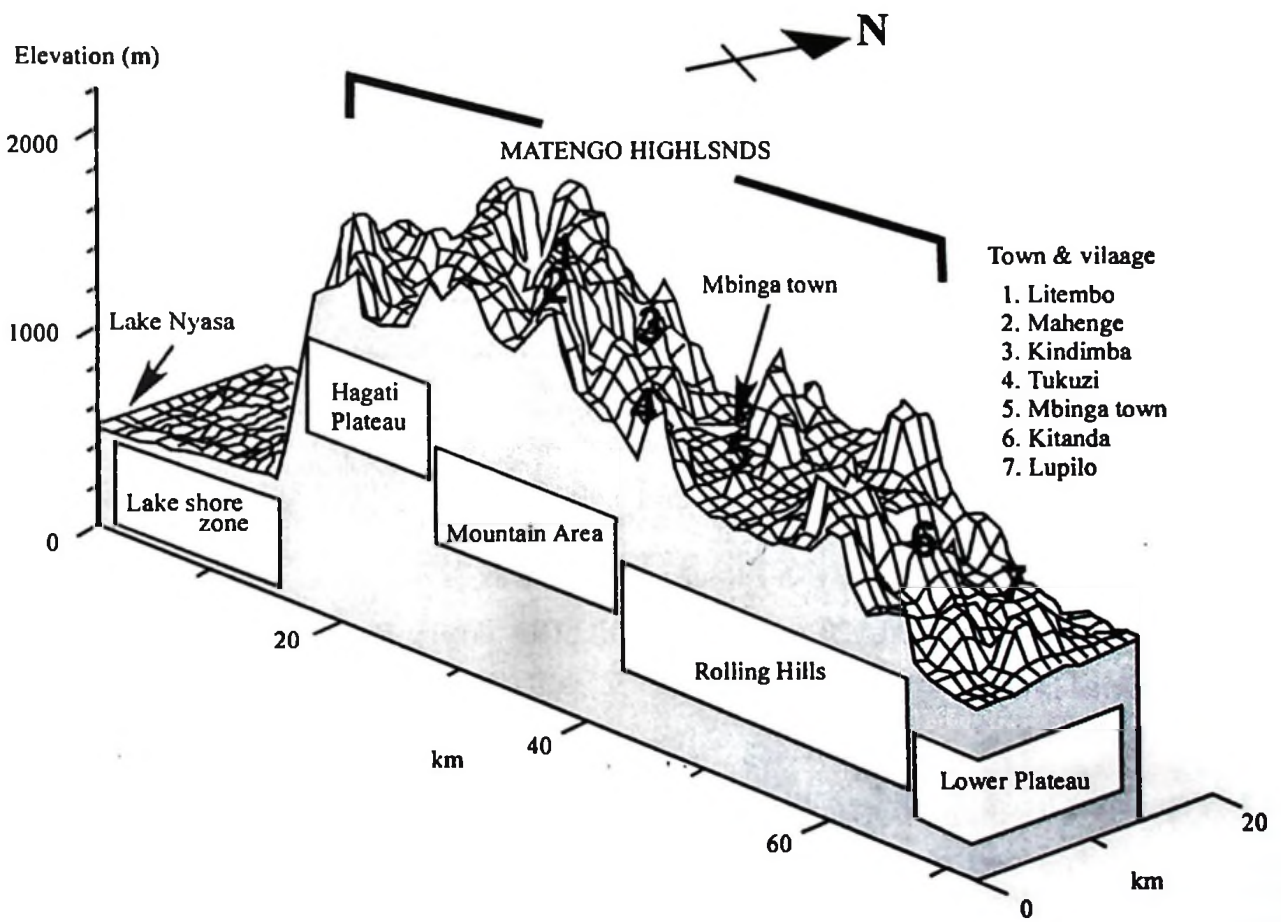

Fig. 4. Transect of Mbinga district agro-ecological zones (After JICA, 1998:41)

The hill summits were round and had an elevation ranging between 900 and 1500 m above sea level (Msanya *et al.*, 1995; 1996) dominated by the process of denudation due to steep slopes. The materials removed from the hilltops were deposited as colluviums on the piedmonts and valleys. The valleys formed the sink for materials denuded laterally from the higher landscapes as well as longitudinally along the course of the drainage ways and rivers.

A cross section of the district presented in Fig. 4 clearly shows that a gradual increase in elevation from the Lower Plateau to the Mountain Area was suddenly cut down to the level of Lake

Nyasa. This suggests compressive forces must have acted between Lake Nyasa and Lower Plateau to uplift the area (JICA, 1998).

2.1.2 Administration

Mbinga was comprised of 181 registered villages. The entire district included 69,974 households of which 67,875 (97%) being farm families (DALDO, 2001). There are 37 wards and 6 administrative divisions namely Luhekei, Namswea, Ruhuhu, Mpepo, Mbuji and Mbinga Urban. The later division was where Kindimba and Kitanda villages were situated. Matengo highlands are largely found in the latter two divisions. The two latter divisions cover approximately 46% of the total area of Mbinga district land.

2.1.3 Demographic characteristics

Mbinga district is comprised of three main ethnic groups, namely the Matengo, the Ngoni, the Manda and Nyasa. The Matengo accounted for about 60% of the total population (Mbinga District Socio-Economic Profile, 1992-1996). The Matengo occupy the highlands in the centre of the district, the Ngoni mainly in the north-eastern lowland areas while the Manda and the Nyasa are found along the shore of Lake Nyasa.

By the 1988 Mbinga district had annual natural population increase of 3.4%. By 2000 the estimated average population density in Mbinga District was 34 people/km^2 but in the Matengo highlands it hovered around 100-120 people/km^2 (DALDO, 2001). Population change in Mbinga district is presented in Table (1) below.

Table 1. Population trends in Mbinga district

Year	Pop. Size of male	Pop. size of female	Total district population
1957*	NA	NA	57,329
1967**	67,029	77,030	144,059
1978**	94,047	102,120	196,167
1988	132,735	139,110	271,845
2002	197,789	206,030	403,819

Source: * *Basehart, H. W (1972), **Mbinga District Socio-Economic Profile (1992-96)*; *Bureau of Statistics (1988; 2003)* NA-Not Applicable

The 2002 national population census showed that the district had highest human population percentage (36.2%) of the total Ruvuma Regional population size (Bureau of Statistics, 2003). This was possibly due to its high agricultural potential and cool climate found in the Mbinga district.

Human population in the district is unevenly distributed with concentration in the mountain areas of the Matengo highlands. Such high population densities are assumed to give rise to increased land pressure, lead to intensive agricultural practices and considerable out migration especially of young persons and/or families in an attempt to acquire more land (Lyimo and Kangalawe, 1997). In the Matengo highlands especially from the Mountain area, many people have mainly migrated into north-eastern part of the district in the woodland. The new tendency of migration is also towards nearby Songea Rural district. This situation created pockets of more dense population in otherwise sparsely populated forest areas such as Mpepo, Liparamba and Mpepai (Mattee, 1991).

2.1.4 Climate

Ellis-Jones *et al.* (1994) and JICA (1998) described the climate of the Matengo highlands as medium to high altitude temperate tropical climate with reliable unimodal rainfall pattern, starting in November and ending in May of the following year. The rest of the year is virtually dry. During the rainy period, crop production is feasible with sufficient rain fed. Normally, the mean annual rainfall is more than 1000 mm (Fig. 5i). However, rainfall characteristics is characterised by intense rainstorms with erratic rainfall events. Such a situation calls for more strict land management practices if soil erosion and its associated degradation have to be avoided.

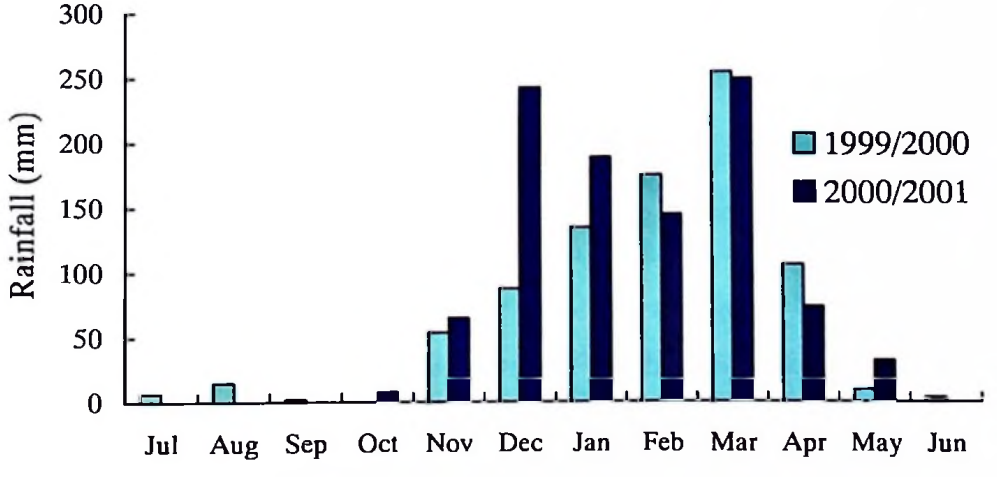

Fig. 5(i): Monthly rainfall distribution in Matengo highlands

Source: Mbinga DALDO's office: Quarterly report on vegetable cultivation (May-July 2001).

The average annual temperature is 20^0C or lower. Seasonal variations in temperature exist whereby the dry season (May to September) is cooler than the rest of the year. Temperature variations depend on the

micro-climatic fluctuations owing to the broken topography (Fig. 5ii). Relative humidity is very hi during the rain season and wind speed is moderate (Mchau, 1993).

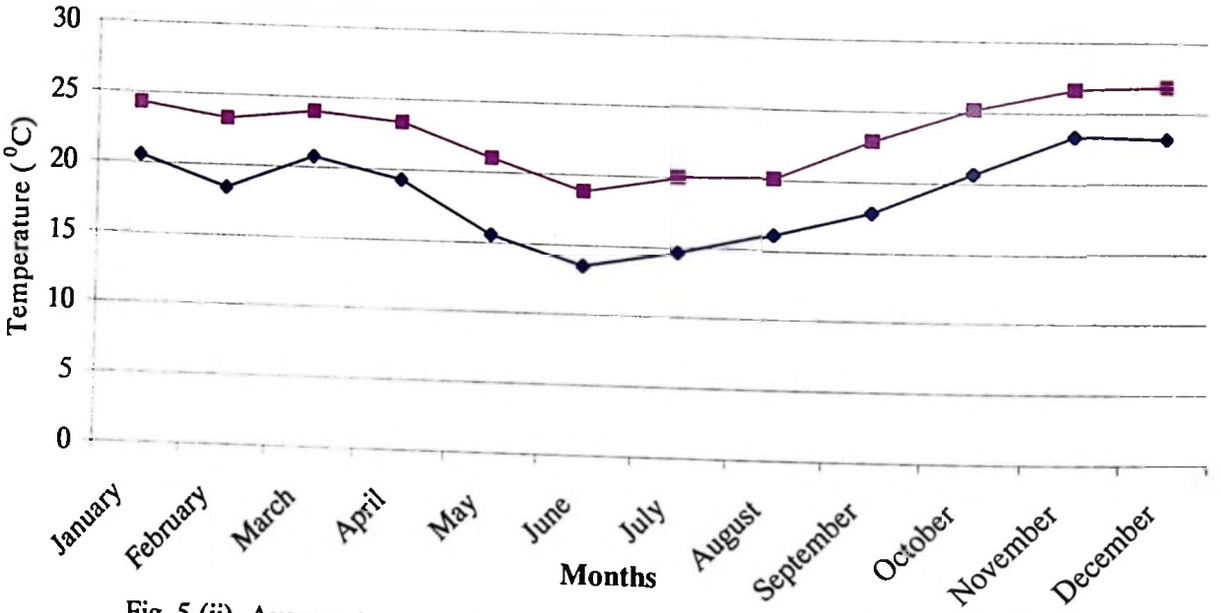

Fig. 5 (ii). Avarage temperature variations at Mbinga metereological station (2000-2003)

Source: Modified from Kurosaki, Ryugo unpublished field data (2003)

2.1.5 Geology and Soils

The pre-Cambrian Basement Complex (PCBC) geology underlined the region of Matengo highlands almost entirely. It consists of either granitic rocks with hornblende and/or biotite, or metamorphic rocks moistly gneisses but also schists and quartzites (Geology Survey Department, 1956; Ministry of Commerce and Industries, 1967).

Soils of Mbinga are generally classified as Haplic or Humic Acrisols, Oxisols, or Ferralsol depending on their position in toposequence (ICRA, 1991). At higher elevations most common soil used for crop production are of granitic and gneissic origin, deeply weathered, highly leached and wel drained red sand clays (Lyimo and Kangalawe (1997). At lower elevations soils are less leache reddish brown sandy clay loams and sandy clays (Ellis-Jones *et al.*, 1994). These soils are ver susceptible to erosion because they are very fluffy and become softened by rain (ICRA, 1991). Mo soils in Mbinga district bear a strong relationship to land forms (JICA, 1998).

At both low and high elevations, the major difference in soil type is either the presence c absence of topsoil horizon due to soil erosion (ICRA, 1991). The organic matter content is high whe the topsoil is present. In the case of low topsoil, farmers must cultivate the subsoil. The wic perception amongst farmers is that soil fertility has progressively declined, resulting in poor cr performance coupled by changes in soil colour, from brown to red (Ellis-Jones *et al.*, 1994).

2.1.6 **Vegetation**

In most cases, original vegetation in the Matengo highlands have been greatly encroached and cleared as a result of intensive cultivation of *ngolo*, slash and burn agriculture, population pressure- and ever increased demand for forest products. Only remnants in some catchments areas are left.

The vegetation types in the mountain area could be classified into two categories. The Afromontane Forest or Moist Mountane Rain Forest with dominate tree species such as *Chyrsophyllum gorungosanum, Macaranga capensis, Aningiria adolfifredericii, Entandrophragma excelsum, Parinari excelsa and Ocotea usambarensis*. Another category is Afromontane Undifferentiated Forest or Sub-Afromontane Rain Forest (typical of Kindimba village) is dominated by *Albizia schimperiana, Bridelia micrantha, Dombeya rotundifolia*. Other species are *Macaranga capensis, Catha edulis, Cordia africana and Schrebera alata.* Common grass species include *Impera cylindrical, Tegetes minuta, Hyparrhenia,* and *Corzya* (JICA, 1998). These natural vegetations have been replaced to a lesser extent by exotic tree species including *Eucalyptus* sp., cypress (*Taxodium* sp.), black wattle (*Acacia mearnsii*) and *Grevillea robusta* (Kimaro *et al.*, 1995) (Fig 6).

Kindimba village (Mountain Area) Kitanda village (Rolling Hills)

Fig. 6(ii). Vegetation and landscape in Kindimba and Kitanda villages

Left: The figure (6ii) shows some vegetation stability in Kindimba village after long establishment of coffee and eucalyptus woodland. Steep slopes can vividly seen to characterise the village and red spots are *ngolo* fields on steep slopes

Right: The figure (6ii) indicates remnants of miombo woodland in rolling hills (Kitanda village). Undulated slopes definitely characterise the village.

The *Miombo* woodland covers a great part of the rolling hills (see Fig. 6i). In these areas natural vegetation still exists in the hilly lands and some parts of the piedmonts. The remaining parts of woodland have been cleared for arable agriculture (Msanya *et al.*, 1995: 1996) and other forest product demands (Fig. 6). There are two common vegetation types, namely Zambezian *Miombo* Woodland or *Brachystegia* Woodland lying between 600-1400m above sea level, dominated by tree species such as *Alzelia quanzensis, Brachystegia spiciformis*, and *Brachystegia boehmii*. Other species are *Julbernadia globiflora, Burkes africana, Parinari curatelifolia, Uapaka kirikiana* and *Pterocarpus angolensis*.

Another vegetation type is the Zambezian Swamp and Riparian Forest found between 600-1400m above sea level along rivers, swamps and near lakes that is dominated by *Treculia africana, Uapaca guineensis, Uapaca nitida, Breonardia salinina, Syzygium guineese, Syzygium owariensis, Vitex doniana and Xylopia erubescens*. Common grass species are *Hyparrhenia*, *Brycharia* and *Pteridium* (ferns) (JICA, 1998). These trees are used for socio-economic needs and environment conservation.

2.3 Development of land management in *ntambo*

Ntambo landholding in the Matengo highlands forms the archetype unit of the land tenure, which has all times influenced the unique pattern of land use. As a topographical unit it refers to a unit on the mountainside that is circumscribed within two river streams (JICA, 1998) (Fig. 7). And it is also considered as a socio-geographic unit managed by patrilineal extended family. However, with population expansion and migration to new areas it is currently quite common for *ntambo* to be inhabited by multiple clans. The height and area of the *ntambo* ranges from 100 to 600 metres and 10 to 70 hectors, respectively (Kato, 2001). As it often becomes a unit of land tenure and so as changes in land use and environmental management are assumed to be closely related to land ownership based on *ntambo* management. The village and sub-village (location) establishment in the Matengo are also believed to evolve from the *ntambo* land management system (JICA, 1998).

Ntambo originates from the word *lupimbi* in Matengo vernacular, which means, "sufficient land for the lineage (*lukolu*) for purpose of supporting their livelihood". When villagers speak of "sufficient" they mean that land should be able to meet demands of three generations, or insufficient may mean that family members migrate to other area in search for land when their territory within identified *ntambo* is limited for their livelihood (JICA, 1998). Thus, there is a possible positive relationship between *ntambo* maturity stage and population density.

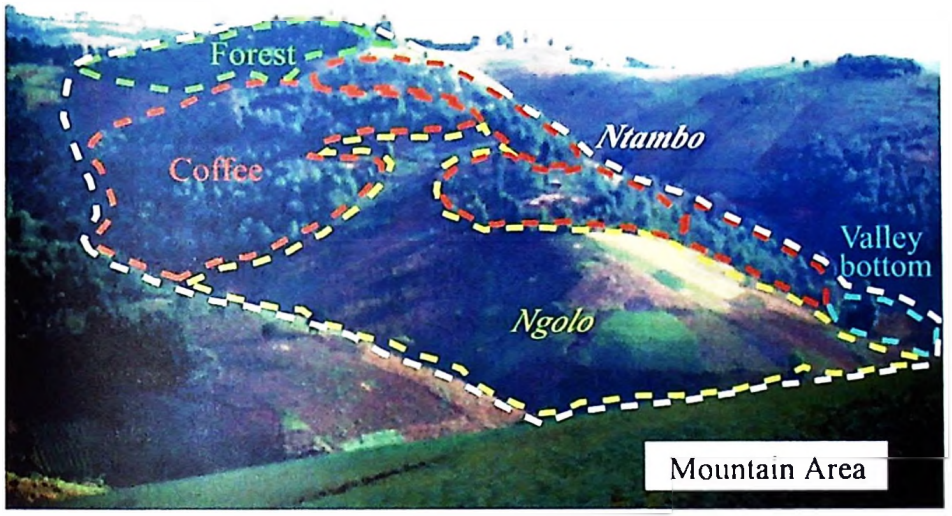

Fig. 7 An overview of land use within *ntambo* in Matengo highlands

Typical *ntambo* is first established and owned by one person in a given clan, and that person may be regarded as the ancestor or grandparent. Thus, historically, *ntambo* was once occupied by certain family and later by its offspring (extended family). The first person to come was normally settled and exploited the middle portion of the *ntambo* on the mountainsides. Forest was opened and new *ngolo* fields were made when new generations came up. After one generation and with increase in family size, some members began to expand outwards within their *ntambo* until the entire *ntambo* is occupied, something which might have necessitated them to look for another *ntambo*.

JICA (1998) found that development of *ntambo* could be viewed as people's accumulation process and reorganisation of land ownership within mountain interfluves. The process of exploitation in Matengo land occurred more or less at the same time involving not only a single clan rather with other clans from several places too. During the process of exploitation, expansion of one clan's land area was almost impossible due to co-existence of different clans who might have moved in at almost the same time. Because of these circumstances the settlers were forced to adopt an intensive system of farming within their *ntambo*. Meanwhile *ntambo* became overpopulated beyond subsistence intensification, and successive generations were obliged to seek new land outside the origin *ntambo*. The *ntambo* development process from initial stage of exploitation to maturation normally takes about three generations (JICA, 1998). However, more complicated process is associated with the development of *ntambo*. When certain land becomes vacant due to out migration, sometime new people from different clan come in and start

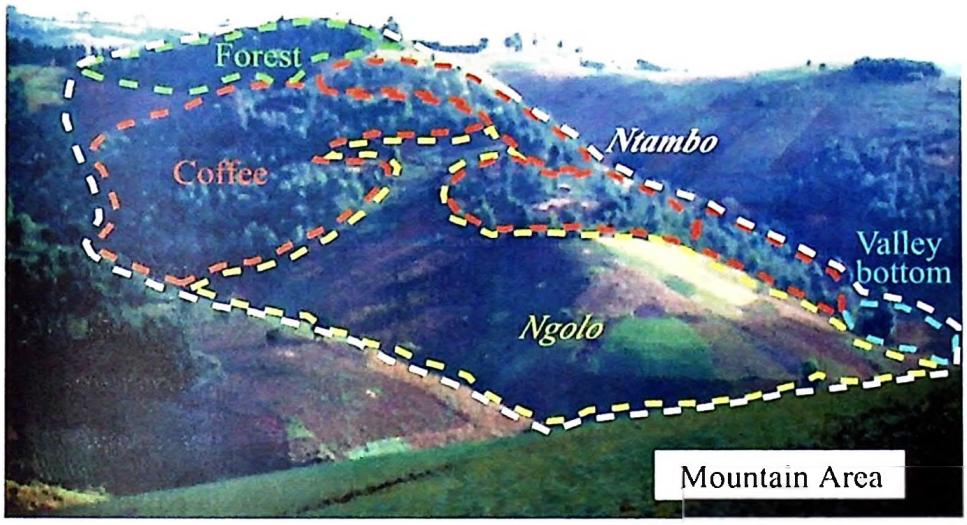

Fig. 7 An overview of land use within *ntambo* in Matengo highlands

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developing families, furthering the complexity in terms of both landholding and social organisation within the *ntambo*.

Increase in family size within the *ntambo* resulted to formation of *musi*, which is referred to by Schmied (1989) as small village. *Musi* is a settlement occupied by relatively many households whose family members are of the same common ancestor (JICA, 1989). The head of the founding *musi* directly controls the *ntambo* as well as people within that *musi*. Though at the beginning of *ntambo* exploitation there exists only one *musi* in one *ntambo* but later increased. According to Schmied (1989), sons who reached puberty stage are given their own settlement near that of their fathers and later they establish new *musi* consequently increased the number of *musi* in the same *ntambo*. Likewise, after the death of head of households the sons go out and establish their own *musi* in the same *ntambo*. Hence, men live patrilocally, whereas women move to their husband's home after marriage, i.e. they take virilocal residence and polygamy is an optional. After three or four generation one can find three or four *musi* in the same *ntambo* owned by people of the same ancestor (JICA, 1998).

Musi was promoted and maintained by a customary system referred to as *sengu*. *Sengu* was a system whereby people of the same ancestor would come and eat together under the leadership of the head of that sibling, usually an elderly man. *Sengu* made possible the exchange of ideas related to land use e.g. *ngolo* farming system and general livelihood within *musi* and helped in controlling and managing land use in the *ntambo*. All people in that *ntambo* had to adhere to the word of the head of that *musi*.

Only a few houses in the *ntambo* existed during *sengu* and people lived reciprocally e.g. they worked together in various farm activities and ate together. Landholding was based on family ownership under the leadership of *musi* leader (*bambo*). The head of the *sengu* had some authority on land ownership, allocation and/or its distribution among family members. Thus, *sengu* played a decisive role in keeping people together and shaped people's daily life and maintained their land use system. The head of the clan had a mandate to grant or deny a land allocation to new comers. Clan members continued to use the same plots of land for many years, inheriting it to one generation after another until further divisibility became impractical.

During *sengu* and almost even now male kids are the ones automatically inheriting land from their parents. Divisibility of land among the sons or family members, increased population, and later private land ownership and increased land demand for both coffee and food crop cultivation led to fragmentation of landholding among the Matengo (Schmied, 1989). This situation led to land squeeze and obliged the Matengo to look for alternative land elsewhere. It is

quite common practice among the Matengo families with shortage of land that elder adult son become the first to migrate to the new land. The father would first go to new area and secure a land and later the son would join the father who after about three years will return to the original village after assisting the son to establish new farms. At this moment organisation in *sengu* faced one of challenges ahead as some members started to emigrate elsewhere.

The supreme effectiveness of the *sengu* custom was also battered partly because of Christianity and colonialism. Christianity challenged the power of the traditional paramount chief by arguing people to submerse to One God and influenced households eat alone within their domicile on table. This led to gradual denounce of the power invested to traditional beliefs and individualism came in. Matengo households started cultivating and eating individually. Educated natives denounced Matengo culture as inferior and perceived western foreign culture as superior one. Education as well caused emigration in search for jobs that could not be found in the highlands hence disruption of established social organisation.

The prologue of money economy to facilitate trade and exchange during colonial period and in particular the introduction of coffee as a cash crop also had a dimension on collapse of *sengu*. Africans were required to pay poll tax in specific currency hence forced to work in colonial offices, plantations and mines all of which situated in distant territories away from the Matengo highlands. The son of native Chief Christostoms Makita introduced coffee in Mbinga at around late 1920s for the purpose of enabling the Matengo people pay poll taxes that were demanded by the colonial administration. As coffee production developed, the traditional system of communal land ownership became undermined and the individual got power over the disposition of land. Money economy became into Matengo being and it has been accounted that it led to individualism, greed and mistrust among the people, as it was impossible to own money communally. Land and its products were now privately owned. With population increase private land had to be divided into small units to meet household demand hence its shortage. At this juncture emigration became apparent.

With the crumble of the *sengu* custom the *musi* was left without the overall leader and subsequently this led to disintegration of the established system of proper land use. Despite of this change, the process by which *ntambo* is established is still influenced by old traditions, and it is still the same process by which new villages in Matengo highlands are established (JICA, 1998).

The above vindication shows that village and sub-village were established through the *ntambo* system or socio-graphic unit. On that matter *ntambo* could be regarded as the basic unit for location and village formation. Thus, changes in land use and environment are closely related with

the change in land ownership based on *ntambo* land management. Therefore, characterization of *ntambo* is a key to understand the whole development process of the Matengo society, their land use and environmental management.

2.3.1 Land classification in *ntambo* in the Matengo highlands

Traditionally, the Matengo do classify land in *ntambo* by vegetation, topography and type of use (Fig. 7). The upper part of the typical *ntambo* consists of dense primeval forest called *kitengo*, which is derivative name of Matengo. A substitution forest is characterised by either *kinzege* that indicate grassland and/or *kigona*, which represents a shrub fallow. Symmetrical terms of *kitengo* or *kigona* are *litui* or *ngunda* a generalised term for farming fields. Residential premises are built on small terraces on the ridgeline of mountains called *lubanza*.

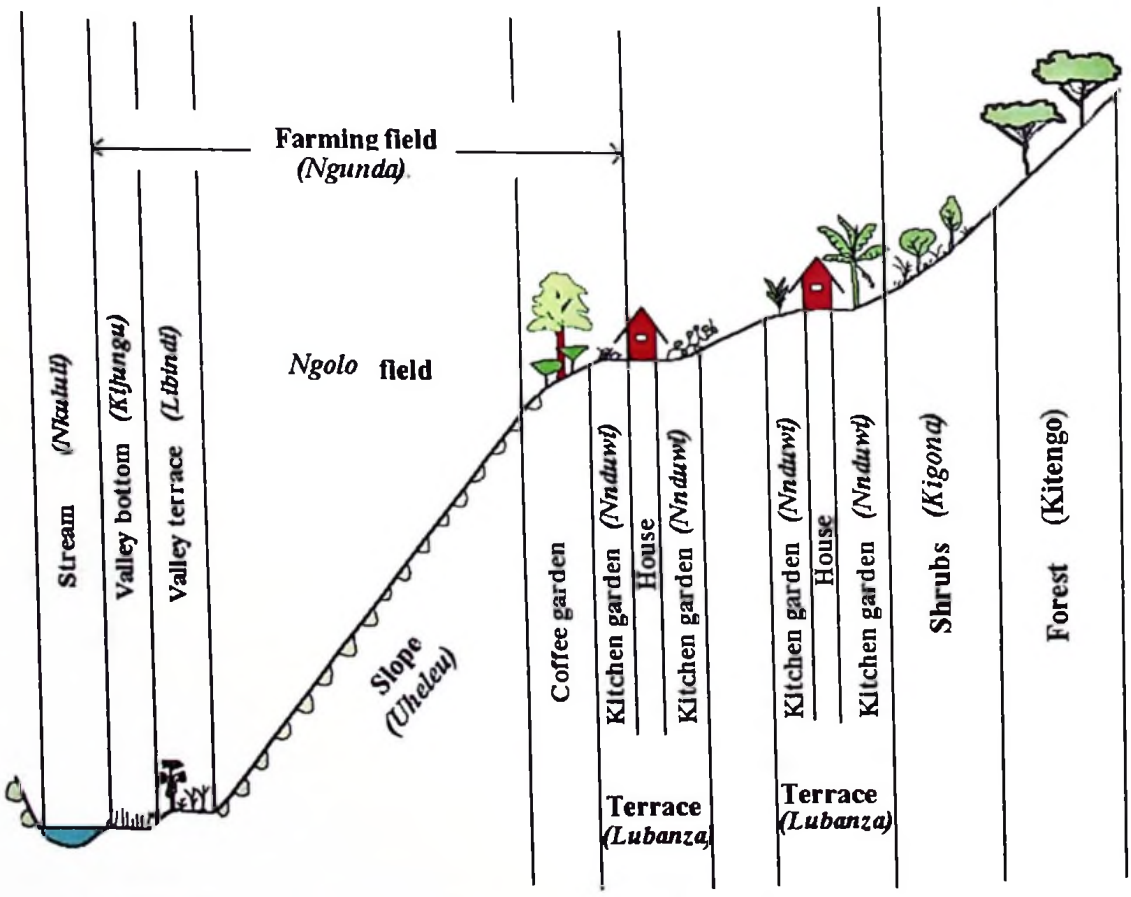


Fig. 8. Land classification and land use in typical *ntambo*

The kitchen garden is notably known as *nnduwi*, a dumping place for garbage, sweepings and scattered livestock droppings. The soil around this premise is fertile and normally planted with such crops as amaranth, pumpkin, sweet potato, tomato, lemon, mango, and guava. Coffee is generally

planted around homesteads for easy management. *Grevillea robusta* (*mkabilia* as popularly known among the Matengo), banana and fruit trees are grown in the coffee farms as shed trees.

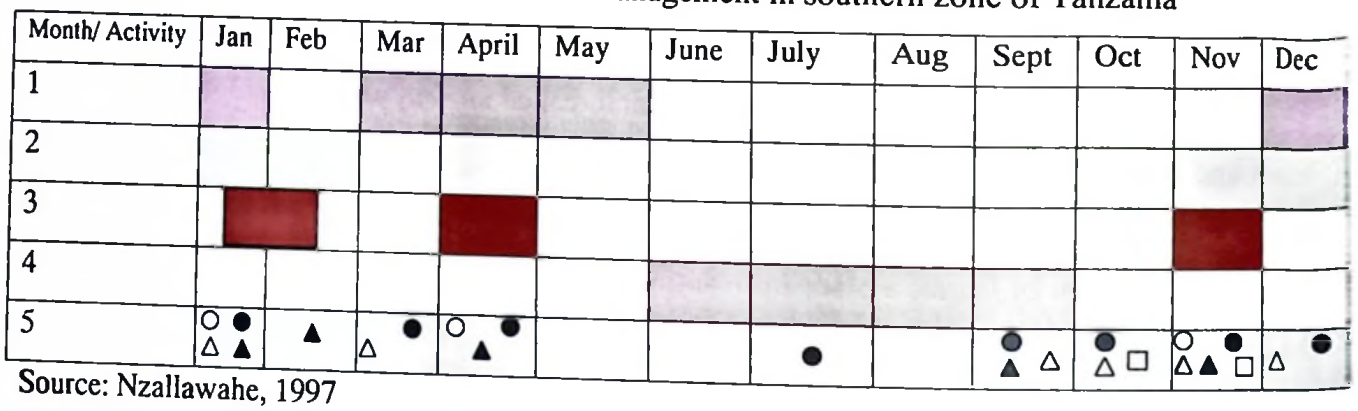
Ngolo fields are usually made on slope land, called *uheleu*, where staple foods such as maize, beans and cassava are produced. Small alluvial plains in the valley bottoms benefit from rich eroded soils and high moisture, which make dry season cultivation possible. The seasonal dry plains are described as *kijungu* or *likata*, a place for planting vegetables, maize, beans and even coffee nurseries in the dry season. Valley terraces are identified as *libindi* and are used for planting some perennial crops, such as banana, papaya, sugarcane and taro (*Colocasia esculenta*). Hence the prototypic *ntambo* consists of homestead premise, kitchen garden, coffee fields, *ngolo* farms, lowland fields, grass fallow and forests. Before population influx in the *ntambo*, households can mainly obtain much of their foods and cash requirements within *ntambo*. Under Thus, *ntambo* forms an integral part of Matengo livelihood and their land management systems.

2.3.2 **Land use in the** Matengo **highlands**

There are two major kinds of land use in the highlands i.e. improved indigenous agriculture and fallow/grazing land use systems. These land use systems are mainly practiced in the piedmonts and river valleys. The main production systems are *ngolo* and/or ridge cultivation systems, for producing annual crops such as maize, beans and wheat. Beans are planted in March and harvested in June/July and maize constitutes the major staple food and is planted in November/December and harvested in July-September. In the river valleys beans and maize are planted from August on residual moisture and harvested from December to March. Maize, however, faces insurmountable hindrances including, attack by insects and diseases, such as stem borers (*Zea-diatraea* sp.) and maize leaf blight pathogen and low soil fertility (Mattee *et al.*, 1996). Arabica coffee as almost the sole cash crop in the district is grown either on bench terraces or flat seedbeds depending on landscape orientation. Coffee farms are normally intercropped with *Grevillea robusta*, banana, maize, taro and macadamia as shade trees. The annual series of on-farm activities in coffee are shown in Table 2 below.

Grazing is mainly practised on the plateaus and other areas waiting for crop rotation cycles. Livestock keeping is common for animals such as pigs, cattle, goats, sheep and poultry. Animal husbandry is a small-scale source of protein, cash income and social value. Livestock keeping systems are of three different types: pigs and small ruminants such as rabbit and giant rats are normally under zero grazing; cattle and goats under semi-permanent grazing and/or tethering; poultry are kept free ranging. Other minor land use systems were cultivation of sweet potato, sugarcane and vegetables during dry season in valley bottoms. *Ngolo* is also practiced in poorly drained areas in the valley bottoms.

Table 2. Generalised calendar of coffee farm management in southern zone of Tanzania



Source: Nzallawahe, 1997

Weeding
Pruning
Fertilizer application
Harvest
Pesticides application

○ Fenitrothian-for antestia &leaf minor
△ Red copper-for Leaf rust & CBD
▲ Blue copper-for Leaf rust
● Anti CBD spray
□ Dieldrin spray-for Stem borer

2.4 Background of the Matengo

The origin of Matengo ethnic group is rather ambiguous and complex. They are believed to have first settled in Litembo located in the western mountain area well before 1900 at the time when very dense evergreen forests existed there (Kato, 2001). Their history reveals that Matengo political organisation was primarily non-hierarchical, comprised of sovereign patrilineal groups of equivalent status and diverse origin (Schmied, 1989). There were, however, some elements of inequality in the system that owners of the land had a superior position with respect to later settlers (JICA, 1998). Each patrilineal group (*kilau*) represented a descendant of a common grandfather who, during his lifetime, had been the unquestionable leader (*matukolu* or *bambo*) of the band (Basehart, 1972). Nevertheless, in the late 19th century the Matengo Kingdom was formed in the process of resolving a conflict with the Ngoni (Kato, 2001). The colonial rule by Germany, which began at the end of 19th century, weakened the Kingdom although the Matengo did resist Germany in the beginning (Ndunguru, 1972; Iliffe, 1979; Schmied, 1989).

About the middle of the 19th century, the Ngoni marching from the southern part of Africa escaping the conqueror Chaka Zulu attacked shifting cultivators in Southern Tanzania (Kato, 2001). In those days some refugees reached the east of Songea, the centre of Ruvuma Region, and become *Ndendeule*. Another group arrived in the mountainous area in Mbinga district and became Matengo (Gulliver, 1955; Ebner, 1959; Allan, 1965; Schmied, 1989). It is surmised that before

1889 the Ngoni developed relationships with Arab and Swahili slave traders such as *Yao*, and a mutually profitable traffic in slaves and ivory was instituted (Oliver and Boyd, 1965; JICA, 1998). Continuing anarchy by the Ngoni and raids for slaves by the Arabs and *Yao* drove small and weak ethnic groups into this upland country and consequently increased the population in the Matengo highlands, which was thought to be safe hiding place (Basehart, 1972).

The first mountain settlers concentrated their settlements on a very limited area near large natural curves offering a readily defensible refuge, or on the more inaccessible mountaintops (Stenhouse, 1944). Due to limited land availability they were forced to cultivate thin and steep areas for fear of raids by neighbouring ethnic groups. These raids devastated much of the area of southwestern Tanzania until the German occupation in 1897 (JICA, 1998).

Basehart (1972) alluding to the heterogeneous elements among the Matengo population cited four family names whose ancestors came from different areas outside Matengo country. The ancestors of Ndunguru and Kawanila patronymic (*kilau*) arrived from Nindi country in the vicinity of the Mozambique-Tanzania boarder. Similarly to Mpundumi, the founding father of the Makita dynasty was from Mozambique and fled quarrels at home. The Komba patronymic are immigrants from Nindi and Ngoni areas (different names of women differentiate the two groups). The huge Komba patronymic extended family group that originated from Ngoni were famous smiths. Similarly Kapinga hailed from Ngoni (but were not smiths) and Ndimbo from Nyasaland. Basehart (1972) further emphasised that these families were largely the victims of incursions, slave raiding and family commotions.

Increased settlement in the mountains was also associated with the Makita dynasty. After settling in these highlands, the Makita dynasty later launched war against the Ngoni and peoples of the Nyasa lakeshore, which found Matengo fighters coming back to their mountain home with war captives. This suggests that movements into the Matengo Mountains took place from all directions except the east, where armed invasions came later (Basehart, 1972). The multidirectional origin of the Matengo group is symbolised by their burial practices, with the head of the corpse is directed in direction of the immigrants' natal country.

The mainstay of the Matengo has always been agriculture. Until 1860-1870 they followed the ordinary principles of shifting cultivation (Schmied, 1989). The Matengo pit system (*ngolo*) later came into being as their indigenous cultivation method. The cultivation of valley bottoms has been part of their farming system ever since they settled in the mountains, though much of the crops were often plundered by the Ngoni in those early days (Stenhouse, 1944). Cash crop coffee was introduced in the highlands by late 1920s (Kato, 2001). They also raise animals such as cattle, goats and chicken

as a source of protein, a symbol of prestige and for sacrifices. Many oral traditions also attach great value of hunting adventures among the Matengo (Schmied, 1989). Though proximate ethnic groups regard the Matengo as industrious farmers, conversely, they are poor in merchandise. Presently, the Indians, the Arabs and the contiguous ethnic groups the Kinga and Bena dominate commercial endeavours in Mbinga town (Kato, 2001).

The social organisation of the Matengo has been patrilineal oriented and that the non-segmentary agnatic lineages were the main reference for an individual. The social organisation of the Matengo is different from many ethnic groups in Africa whereby one lineage occupies one village. The phenomenon that makes the Matengo people different is their diverse historical backgrounds. In early *ntambo* establishment (typical *ntambo*) one finds people of one *ntambo* to be related whereas people in different *ntambo* were not though living in the same village. In recent years however, due to increasing population pressure and migration even those people living in the same *ntambo* are not necessarily closely related.

The Matengo land use system is typical of their history. To survive in these steep slopes, the Matengo had to evolve a method of checking the raids, as well as having a sustainable agricultural system that would conserve the soil and increase productivity (Stenhouse, 1944; Oliver and Boyd, 1965). It was from this course of events that, the Matengo evolved a unique method of cultivating steep slopes, the system that allowed sedentary agriculture, crop rotation, soil and water conservation and increased productivity (Nindi, 1999). This spectacular indigenous farming system is known as *ngolo* or the Matengo pits. The origin of *ngolo* farming system is therefore hooked to the formation of Matengo ethnic group. Much of its multifunctional aspects are remotely known in the contemporary agricultural sciences. Kato (2001), Lyimo and Kangalawe (1997) and JICA (1998) pointed out that Matengo people have repeated this cultivation for more than 100 years.

2.5 Profile of Kindimba Village and process of *ntambo* exploitation

2.5.1 Location and landforms

Kindimba village is located in the mountain area sub-ecological zone of the Matengo highlands. The village is one of the oldest villages in the Matengo highlands and has long history of agricultural land use and environment management archetypal of the Matengo society. The village is located about 15 km west of Mbinga town (Fig. 8) and is saved only by earth road, which occasionally, particularly during rain seasons become impassable.

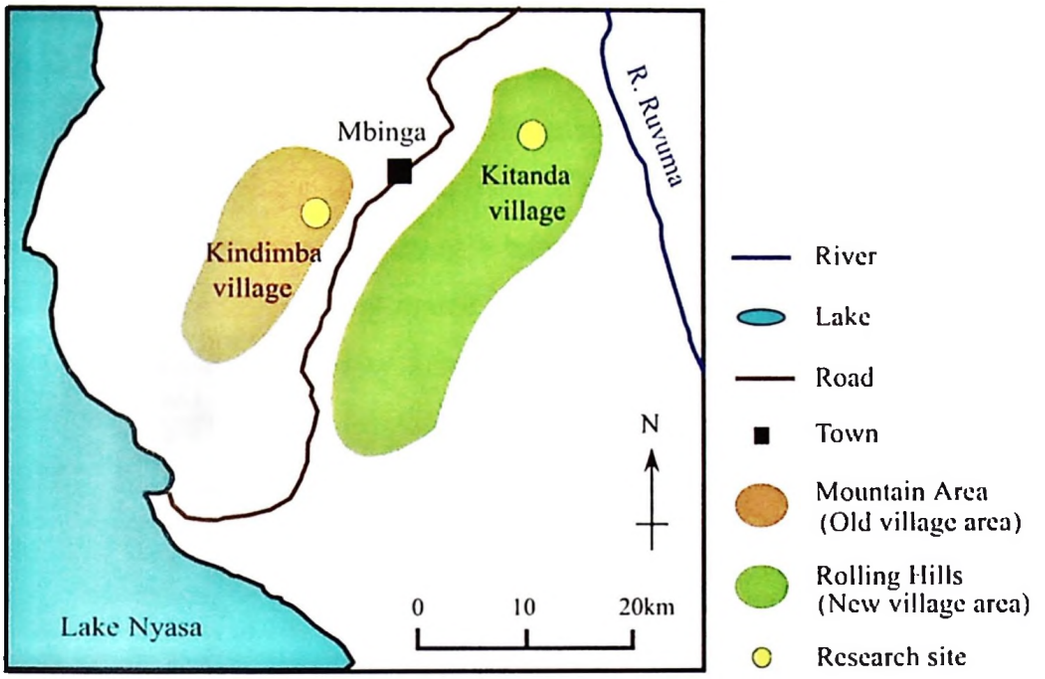


Fig. 9. Location of Kindimba and Kitanda villages

In terms of topography, the village is located in the area where straight valley (Mungaka river) with bent cross sections penetrates into the mountain area from the north rolling hill area. The dissected steep slopes with round or horseback ridge type cross section commonly characterise the village. These features according to JICA (1998) reflect polycyclic nature of land formation, and hence, have strong influences on type of soils and *ntambo*.

2.5.2 Administration and demographic pattern in Kindimba village

Kindimba village is composed of eight sub-villages or location (*vitongoji*), which are usually demarcated by the natural topographic features such as mountains and streams (Fig. 10i). The locations are Ndembo, Mkanya, Kindimba, Kitunda A, Kitunda B, Torongi, Walanzi and Mtungu. Each sub-village is under leadership of a chairperson and below him there is a ten-cell leader. The sub-villages are reported to be of varying area of 1.18 to 4.94 km^2 and average size of 3.14 km^2 and population density varying from 44 to 368 people/km^2 (JICA, 1998).

Human population trends in Kindimba showed a decline in recent years. In 1988 population was about 3082 people with 1603 (52%) females and 1479 males (48%) occupying 560 households (JICA, 1998). In 2002 population census it declined to 2288 people with 1167 (51%) females and 1121 (49%) men accommodated in 535 households. Village Executive Officer (VEO)

ascertained declining human population in Kindimba as a result of dividing the village into two villages (forming another village called Mundeki) and out migration mostly to rolling hills and nearby Songea rural district in search for more land.

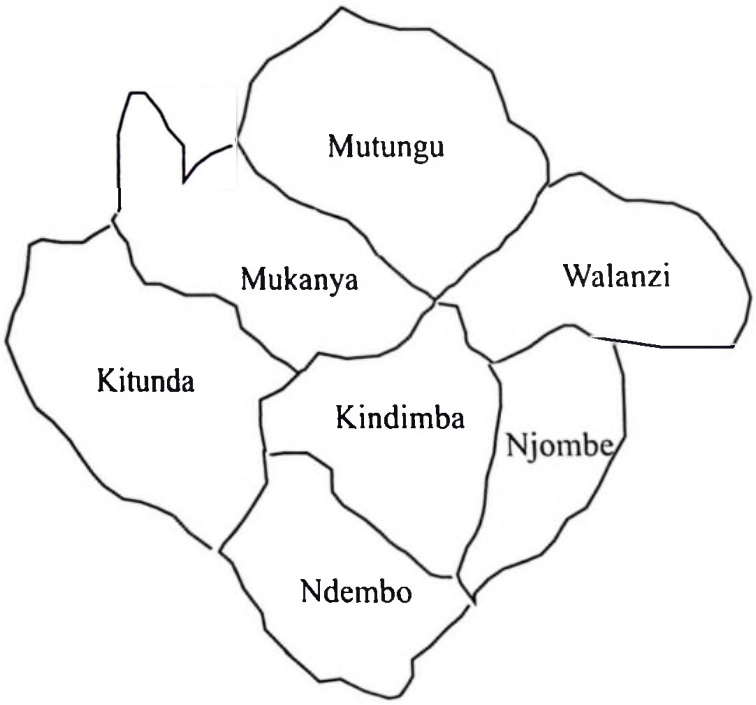


Fig. 10i. Sub-village distribution in Kindimba village (After JICA, 1998: 238 before split of Kitunda sub-village into Kitunda A and B sub-villages)

Temporal migration is rampant according to VEO and as revealed by my own data in the subsequent chapters. VEO estimated that over 50 percent of all households in the village are engaged in distant farm cultivation located in the woodland (rolling hills/lowland) areas mainly for farming purpose. Most destination villages are Kihungu, Kikolo, Kizuka, Masimeli, Lihale, Lukalasi and Utiri in the rolling hills. Permanent migration is also not uncommon largely in search for more landholding due to declining both landholding and fertility in mountain area. VEO also revealed that about 10 families have left Kindimba village permanently since 1997.

2.5.3 Climate

2.5.3.1 Rainfall pattern

Climatic data collection in Kindimba village began in 1990s by Sokoine University of Agriculture Centre for Sustainable Rural Development (SCSRD) and the Catholic Mission. In general, the climate characteristic is typical of that described under Mbinga district rainfall prototype.

2.5.3.2 Influence of rainfall patterns on land use

Various on-farm activities correspond to rainfall pattern and the Matengo have names of such rainfall patterns. The Matengo classify rainfall season into three periods, largely depending on activities on *ngolo* fields. Rainfall season normally starts between November and December and such early rains are known as *iyula ja matemangale* "rains for field preparation". At this time old *ngolo* fields are weeded using a hand-hoe, *ngolo* ridges are reformed and furrows and made (*makene*) on it before sowing maize seeds, roughly at 20 cm intervals.

The January–February heavy rains are known as *iyula ju kukulagalila/kutukupila* "rain for weeding". Weeding (*kukulagalila*) and thinning (*kutukupila*) in maize fields are done during this time. Weeding make the *ngolo* soil loose and erodes from the *ngolo* and deposits in the pit. Rarely does the eroded soil flow downhill unless the *ngolo* were poorly made. Normally March-April months are characterised by showering rains of which are referred by the Matengo to as "rain for beans" (*iyula ja kupandii ngondi*). It is at this time when field preparations and making of *ngolo* are done. Between late April and early May rainfall subsidise gradually and reaches to an end, respectively, and known as "the last rains". Sometimes farmers can make new *ngolo* at this time and either plants them with beans or just leave them unplanted until November-December rain commences.

2.5.4 Soils

JICA (1998) classified the Matengo mountainous and plateaus soils as *Eutric, Leptosols and Regosols* and foot slopes (piedmonts) soils as *Rhodic, Haplic, and Geric Ferralsols, Ferric and Humic Acrisols and Ferric Lixisols*. In higher altitude areas the soils are moderately thick dark reddish brown, sandy clay-to-clay topsoil due to great deal of transformation made by the *ngolo* farming practice. The minor river valley soils are classified to as *Umbric Fluvisols*, which are very deep, poorly drained, greyish brown, stratified and mottled sand clays and clays. Generally the soils have low cation exchange capacity and poor supply of key nutrients i.e. nitrogen and phosphorous. Most of the basic cations such as Ca^{2+}, Mg^{2+} and K^{+} are low to medium. The steep slopes and shallow soil depths in the hilly landscape in the village generally inhibit agricultural productivity due to low soil fertility.

2.5.5 Vegetation

The original vegetation of the village could be described as Afromontane Undifferentiated forest or Sub-Afromontane rain forest. This vegetation type usually replaces the Afromontane rain

forest on higher altitudes and on wetter slopes or below Afromontane rain forest (JICA, 1998). The prevailing tree species found in this type are the same previously mentioned under Mbinga district vegetation description. Alike, the natural tree species have almost disappeared due to intensive clearance through farming and settlement. A few existing trees are mainly planted ones such as eucalyptus, cypress (*Taxodium* sp.), black wattle (*Acacia mearnsii*) and agroforestry in coffee farms.

2.5.6 Land use

Coffee plantation and food crop (maize, beans, wheat and tuber crops) cultivation command the major village land use system. The main production system for food crops is *ngolo* farming system. Valley bottom farming in longitudinal river bottoms is also widely practised for planting vegetables, sugarcane, maize and beans. Coffee farms are mainly found around homesteads and the farms are made of bench terrace and/or flat seedbed depending on topographical setting of the farm plot. Arabica is the only coffee specie grown here and is intercropped with *Grevillea robusta* trees, banana, maize and some fruit trees.

Fallow/grazing land is another important land use system in the village. However, grazing land and/or pasture availability is one of the striking problems facing livestock sector in the village. Animals are grazed largely on restricted areas in mountaintops. During rainy season animals are grazed on plateaus or mountain slopes, along roads and in dry season they are grazed in harvested farms. Before mid 1990s it was also common to graze along valley bottoms but to date the valley bottoms are flattering with crop gardens. Animals mostly kept in the village are cow, pig, goat and chicken. Cow and goat are kept under semi-free grazing and tethering systems, pig under zero grazing and chicken enjoys the free-range system.

2.5.7 Village/*Ntambo* establishment and exploitation

Fig. (10ii) shows that Kindimba village consists of 43 *ntambo* of ranging sizes and varying population densities. The mean *ntambo* sizes range from 0.24 km^2 to 0.86 km^2. The geomorphologic features that circumscribe *ntambo* such as mountain ridge and stream boundaries are well marked in this village. Though some clans dominate certain *ntambo* but generally multi-clan settlement is common in most *ntambo* and no clan could claim superior over the other hence, harmony has prevailed throughout.

JICA (1998) supposed that exploitation of *ntambo* in Kindimba began at around 1900s when very dense evergreen forest could have existed at that time. Since that time Kindimba was subjected to intensive cultivation to the extent that long fallow periods are now hallucination. The

historical standpoint described by JICA (1998) discloses that the first clan to settle in Kindimba include the Komba, Lupogo, Ndunguru and Kapinga patronymic groups. The criteria, which they used when selecting *ntambo* for settlement were soil fertility, possibility of expansion, water availability, topography of the farmland and availability of grazing areas. Similar merits attracted the missionaries who decided to settle in Kindimba village around 1909 and introduced western religion and later formal education in 1930.

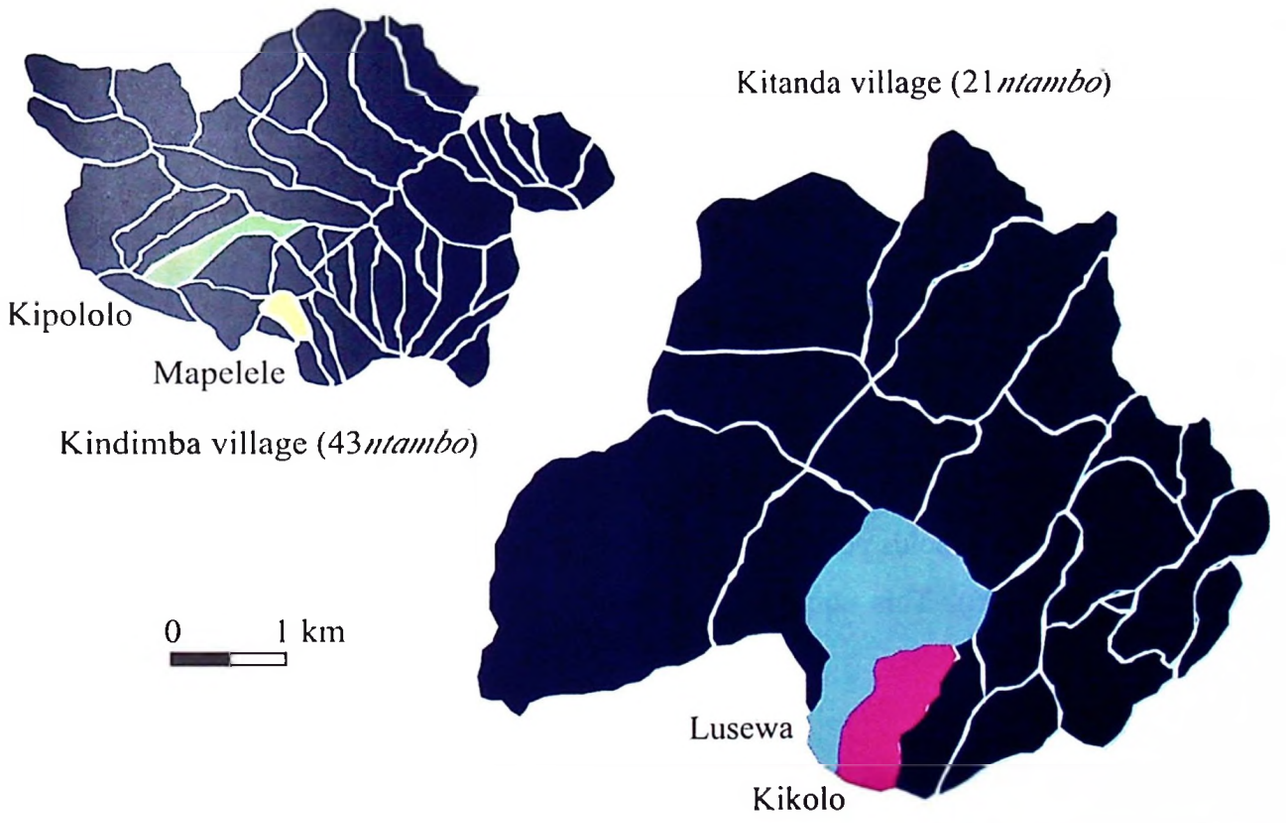


Fig.10ii. *Ntambo* distribution in Kindimba and Kitanda villages (Modified after JICA, 1998: 238/246

Kitunda A and B, Ndembo and Kindimba locations constitute oldest sub-villages in Kindimba village. JICA (1998) also divulges that these locations possibly had been exploited well before 1900s and their ancestors might have come from Litembo or elsewhere. Later exploitation in Walanzi, Mtungu and Torongi locations are assumed to be largely by within village migration pattern. Even if there were differences in terms of time for which a given *ntambo* was established or began to be exploited, this difference is negligible. Generally, the exploitation process continued in each *ntambo* almost at the same rate. It is possibly that when one clan was exploiting or occupying another clan was doing the same in the neighbouring *ntambo*.

Characteristically, Kindimba village is endowed by well-established coffee farms with high population densities caused by high birth rates. Basically, high birth rate has is influenced by the number of wives a person has (Schmied, 1989).

Ntambo in Ndembo and Mtungu locations showed respectively highest and lowest population densities. Hence, Ndembo is contemplated more matured than Mtungu. Normally three to four generations occupy *ntambo* before family members thought of migrating to other areas (JICA, 1998). The earliest occupied *ntambo* such as Kipololo and Kukwela of Kitunda location were already "fully" occupied at around 1950s and 1960s making out migration apparent. During emigration some family members were/are left behind to maintain the homesteads in the mountain areas. In another option, some parents migrate with their sons to other places. Parents could either sell land to close relatives or as a rare case to other person or left it to one of their relatives to take care of the land or maintain it through temporal visits.

In fact some elements of truth show that by 1940, the potential of the population to increase inside the *ntambo* in Kindimba was already constrained by the size of the land. During this time introduction of coffee constrained landholding per household within the *ntambo*, something that pioneered land intensification. Despite some changes in land utilization there are no much changes regarding to number of households per family as well as increase in total population occupying given area (Rutatora *et al.*, 1996). This equilibrium was and has been maintained due to continuous emigration process.

2.6 Profile of Kitanda Village and process of *ntambo* exploitation

2.6.1 Location and land forms

The village is located some 20 km east of Mbinga town situated in the rolling hills south sub-ecological zone of the Matengo highlands and it is saved by earth road. The village is one of the newly established villages in the Matengo highlands inhabited by the immigrants largely from the mountain areas. The landforms and geology as described by Msanya *et al.* (1996) show that hilland forms the larger part of the village, and includes backslopes and slope facet complexes. Following the hilland are piedmonts, which are primarily colluvial (depositional) sites but are of secondary denudational sites. The lowest-lying points are the river valleys. These forms the ultimate sink for nearly all materials eroded from the higher lying land. In terms of geology, mixed intermediate and mafic metamorphic rocks underlie the village.

2.6.2 Population and administration

The 1988 population census shows that the village had 3,609 people of whom 1,162 (32.2%) were females and 1,847 (67.8%) were male (JICA, 1998). The 2002 national population census reported by VEO showed the village had 2,358 people of whom 1,279 (53.6%) were female and 1,079 (46.4%) male. The VEO mentioned split of the village into three registered villages in 1994 (Kitanda, Lupilo and Masimeli) contributed to population squeeze into the village.

Kitanda village is composed of seven sub-villages or location (*vitongoji*), namely Muungano, Lami A, Lami B, Kiburang'oma, Machimbo, Nsenga A and B, which are not regularly demarcated by the natural topographic features such as mountains and streams. The sizes of sub-villages are reported by JICA (1998) as of altering area of 7.38 to 15.8 km^2 and average size of 10.7 km^2. Average population density is 49, which are very much different from 143 that of Kindimba.

Fig. 11. Distribution of sub-villages in Kitanda village (Modified after JICA, 1998:246 before split of Nsenga sub-village into Nsenga A and B sub-villages)

2.6.3 Climate

Similarly, Kitanda has no specific climatic records before 1996. The climatic conditions according to Msanya *et al.* (1996) follows the general trends as described under Mbinga district profile. Mean annual temperatures are expected between 20°C to 25°C. Mean monthly rainfall distribution is shown below in Fig. 13.

2.6.4 Vegetation

The vegetation of the area is largely poised of *Miombo* woodland. This vegetation occupies largely the hillands and the piedmonts. The dominant tree species are typical of those described by Msanya *et al.* (1996) under Mbinga district profile. Trees are used variably, ranging from building poles, timber, rope, edible fruits, and fuelwood and medicinal. Nevertheless, larger part of this vegetation has been and is still being cleared through opening up new farms for cultivating food crops such as maize, beans, sweet potatoes, and finger millet as well as for growing cash crops such as coffee and tobacco (JICA, 1998).

2.6.5 Soils

Soils in Kitanda are assumed to be much better in terms of nutrients than exhausted mountainous soils that have been under constant intensive cultivation for a much longer period (JICA, 1998). Kitanda soils fits in general terms of soils of Mbinga district, which in terms of mineralogy are strongly weathered and dominated by kaolinite clay mineral (Msanya *et al.*, 1996). The soils are mainly poor of major nutrients supply, which call for attention to amend the declining natural fertility. Continuous cultivation without adequate fertilization is linked to this ailing situation.

Msanya *et al.* (1996) described the hilly summits and upper slope soils as subjugated by *Umbric Leptosols* (*Lithic Ustorthents*). The moderately dissected steep hill slopes dominated by *Eutric Leptosols* (*Lithic Ustorthents*) and steep and strongly dissected slopes surface complex are mainly covered by *Ferric Acrisols* (*Ustic Kandihumutlts* and *Typic Kanhaplustults*). On the piedmonts with gently undulating and strongly dissected very steep slopes with narrow interfluves sloping towards the streams, the soils are *Ferric Lixisols (Ustic Kandihumutlts).* Moderately dissected slopes, with broad interfluves and short steep slopes towards drainage system are dominated by *Rhodic Ferralsols* (*Rhodic Kanhaplustults*) whereas flat to almost U-shaped river valleys are covered by *Dystric Fluvisols* (*Aeric Fluvaquents*).

Generally, the soils in the village have serious limitations in depth for hillands and low fertility in the piedmonts and river valleys. This situation calls for an immediate research or action on proper soil management practices e.g. agroforestry practices.

2.6.6 Land use

The major categories of land use in Kitanda village are *ngolo* and/or ridge cultivation for maize, beans and cassava crops. Coffee farms dominate homestead land largely made on flat

seedbed. Slash and burn practices (*matema*) for opening a new farm can currently be seen in isolated areas within the village. In the hilly summits, upper slopes and moderately dissected steep hilly slopes the farming systems include few ridges and *ngolo* cultivation used mainly for maize, cassava and beans production. Farming system along steep and strongly dissected slopes surface complex are characterised by *ngolo* and ridges for food crops (mainly beans, maize and cassava). Coffee and *Grevillea robusta* agroforestry, cultivation of banana and mango are also common in these sections. This is similar to piedmonts with gently undulating and strongly dissected very steep slopes with narrow interfluves sloping towards the streams and areas with moderately dissected slopes, with broad interfluves and short steep slopes running towards drainage system. Flat to almost U-shaped river valleys are made of flat seedbed, ridge and *ngolo* cultivation systems with maize, beans as main crops. The land hold per households is larger than that of the mountain areas and they cultivate large tracts of food crop fields both for household consumption and sell to compensate young and ill-performing coffee.

Livestock are mainly chicken, goat, cow and pig. The rearing system and rationale for keeping livestock are typical of the mountain areas. However, the area is benefited with enough grazing land and pasture. Out door animals are tethered and grazed mainly on plateaus where there exists huge tracts of grass fallow land (*lipusa*).

2.6.7 Village/*Ntambo* utilization in Kitanda village

Kitanda had a total of 21 *ntambo* (see Fig. 10ii above under description of Kindimba village/*ntambo* utilization) though some of them could not in strict geographical sense be considered as *ntambo*. For instance, some *ntambo* in Lami sub-village were simply indicated as or area (*maeneo*) as the *ntambo* was not geo-physically delineated. In other areas, *ntambo* is named after the landholder's names, which according to JICA (1998) symbolize primitive stage of *ntambo* development. Most farm fields concentrate in mountain slopes possibly due soil condition, which helped accumulation of organic matter in the lower horizons and more fertile soils in the slope as opposed to deeply weathered soils in stable slopes or piedmonts.

Kitanda is a relatively new village largely inhabited by the immigrants from the mountain areas. The village consists of patches of *Miombo* vegetation, which have recently been subjected to intense exploitation largely by mountain immigrants. Village exploitation by immigrants began in the end of 1950s and early 1960s and by late 1970s there was no more vacant *ntambo* for the village government to allocate to new immigrants. Though actual exploitation to some *ntambo* in Kitanda began in the 1990s using slash and burn system of land preparation, however, by 1980 all

ntambo in the village were already under ownership of certain extended families. Land acquisition by new comers was then possible through negotiations with the *ntambo* owners and not the village government. It was at the same 1980s those found no more land for expansion within the village started emigrating to nearby areas such as Lupilo and Masimeli and more recently to Songea rural district. It must however, be acknowledged that this village was inhabited by early settlers well before the arrival of mountain immigrants. Clans of Damian Ndunguru (Kayumba/Kawasiwasi) and his uncle Kabhusa are assumed to be the earliest settlers. Later came Mwakambaya Tegete (Mtwara) the 'Bishop' from Ungoni area, Athanas Mbunda, and Thomas Charles (Mpigasimu) from Ungoni and Simon Mapunda a Matengo from Matiri village.

These clans believed to have settled here long before the influx of mountain immigrants. Thus, early settlers were both Ngoni and Matengo. Later came Pronus Matola (September), Fabian Mbunda (Madhubuti) from nearby village Utiri and Oranzi Ndunguru (Kasuku) from mountain area that settled in the village in 1950s.

JICA (1998) regards Lami as the first location to be exploited at around early 1960s by Mbunda and Hyera clans and later exploitation extended to Muungano, Nsenga and lastly Kiburang'oma locations. However, the indigenous people have existed in this village well before 1960s. Since Damian Ndunguru and Mwakambaya Tegete were the first settlers, then the first location to be exploited is possibly Muungano (Iganga and Mtwara *ntambo*) where Damian and Mwakambaya clans lived. The process of village formation is typical of Kindimba and process of land acquisition and social organisation in Kitanda is quite similar to the one that existed in Kindimba in the 1950s. Of late, *ntambo* in Lami sub-village appeared highly populated, as it has developed as business centre. Dominance of clan in certain ntambo is relatively indistinct in Kitanda village as compared to Kindimba. This is possibly because of the physiographical boundaries in Kitanda are somewhat unclear due to gentle slope landform.

It can be deduced from above sections that the size of sub-village in Kitanda is larger than those of Kindimba. Population density is higher among Kindimba *ntambo* than those of Kitanda indicating different stage of maturity. Thus, as mean *ntambo* size becomes smaller, population density increases. This was actually the process that takes place in the area caused by the accumulation of people due to subdivision of land, largely through inheritance.

It was also observed that Kitanda people preferred using the term *mtaa* to classify their area of settlement than *ntambo* as popularly used by their colleagues in the mountain area. *Mtaa* in Kitanda were mostly found in *ntambo* inhabited with multiple clans. These clans settled in different specific areas scattered from one clan-nucleated settlement to another hamlet within the

same *ntambo.* People name these isolated hamlets as *mtaa.* As a socio-graphic unit *mtaa* could be referred to as a section of *ntambo* occupied by extended clan(s) of which the inhabitants equate its functions as *ntambo* since they could obtain most of their agricultural need within it. Thus, people in Kitanda identify themselves through *mtaa* than *ntambo.* Kitanda folks especially the young generation hardly mention *ntambo*. They however refer *ntambo* especially when they intend to emigrate out. For instance, those intend to emigrate permanently or whose family members have permanently emigrated to other village they mentioned it because the emigrants moved to such village because they got *ntambo*. They never mentioned *mtaa* in such a situation. Thus, people in new land they refer *ntambo* mainly as a geographical unit and *mtaa* as socio-graphic unit.

2.7 Research Methodology

2.7.1 Materials and methods

Understanding the dynamics of indigenous agricultural land use practices and the environmental management intricacies require the involvement and dialogue with local people who have gone through these changes. Indeed for a research of this type, a combination of methods was necessary.

2.7.1.1 Study area

The study was conducted in two villages namely; Kindimba located in the mountain area and Kitanda situated in rolling hills south. Kindimba village was selected because it was one of the oldest villages in the Matengo highlands and has a long history of agricultural land use and environmental management typical of Matengo society. Kitanda village was selected as it represented one of the new settlements of emigrants from mountain areas that adopted some new cultivation methods. Kitanda village had more natural forests compared to Kindimba, and represented one of the new villages where people have immigrated since the 1950s and early 1960s. In Kitanda, people cultivate large tracts of food crop fields, both for household consumption and for the market. Similarly, coffee trees in Kitanda are still young. Kitanda still enjoys a sparse population density while it is heightened in Kindimba.

2.7.1.2 Selection of study *ntambo*

Four *ntambo* were selected, two from each village. The *ntambo* selected had the following features: clear geographical boundaries, coffee and *ngolo* fields, valley bottom farming, and single or multiple clan dominance of more than 10 households.

2.7.1.2.1 *Ntambo* from Kindimba village

Kipololo and Mapelele *ntambo* (see Fig. 12) from Kitunda A and Ndembo sub-villages were respectively selected from Kindimba village. Kipololo *ntambo* was one of the oldest and highly populated *ntambo* in Kindimba, inhabited by more than 30 households from six different clan backgrounds (three different clans of Komba, Njako, Haule and Ndimbo). However, narrow valley bottom shape affected valley bottom farming. Mapelele *ntambo* was also developed nearly at the same time as Kipololo. However, a mono clan called Ndimbo inhabited it. This *ntambo* was relatively smaller than Kipololo and had 13 households. Coffee farms dominated land use around homesteads of both *ntambo*. Both *ntambo* were at full maturity stage and crop farms covered about their whole land, mainly coffee and *ngolo* fields that signify land shortage faced by the inhabitants. Exploitation of both Mapelele and Kipololo *ntambo* began at around the 1900s (JICA, 1998).

2.7.1.2.2 *Ntambo* from Kitanda village

Lusewa and Kikolo *ntambo* (see Fig. 14) from Muungano sub-village were selected from Kitanda village. Lusewa *ntambo* was sparsely populated and larger than Kikolo. The natives called it *mkomboti* because multiple clans inhabited it. About seven clans from different backgrounds inhabited it (three different clans of Ndunguru, Komba, Nombo, Mbunda and Haule). Landholding per households was larger than in Kikolo. The *ntambo* was characterised by long fallowed lands (*lipusa*), patches of shrub fallow and degraded *Miombo* woodland (*kigona*).

Two different clans called Ndunguru and Komba inhabited Kikolo *ntambo*, and though located in a new land use area, they were already facing land scarcity. Some of the inhabitants from Kikolo have started migrating to newer lands in search of more land. The natural *Miombo* woodland vegetation had to a greater extent disappeared in this *ntambo*. Exploitation in Lusewa began in the late 1950s while in Kikolo begun in 1964 both by people from the mountain area. Both Kikolo and Lusewa were delineated by clear geographical boundaries, compared to many of the *ntambo* in the village.

2.7.2 Data Collection and duration

Both primary and secondary data were collected and utilized. The researcher generated primary data during field surveys whereas secondary data involved collection and review of relevant literature and data of past studies in research areas or areas with similar agro-ecological characteristics. The researcher spent a total of twelve months between 2001 and 2003 in the Kindimba and Kitanda villages and observed various activities related to land utilization and environmental management.

2.7.2.1 Preliminary data collection (Reconnaissance survey)

This was done between October and November 2001 to obtain general overview of the study area in relation to land use systems, landholding, environmental management and demographic characteristics. Data obtained served to make the basis for an in-depth survey and helped to comparing the general situation to specific ones. Several villages in the mountain area, rolling hills and Lakeshore zone were visited and a number of people from the village to district levels were consulted.

2.7.2.2 Physical survey

This was only restricted to specific study areas, to determine the type and change of agricultural land use and environmental management. Through these assessments the gravity of the problem was developed. In this aspect the following data/measurements were collected:

(i) Use of Global Positioning Systems (GPS) enabled the measurement, determination and identification of various land uses in the *ntambo*. Thus, GPS was helped to classify land use patterns of the surveyed areas.

(ii) Changes in vegetation in the study villages were examined. This necessitated the use of satellite photos of December 1984, November 1989, August 1991, October 1994 and October 2000. These photos and maps enabled to estimate the extent of change in respective periods.

(iii) Environmental attributes were examined through soil properties characterisation and vegetation determination. Soil samples were collected in all studied *ntambo* and some basic soil properties were analysed. The analysed soil properties were soil pH, Extractable Phosphorous (P), Total Nitrogen (TN), Organic Carbon (OC) and Cation Exchange Capacity (CEC). Other variables included exchangeable bases, Calcium (Ca^{2+}) and Potassium (K^{+}). Soils were sampled at three different points (upper, middle and lower parts) of the studied *ntambo* and were collected at three depth levels (0-50, 150-250 and 350-450 mm, respectively). Four-soil collection pits were randomly

made at every collection points i.e. upper, middle and lower, making a total of 36 samples collected in every *ntambo*. Thus a grand total of 144 soil samples were collected from all four *ntambo* studied (Table 3.). Soil samples from Mapelele and Kipololo *ntambo* in Kindimba village were collected from harvested *ngolo* fields as the entire *ntambo* were filled with farm plots. Soils were collected on *ngolo* ridges and not from the pit. In Kindimba village however, soil samples were collected from areas of long fallow periods (*lipusa*) and shrub fallow (*kigona*). Collected soil samples were brought to the Sokoine University of Agriculture Soil Science laboratory (Tanzania) for analysis.

Table 3. Soil sampling design

Sampling points	Number of sampling pits	Sampling depth levels	Number of samples per sampling point
Upper part of the *ntambo*	4	3	12
Middle part of the *ntambo*	4	3	12
Lower part of the *ntambo*	4	3	12

(iv) Vegetation cover was determined in all *ntambo* studied. This included determination of vegetation types, tree species, diameter and dominance. Another quadrate was made at Lupilo village as a supplementary area to determine the conditions of undisturbed miombo vegetation. The size of each quadrate was 30 x 30 m. Ranging pole and telescope (Ushikata Trancon Telescope Model S-25) were used for quadrate determination and tape measure for tree diameter determination.

2.7.2.3. Household and key informants survey

The survey involved using open-ended questionnaires and semi-structured interviews by checklist.

(i) Open-ended questionnaires (OPEQ)

OPEQ were administered in 72 households instead of 73 households as one household was missing in Lusewa *ntambo* because he migrated out before completion of the study (Table 4.). Thirteen and thirty-two households were interviewed in Mapelele and Kipololo *ntambo* in Kindimba village, respectively, whereas Kikolo had fifteen households and Lusewa composed of twelve households only. The OPEQ focused on types and changes of agricultural land use systems, challenges and alternatives in land use. Other attributes investigated were migrations, land tenure/holding and environmental management. This was important so as to establish the socio-ecological conditions in the study area and response to the problems at hand.

Table 4. Household questionnaire administration in studied *ntambo*

Village	*Ntambo*	Number of households	Missed household
Kindimba	Kipololo	32	0
	Mapelele	13	0
Kitanda	Lusewa	12	1
	Kikolo	15	0

(ii) **Semi-structured interviews using checklist**

Checklists were administered to selected village leaders, elders and key informants so as to understand the evolving land use and environmental utilization in the area. Village leaders interviewed from each village included the village chairman and village executive officer. Ten village elders and key informants from each village were selected and interviewed. Village elders were randomly selected from entire village and village leaders assisted initial stratification of elders. The preferred age was from sixty years old and above. However, some interviewees were younger than sixty years old but were interviewed because of their understanding of Matengo society and the general study context.

Checklists were also employed to all ten-cell leaders in both Kindimba and Kitanda villages. There were forty ten-cell leaders in Kindimba and thirty ten-cell leaders in Kitanda. The questionnaire was about land use patterns of five households from each ten-cell domicile. This partly helped to extrapolate the extent of land pressure in each *ntambo*. Likewise, checklist was employed to District Agricultural and Natural Resource Management officials so as to understand the dynamics of land use and environment management issues from a District perspective. The Officer in Charge of Ugano Coffee Research Centre in Mbinga was interviewed on trends of coffee production and marketing.

2.7.2.4 Secondary data collection

This involved the use of literature of previous studies in the area relevant to the research topic, national statistics e.g. population data and ecological/climatic information. Literature was obtained from Kyoto and Sokoine Universities libraries, Mbinga District Offices (Agriculture and Livestock Development, Natural Resource Management, and District Executive Director Officer's office). Much of the literature is reviewed in the text and listed under references.

2.7.3 Data analysis

2.7.3.1 Soil analysis

Soil analysis was done at Sokoine University of Agriculture (Tanzania) Soil Science laborato Exchangeable bases Calcium (Ca^{2+}) and Potassium (K^{+}) were measured in neutral 1M ammoni acetate by the neutral ammonium extract method outlined by Rhodes (1982). Cation exchange capac (CEC) was determined after percolation with 1 M ammonium acetate at pH 7.0 followed by ethanol a acidified 1M potassium chloride (KCl) and titration with 0.5N sulphuric acid (H_2SO_4) followi Kjeldahl distillation of the filtrate with sodium hydroxide (NaOH) to determine absorbed NH_4^+ (Rhode 1982). Phosphorous (P) was extracted using the Bray and Kurtz-1 method (Bray and Kurtz, 1945), a then spectrophotometrically determined as described by Olsen and Sommers (1982). Organic Carbo (OC) was measured by the Walkley and Black method outlined by Nelson and Sommers (1982). To nitrogen (TN) was determined by the Kjeldahl procedure as outlined by Bremner and Mulvaney (198 and soil pH was potentiometrically measured in water at the ratio1:2.5 (w/v) soil to water as outlined b McLean (1982).

2.7.3.2 Statistical data analysis

Data analysis techniques included descriptive statistics such as mean, ranking, and percentages. Pie charts, histograms and scatter graphs were adopted to establish the relationship and trends between variables. Computer program EXCEL was used for statistical data analysis. Data analysis techniques include descriptive statistics such as mean, ranking, and percentages. Pie charts, histograms and scatter graphs were adopted to establish trends and relationship between variables. Computer program EXCEL was used for statistical data analysis. GIS programmes ERDAS and ARC VIEW were adopted for satellite image analysis.

CHAPTER THREE

ASPECTS OF LAND USE DYNAMICS

3.1 Perspective of Land Use Dynamics

A priori judgments about the importance or character of man's use of land dominate official documents such as International Conventions and National Environmental Action Plans, which underpin environmental and natural resource management politics (Reenberg, 2001). In such conventions, at least the antiquity, originality and dynamism of African agricultural land use systems have been acknowledged in academic circles if not in popular thinking. This is possibly due to the fact that these traditional systems have been sustained for centuries or so partly because they are peculiar to their particular environments and to the cultures, which developed these specialized agricultural systems (Sutton, 1989). In due of this perspective, this work specifically focuses on the issue of changing land use system and environmental management related to the human utilization of land. It does so by first presenting theories that concern the process of land use changes, mainly emphasizing those that include land use patterns, tenure and crops grown.

For one thing, agricultural land use dynamics is enormously complex and varied geographically. The ambiguity outcrops from an obvious inadequacy of both the invention of the concept as a notion of a simple dichotomy between a livelihood base and on cultivation and one based on environmental management (Sutton, 1989). Definitely, how any agricultural land use system began is equally important as to how it has developed and what it has so far achieved. These achievements, the success of African agricultural land use system in other words, reflect so much the adherence and stability to changing "traditional" systems and the maintenance of an ecological equilibrium and the constant adaptation in the face of the ecological stress and population growth (Reenberg, 2001).

Characteristically, tropical African agricultural land use systems have primarily been of the shifting cultivation or slash-and-burn variety (Knight, 1974). They consist of mosaic of crops, traditions, and techniques that does hardly reveal a centre, nuclear area or a single point of origin (Morgan, 1969; Harlan *et al.*, 1976). The farming practices largely depend on nutrient cycling and biological processes on soil fertility maintenance. Agrochemicals and mechanization are far less accessible by most of the farmers whereas complex cropping systems and overall dependence on rain fed are widespread. The systems also take advantage of micro-ecological conditions and the production systems are mainly under management of a family or farm families (Okigbo, 1990). As a result their land use systems are typified by subsistence objectivity, miniature farm holdings and labour intensive (Knight, 1974).

Usually the agricultural land use systems in sub-Saharan Africa have been analyzed in economic and agronomic terms focusing in different forms of extensive and intensive cultivation systems (Hakansson, 1989). However the intensive form of agricultural land use has received a far little attention and is habitually seen as exceptional developments in special environments (Allan, 1965; Ludwig, 1968; Bronson, 1975; Schneider, 1979). High population density has often being stressed as the casual variable for intensive agricultural systems (Allan, 1965; Boserup, 1965; Ludwig, 1968; Netting, 1969). However, unprecedented recent researches have shown that despite less population density pre-colonial East Africa, Tanzania in particular, intensive cultivation was possibly more widespread than now (Hakansson, 1989). The profound pre-colonial intensive agricultural land use systems in Tanzania were found in areas such as Kilimanjaro with irrigation canals of the *Chagga* (Allan, 1965), *Ukara* island in lake Victoria with mixed farming (Thornton and Rouce, 1936), Matengo highlands in southern Tanzania with pit system (Stenhouse, 1944), *Fipa* mounds of western Tanzania (Lunan, 1950) and *Iraqw* farming system in northern Tanzania (Hartley, 1938). It is agreed that socio-political, economic and ecological factors and regional systems of exchange must have sustained these intensive agriculture systems without soil exhaustion and erosion for long (Hakansson, 1989).

From this tract therefore the history of change is obvious not sufficient enough from just a simplistic observations of its extreme variety, and diversity of long historical process. It is rather a deep and keen understanding of the entire production system, its practices, technology and their history that have permitted the modifications in land uses and field arrangements. As a discourse some may disagree with this approach, but more positively one needs to examine the reasons of these cultural-and agricultural-changes in the broader socio-ecological and economic context. In a matter of dynamism it must borne in mind that indigenous African crops and production systems have been evolving and some for instance have been grafted to "modern" production systems (Okigbo, 1990). Hence, some elements of traditional and transitional African agricultural systems exist alongside with some "modern" production systems and local-inventions.

It is apparently from this dialogue that global validity of conventional wisdom within the area of land use and the environment management has been questioned (Tiffen *et al.*, 1994; Leach and Mearns, 1996; Raynaut, 1997; Adams and Mortimore, 1997; Marcussen and Reenberg, 1999). For instance, though it was more frequently argued that population growth is one of the major driving forces of environmental change, there are still significant local variations in the interrelationship between people, crop production systems and environmental change (Uitto and Ono, 1996) and that no simple relation exists (Mazzucato and Niemeijer, 2000). Thus, several key

issues need to be revisited in multidisciplinary courses to understand the land use dynamics process and resource management strategies at a local setting (Reenberg, 2001). One of the important issues to address the land use systems dynamics is to understand the forces that drive land use changes in various environmental, socio-economic and cultural contexts (Scoles *et al.*, 1994). This may yield a valuable basis to develop a much-needed framework for conceptual models that are capable of extrapolating and generalizing local observations to expected trends at regional, national and global level.

3.2 Debates and Theories on Dynamics of Land Use Systems

3.2.1 Cultural dimensions of land use change

A comprehensive theoretical literature addresses the process of change in agricultural land use systems as regards to intensification and parts of it also concern spatial aspects in terms of land use patterns (Reenberg, 2001). In such literatures the role of population growth has been given much attention. In fact, possible correlations between population densities and resource characteristics have long interested geographers, anthropologists, and others (Meadows *et al.*, 1972). In much of their studies simple cause-impact relationships between increased population sizes, agrarian change or eventual collapse of the ecological balance dominate (Meadows *et al.*, 1972; Scott, 1979).

Malthus (1960, p.1798, 1803) presented a crisis scenario theory, in which he argues that population, if left unchecked, grows more rapidly than food production. Ricardo (1817) added that land, being limited, would provide the prime impediment to agricultural growth. Along these lines, the neo-Malthusian school of thought sees population growth as leading to irreversible degradation or depletion of resources (e.g. Meadows *et al.*, 1972; Scott, 1979). In this aspect therefore demographic pressure is believed to lead to cultivation of agriculturally marginal land or to degradation and unsustainable use of existing fields.

Conversely to Malthusian crisis model on the population viewpoint, Esther Boserup (1965) and a number of her notable successors such as Gleave and White (1969) and Clark and Haswell (1970) have formulated the most intriguing universal scale model of agricultural land use change. Boserup basic premise is that population growth is an independent variable determining agricultural development. According to her hypothesis, intensification of agriculture leads to increased yield per unit of cultivated land, but at a cost of higher labour input. Thus, increased need for food and land scarcity caused by population growth were countered by an intensified use of technologies in which more labour was used in conjunction with land improvement

technologies. They viewed the increase in population density or land scarcity could trigger agricultural intensification contrary to the crisis theories suggested by the Malthusian school of thought. Boserupian theorists believe that under conditions of limited land availability, population growth makes shorter fallow periods necessary in order to provide land and food through more increased labour input in soil conserving techniques and manuring. In other words, farmers are not likely to intensify their agriculture until they are forced by population growth.

Bilsborrow and Ogendo (1992) propose a conceptual framework wherein the population driven changes in land use is seen to be manifested in various forms, including land-tenure arrangements, intensification of agriculture and extension of agricultural land. They suggest that the effects of population pressure are likely first to be felt through changes in tenure arrangements. The second phase of adjustment is expansion of land. This occurs when communities do not have a sufficient stock of land in their immediate area, but where there remains land, which is both arable and physically accessible. The second phase may occur simultaneously with the first or the third phase. These first two phases may or may not be accompanied with radical changes in land use practices. The third phase is adoption of new technologies, the distinctive feature being intensification and an increase in land productivity. The last response in the population/land use continuum, the fourth phase, involves a fertility reduction. It is seen as related to phase two and three in the sense that (a) out migration is an alternative to fertility reduction and (b) intensification makes larger family units possible and even desirable.

Nevertheless, the Boserup model has been widely criticized of being primarily fit to pre-modern societies in which economic incentives have not short-circuited the population-intensification process (Knight, 1974). Similarly many scholars have been sceptical about the applicability of such global theories at local level. For instance the barriers against intensification in most Savanna and woodland soils of sub-Saharan Africa include low fertility and heavy leaching soils in cleared land, which makes fallow necessary in order to regain fertility (Grigg, 1979; Hakansson, 1989). Because of the character of soils and climate, there exist definite upper levels to population density and agricultural intensity (Allan, 1965; De Wilde, 1967; Ruthenberg, 1977). Hence, these difficulties have led to a population-pessimistic view of the potential for agricultural intensification in Africa. Similarly, during pre-colonial times the population distribution and density largely followed soil potential and when an area became over-populated and yields started to decline, people migrated and settled in new lands (Allan, 1965; Uchendu, 1968). Thus Boserup model does not ubiquitously apply to all surrounding circumstances of

agricultural land use intensifications in traditional societies as it fall short to tackle the multifaceted nature of land use dynamics.

Boserup and her predecessors have also been disapproved of their inadequate explanations on such situation as declining agricultural intensity with increasing population. Hakansson (1989) reports the case happened in Pare Mountains in northern Tanzania where during nineteenth century, irrigation, terracing and manuring were practiced and a large agricultural surplus exported. But according to Fleuret (1985) intensive agriculture in these areas was more widely spread in the pre-colonial past but has since declined, being replaced by extensive systems and the people are now experiencing food shortages. Thus, the Pare here exhibits the reverse to Boserup's model where, despite increased population, intensive agriculture has been abandoned. Similarly, linear judgments are difficult to draw on Matengo land use intensification basing on Boserup thesis. According to JICA (1998) and Kato (2001) the Matengo of south-western Tanzania perform intensive agriculture even in sparsely populated areas where they have recently moved in. In these contexts the applicability of population density-agricultural intensification model following Boserup thesis is highly questionable as it fails to address the effect of other independent factors such as political economy, ecology and local people's inventiveness on agricultural land use change.

The Boserup thesis also is not equipped to explain why many areas of current high population densities such in Kenya (Ominde 1968; Ostberg, 1987) and Mbozi in Tanzania (Knight, 1974) have not experienced intensification of cultivation through soil conservation methods. It is purported in these areas that the existence of alternatives to soil conservation, such as extension of acreage, utilization of low soil fertility tolerant plants and labour migration, have led agriculture along a path different from the one envisaged by Boserup (De Wilde, 1967; Meertens *et al.*, 1995).

On the same way, diverse evidences have been brought forward which epitomize that there is no simple relationship between population growth, land scarcity, expansion of cultivated land, land intensification and degradation (Tiffen *et al.*, 1994; Christiaensen and Tollens, 1995; Snyder, 1996; Adams and Mortimore, 1997; Mazzucato and Niemeijer, 2000). According to Ruthenberg (1977) shortening of fallow periods is not necessarily accompanied by soil-improving methods such as terracing and fertilizing as purported by Boserup thesis. Intensification has also not been always advantageous in some parts of Africa since the consequences of agricultural intensification on low to medium potential soils have in some parts of sub-Saharan Africa led to a decline in fertility and soil deterioration (Ostberg, 1987). As a result larger tracts of land are needed to supply the same amount of food (Allan, 1965; Greenland, 1975; Ruthenberg, 1977). According to

Meertens *et al.* (1995) it is ecologically more advantageous for a Sukuma farmer of Tanzania for instance, to extend acreage than to employ intensive cultivation methods in fragile sandy soils.

Mortimore (1995) argues that the regional association of rising rural population densities with agricultural expansion hides sharply contrasting experiences at micro-scale. Thus, perception of land use dynamics should include a hierarchy of scenarios at a local, national or continental scale that would provide valuable contribution to the analysis of global environmental change. On the other hand, these changes have to be seen as a result of a diversity of parameters and processes that can only be analysed at a much finer scale (Reenberg, 2001).

Ethnic variations for example are known to be important factors influencing agricultural strategies, and often deserve to be included as a key parameter in regional studies of the agricultural land use change. Cultural values rooted in ethnic differences play an important role for land use structures and development (Berry, 1993; Snyder, 1996). Of course acreage cultivated cannot be explained entirely as a simple consequence of population size and need for food. Ethnically determined perceptions and values have significant impact on the availability of and demand for land. Changing ethnic dominance could therefore be an important driver for change in land use strategies. Reenberg and Paarup-Laursen (1997) discuss ways in which *de facto* ethnic-specific perceptions of the natural environment have a considerable influence on the use of land change.

It has increasingly been acknowledged that though farmers are rational (Richards, 1988) but they do not run a business rather manage a household (Reenberg, 2001). Their land use strategies even if based on risk minimizing practices, they are also influenced by other factors such as ethnic traditions (Claude *et al.*, 1991; Reenberg and Paarup-Laursen, 1997) and social status and preferences (Berry, 1993; Snyder, 1996; Mazzucato and Niemeijer, 2000). Therefore, the susceptibility of land use to external changes cannot be completely understood without considering such aspects as well. Furthermore, issues such as state politics, market incentives, climate variations, and access to land and water resources are generally accredited factors determining the course of land use change (Kull, 1998).

As for a discourse, the Boserup (1965) hypothesis though imperative, is not sufficient enough to account for the multifaceted nature of land use dynamics. It is thus important to understand the historical processes that brought about population increase, and the kinds of production relations, which support particular populations. For instance, intensification may result from a necessity to provide surpluses for tribute (Price, 1984), and taxation (Winter, 1955), poll

tax (Schmied, 1989) or as a result of opportunities provided by urban food markets (Bronson, 1972, 1975; Hopkins, 1973) and cash crops (Wharton, 1970).

3.2.2 Influence of economic policy on land use change

Clearly, the agricultural land use development process is also embedded within and dependent upon a national and international world of markets and money (Knight, 1974). According to Lloyd (1965), Stevenson (1968), Friedman and Rowlands (1979) economic factors may themselves encourage population concentration. Likewise economic factors such as market systems and distance from urban centres may stimulate high productions for exchange (Bronson, 1972, 1975; Hopkins, 1973). The role of taxations to agricultural land use change highlighted by Winter (1955) indicates that a model of agricultural change as seen in Uganda demonstrate the effect of taxes as an economic incentive and alternative development processes resulting from cash farming or industrial economy.

Colonial rule in Africa, for instance, established economic policies that aimed at transforming indigenous land use systems for the sake of maximizing profit to the colonizers. This implied, in a rural society, stimulating cultivation for the market. A variety of such means as head taxes payable in cash or in valuable crops, private-sector plantations, and the encouragement of white settlers were deployed to this end. Beginning during the World War II and especially after it, the British in East Africa turned to planning large-scale development projects and mobilizing the required labour. A straw in the wind was the conscription of nearly thirty thousand labourers for work in plantations (particularly in sisal plantations) during the war. Post-war schemes, although they often they had pre-war precedents, were far more ambitious: a gigantic groundnut (peanut) scheme, various tobacco, rice, cotton, and cattle schemes; and, above all, elaborate soil conservation plans mandating a strict regimen of practices. Resettlement and mechanization were integral parts of many schemes that had an impact on indigenous land use systems (Scott, 1998).

According to Schmied (1989) one of the most striking changes in East African agriculture during the last hundred years is its progressive integration into cash economy. This follows the prerequisites created by the Arab and Portuguese coastal trade and the main impetus given by the European colonial powers through their conversion of the system for exchanging goods from one that involves barter to a monetary economy, together with their levying of taxes in cash. In return it resulted not only in the creation of large commercial farms, but also-probably even more important-in the transformation of small self-sufficient cultivators into increasingly market-oriented farmers. Though in most cases taxes have been a means to secure revenue for government

operations, however, in some cases, taxation was also intended to force local people to provide labour for distant estates and mines or enacts cash cropping. On land use side, the above situations brought the necessity to expand land under cultivation, changed the cultivation pattern, created new farming system and diminished the role of crops grown to meet the basic subsistence requirements.

3.2.3 Climate and land use change

Mazzucato and Niemeijer (2000) stress that climatic changes can cause changes in land use practices, which however, have to be interpreted with care if false conclusions are to be avoided. They observe in their case study from eastern Burkina Faso that higher situated fields are being abandoned because the reduced rainfall no longer allows sufficient yields. In other words, the reallocation of fields in recent years from uplands is a result of an adaptation to changing environmental conditions in terms of declining rainfall rather than a result attributable to declining soil fertility due to decreasing fallow as suggested by Vierich and Stoop (1990). Thus, climatic events override possible soil degradation as a major driving force for land use changes in this case.

Reenberg *et al.* (1998) likewise document that land use pattern has fluctuated significantly within the last 50 years in the Sahel as documented from a series of aerial photos, satellite images and GPS measurements carried out in the field. While the statistics in the area reveal the expansion of the cultivated area corresponds to the population increase, these quantitative estimates do not support the view that farmers compensate for degraded soils and declining yields with larger fields. The area has expanded in size, but just as important to notice is the change of field location from one landscape unit to another.

The reallocation of fields may be seen as a response to the changes in precipitation. The impact of rainfall changes on landscape specific priorities exposes why the concept of `marginal land' may lead to simplistic interpretations of the expansion process. The classification into marginal and non-marginal land presupposes that one type of land can unambiguously be perceived as more suitable than the other. This may change rapidly, e.g., as a result of rainfall changes. Thus, changes in land use strategies results not only in a simple expansion of fields to new and less attractive land. They are influenced by a more refined adaptation strategy by which the farmers try to ensure the best possible outcome of their labour input. The net result in the present case has been an expansion of land with an important element of reallocation of fields from one soil type to another driven by climatic events.

3.2.4 Political organizations and land use change

Changes in agricultural land use systems also entail socio-political circumstances (Dumond, 1972). Socio-political structures organize and utilize production (Kirch, 1984), reorganize production systems, farm labour and ownership arrangement (Price, 1984). It alters residence patterns with its implications for family form, kinship structure and land tenure (Bronson, 1972, 1975; Dumond, 1972; Netting, 1974). Likewise, research in Meso-America (Price, 1984), Polynesia (Earle, 1978; Kirch, 1984) and Southeast Asia (Friedman and Rowlands, 1979) has moreover shown a close relationship between political organization and agricultural production.

Kirch (1984) found the process of intensification in Polynesia as a result from both increased consumption needs by growing population and the demand by chiefs for surplus sufficient to underwrite their political actions and to enhance their prestige. As representatives of ancestors and gods, chiefs are also the custodians of fertility, which entitles them to receive gifts in return for maintaining prosperity of the land. Therefore, in the development of chiefdoms, ritual regulations as well as redistribution of food and other goods sustain production at a certain level of effort, assuring continuity of the established political order (Sahlins, 1972; Friedman and Rowlands, 1979; Kirch, 1984; Price, 1984).

Models developed in these studies may be helpful in analysing dynamics of agricultural land use systems in Matengo highlands. In Matengo for instance, the presence of warring Ngoni tribesmen in surrounding plains forced the Matengo intensify their agriculture, cultivate and produce more than their subsistence demand so as to distribute part of the output to their aggressors through food tributes. According to Price (1977, 1984) and Friedman and Rowlands (1979) such political competition may led to productive intensification in a regional context of competing political units.

3.2.5 Gender and land use change

Theories on land use changes seldom reflect the potential impact of gender specific priorities on land use patterns. It is widely known that households consist of several production units with different status, which affects labour allocations (Whitehead, 1984; Saul, 1993; Nyerges, 1997; Breusers, 1998; Smith and Chavas, 1999). Frequently, the male household head controls a 'communal' production unit for which he can claim the labour of his dependants. However, the household consists of a number of `personal production units' controlled by wives and junior males (Reenberg, 2001). In their on-farm activities women need to combine work on the household fields, possibly on their husbands' personal fields, on their own fields, and in the domestic domain. Yet

enormous results show that women's role as land users, especially in male dominated agricultural systems, seem to be underestimated in terms of their impact on the overall land use pattern (Reenberg, 2001).

Land use decision-making is thus separated into different spheres, and household members do not necessarily share the same production objectives or pursue a single strategy. The sub-units within a household are related in a complex, sometimes gender specific set of obligations, rights, and responsibilities (Moore, 1992; Kabeer, 1994; Berg, 1997). Thus, gender specific aspects may have a considerable bearing on contemporary pattern and not least on susceptibility of the land use pattern to changes and the society at large. Therefore, they deserve to be taken into account not least in theoretical thinking.

It is so far evident that, land use changes may not be simple to explain and predict as there a number of incentives, pressures and competing segments operating at the level of household or individual level that accentuate land use change. Even in subsistence agricultural systems, changes in the land use systems should not only be analyzed and understood as a simple relationship between population pressure (or need for food) and the potential of the natural resources. Where land is still available, invention, change, adaptation and other elements of development take place. This according to Brouwers, (1993), Mazzucato and Niemeijer (2000) indicates that population pressure is not the only stimulant for change. Brouwers (1993) argues that land use patterns have a random element, thus land use change might respond to large number of driving forces and such conditions may change any time.

Either local innovation or diffusion of production systems from elsewhere provides potential solutions to scarcity of land with respect to population. Within society, however, alternative skills and technologies are evaluated by cognate process; contained by social and political systems; and eventually become incorporated as part of the ongoing cultural package of cognition and behavior with respect to the environment (Knight, 1974). When innovations interact with population growth, capital formation and economic development change the institutional, economic and socio-cultural environment of the farm. The natural conditions are also changed, because natural economic development influences the ecosystem in a positive or negative way (Ruthenberg, 1980).

It is thus logical to surmise that predictions of land use pattern trajectories and evaluation of resilience of land use systems has to be based on a multidisciplinary analysis that recognizes a strong random element related to unforeseeable events (Raynaut, 1997). Many documents that underpin the development discourse concerning sub-Sahara environmental issues assume that an

unambiguous linkage between population pressure, land use, and adverse environmental impact is proven beyond any need for debate (Snrech, 1994; Mortimore, 1995; Raynaut, 1997). However, systematic studies that deal with spatial aspects are still scarce in spite of the growing evidence concerning other aspects of agricultural land use changes in Africa (Wiggins, 2000).

This makes a strong case for looking at processes of land use change in another perspective than that of a unidirectional, continuous change. Recognizing that the links between ecological constraints and human development are not linear is thus imperative (Meertens *et al.*, 1996). It might be useful then to confront empirical evidence on land use pattern changes with accepted models of change; not necessarily with the aim of creating new models, but in order to avoid having simplistic myths survive and persist as the grounding for environmental counselling (Reenberg, 2001).

Looking at land use changes in a diachronic perspective can help to disclose important traits of land use strategies that are otherwise disregarded. The idea of tracing the use of a specific unit of land through history offers a simple, but efficient means of decoding spatial messages and translating them into important information about the dynamics of the agricultural land use systems and resource management strategies (Reenberg, 1999). Garrity and Augustin (1995) have drawn attention to diachronic viewpoint due to the fact that the development of a tool to effectively capture the evolutionary trends in agricultural systems has been neglected. Landscape specific land use sequence analyses can make a useful contribution in that context, albeit not without skilful combination with other approaches to land use dynamics that take into consideration socio-economic factors (Reenberg, 1998).

What is so far missing is a means to link this multitude of explanations to an overall understanding of the process that leads to transformation, an approach that handles a variety of intertwined, yet distinct explanations. Single theory explanations may have their persuasive moments, yet explanatory theories can be more usefully regarded as complementary rather than excusive (Turner II *et al.*, 1993). Following this line of thought, Kull (1998) suggests adoption of (White, 1961; Wescoat, 1987) `range of choice' concept as a heuristic devise of organizing variety of ideas, which are required in a plural explanation. The range of choice concept is based on the assumption that a person's use of resources reflects the range of opportunities he or she possesses. The practical range of choices available is conditioned by ecological, political-economic, cultural, market, and social factors. Although such considerations could lack social theory to address the mediation of individual action by social context and political economy, Kull (1998) sees it as a useful device to link the contributions of relevant theories, including theories on social change.

The range of choice is powerful in providing a framework for combining factors that are dynamic (Berry, 1993) in the sense that they are constantly changing, moulded through the processes explained in political-economic, ecological, social and other theories (Reenberg, 2001).

3.3 Debates on land tenure and land use change

Modern growing debates have seen the demise of agricultural productivity and environmental degradation in developing world especially in sub-Saharan Africa as largely linked to ambiguous and complex land tenure systems that persist in the region. In other words the contemporary analysts of land tenure arrangements largely consider the so-called traditional forms of land tenure exist in Africa as an obstacle to agricultural development. They affirm that farmers in Sub-Saharan Africa are subject to a high degree of tenure insecurity, mostly because of the precarious rights they possess in the absence of formal land titles, the insecurity that limit investments (Feder and Nishio, 1999). So the agricultural practices used remain rudimental hence low productivity. According to UNCHS (1996), up to 80% of land deliveries in the developing world are informal. Such a situation according to Fourie (1998) implies the need for radical transformation to the existing land registration systems and regulatory frameworks. Severe doubts have, however, been raised on the linear applicability of these assumptions in the sub-Saharan Africa landholding and efficient land use context.

Until recently, however, there has been little systematic discussion of rationale of titling and individualization of Africa's land tenure systems. Most of the academic interest has been concentrated on tenure reform and agriculture production. Especially debated is the issue of whether transform Africa's customary land tenure systems or not. Some of these discourses, particularly those that were published from the 1980s onwards, have been linked to efforts at mitigating the continent's agrarian crisis (Migot-Adholla and Bruce (eds.), 1994). Similarly, aid donors, agronomists, economists, and policy makers have increasingly interpreting Africa's deepening economic and political crisis in terms of the prevalence on non-individualised land tenure systems. Even then, where access and control are discussed, there are clear overtones of "economic reductionism", which seem to becloud the quest for useful insights. In this regard, discussion is particularly more focused on the interrelationships between tenure changes/regimes and its connections to agricultural productivity in the framework of the conventional wisdom that the "communal" land tenure systems that are prevalent in much of sub-Saharan Africa are an obstacle to increasing agricultural production (Kanyinga, 2000).

Current debates and struggles by donor agents and independent sub-Saharan African nations to transforming indigenous land tenure systems is a copious of what the colonial masters tried to do in some colonial African states. The thesis first began with the anthropological studies carried out during colonial times and which largely influenced the colonial administration's thinking on how to improve agriculture in the colonies. The need to reform the customary land tenure system engaged the colonial administration constantly from the mid 1930s until independence period in the 1960s. Most of British colonial Africa, particularly Kenya, Northern Rhodesia (Zambia), Southern Rhodesia (Zimbabwe) and South Africa, experienced attempts at reforming indigenous land tenure systems because these systems were seen as detrimental to efficient land use (Kanyinga, 2000). Nevertheless, much of such schemes yielded remote benefits to the African peasant farmers. Post-independent African states also attempted to transform the customary land tenure systems in favour of titling or individualization of the land; once again the results were discouraging. Recently with the powerful influence of World Bank policies on Africa development, the titling and individualization of land has come into spotlight again.

The recent giant International Conference on Land Tenure and Administration was held in Orlando, Florida in 1996 aimed at providing experiences and challenges on land tenure issues in developing countries. Specific to sub-Saharan Africa the conference focused on majority of non-formalized parcels of land, which partly prevents the use of land for economic development, especially amongst the poorest parts of the population. Equally important it raised the need to address tenure issues as incentives to promote for integrated sustainable development strategies and the need to alleviate the indigenous groups who are in danger of losing their culture and their land. The need to reform the highly centralized and bureaucratic public agencies charged with land tenure affairs was also brought into scrutiny.

To signify the importance of formal preoccupation with land, and with arrangements pertaining to land use and possession Feder and Nishio (1999) quote the references in one of mankind's most ancient documents: the Bible. The Bible reveals that some 3700 years ago, the patriarch Abraham, a wealthy without land declined a free offer of the land to burry his wife. Instead he insisted of buying it apparently because he wanted to establish, through the payment of money, his and his heir's unchallenged ownership. Furthermore, the actual payment took place at the city gate, a traditional public meeting place, in front of the city notables and with many citizens witnessing the transfer of possession (Genesis, 23). The emphasis placed on witness and publicity stems from an issue, which is still relevant in today's land transaction: the need to verify who owns land so that there will be no risk of future challenges that may prompt land disputes.

Similarly, in the same Bible, prophet Jeremiah bought a land from his cousin. This time besides the presence of some witness, the transaction was recorded in two copies of a written deed, where all terms and conditions were specified and presented to the priest for safe upkeep. One deed was sealed and another one was kept open for an easy access of the public (Jeremiah, 32). The priest here served as the repository of land records and the deed left open can mean the need of transparency in dealing with land right issues. It also shows that even though Prophet Jeremiah bought land from presumably a trusted cousin, he insisted on a written deed so that future disputes of ownership could be referenced to the written deeds. And when in need to sell it he would have certification of ownership guarded by the corruption-free board, the priest. These testimonies in the Bible justify that demand for statutory land tenure rights has emerged even in various ancient societies.

The debates of transforming complex African indigenous land tenure systems has characterise the systems as "communal" and, therefore, incapable of accommodating modern methods of agricultural production (see Falloux, 1987; Feder and Noronha, 1987; Harrison, 1987). The critique, largely influenced by Hardin's (1968) thesis on "the tragedy of the commons", emphasises that communal or common rights to use land fail to include right to deprive others of access to it and, therefore, "carry with them the risk to ruin and overload the land". Thus, restructuring indigenous land tenure systems would promote efficiency in agriculture and, thereby, positively influence the course of economic development. Hence escape from the horrors or tragedy brought about by the common ownership of he land and in turn act as an incentive for husbanding and conserving land.

The ongoing land tenure discourses in developing countries also consider land titling to be a high priority in the quest to develop their economies. This is especially important at this juncture of market liberalization where right to land can facilitate collateral arrangements and access to institutional credit, and enhance tenure security. According to Feder and Nishio (1999) economics of land indicate that productivity of land is dependent on complementary investments in it. The initiatives to undertake the investments are significantly affected by expectations regarding the length of the horizon over which the investor might reap the benefits. The expectations, in turn, depend on the risk or tenure insecurity to possess the land such as ownership disputes, eviction, or expropriation by the government. They further argued that with defined statutory land tenure system such risks are minimized and likelihood of incurring high costs to defend one's possession of land is lower. It would also promote smallholders to invest more of their resources, including labour and time, in the land, to access credit, engage in responsible, environmentally-friendly land

use, and, overall, raise the level of agricultural productivity whilst limiting the damaging consequences of the "tragedy of the commons" (Kanyinga, 2000).

Indeed, it is widely recognized that customary land rights largely common in Africa usually evolve to handle transactions within the community, and they can function effectively in supporting transfers of land rights from one person to another, mostly within a specific group of people (Feder *et al.*, 1988). Feder and Nishio (1999) stressed that there are many situations where the customary land ownership system provides sufficient security to induce investments. But as land markets expand and transactions increase between individuals who are not closely related, uncertainty over the entitlement of an owner to transfer land rights becomes increasingly relevant (Feder *et al.*, 1988). Under such situation tenure security provided by traditional system is no longer sufficient enough to protect local people's claim from outsiders, be it government intrusion e.g. resettlement programs or any other developers. Thus, titled tenure system can introduce better protection of the rights of socially weaker groups and can provide better scope for poverty alleviation.

Simpson (1976) described statutory land tenure as "only a means to an end and not an end to itself". Further, asserted that much time, money and efforts could be wasted if that elementary truth was forgotten. Thus, new reforms in land tenure will not be at its full sense if it does not coincide with distribution of skills and means to make best economic use of land. Equally, benefits of land titling and its greater efficiency cannot be just taken for granted especially when the country's land holding systems, land market investments and land registry systems and bureaucracy are not that much transparent and accessible most by the poor. If not implemented properly the land titling can certainly produce undesirable and unintended outcomes such as land grabbing by better-placed few, thus creating landed and landless classes. It is also possible to provoke the poor and smallholders to sell their land to wealthier persons. This may lead to emergence of another large pool of hopelessness, the landless class and that would exacerbate more social instability.

Empirical evidence collected from coastal district of Kenya, an area with long history of private land ownership, which is also situated in a country with one of the most comprehensive efforts at land tenure reform dating from the colonial, also challenges the key assumptions of the proponents of land individualization. Kanyinga (2000) points to the much dysfunctionality associated with land privatization, including the numerous conflicts it generates on account of the dispossessions and landlessness associated with it. It also reinforces growing critique that customary land tenure is far more complex and flexible than its critics are prepared to concede.

Focusing on private title-agriculture output/productivity nexus, proponents of land individualization also engage in excessive economic reductionism, which neglects the key political and social issues that underpin the land tenure in sub-Saharan Africa.

A counter-argument to, and a strong criticism to private property of private land ownership and rights has also emerged even from within the World Bank itself where it has been emphasised that there has been no relationship between land privatization and increased agricultural production (Barrows and Roth, 1990; Bruce, 1994 and Migot-Adholla *et al.*, 1994). This criticism points out that the principle of exclusive rights in land generates disputes over usufruct rights because the privatization of land does extinguish all rights institutionalised under indigenous tenure systems. It is then concluded that efficiency and production in agriculture cannot be explained, alone, by rules governing property rights in land because other factors such as structure of production and community organisation have a bearing on this (Kanyinga, 2000).

The critique of private property rights also emphasises that, generally, land reforms have facilitated the disarrangement of indigenous tenure systems. The reforms create the basis for inequalities in land ownership (and therefore, socio-economic inequalities) and undermine the structure of social security developed under the customary land tenure systems (Haugerud, 1983; Bruce, 1986; Downs and Reyna, 1988; Berry, 1993). Others stress that change in the rules of tenure have promoted a multiplication of claims over ownership as a result of clashes between new and emerging rights and those rooted in indigenous regimes (Okoth-Ogendo, 1976; Berry, 1988; Lund, 1994; Platteau, 1996).

Similarly, notwithstanding its enormous significance land titling has so far shown unclear impact on productivity, land improvements or access to credit systems and marketing institutions in sub-Saharan Africa (Migot-Adholla *et al.*, 1994). This might possibly bring the need re-assess how the existing tenure system would provide sufficient tenure security than introducing the new ones. Undeniably, unless such factors as functioning financial markets, clear statutory framework, accessibility to inputs and market, landholders' participation and enterprising labour force are put in place the rationale of land titling in sub-Saharan Africa will remain dillydallying.

Thus, for the sake of betterment of on going debates on land tenure reforms in sub-Saharan Africa, there is a need in the land reform process to focus on transparency on land distribution and titling. Important also are participation of landholders and recognition of their customary land rights and social equity issues that if overlooked could negatively affect the benefits of the reform. Effective monitoring of developments on the ground and cost effectiveness should be sincerely considered in such risky exercise to maximize net social benefits and improve sustainability. Such

systems that intend to serve the welfare of the society must cater for great accessibility especially for the poor both in terms of location and culture. Therefore one of the greatest challenges of land regulatory frameworks is to make them useful to the ordinary people so as to administration, planning and sustainable development of the country (Feder and Nishio, 1999).

According to Kanyinga (2000) the contemporary studies show that customary land tenure systems are not as static and rigid as the critiques made of them have claimed. Instead, African indigenous tenure systems have been characterised by a complex array of rights ranging from "open" communal ones to individualised transmission via kinship arrangements and/or a combination of these. In some societies, control of land was vested in "a descent group and access was determined by social identity and status in the society". Certain conditions encouraged the individualisation of land rights such that private property rights developed alongside communal ones. It was, indeed, a common practice among many agricultural communities for a family or a kinship to consolidate exclusive cultivation rights in a " claim-free" holding if the family was the first to occupy it and invest labour in clearing the bush. Such claims were updated by continue use by the owners to avoid creating an impression of unoccupied holding (Berry, 1993; Migot-Adholla *et al.*, 1994). There was, thus, no necessary contradiction between notions of community rights and corporate and individual rights: the existence of one did not necessarily prelude that of the other (Mamdani, 1996).

Basically, in the customary tenure system, man-land relationship had always been specific to various land use functions, so that in a community, a number of rights could coexist with varying degrees of control and be exercised at different levels of the social organisation (Kanyinga, 2000). The result was a degree of equity in distribution of these rights among all members of the community (Okoth-Ogendo, 1976; 1991; Glazier, 1985; Migot-Adholla and Bruce (eds.), 1994). Those holding this position conclude that other factors besides land tenure have more influence on agricultural productivity and that attention should be shift to this, other which includes such variables as government policies, agricultural infrastructure, and the relations of production. Land use and politics, relations of access to land and agrarian accumulation, and struggles of access to land and their linkages to broader struggles to democratisation are also pertinent to land tenure change (Kanyinga, 2000).

The establishment of statutory land tenure reform based on market-centred approaches *per se*, as that swooped larger parts of Latin America and Asia can be disastrous to the Sub-Saharan African poorest agrarian sector (Wiebe and Meinzen-Dick, 1998). This is partly because of heterogeneity levels of agrarian reforms and diverse land access and holding inequalities that

persist in the sub-continent. Additionally Meinzen-Dick *et al.* (1997) argues that well-documented examples of statutory land tenure arrangements involving market transactions that accommodate multiple uses and users are scarcely available in developing countries, hence such lessons have not yet been brought to attention. Wiebe and Meinzen-Dick (1998) ascertain that emergence of land markets in developing countries sometimes concentrate property rights in individual owners, restricting rights held by other claimants under customary tenure systems. According to (Ojo, 1968) private land tenure makes land less fluid in the society. By neglecting livelihood and environmental externalities, this may undermine the objectives of sustainable development. For instance, if formalization of tenure arrangements involves enclosure of fields, forest and natural resources that restrict traditional access of local communities, then enormous upheavals become commonplaces. It is also terrible when statutory land tenure arrangement imposes environmental burden on neighbours or society at large.

In Kenya, the famous land tenure reforms of 1950s found that more marginalized peasant farmers or non-master farmers were the ones began to grow cash crops contrary to the expectations that this would be confined to the master farmers or the squirearchy that would emerge from evolution of land markets in the wake of the registration of land (Kanyinga, 2000). Nevertheless, the reform, as expected led to markedly skewed distribution of land. The chief, loyalists, and the wealthy acquired more land than others while others lost considerable amounts of land, especially if they did not participate in the adjudication of their land. The reform generated disputes rather than resolved them and it decreased people's security in land. The exercise itself was and continues to be open to abuse by those involved in defining the existing structure of rights.

One obvious premise for land expansion for instance is that idle, uncultivated land must be available to the farmer. However, land availability is influenced by social and cultural factors, which enable and constrain access to land. Most African societies operate with a notion of `first occupants' and their descendants who enjoy the right to use and allocate land, and the notion of `latecomers' or `strangers' and their descendants who depend on the benevolence of the first occupants to access land (Place *et al.*, 1994; Le Roy *et al.*, 1996). Consequently, when someone who is not a descendant of the first occupant accesses a piece of land, a transfer transaction takes place. This transfer is, on the one hand, essential to the flexibility of African indigenous land tenure systems and on the other hand it is a source of conflict due to its ambiguous nature, and finally, it is a potential cause for changing situations.

A third school within this broad perspective has been evolving in recent years and is inspired by second of these positions. The school-associated with Bruce (1986) and Plateau's

(1996) evolutionary theory of land rights-generally points out that land tenure systems can change on their own as a result of the increased commercialisation of agriculture and increasing population. What needs to be done, therefore, is to support these evolutionary trends rather than imposing them. This thinking argues that governments should intervene towards industrialization.

One may tentatively conclude, therefore, that tenure systems obtaining in sub-Saharan Africa cannot be simply blamed for the agrarian crisis ploughing many countries. Despite these findings, pressure is still being mounted on the countries of sub-Saharan Africa to pursue orthodox approaches to land tenure reforms. In the meantime, little attention is being paid to the socio-political consequences, including the disruption of social order, that accompany these reforms. Analyses continue to focus on the implications of the reforms for agricultural production and ignore the political process attending the land reform itself. These analyses ignore struggles around the control of land and their relation to changing tenure systems. Therefore, any changes to land tenure systems, and particularly in the structure of ownership, must be seen in the context of wholesale restructuring of the social formation and not just its agrarian system (Kanyinga, 2000).

Titling and individualizing of the land tenure becomes a hoax when regulations to landholding become homogeneous and uniform to the entire state or national code that inhabits multicultural bands. In reality however, the country or state is a collection of multiethnic groups with distinct codes to land tenure and landholding. Local land tenure system is perfectly legible to all who live within it. Its details may often be contested and far from satisfactory to all its practitioners, but it is completely familiar; local residents have no difficulty in grasping its subtleties and using its flexible provisions for their own purposes. Modern land tenure is mediated through the state and therefore readily decipherable only to those who have sufficient training and a grasp of the state statues. Its relative simplicity is lost on those who cannot break the code, just as relative clarity of customary tenure is lost on those who live outside the village (Scott, 1998).

Of fundamental concern is that demands for the privatization of land ownership have not been accompanied by demands for the reforms of agrarian structures and the conditions under which production takes place. The debate has not fully acknowledged that the reforms in land tenure systems is not about issues of production only; it is also about socio-political relations and the organisation of society, and touches virtually all structures of a given social formation. The land tenure systems do not consist of a single issue but several issues, each of which has other separate aspects and dimensions. It includes aspects such as land use and agrarian production; population growth/movements and changing settlement patterns; agrarian accumulation and class formation; ethno-regional identities; and peasant politics/social movements. These different

aspects have additional dimensions anchored in continually changing social, political, ecological and economic structures. Thus reforms in land tenure systems cannot be reduced to single issue and solution. Nor are reform of land tenure and its relation to agricultural production and/or land use by any means the only important component.

More specifically, the studies by Astowood, Barrows and Roth, Migot *et al.* and recently by Bogedain and Kirk (Elsevier, 1996) point out that land tenure is not synonymous with insecurity of cultivators. That is, the agricultural methods employed and yields per hectare obtained do not depend on the form of property or usage rights on the plot considered. In other words land titling does not necessarily improve the performance of the agricultural sector. In a subsistence setting, the production could not be controlled by a surveyor, rather is expressed in an immerse variety of local measures whose equivalency could not always be established. About 86% of landholdings in the sub-Saharan Africa are held by virtue of hereditary family (not individual) possession. Yet, no insecurity prevails regarding this land, since these property rights, even if does prevail in informal nature, are known and respected (Elsevier, 1996). It is possible that land tenure in such a situation is inherently not insecure and the cases of precarious land rights are quite rare, provided that there is no government or political intervention. Land insecurity arises most often when external action does not sufficiently respect local systems of land management.

In fact the management of land rights in parts of Africa is continuously facing change. Tenure regimes change and adapt to circumstances and people jockey for position according to their perception of the circumstances and in anticipation of the future (Place *et al.*, 1994). Up until now, virtually enormous transactions have followed a verbal agreement, yet recently some farmers in the African region have begun to register these transactions in writing. More statutory established rights might thus increasingly influence the pattern of land use changes. As opposed to the current situation where labour availability, social relations and distance to the land seem to be the main constraints on land expansion, tenure rights may in a near future become a major determinant for land use trajectories. Given the decimal level of investment in agriculture, it follows that agricultural practices in contemporary sub-Saharan Africa do not vary significantly as a function of land rights. Land productivity thus depends on factors other than property rights, mainly the natural fertility and climatic conditions (environmental determinism). Thus, formal/statutory land rights need to be carefully addressed before the society and its implementation should largely depend on underlying local conditions.

Local practices on customary landholding systems centre on myth that *the capital has its order, the village its customs* (Javanese proverbs quoted by Scott, 1998). Customs embedded on

indigenous land tenure are better understood as a living, negotiated tissue of practices, which are continually being adapted to new ecological and social circumstances-including of course, power relations. Customary systems of land tenure should however not be romanticized; they are usually subject to inequalities based on gender, status, and lineage. But because they are strongly local, particular, and adaptable, their plasticity can be the source of micro-adjustments that lead to shifts in prevailing practice.

3.4 Historical Land use change in the Matengo highlands

Throughout their history, the highlands of East Africa have been densely populated compared with the surround regions (Messerli and Hurni, 1990). Many of these mountains have been central premises of attractions used as sanctuary for population that were exposed to external political/military pressure (Bencherifa, 1990); cultural and historical centres of mankind (Ives and Wolde-Mariam, 1990) and increasingly important for providing natural resources for rapidly growing population (Messerli and Hurni, 1990). These highlands offer a multitude of habitats, most of which have long been filled by different economic adaptations-agriculture, pastoralism and/or mixes of the two (Kates, *et al.*, 1993). Anthropological and geographical studies reveal that most parts of mountain habitats have favourable environmental conditions and greater resource potential such as combination of rainfall, soil, or pest/disease absence that offers less resistance to occupation than do the surrounding lowlands, although exceptions exist (Lewis and Berry, 1988).

According to Messerli and Hurni (1990) the people inhabiting these highlands have so far demonstrated greater efficiency in adapting the utilisation of these rugged environments. Turnell II *et al.* (1993) described such major innovations as not uncommon in such difficult sites that could not have managed sustainably without them. They further urged that wetlands and steep lands can both be used without innovations, and so can difficult soils, but their continued productivity cannot often be achieved without some forms of physical transformations. There are a few hill slopes that can be worked for long period without loss of soil, unless there is some form of slope protection.

Underlying this perspective is a focus upon the Matengo highlands whose people reflect skilfully on ongoing process by receiving or devising more intensive agricultural land use systems to cope with diverse exigencies. The following sections reveal that evolution of agricultural land use change is not entirely dependent to population density rather socio-ecological, political and economic circumstances surrounding the indigenous farming system. Such appraisal could be best fit with Knight (1974) contention that within society alternative skills and technologies are evaluated by cognate process; contained by social and political systems; and eventually become

incorporated as part of the ongoing cultural package of cognition and behaviour with respect to the environment.

Certainly, much of the studies on land use change in the mountains are related to dramatic population pressure. Nevertheless, Bedele (1990) argues that land use in African mountains is never static to population pressure or uniform. It changes with time and space responding to number of factors, paramount among which are historical background, culture and the need of the people. And because we study changes we are concerned with the history of change in agricultural land use, society and the environment. Although many have tried to study changes, conclusions about change cannot be established without studying history (Brookfield, 1996). Thus studying land use change of the Matengo in diachronic perspective was given priority in this study. The following sections will therefore examine some of the land use systems in the Matengo highlands and have been changing over period of time.

3.4.1 Slash-and-burn agriculture

Shifting cultivation remains a highly successful means of environmental interaction throughout Su-Saharan Africa (Schneider, 1981) where it forms the economic basis for many societies in the southern continent (Vogel, 1989). Despite the fact that the archaeology of this land use is only recent being detailed investigated (Jones, 1984; Sutton, 1986, 1989), it is already evident that its relationship with man in Africa has been long and fruitful (Schneider, 1981; Phillipson, 1985). In practice shifting cultivation is a particularly flexible mode of production, and the continent's farmers have exploited its ability to suit a diversity of environmental situations and many different kinds of social enterprise (Vogel, 1989).

In particular, the methods of slash-and-burn cultivation sustain environmental transfer on the weak leached woodland savannah soils, which are characteristic of much of the subcontinent (Allan, 1965). As a consequence, it played a vital role in the establishment of future farming systems. These low-cost and limited production economies were nevertheless required to intensify work effort and increase energy subsidies in the form of labour in order to sustain a viable household subsistence. Shifting cultivators dependent upon the organisation of socially mediated ecological networks ensuring material flows and obligated services as much as they did on knowledge of the environment and farming techniques (Vogel, 1989).

Indeed swiddening was common even in Europe and in the Scandinavia into the 20th century (Clarke, 1947; Davies, 1952; Mead, 1953 and Montelius, 1953). Historical studies indicate that shifting cultivation has been an early method of agricultural production in virtually all forested

areas of the world when subsistence production supported a relatively sparse population (Knight, 1974). It was equally common in colonial America where early settlers, in response to plentiful land resources, reverted to traditional American Indian techniques of slash and burn (Carrier, 1923; Gras, 1925; Sauer 1941; Waibel, 1950; Knight, 1974).

Swiddening pattern of land use according to Harris (1972) and Smith (1972) creates thinly settled regions of widely spaced settlements amidst tracts of open land left fallow. When field-use is under full effect, pioneer of slash-and-burn require a periodic abandonment of established territories and reallocation of new fields in primary forest (Vogel, 1989). The status of land ownership and authority to land should be weak to non-existence in such circumstances. With changing socio-ecological and political circumstances this systems adjusts itself to another course to maintain stable and sustained yield. The transformation from a pioneering slash-and-burn ecosystem to residentially stable cyclical swiddening displays socially arranged adaptation (Vogel, 1989).

According to the Matengo's traditions, the people lived in the highlands prior to the establishment of *ngolo* farming system had conducted an extensive slash-and-burn cultivation with minimum cultivation locally known as *liande*. The system followed ordinary principles of shifting cultivation (JICA, 1998). Other systems, which were tried, were such as flat and ridge cultivation. In the Matengo highlands slash-and- burn system of cultivation has been a common practice for finger millet (*Eleucine coracana*) production. The practice is now mainly found in the southern rolling hills where miombo woodlands still prevail. It is impossible to carry it in the mountain area due to lack of virgin forest to burn (Fig. 12).

In the history of Matengo agriculture, swiddening has been practiced in different ecological conditions. In the virgin *Miombo* woodland (*kigona*) trees are felled, cut randomly and burnt in piles. Un-burnt areas are hoed also for finger millet planting, and to a lesser extent for maize, pumpkin, sunflower and sesame. This field preparation method is popularly known as *matema* and the field as *kikuyu* in Matengo argot.

According to Willis (1966), Birch-Thomsen (1993) and JICA (1998), the *matema* system of southern Tanzania appears similar to *chitemene* practiced in northern Zambia and *ntemele* practiced in Rukwa in western Tanzania (Lyimo and Kangalawe, 1997). Other environmental conditions where swiddening took place include the areas of long fallow areas with less vegetative cover (*lipusa*) and in grassy vegetation due to short fallow (*kulazwa*). In such areas grasses and bushes are cut and collected into heaps (*matutila*) or large connected heaps (*mandanda*) and burnt. Un-burnt area is also hoed for finger millet and other trivial crops.

Fig. 12. Swiddening (*matema*) in rolling hills of Matengo highlands

Heavy works in *matema* such as (felling trees and ploughing) is done during harvest time when food is plentiful. Men cut trees during the early dry season and then burn them at the end of the season. In the rainy season, seeds of finger millet (*Eleusine corocana*) are broadcasted on the flat field without ridging and then the full-matured panicles are harvested in the next dry season. In shifting cultivation of east Africa, farmers generally call a maiden field a particular name and distinguish it from other fields. In swiddening cultivation system of Matengo the first year field is called *kikuyu* and after second year the field is known as *lupeto*. The present slash-and-burn cultivation is only a transitional and temporary system for the Matengo, and it is only a way of opening up woodlands mainly for *ngolo* cultivation.

The importance of slash-and-burn agriculture centres on the merits of farmers to maximize productivity resulting from improved finger millet growth due to nutrient derived from ash and radiant ability of the system to adapt to the environment. Experiment by JICA (1998) in rolling hills of Matengo highlands confirmed that under strong influence of ash, pH values of surface soils reached over 8, which according to EUROCONSULT (1989), Landon (1991) and Baize (1993) could be classified as moderately to strongly alkaline. Same study also found a close relationship between increase in soil pH and the amount of extractable calcium (Ca) and potassium (K) due to addition of ash. Other soil attributes influenced by ash were extractable phosphorus oxide (P_2O5) levels, ammonium ion (NH_4^+) and dinitrogen trioxide (NO_3-N). Improvement of these soil aspects also influences the crop performance. However, with increasing population, ailing demand for

finger millet and overall changes in socio-economic conditions in the district, the speed of deforestation seemingly escalates than usual (JICA, 1998).

The establishment of *ngolo* changed remarkably the Matengo life style as well as their agricultural land use systems. Presently, the western parts of the highlands that historically were political and economic centre of *ngolo*. Entirely, the 'westerners' do not at present conduct slash-and- burn cultivation due to a thorough exploitation of natural vegetation in the past time. However, in the rolling hills (in the eastern and southern parts) of the district are still covered with the dominant miombo vegetation. In this area slash-and-burn system strives along with *ngolo* as it lays ecological preconditions for the *ngolo* establishment. Thus present slash-and- burn cultivation could largely be viewed as a transitional and temporary system for the Matengo to opening up woodland for *ngolo* cultivation.

3.4.2 *Ngolo* cultivation system

The history of the Matengo elucidates that the drain upon the scanty soil resources available to the Matengo highlands might have been severe. The Matengo had to feed themselves as well as supply the satisfactory amount of food for the raiders. The problems of how to maintain fertility, and how to prevent erosion on the steeply sloping land available had to be tacked. The system evolved to meet these problems is probably unique, and will be best understood if a description is given of how the work is undertaken.

The Matengo have been noted for the intensive cultivation of the steep mountain slopes of their homeland. They have established unique farming system for soil conservation in the mountainous land where soil erosion is of constant concern (JICA, 1998). Basehart (1973) stressed that their intensive cultivation involves alternative forms of cultivation and not the combination of intensive and shifting agriculture as reported for Lugbara by Nadel (1947) and Middleton (1965). *Ngolo* farming practice has evolved among the Matengo over 100 years ago (JICA, 1998) though some researchers consider the system to have evolved over 200 years ago (Temu and Bisanda, 1994). Literature on pit cultivation started to appear when German rule reached the Matengo area in about 1890's (JICA, 1998).

Ngolo literally mean a pit surrounded by four-tied ridges and the pit act as a reservoir (rain water harvest technique) by intercepting and prevent destructive effect of surface runoff in the cultivated steep slopes (Mattee *et al.*, 1996). Although analogous procedures, termed "basin listing" or "tie-ridging" have been reported elsewhere, but according to Basehart (1973), the Matengo practice of cultivating entire hillsides is unique. *Ngolo* is also appraised by its ability to

soil moisture conservation and fertility maintenance. As well, Lyimo and Kangalawe (1997) configure that this soil conserving cultivation practice was initiated as a response of people to intense rainfall (1500-1700 mm per annum) that was experienced during those years. Such rainfall was destructive on crops that were planted on steep slopes under flat cultivation (*sesa*). Future integrated archaeological studies could solve the puzzle of exact time of *ngolo* establishment.

Prior to *ngolo* establishment, the Matengo cultivators used to make furrows or diversion ditches in the upper slopes of cultivated fields to divert surface runoff away from flat-cultivated fields down-slope (MOA, 1983). Logs and twigs of trees reinforced the furrows or ditches. With time these ditches were no longer adequate to control huge volumes of runoff and associated soil erosion. At this time the Matengo had to evolve other best options to conserve their land, hence *ngolo* became into being.

It deemed possible that well before 1700s the *ngolo* cultivation system involved great deal of digging pits randomly using digging sticks. Early pits were not arranged in squares as the contemporary ones (Lyimo and Kangalawe, 1997). These early pits are acknowledged in controlling soil erosion as well as conserving soil moisture. Nevertheless soil fertility conservation was difficultly maintained due to non-incorporation of grasses during *ngolo* making. MOA (1983) estimates the possibility that the present-day type of *ngolo* could possibly been developed between 1700 and 1750. It is said that during this time farmers realised that in places where soil from the pits that was piled over grassy vegetation produced more crops-indicating improved soil fertility than where no grass was heaped and buried underneath.

Such experiences propelled the changes in the original form of *ngolo* to the present one where grassy vegetation is deliberately laid down in the field and covered by soil for soil fertility maintenance through composting. Intense and extended rains also seemed to play a profound role in *ngolo* dynamics. Because of intense rains farmers could not burn all the grass during field preparation, hence extra grass had to be buried. This provoked the quest to design a way in which after slashing, the grass would be laid down into a certain pattern (*kubonga*) and later covered by soil (*kujalila* and *kukulila*). The arrangement of grass that evolved followed a grid system, forming a series of squares (Fig. 13). Similarly, the influence of Pangwa ironsmiths in introducing iron tools such as hand hoe improved the structure of *ngolo* we observe today (Kapinga, 1972).

In essence the evolution of *ngolo* system of cultivation is related to the process of the Matengo ethnic group formation (Kato, 2001). As stated earlier, the Matengo are hill people and about two hundred and two hundred and fifty years ago, they seem to have lived unmolested and followed the ordinary methods of slash-and-burn cultivation (Allan, 1965). Then came the raiding

period by the Ngoni of the west and north and the *Yao* slave traders of the south and both ravaged the country. The incursions by Ngoni pushed the Matengo into restricted mountain natural caves and steep slopes where they could defend themselves, or became inaccessible by the invaders (Stenhouse, 1944). The people thus were forced into concentration in restricted natural caves and steep slopes where some measures of protection existed. Two ideal sanctuary places were at hand; the large caves and hillsides at Litembo and Langiro but as the country around Langiro was infertile, the main concentration was thus at Litembo (Schmied, 1989). Litembo is therefore considered to be the "centre of diversity of the *ngolo* system" (JICA, 1998). Here was rather narrow fertile valley close to the caves. At this time the Matengo could never move far away from their refuge in fear of the nuisance from Ngoni and *Yao* (Allan, 1965). The system was thus invented as a method of survival on the steep hillsides and probably as a strategy to ensure that fertile soils were not exported to their archenemy Ngoni cultivating the foothills.

Under such circumstances, survival was possible only by a fundamental innovation in land use system (Schmied, 1989). So every available inch of the valley bottom had to be cultivated and kept in cultivation almost indefinitely (Pike, 1938). In a wake of increasing land shortage, with no option but to cultivate the steepest slopes or starve, with no cattle to provide manure, the Matengo evolved an admirable system of agriculture. The system that includes crop rotation, maintenance of fertility by composting grass, weeds, and crop refuse, systematic use of grass fallow, and highly effective devise for protection of the land against erosion (Allan, 1965). Thus the steepest hillsides were taken under cultivation and kept in a cross-ridge system-the so-called *ngolo*-literally translated as "pit" in Matengo lingua (Schmied, 1989). Describing the spectacular land use in Matengo highlands, Stenhouse (1944) paints that this hillside cultivation is of very striking appearance, showing an orderly layout, with straight-cut edges, and the surface of the fields curiously pitted. The impression gathers force that this cannot be native cultivation; but it is. It is the Matengo pit system of cultivation.

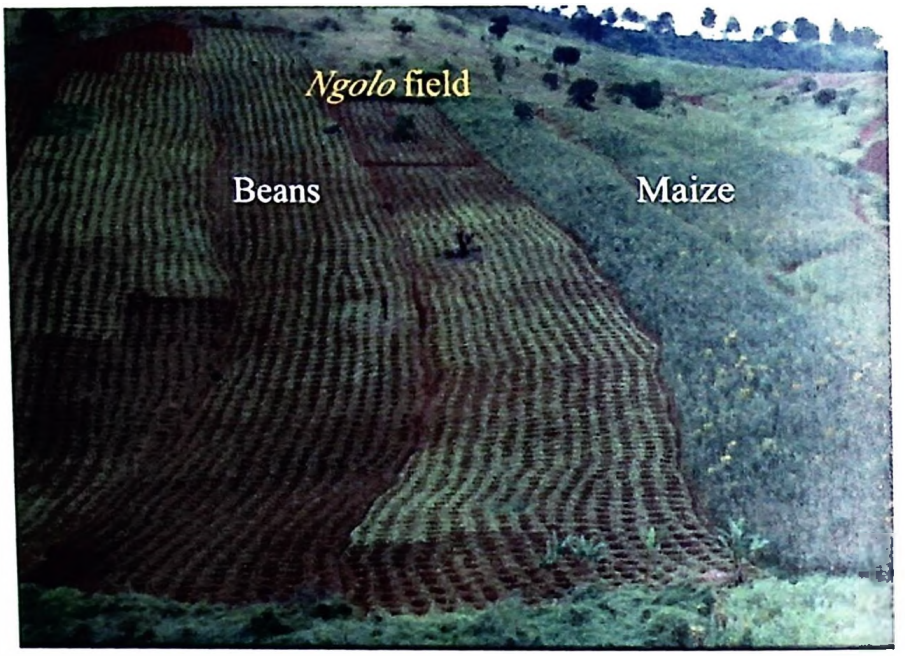


Fig. 13. Present arrangement of *ngolo* field showing crop rotation in the Matengo highlands

Pike (1953) pointed that these industrious cultivators have evolved a system with a technique both methodical and simple by which they can cultivate incredibly steep hillsides and yet erosion is almost non-existence. The underlying principle of the system is if a large volume of down pour can be broken into sufficiently small parts, it is controllable and accordingly as the rate of flow of each of these parts is reduced, erosion is eliminated. The final point is reached when the water can be kept standing a sufficiently long time then it will sink into the ground gradually and instead of erosion there will be a conservation of the water, a most pleasing end. When carried out with care the Matengo pit system gains this desirable benefit.

As an accompanying protection method, the Matengo deliberately left some of their cultivated fields to the periodical raiding by the Ngoni (Schmied, 1989). Foodstuffs were made readily available to the Ngoni persecutors in the most accessible and fertile valley-bottoms. So long as these valley bottom supplies lasted, the less accessible hill cultivators were left alone. Thus, Matengo land users were compelled to cultivate so energetically approximately twice the area of crops than needed for their own use (Oliver and Boyd, 1965) and still does on the same manner to date. Half of this crop was expected to lose to the raiders, and the remaining half retained for own use (Stenhouse, 1944). The women laboured most in *ngolo* fields as men largely kept guard for their women and territory. As harvesting was always a rushed job when danger was generally near, men had to work as well and thus the division of labour arose, which exists to this day. Largely up

to now the Matengo women still does hoeing alone but the men may help at the harvesting and immediate work and it is still remaining that women form the hub of household food supply.

This system can be classified as a grassland fallow farming system, although the cropping is repeated for many years without fallow (JICA, 1998). The Matengo pit (*ngolo*) is simple and almost foolproof; no instruments of modern science were ever employed; only a billhook to cut the grass and the usual African hand hoe are used. *Ngolo* cultivation starts in mid-February to mid-March (Table 7) with slashing of grass (*kukesa*) as close to the ground as possible. The grass shoots are left to dry for about a week or two before arranged into square grids (*kubonga*) of roughly 1.5-2.0m and the shoot bundles forming lines are known as *mabongi* (Figs. 14 and 15).

Farmers' indigenous knowledge on this practice is that if non-dried shoots are buried into the ridges, the beans could not germinate due to exothermic of green manure applied as fertilizer to the field. However, JICA (1998) configured that germination of beans could probably be hampered by heat from a toxic organic acid produced from green manure. Correspondingly in Asia, paddy fields are customarily left for a week after ploughing green manure in and then irrigated for the purpose of removing such toxic substances. Since bean seeds in *ngolo* are sown just after burying the cut shoots into the ridges, the substances toxic to germination must be removed prior burying.

Extra shoots are heaped up elsewhere in the field and usually set on fire at the end of rainy season for planting finger millet (*Eleusine corocana*) or pumpkin (*cucurbita* ssp.). The grids are made with one set of rows across the slope, roughly following the contour and the other running up and down the slope at right angles to the first. Normally adult men do these preliminary preparations. Later from mid-March to April women succeed men for later stages.

Ngolo cultivation system involves distinct gender labour roles. Women largely do subsequent works, as it was historically the duty of the men to stand guard against the invaders once the grass had been cut. The topsoil in the squares/grids enclosed by grass rows is dug out using hand hoe (slicing style) and pullet on top of the laid grass. The cultivator works a round each square I turn, first facing the downhill to pull the soil up over the row of grass (*mabongi*) forming the top of the square. Then she stands astride the slope to cover the vertical row, and then facing uphill to pull the soil over the lower low. This prevents denudation of hilltops (Pike, 1938). Only a handful amount of soil is used at this stage to making half-finished *ngolo* (*kujalila*). Thereafter a woman sows bean seeds in a broadcasting way (*ku-lekelela ngondi*) on *ngolo* seedbed.

Fig. 14. Making square matrices in *ngolo* (*kubonga*)-upper and completed *ngolo field* (chessboard-like)-below

In the final stage a woman standing in the square skilfully digs up the surface soil around her feet pushing it to the surrounding ridges using a hoe, i.e., she refills the grid with another soil to cover up the seeds (*kukulila*). This allows the centre of the square to form clearly defined square matrices of honey comb-like-structure. In this way the cut grass and all the original vegetation on the site are buried under large banks of dark brown rich in organic matter topsoil leaving a pit of some 0.5-1.0 m deep in the centre of each square with subsoil exposed at the bottom of the pit.

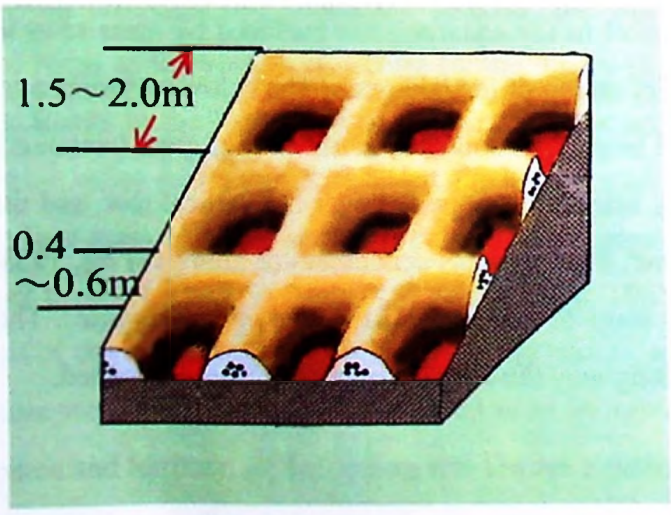


Fig. 15. A profile of *ngolo* ridges (After Itani, 1998:61)

During digging the woman stops as subsoil appears. Much of work is required to be completed within a day because torrential downpours could easily remove the soils covered by *mabongi* and bean seeds even in this season.

The ultimate result is a series of pits each one separated from the next by a bed on which the crops were/are planted. From a distant the crossing rows of grass with the squares of soil in between give what Stenhouse (1944) described to as a "chessboard" effect. Other important subsistence crops, which are planted in the soil beds around the pit, are such as maize, wheat, sunflower and cassava. Naturally nothing is planted in the pit itself, which generally reaches the subsoil.

Table 5. Farm activities in *ngolo* field for bean-maize rotation

Year/month	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
1st Year	Short-term fallow											
2nd Year										Short-term fallow		

Source: *Farmers' experience*

1st Year Calendar
Mid Feb-Mid March: *Slashing and drying of grass*
Mid March-End April: *Ngolo making and sowing of beans*
June-July: *Harvesting of beans*
End Nov-Dec: *Repairing ngolo ridges & planting maize*

2nd Year Calendar
Mid Feb-Mid March: *Weeding of maize*
July-Aug: *Maize harvesting*

Ngolo field that has been properly cultivated in this manner can withstand the heaviest downpour experienced in these highlands and no signs of erosion can be seen (Pike, 1938). The water may stand for considerable time in the pit according to the nature of the soil but eventually it soaks away. Clean weeding is the rule and during the year, if at any time the field is cleaned, the weeds, crop residues, grass and silt are thrown into the pits to rot, thus forming valuable compost for the following year. It also seems that the Matengo know the importance of timing their farming system calendar, they begin making *ngolo* when frequent and intense rains have subsided. Despite the fact that the *ngolo* farms are privately owned but its overall cultivation involves co-operative work (*ngokela* and/or *chama*) and recently hired labour. *Ngokela* is stimulated by the prospect of the traditional beer party and special food is made-normally chicken or goat and recently pig could

be slaughtered or beef or pork could be supplied. Provision of such a party or feast is optional for reciprocal labour *chama*.

In the next year of revitalizing new *ngolo* the whole process is reversed and what was a pit now becomes a ridge and vice versa. Thus, the old soil beds are split and the new beds are formed over the old pits. The new pits occupy the place where the old beds intersected. Matengo says that with favourable and proper succession of crops and fields, this cultivation/rotation method or style may go on for periods as long as ten years before the fertility begins to fail and the field is allowed to revert to natural grass fallow. Even when the field is lying fallow, the old ridges and pits still function to prevent the surface water from rushing down the hillside, instead of which it sinks into the ground (Allan, 1965). This might be the reason why little streams are found starting so high up the hills and why these little streams do not fail even at the end of the dry season. It may also be the reason so few wash ways occurs on the roads in the Matengo highlands (Pike, 1938).

The rotation adopted is the simple one of alternating leguminous crops mainly beans (*Phaseolus vulgaris* L.) or wheat planted in the first year and grain crop maize (*Zea mays* L.) in the following year. This alteration is absolutely regular and is carried on until the soil requires time to be fallowed. The fallowed fields simply revert to natural grass. Crop rotation in *ngolo* follows that during early rain season (December to February); the *ngolo* fields are left without cultivating until March. The fields in early rain season are allowed to grow with weed species mainly *malumba* (*Conzya sumatrensis* and *Nidorella resedifolia*) that indicates soil fertility and *masilu* (*Pteridium* sp.), which generally indicates infertile soil. Beans are planted in March/April and harvested in June or July and *ngolo* fields are left to rest until November/December of the same year, depending on the onset of rains. In November/December farmers don't make new *ngolo*, rather they remove a few grown grasses and make micro-ridges (*kutemea*) on existing seedbed for planting maize. This time men and women work together. Maize is harvested in July-September of the following year and *ngolo* fields are left in short-term fallow until February-March of next year for new *ngolo* cultivation. It takes about two years to cultivate new *ngolo*, thus, *ngolo* characterises itself as a semi-permanent cultivation. While this agricultural system is properly described as "intensive" it should be noted that fields are not in continuous yearly cultivation. Commonly, a field is rested for seven months to a year after a crop rotation cycle.

Thus, throughout the dry season *ngolo* field is laid fallow until the beginning of the rain season when it is planted with maize on the ridges where beans had previously been grown. The maize seeds are sown along the contour lines. Space between plants in *ngolo* is narrower than one in a conventional ridge, possibly because the light competition among maize plants in *ngolo* field

is not a serious problem due to slope effect and available open pit space (JICA, 1998). Because *ngolo*-farming system is repeated in a two-year-cycle and due to the fact that maize and beans are main food crops for the Matengo, they need to own at least two fields for rotations.

Land husbandry such as crop rotation, fallowing, returning of all weeds and crop residues in the soil form good agricultural practice (Stenhouse, 1944). According to Kato (2001) the accumulation of humus and the process of changing *ngolo* position led to mixing of the top and sub-soil soils as well as the grasses and hence this process matures the soil. In this course soil fertility has been retained and built up. The pit system of cultivation (a system of box-ridging) is also effective in checking erosion. It is wonderful that such hill slopes so steep that is difficult to ascend without using one's hands, are under cultivation by simple techniques and by remote farmers and yet there is no erosion (Stenhouse, 1944).

It can be deduced from this discourse that the paying of food tribute to the Ngoni may have been imposed on the Matengo but on the other hand the Matengo may have evolved it for their protection. And the pit system evolved on the wake of lack of land for cultivation and the need to protect the slopes from intense rains. This lack of land was accentuated to some extent by the need to provide tribute in the form of food crops for their Ngoni persecutors; the imposition that compelled the Matengo to cultivate approximately twice the area of crops required and for their own use (Oliver and Boyd, 1965). The importance of valley-bottom during needy times has never been forgotten even by contemporary Matengo society. For instance, during the events of hunger and starvation recorded in recent decades fairly due to extreme weather condition and falling soil fertility in upland fields again drove the Matengo to their common saviour; the valley-bottom gardens.

The preceding situation shows that the problem of survival in such steep country, and in such restricted settlements must have been acute; the Matengo proved equal to it. Not only did they evolve a system, which gave them a degree of immunity from the most destructive raids, but also they evolved a system of agriculture that enabled them to keep their restricted land under constant cultivation and conserve the soil on the steepest hillsides (Stenhouse, 1944). Here the morale to land use change can be viewed as accelerated by the cultural-political situation (raids) prevailed at that time. This situation also raised the gender division of labour that we observe in contemporary Matengo society too. The environment (steep slopes, intense rains and thin fertile valley bottoms) also was the prerequisite to land use intensification. These scenarios partly exemplify the flexibility and adjustments to restricted choices by rural African communities. *Ngolo* as an indigenous tillage system was thus born as necessity to certain areas of strategic

importance, to the ethnic group had to be kept in cultivation, producing their maximum harvest almost indefinitely, if the ethnic group were to survive (Pike, 1938).

As it has been always, although significant, priorities in land use changes at the micro-level related to women's farming activities are forgotten. The Matengo women deserve a keynote in understanding the process of *ngolo* formation. They are the ideal experts in this farming system and the society has crowned a socio-cultural index to their expertise. Perfect *ngolo* making skills among unmarried women draws a crucial role of recognition and holds the key to their future marital prospects. Consequently, the *ngolo* cultivation system has largely been maintained by the common recognition of women's labour and integrity (Kato, 2001).

About 1890 when the Germans first reached the Matengo country they found a huge concentration of the tribe at Litembo, all practicing *ngolo* method of cultivation (Stenhouse, 1944). The strong population concentration around Litembo dissolved only towards the end of Germany rule and the beginning of the British colonial period (Schmied, 1989). JICA (1998) postulates that the spread of *ngolo* to all over the Matengo highlands was necessitated by the cease-fire under the Germany rule in the area. After Matengo moved out from Litembo concentration carves, *ngolo* still continued to spread even in those sparsely populated areas or new areas of immigration. This shows clearly that intensification of land use is not always influenced by population pressure as largely reported by Esther Boserup (1965) and Netting (1969). Expansion of *ngolo* cultivation systems to sparsely populated areas can be assumed because of its well attachment in the socio-cultural context of Matengo livelihood. *Ngolo* is their marvel of life and success, their integrity and potential proud of their history; it is their legendry that they cannot easily abandon. Possibly without *ngolo*, the life in these hillsides could today be unspeakable.

Pingali *et al.* (1987) asserted that many factors influence the concentration of population. These have ranged from ethnic conflicts and slave trades, to land use policies and transport infrastructures. For this matter even the connotation by Stenhouse (1944) echoed by Boyd and Oliver (1965), Basehart (1973), Temu and Bisanda (1994) on the movement of Matengo to less populated outward areas as coupled with adoption of lazier methods of cultivation can not pass without a close scrutiny.

Kato (2001) commented that the Boserup theory of land intensification does not ubiquitously fit into this local environment. It seems that Stenhouse (1944), Boyd and Oliver (1965), Basehart (1973), Temu and Bisanda (1994) looked on the existence of extensive agricultural practices along with *ngolo* in sparsely populated areas with a squint eye. It is possibly that these researchers did not observe the entire process of *ngolo* establishment. This is possibly

due to less time they spent studying this unique farming system. Turnell II *et al.* (1993) described such situations as common and they mostly lead to little recognition and misinterpretation of farmers' experiments by external observers. They further pointed out that most external agents remain in a farming region only from hours to, at most, very short periods of years. Yet changes in farming system take place across periods of decades that the amount of largely spontaneous changes can clearly be seen.

It is possible that when less time in spent to analysing Matengo land use system one can real find development of extensive agricultural practices going on in newly settled areas. Lyimo and Kangalawe (1997) found in Mpepai that only a few people were cultivating *ngolo* and non-in Kindimba Juu though one Matengo tried and later abandoned it. They postulated this situation as due to dominance of Ngoni and *Pangwa* immigrants who are not *ngolo* cultivators by tradition and they came with their own cultivation methods, mainly flat and ridge cultivation. Another reason could be due to flat terrain orientation, which makes *ngolo* practice less vital. In such areas ridge cultivation for cassava is mainly used where the soil or vegetation indicators cast a doubt on the outcome of the major staple food crops maize and bean.

In fact in new fallow land or woodland, *ngolo* making is not an instant activity, it is preceded by common extensive slash-and-burn and ridge making cultivation systems and it takes some years to start making *ngolo*. Kato (2001) found the practise of extensive agriculture along with *ngolo* is not adoption of lazier methods rather a transition to establishment on *ngolo* fields. Farmers undertake extensive practices to soften the soil and to increase organic matter, thus, adequate pre-conditions for *ngolo* cultivation can be prepared throughout the period of this extensive practices.

It is thus logical to demonstrate that the Matengo have evolved a system of agriculture adapted to their particular environment. It survived the ethnic unit in a very constrained environment, so the system must have been so effective in all times (JICA, 1998; Kato, 2001). These pits conserve soil and water, while the buried weeds mature the soil (Allan, 1965; Basehart, 1973; JICA, 1998; Kato, 2001). Pits work as rain water-harvesting structure to protect the crops against water stress after cessation of rains. Kato (2001) dealt with special attention the question of soil maturing in *ngolo* cultivation. He ascribes that basically the soil of Mbinga consists of clayey red soil known as *luhumbi lukeli* in Matengo idiom. Its common that *ngolo* making process involve mixing of *luhumbi lukeli* with arranged grass layers (*mabongi*), which later result into formation of dark soil rich in organic matter locally known as *luhumbi lujilo*. Formation of *luhumbi lujilo*, which provides favourable conditions for crop performance, is one of the

spectacular features that characterise *ngolo* cultivation system. In this way, the *ngolo* system can be characterised as a soil forming system.

3.4.2.1 Sustainability of the *ngolo* farming system

Agricultural sustainability is a bio-economic activity with complex implications related to physiochemical, biological, technological, managerial and socio-economic elements. These elements interact in such a way as to determine the location-specific adaptations of various farming systems to different locations, thereby satisfying objectives with minimum adverse consequences (Akigbo, 1990).

Several physical, chemical, biological and socio-economic hindrances affect the agricultural land use in various agro-ecological zones of Africa. Some climatic constraints include unreliable rainfall, unpredictable periods of droughts, and floods. Soils are constrained by high degree of weathering, rapid rates of organic matter decomposition, and high levels of soil acidity and high tendencies for phosphorous fixation (Akigbo, 1990). Biologically is affected by unimproved crops and farm animals with low yields, susceptibility to pests and disease and weeds. Parasitic diseases affect both people and livestock ability to contribute to agricultural land use development. Human activities have to a greater extent modified ecological equilibrium and environmental quality. Socio-economic constrictions include unfavourable land tenure systems often resulting to fragmentation of holdings, shortage of labour at peak periods, low income and lack of credit. Others include poor marketing facilities and pricing structures, poor extension services, poor rural infrastructures and inappropriate agricultural development policies and various political constraints.

The sustainability and future prospects of *ngolo* system relies heavily on its multi-functional in controlling soil erosion, maintenance of soil fertility through composting and moisture conservation by trapping rain water into the pits where it stays for longer periods of time (Lyimo and Kangalawe, 1997). Alike, sustainability of *ngolo* is vested upon the local people's perception on the importance of the system JICA (1998). Owing to immerse merits of *ngolo* farming practice the majority of farmers in the Matengo highlands would continue with pit cultivation as a means of survival for many years to come. They cannot risk losing their fertile soil through erosion to the valley bottoms. They have a thorough knowledge of the multifunctional nature of *ngolo* cultivation system such as maintenance of soil fertility, erosion control and provision of underground system (Itani, 1998). The arrangement of *ngolo* ridges along and across slope intercepts runoff water. The pit temporarily traps moving rainwater and soil from ridges in

the upper part of the slope. Similarly, it facilitates the infiltration of the temporarily stored water into the soil hence; severe erosion is hardly seen on most slopes under the *ngolo* system. Farmers have the knowledge that these features as the ones that make this system environmentally sound and productively sustainable.

Likewise, the sustainability of *ngolo* is also best fitted to farmers' knowledge on their local environment. Usually local farmers are certainly very responsive to soil conditions, which they recognise according to colour, texture and type of weeds growing (Swindell and Iliya, 1989). This kind of environmental perception or the indigenous "scientific" knowledge of farming is also common among the Matengo as described by JICA (1998) and Kato (2001). Matengo farmers have variable agricultural calendars, which divide the year into seasons of varying farming activities in *ngolo* due to availability of various agricultural attributes (See Kato, 2001). They classify soils and vegetation according to their suitability and possible land use (JICA, 1998). However, farmers' methods of organising space and time, classifying soils, land–use potential, vegetation, and farming technology have received only limited analysis by researchers though worthy a far more attention (Richards, 1985).

3.4.2.2 Challenges facing *ngolo* farming system

3.4.2.2.1 The effect of environmental conditions

So far it would appear as if the *ngolo* system was a cure for many of the ills that Matengo highlands have suffered from erosion due to cultivation but it has doubtful features. The first and most doubtful of these features is that it is seldom employed where there is virgin bush as roots and stumps in the ground cause difficulties to *ngolo* making. Here the ordinary flat cultivation method of land preparation is undertaken for about the first two years or so with a result that much of the valuable topsoil is lost before conservation it started. Though maize, wheat, beans and native crops generally flourish but some crops seem to thrive in this system. Root crops seem to suffer from an excessive of moisture of *ngolo*, especially cassava. Sustainability of *ngolo* on the effects of December-February intense and erratic downpour during maize cultivation also needs to be exemplified.

Although Matengo are industrious and efficient cultivators, Basehart (1973) reports that a "hungry time" towards the end of the rainy season is not uncommon. There is as well, recognition of declining productivity in *ngolo* due to increasing pressure of population on land and perpetual plunge of soil fertility due to declined fallow periods especially in oldest villages where pit system predominated the production of hillside farms. Frequent bush fires and shortened fallow periods

due to continuous cropping has gripped the vigour of grass to grow that could offer enough buried shoots making natural soil nutrients composting difficult. Consequently, only a diminutive amount of grass is available for incorporation in the pits. Such a situation renders a serious imbalance to *ngolo* effectiveness.

3.4.2.2.2 The influence of land ownership and tenure

Land ownership and tenure in Matengo highlands is nearly emblematic from what can be seen in other parts of Tanzania. According to land legislations all land, whether occupied or not, belong to the Republic of Tanzania (Lyimo and Kangalawe, 1997). The maintenance and improvement of the quality of the land, however, depend crucially upon the land user, and often demands considerable investment of resources in, for example terracing or any other conservation manipulations.

In the Matengo highlands, most of the agricultural land is held under customary and rarely by communal system. Most of the land is owned on a family basis and inheritance patterns are patrilineal. In terms of land accessibility one can acquire land by virtue of being member of the family or purchase or lease/borrow from other individuals, though only under a very strict situation village government can allocate land to individuals mainly for conservation purposes.

Until recently *ngolo* farming system and perennial crop coffee had made the Matengo people resort to permanent tendencies of settlement with relative low mobility levels (Lyimo and Kangalawe, 1997; JICA, 1998). Their permanent settlements and perennial crop coffee once avoided them from the giant government resettlement policy of early 1970s. Thus, though their land is not titled still they managed to defend it before the state intervention. With time however average farm size and fragmentation of crop fields has heightened largely due to population pressure. The lack of extra opportunities for farm expansion might have necessitated the Matengo to put more value on land. This situation has motivated investment in land conservation techniques such as *ngolo* so as to wrest a livelihood from such miniature pieces of arable land. On the extreme case of land scarcity out migration becomes apparent in search for more land elsewhere. In such mobility phenomenon clear land ownership system seems vital to avoid possible land dispute in fragmented plots of farms or land that the farmers own.

3.4.2.2.3 Farm labour constraints

Like many other traditional intensive farming systems such as Fipa mounds, the upkeep of the Matengo pit system is very much determined by labour availability. The demand for labour

and labour supply or availability varies from one household to another and between seasons depending on the nature of activities falling on the farmer's cropping calendar (Lyimo and Kangalawe, 1997). Since making of *ngolo* is labour intensive there is labour competition especially when other labour demanding operations e.g. activities in coffee farms. Farming calendar in both *ngolo* and coffee signifying labour competition between the two farming systems as shown in their respective tables.

An added bottleneck in *ngolo* farming system especially in the mountain area is that the practice involves distinct gender roles (Rutatora and Sugimura, 1996; JICA, 1998). Men do the initial two stages of *ngolo* preparation and women perform the subsequent works though both men and women engage in planting of maize (*kutemea*) and weeding. In situations when any one of the spouses in a household is engaged to activities other than *ngolo* operations during the season, the errands related to *ngolo* are depressingly affected. Similarly economic crop coffee is being more and more planted in the area and this is generally the concern of the men alone and this leads to a decay of the *ngolo* system.

Regularly households do experience labour shortage during peak seasons. To curb labour constrain, households venture into different strategies such as preparation of local brew and inviting neighbours or relatives to work and drink beer on exchange of labour (*ngokela*) or hiring labour. Another reciprocal labour organisation in farm operations is known as *chama*. In *chama* farmers organise themselves in a group and work in members' field in turn and usually though not obligatory local beer and/or food is offered by the host member after work whereas it is compulsory for *ngokela* to provide food and/or beer. The use of hired labour (*kibarua*) at various stages of *ngolo* operations is also common. Casual labourers are blamed of being less intent in making good quality *ngolo*. This is possibly promoted by the fact that the pay is proportional to number of *ngolo* made. Here the pay to product labour is based on the quantity produced than the quality of ultimate product, hence carelessness and rushing to make as many *ngolo* as possible diminish the *ngolo* eminence. Usually an acre of *ngolo* contains 500-600 pits but with hired labour the number goes to 800-1000 due to making of small sized pits for more cash. Beside of being small in size, such *ngolo* also tend to be shallow in depth with less buried grass shoots. Such *ngolo* are possibly not effective to meet their primeval objective of soil and water conservation in rugged environment.

When labour squeeze is unprecedented, some households embark on the use of child labour in *ngolo* making without strict supervision (Lyimo and Kangalawe, 1997). ICRA (1991) observed regular supply of pupils in *ngolo* and coffee fields in the Matengo highlands. Due to lack of

experience the product of child labour corresponds to that of hired labour. It is of utmost important that child labour in *ngolo* should be done under companion of the elders. Similarly, with increased events of intermarriages to people of different ethnic backgrounds, the Matengo are bringing in inexperienced *ngolo* cultivators. In first years of their settling in these "alien" possibly perform "strange" *ngolo* with poor quality. This is because *ngolo* making, at least for now, is a special art mastered by the Matengo only (JICA, 1998).

3.4.2.2.4 Limited spread of *ngolo* system

Ngolo practice is ecologically most desired in the hilly landscape. However, the system has proved relatively difficult to be adapted elsewhere partly because of its high labour requirement and the complexity manoeuvre it requires. Above all sustaining *ngolo* cultivation system is more less a cultural artefact emended in Matengo livelihood of which its transferability requires very systematic procedures. Efforts to transfer *ngolo* were made to Zanzibar in 1970s (MOA, 1983) in Kenya in 1980s (Mututho, 1989; Gichangi *et al.* 1989, 1992), Northern Tanzania (Allan, 1965) and recently continued efforts by SCSRD to transfer it to Uluguru Mountains (JICA, 1998). However, there is limited information on success or failure to adapted system. This calls for the need to establish feedback mechanism on practical significance and constraints of the transferred technology.

Inherently access to credit, input supply systems and extension services remain ones of the major hindrances facing food crop production systems in the area. Ever since colonial era more emphasis was largely given to cash crops than food crop production the same continues today. Despite its uniqueness one may be surprised to find how the system is remotely known even among the district agricultural officials. It is even difficult to find *ngolo* display in the district agricultural offices, which are located in the heart of Matengo highlands. Likewise, feedbacks of a few *ngolo* researches already have done hardly reported back to neither the farmers nor the district agricultural department.

3.4.3 Coffee farming and land use change in the Matengo highlands

The introduction or new importance of crops predominantly grown to earn cash changes the pattern of cultivation, creates new farming systems and diminishes the role of crops grown to meet the basic requirements of the cultivator i.e. subsistence farmer (Schmied, 1989). Knight (1974) envisage that introduction of cash crops took away required labour that might otherwise have been available for food crop production and, in areas with population pressure, took the land

from the traditional food-crop cycle of production and lengthy fallow. Food crops sector has ever since colonial era received much less attention and has suffered from the loss of manpower due to perpetual labour migration to distant estate farms. Men's concentration on cash crops has left women with the main subsistence burden. Likewise, in some places cash crop production has based on improved ways while food crop production has followed traditional techniques, something not much different from today.

The colonial government in Tanganyika promoted the commercial sector, since agricultural development and commercialisation were seen as one and the same. Political measures and extension were concentrated on commercial crops, while the traditional crops were often neglected (Schmied, 1989). As a result, tension grew between the traditional land subsistence and the modern commercial sectors. The simple farmer was confronted with a completely novel agricultural sphere, with new crop and techniques, and especially with new mental attitudes with which he had to come to terms. The easiest course of action was to add the innovations instead of generally transforming the traditional husbandry. Thus, according to Wharton (1970) the dual farmer came into existence. This signifies that pure subsistence agricultural production does, even in remote parts of Africa, not or no longer exist. Equally rare, however, is purely commercial farmer, who produces exclusively for the market and not all for his own consumption. But the economic, social, cultural and geographical contrasts can best be appreciated through a juxtaposition of the two extreme types of production systems.

The tension between these competing segments has continued up to now even within individual farming units and has created a special type, which is not easy to classify (Rudengren, 1970). This tension has to be counted for, if one is to analyse the changes, problems and opportunities of the Matengo land use systems. By adding cash crop sphere to the traditional agricultural subsistence system a duality emerged that was most felt in the competition for labour, the scarcest production factor as capital factor was once and then neglected (Schmied, 1989). It was therefore necessary to maintain an appropriate balance between the two sectors, as imbalances were risky. This risky is aggravated by the fact that the introduction of cash crops had not changed the technological level, so that typical subsistence risk (environmental determinism) persisted. When looking at colonial "modernisation" Rodney (1972) argues that African went into colonialism with a hand hoe and came out with a hoe. Nevertheless, it cannot be denied that the subsistence land users posses a prudent mentality (safety first) as far as changes are concerned. As the survival of the entire social unit depends on regular success in production, the subsistence farmer tends to use the traditional techniques, which have already proven successful. His readiness

to accept innovations will be particularly low if their failure endangers the maintenance of the philosophical level of living (Miracle, 1968; Whaton, 1970).

So far the Matengo people are mostly reliant on rain fed agricultural production system and produce both cash and food crops. Coffee arabica remains their main cash crop. The colonization of Tanganyika by the European powers-first the Germans and subsequently the British-made possible the contact that brought the Matengo into full interaction with the wider world. The colonial government policy of poll tax for instance, facilitated the diffusion of coffee cultivation as a major cash crop. According to Illiffe (1971) and Schmied (1989) the objective of colonial governments was "logically" to induce the native to produce something above their subsistence. The "something more" could be market oriented production either within a smallholder framework as a native farmer or within the plantation framework as a labour migrant. The main inducement for entering into and staying in the market economy was that of tax. The tax was collected in cash and in a lump sum at a time, which was not necessarily of most probable income for the farmers, i.e. harvest time (Schmied, 1989). Here African native cultivators were caught off guarded, and to survive they had to radiate about ways of obtaining cash.

In due course of tax poll inducement Arabica coffee was introduced in Mbinga at late 1920s for the purpose of enabling the Matengo people pay poll taxes that were demanded by the colonial administration. However, the introduction of coffee in Matengo highlands was initially discouraged by the German regime and can neither be vested as a success of British colonial administration. But is due to the initiative of an African individual: Chrisostomus Makita, the son of the Matengo paramount Chief. Being one of the first educated folks in the whole ethnic group, he worked as a clerk in distant sisal plantations in Tanga from 1924 where he grasped the idea of profitability in market oriented-agriculture. On his return to homeland in 1926 he found his fellowmen being accused by colonial government of not paying their taxes in due time compared to their neighbouring Ngoni and *Ndendeule*. Makita found that the ability of latter groups to pay their due taxes regularly was possible since they lived near the Songea headquarter (*boma*) and were supplied with regular income from work as porters or servants in European offices and Indian trades whereas the Matengo lacked these opportunities. He proposed to the European officials that only the introduction of cash crop could remedy the tax problem among the Matengo (Haule, 1973). The colonial District Commissioner conceded his argumentation and ordered coffee beans from Moshi (northern Tanzania) be brought and handled over to Chrisostomus Makita for planting (Schmied, 1989).

From this discussion it is possible to pinpoint that it was not only the risk-averse mentality, which is emblematic of subsistence cultivators that retarded the initial expansion process rather the attitude of colonial administration was not always favourable either i.e. the refusal to allow African smallholders to enter the market as competitors (Schmied, 1989). See Appendix (2) for the early diffusion of coffee cultivation in *Umaatengo*.

Chrisostomus Makita took over responsibility for spreading coffee and new nurseries were for the first time raised at Myangayanga village in 1929, later Mahenge, Mhagawa and Pilikano villages and to interested cultivators. This was possible because Chrisostomus held certain political influence as he came from a chief's family, and widened views through his modern education and experience as a migrant labour. Illife (1971) described Chrisostomus as an ideal innovator and fully matched the type of African agricultural entrepreneur. The early adaptors were normally respected as gentlemen of high social standing. Majority were Christians with at least formal education or related to Chrisostomus, or schoolmates, or were court elders with whom he probably had had some connections when he worked as a court clerk (Haule, 1973). It is possibly that close personal relationship between the innovator and the recipient cultivators that the novelty spread relatively rapidly, despite some initial snags, for instance with planting techniques.

On its introduction, coffee was planted near water sources and later along hillsides largely by flat seedbed. Bench terraces were later enacted through government intervention and are still largely practiced along steep slopes. Currently, plots near homestead are largely cultivated with coffee, while plots for food crops are prepared further away from home. Farmers also tried to plant coffee in *ngolo* but their experiment yielded counteract results as coffee roots became too cramped in the soil around the basins (Pike, 1938). As coffee production developed, the traditional system of communal land ownership became undermined and the individual got power over the disposition of land. Schmied (1989) pointed that private ownership of land and the inheritance by division among sons, aggravated by the increasing population and the demand for land, has led to fragmentation of agricultural landholding. Most farms consist of numerous discrete parcels, sometimes extends to different boundaries or villages. Coffee production has resulted in reduction of farm sizes for food crops, where farmers used to grow food crops and especially maize, close to homestead. Private parcelling of land possibly raised the events of land disputes in the area. Similarly, a few years after its establishment demand for coffee seedlings increased drastically that there were even some disputes about distribution among the cultivators (Schmied, 1989).

Until recently coffee economy has to a lager extent been supporting *ngolo* and other farming systems in the area (Kato, 2001). It is quite not unusual that the income from coffee is

used to buy inputs and paying labour used in *ngolo* cultivation system. However, other agitators argue that besides being economically viable, coffee has put the Matengo into market dependency. The factors land and labour have gradually been deprived of their traditional functions of guaranteeing survival to the entire social group, instead it is only the family household that benefits most (Rutatora *et al.*, 1996). The factor capital is increasingly gaining importance because of the necessity of purchasing farm inputs and equipments. Coffee farms have displaced food crop farms into distant areas and some into marginal areas including very steep slopes with fragile soils (Lyimo and Kangalawe, 1997).

Nevertheless, coffee has led to the process of commercialisation in the Matengo highlands compared to non-coffee growers in other agro-ecological zones of Ruvuma region. It has similarly, contributed to reliable source of income and reduced rural-urban migration, labour migration to distant estates. An intensive labour requirement in coffee and coincidence of labour peaks with other crops has necessitated the use of temporarily hired labour especially when reciprocal labour (*ngokela*) cannot beat the labour requirements. This situation has attracted immigration for seasonal labour. According to Schmied (1989) coffee farms covered 21,000 ha 1982 and contributed to about 96% of the district's earnings from agricultural production. It is reported that almost every household in the Matengo highlands grows some coffee (Rutatora *et. al.*, 1995).

At the beginning the expansion in coffee cultivation was stimulated by a new desire for cash. Later with declining soil fertility in the mountain *ngolo* fields and unreliable weather conditions, coffee began to be seen as an insurance against food shortage (Lyimo and Kangalawe, 1997). In a year when coffee prices were higher, farmers could earn considerable amount of money, which they used to buy farm inputs and assorted household goods including food, used cars, milling machines, motor bikes and bicycles and built or renovate their houses. Good housing (a house made of burnt bricks and thatched by corrugated iron sheets) establishment in the area are largely linked to coffee income.

Matengo coffee production and marketing grew steadily at the wake of disappointing co-operative unions before 1990s. But by the beginning to mid 1990s coffee prices shot up due to market liberalization and later slumped again due to multiple of factors. Currently, coffee farming is facing tremendous challenges due to volatile marketing systems, aging coffee trees, inaccessible farm inputs leading to poor husbandry and occurrence of pests and diseases. The Structural Adjustment Programmes (SAPs), which the country enacted since mid 1980s that coupled with employment redundancy even among agricultural extension officers led to squeeze of field officers in the villages, making agricultural extension services far reach among the villagers. SAPs were

also accused of bringing in unfair trade competition between private companies and civil institutions such as Mbinga Cooperative Union (MBICU). During its life MBICU supplied farm inputs, micro-credits and extension to farmers the services that are almost extinct during trade liberalization.

Despite such turbulences facing coffee farming, the Matengo have maintained unique feature by not abandoned it as commonly done in other parts of the country. This is partly because the Matengo perceive coffee farming not only as a cash crop rather a prestigious 'child' of the household. It is a symbol of recognition before the society and normally one's trust before the society is vested upon how much coffee farm he has. One can be accepted or denied loan at local transactions just because he has or don't have renown coffee farm, respectively.

3.4.4 National programmes and land use change in the Matengo highlands

The Matengo process of land intensification is so far represents one of the unique features of local peoples' ingenuity in rural Tanzania. Some other parts of the country intensifications were through government-initiated schemes such as the Sukumaland Development Scheme (1947-56), and Nachingwea and Kongwa Groundnuts Schemes, and Sisal Plantations in North-eastern Tanzania. In Matengo highlands however, it was largely the work of the local people who pioneered the land intensification on their quest to invent and adjust to their natural environment and changing socio-economic and political settings. Indeed, only a few schemes touched Mbinga district in 1970s such as the Villagisation Programme, National Maize Project (NMP) and the Mlale Resolution (MR).

3.4.4.1 *Ujamaa* villagisation programme

The *ujamaa* village campaign in Tanzania from 1973 to 1976 was a massive attempt to permanently resettle in villages most of the country's scattered population. These policies were strategies designed, as Goran Hyden echoed by Scott (1998) said, 'to capture the peasantry'. According Schmied (1989) the villagisation programme in Tanzania aimed at "bringing the people together in the villages" as a precondition to agricultural development through grass-root democracy and popular participation. The program was by most accounts the largest forced resettlement scheme undertaken in independent Africa up to that time. At least 5 million Tanzanians were relocated by a relatively benign weak state (Hyden, 1980).

The essence of *ujamaa* villagisation was that the vast majority of the Tanzanian rural population was, in terms of legibility and appropriation, outside the reach of the state. At

independence, the estimated 11 out of 12 million rural dwellers lived 'scattered' across the landscape (Scott, 1998). Much of what they did sell was offered outside at local markets largely outside the ambit of state supervision and taxation. The objective of colonial agricultural policy and also of the independent state of Tanzania was to assemble more of the population into fixed, permanent settlements and to promote forms of agriculture that would yield a greater marketable surplus, especially for export.

Villagization programme poised a challenge to fragile land tenure system that cannot be routinely defended neither by the state nor by the local community. People were resettled sometimes in some areas by force, the eviction that they cannot claim for compensation largely because there is no legal framework to defend over the properties they own. The state owns the land, the laws and the people hence becomes the paramount ruler while the land users become mere custodians of the land. This situation may possibly create infidelity between the state and the land users hence bottleneck the whole process of sustainable land use. Investments on environmental conservation and general trends of sustainable land use require a full proof confidence and security of the land users over their rights to own and use the land. Thus future sustainability of land use in Tanzania has to be worked out from defined land tenure systems than the persisting fragile and complex ones.

However, a few regions were little affected by the programme. Officials there simply designated many existing settlements as planned villages and left it at that. There was both an economic and political reasons of the exclusions. Wealthy, densely settled areas such as Kagera in the Western Lake Victoria, Kilimanjaro, Rungwe in Mbeya and Matengo highlands were largely spared for three reasons; farmers there were already living in populous villages; their undisturbed productivity in cash crops was vital for the state revenues and foreign exchange; and the groups residing in these areas were over represented among the bureaucratic elite. Specifically, for the Matengo highlands, thanks to *ngolo* and coffee farming systems that developed permanent and stable settlement pattern that were strong enough to be intervened by the state (Schmied, 1989; Lyimo and Kangalawe, 1997).

3.4.4.2 The National Maize Project (NMP)

Villagisation scheme coincided with poor rainfall in 1972-1974 that caused disruptions in the food crop production, especially the staple maize (URT, 1975) and led to heaviest food crisis since independence (Schmied, 1989). In order to safeguard production of maize and to establish strategic grain reserves, the government of Tanzania with the financial assistance from

International Development Association launched the NMP in 1973. The earmarked villages received maize inputs (e.g. composite and hybrid seed, fertilizer and insecticides) at subsidised prices and support maize production demonstrations and research trials (URT, 1975). Improved maize storage and strengthening of extension services were also priority. The project aimed at raising maize yield in project villages from the average of about 1,370 kg/ha without the project to 2,050 kg/ha at full development.

The NMP accentuated by suitable ecological conditions and reliable rainfall is believed to have a enormous impact on maize production and led to what until recently known as the "Big Four" regions, which are famous agricultural production areas in Tanzania. The regions include Iringa, Mbeya, Rukwa and Ruvuma all situated in southern highlands of the country. Though maize has been grown in these regions for ages, but the influence of NMP to increased farm input supplies, acreage, extension services and marketing deserve a keynote appraisal (DALDO, personal communication). It was said at this time the staple crop maize received a massive support never before in the history of land use developments in Tanzania. It was also during this time the cultivators in Mbinga District became into contact with the use of agrochemicals and improved seeds for the first time. The fertility-stricken mountain fields were given a new boost from chemical fertilizers. At a short-lived analysis, intensification of these impetuses to production system possibly led to increased maize production.

As frequently common to many top-down projects, the long-term effects of this programme are disguising. Of course some elements of merits are there but constrictions have also been severe. The project caught rural farmers quite unaware on appropriate use and management of newly introduced inputs such as agrochemicals, hybrid seeds, tractors and the likes hence misappropriations were widespread. Free distribution of inputs led to wasteful use of it and did not develop an appreciation of costs and benefits. The extension staff and services provided were far inadequate to cater for the vastness of the project area. The supply of inputs was also constrained by poor communication networks, typical problem of rural areas in Tropical Africa. The misapplication of agrochemicals in farms is assumed to cause a further soil deterioration in the area. Worst still after the project, farmers could no longer afford buying these agrochemicals, a situation that heightened soil degradation.

3.4.4.3 The Mlale Resolution

The Mlale Resolution of 1977 that was passed in Ruvuma region is another story on policy side. The resolution passed several declarations amongst the sustainable land use, animal

husbandry and better settlement. It pointed out that although the land is unquestionably owned or controlled by the state but the land users play decisive role in maintaining or destroying it. The issue of defined land tenure and population pressure were also focused in this resolution. The MR issued directives to district authorities that dwellers of densely populated areas such as Matengo highlands be advised to shift to sparse areas as Ruvuma region still had huge agricultural-favourable frontiers. At the destinations, farmers were given land at best of their ability to manage it (Mwampeta *et al.*, 1987). This increased mobility and stability of the Matengo ethnic group. The resolution also characterised the Ruvuma region into agricultural suitability zones and possible cultivation practices feasible to each zone.

The MR and villagization programme prompted the change in landholding by migrant Mountain dwellers. Before these two programmes, migrant people could obtain or allocated land by other fellow men in the destination. But with villagisation and MR, villages were demarcated and registered and thus new comers were obliged to follow statutory channel to obtain the land. In villages with "ample" land, village governments were responsible in allocating land to new comers. Where there was no free landholding left for new allocation, land could still be obtained from fellows who have had huge tracts of landholding, although village government approval remained prerequisite. After villagisation migrants were also obliged to show migration permit issued by origin village to the destination (host) village to ascertain their statutory residence in the country or as a criminal-free migrant before the land is allocated to him.

The MR is also believed to have an impact in establishment of "better housing" (*ujenzi wa nyumba bora*) in the Matengo highlands. The resolution went on agitating through meetings and seminars the importance of better housing and in fact it established some model villages for better housing and sustainable land use. Due to this, the Matengo responded vigorously to the campaigns waged by the MR for better housing. Partly owing to this resolution, today one can easily see the flourish of burnt brick houses thatched by corrugated iron sheets in Matengo highlands. Much of the resolutions of MR are now appear in the district by-laws that aim at safeguarding sustainable village land use plans such as compulsory average acreage and type of crops each household should cultivate.

3.4.4.4 Current agricultural land use change in the Matengo highlands

By 1986, Tanzania government enacted the Structural Adjustments Programme (SAPs) to resurrect her ailing economy. Some of the transformations coupled with SAPs include removal of subsidies on farm inputs, redundancy of civil servants and trade liberalisation. A lot of cooperative

unions collapsed after the introduction of trade liberalization, which had been encouraged since the mid 1980s. Collapse of cooperative unions had noticeable impact in some rural areas of Tanzania especially those that had already established mono-cash economy.

Farmers in the Matengo highlands who have economically depended only on monoculture coffee production as a cash crop have so far involved in the market economy. The deterioration of rural economy after economic liberalisation pressed changes to the their livelihood, the indigenous land use system and the natural environment. From the last decade production of both cash and food crops in the Matengo highlands fallen tremendously. To cope with this situation the Matengo embarked on various strategies such as valley bottom agriculture, expansion of cassava and coffee cultivation and distant farms cultivation. Discussion on the influence of economic liberalisation on land use change and environment management in the Matengo highlands, which forms the central premise of this study, are widely covered in chapter five and six.

Table below summarises the four major turning points of land use change and environmental management in the Matengo highlands.

Table: 6. Summary of historical land use change in the Matengo highlands

Period	Event
Mid 19th C	Conflict with the Ngoni
	Intensive agriculture
1890¬	Germany Colonial Period
1920¬	British Colonial Period
	Introduction of coffee
1961	Independence
1967¬	*Ujamaa* Villagisation
1975	National Maize Project
	Introduction of chemical fertilizer
	◆ Further division of land
	◆ No or shortened fallow
1986	Structural Adjustment Program
1993	Liberalisation of coffee market

From the preceding chapters we have so far characterised a series of elementary components within the complex reality of the Matengo highlands. These elements are the people; their models of environment; indigenous agricultural land use systems operating within a man-modified landscape.

Examination of land use systems and techniques used in the Matengo highlands shows sophisticated levels of environmental management, which operate at the micro-scale, being responsive to multitude of causes. Present-day methods of farming and crop types and land exploitation show a remarkable continuity from their development over a hundred years ago. In recent years, changes in national economic policies have meant the new adjustments to the land production systems.

It is also reasonable to argue that socio-economic interventions such as population growth and introduction of cash crops did not alter the ultimate course of traditional land use systems rather simply hastened it. I suppose over a long time period, the evolution of *ngolo* would still have occurred. The resultant emphasis to *ngolo* farming system still has been the response to the need for intensification. Hence, the coming of European has not altered a basic viewpoint toward agricultural land use change, but in fact has compacted the long-term process and made it more readily scrutinised.

The Matengo have demonstrated that agricultural land use development evolves slowly, in a series of small changes over long periods of time. Most of the transitions occurred in small slow steps, and are difficult to pinpoint unless one knew the overall agricultural history of the area. This was also according to Meertens *et al.* (1995) certainly the case in Europe though most European colonial administrators, not fully aware of their own agricultural history, were frustrated by the unwillingness of African farmers to embrace immediate change. Arguably, most conventional today are yet to recognise the changes that have already taken place within local African agricultural land use system, and labelled these farmers as backward and inefficient, blaming farmers for being traditional and conservative. It is thus imperative for contemporary rural development stakeholders to recognise these immerse indigenous knowledge systems that have sustained livelihood and their land use systems in the local environment for such a substantial number of years. Undeniably, their land use systems and environment face challenges that need prompt address and actions to ensure sustainability. Increasing migration, declining soil fertility and clump of coffee economy all pose a challenge not only to Matengo livelihood but also to the environmental sustainability.

CHAPTER FOUR

LAND USE AND ENVIRONMENTAL MANAGEMENT: A DISTRICT PERSPECTIVE

4.1 Crop Production Trends

4.1.1 Food crop production

Table (7) indicate production trends of major food crops in Mbinga district from 1983/84 to projections of 2004/05 seasons. The Table indicates that within 22 seasons (except six seasons for rice) maize commanded largest production volume (average of 57,041 tons) followed in sequence by non-cereal crops such as cassava and potato (average of 24,682 tons), rice (4,407 tons) and least by other cereals (1,944 tons). Thus, about 65% of all food crop production in the district depended on maize trailed by non-cereals, which produced 28% whereas rice and other cereals produced about 5 and 2 percents, respectively.

Table 6. Major food crop production (ton) in Mbinga district

Season	Population	Maize	Rice	other cereals	Non cereal food crops	Total food crop production (tons)	Total food crop demand (tons)	Aggregate surplus/ deficit (tons)
1983/84	237,816	42,145	8,150		23,300	73,595	64,210	9,385
1984/85	245,902	45,198	9,097	418	26,593	81,306	66,395	14,911
1985/86	254,263	46,200	3,175		2,540	51,915	68,651	(16,736)
1986/87	262,908	53,695	19,017		3,466	76,178	70,955	5,223
1987/88	271,847	42,397	2,400			44,797	73,399	(28,602)
1988/89	281,089	57,696	6,670		4,008	68,374	75,894	(7,520)
1989/90	290,646	54,912	2,421		940	58,273	78,474	(20,201)
1990/91	300,527	61,783	2,526		9,027	73,336	81,142	(7,806)
1991/92	301,549	66,641	2,421		12,417	81,479	81,418	61
1992/93	311,802	68,733	3,178		13,497	85,408	84,187	1,221
1993/94	322,403	58,816	2,320		16,745	77,881	87,049	(9,168)
1994/95	333,365	79,382	3,771		20,220	103,373	90,009	13,364
1995/96	344,699	44,931	3,087		23,961	71,979	93,069	(21,090)
1996/97	356,419	57,235	2,416		20,406	80,057	96,233	(16,176)
1997/98	368,537	54,127	3,258		32,682	90,067	99,505	(9,438)
1998/99	381,067	48,128	3,254		32,373	83,755	102,888	(19,133)
1999/00	394,023	60,573	2,986		35,511	99,070	106,386	(7,316)
2000/01	407,420	53,087	3,406	2,708	47,129	106,330	110,003	(3,673)
2001/02	421,272	60,735	3,118	2,070	45,930	111,853	113,743	(1,890)
2002/03*	435,595	56,415	2,100	1,800.00	50,082	110,397	117,611	(7,214)
2003/04*	450,405	66,670	3,870	2,500	47,878	120,918	171,609	(50,691)
2004/05*	465,719	75,394	4,305	2,169	49,620	131,488	125,744	5,744
Average		**57,041**	**4,407**	**1,944**	**24,682**	**85,538**	**93,572**	**(8,034)**

* Estimated values for respective years

Number in brackets in the last column stands for deficit supply of food crops in respective years

Source: (DALDO, 2001)

The above table also shows that average total food crop production in 22 seasons was 85,538 tons while total food crop demand was 93,572 tons creating a pocket of food deficit of about 8000 tons. Basing on such data, the district could be ascribed as hunger stricken area and need of food relief from elsewhere was apparent. However, such generalization has to be taken with cautions as the local people pose several survival means at household level. This includes

eating foodstuffs whose data are generally not available at government offices. Moreover, such data largely depend on crops brought to the market and does not include crops consumed by households directly from the field or as greens. During my study I also found that reliability on data at district level were highly doubtful and inconsistent. Data inconsistence at district agricultural office could be the result of poor data banking and handling systems and/or data managers were not well trained to handle such massive data bank. Data were only stored in ill-handled paper files, thus finding data were a painstaking encounter.

Despite such inconsistencies, Fig. (16) shows increasing acreage that was under crop production at district level. Area under non-cereal cultivation increased for about 70% followed by maize (60%) and cash crop (34%), whereas land under rice cultivation registered lowest increase of only 1% in the entire period. The larger part of new cultivated land involve total clearing of miombo

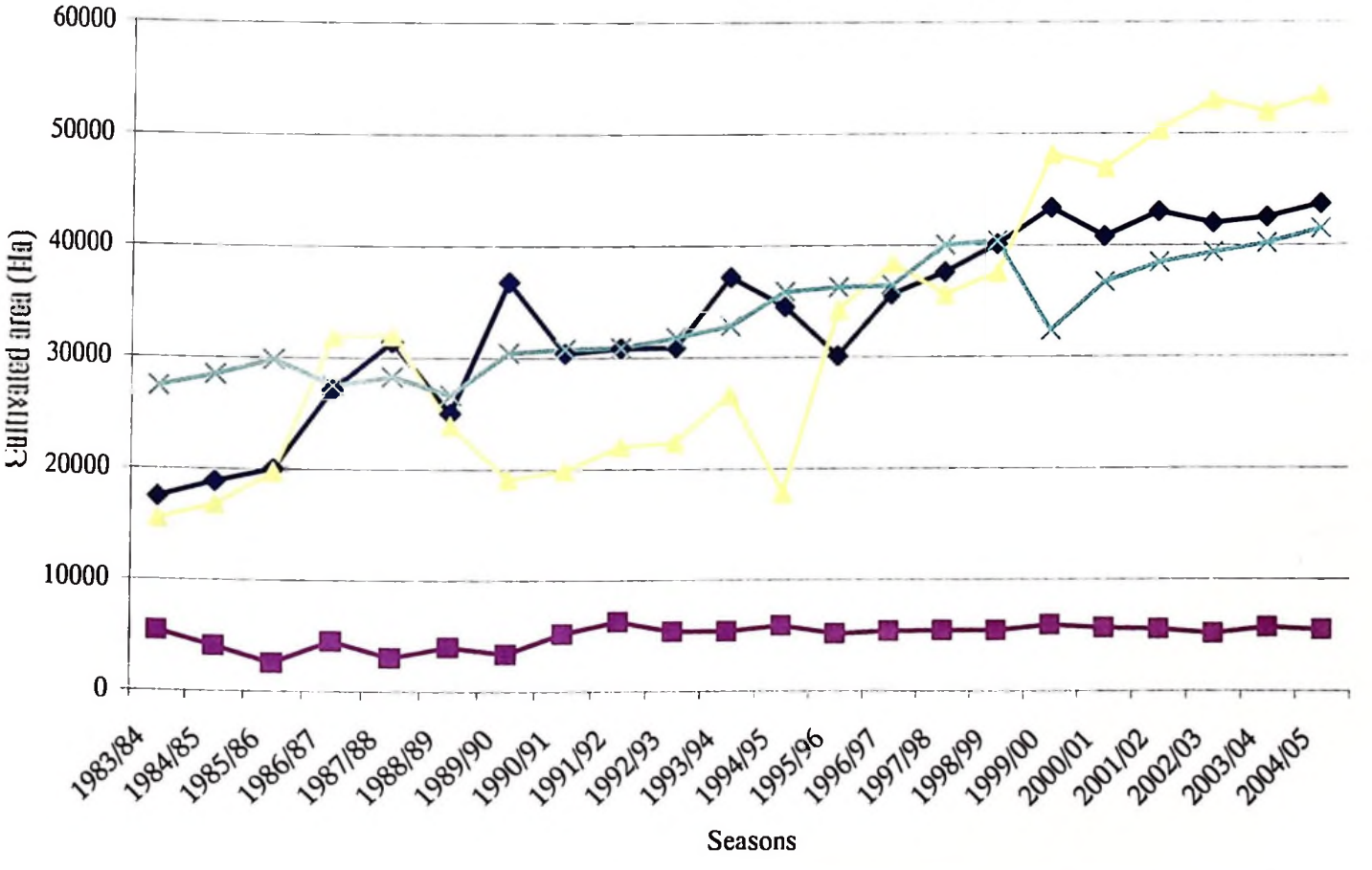


Fig. 16. Estimated area (Ha) under crop cultivation in Mbinga district (1983/84-2004/05)

woodland for opening up new farms mainly in rolling hills and lower zones. Dwindling in expansion of rice-cultivated fields could be due to drying up of most of wetland (*dimba*) mostly along Lake Nyasa areas possibly due to catchments degradation in the Matengo highlands.

Declining crop production trends despite increased acreage cultivated was according to DALDO influenced by multiple factors such as erratic weather conditions such as late onset of rains, extended dry spells and severe rainstorms such as that of El-Nino rains of 1997/98. Other factors mentioned were outbreak of pests and disease (Table 7), antiquity means of labour, poor extension services, debilitating soil condition, deprived conservation measures and poor farm input supply system and its inaccessibility by most farmers.

Table 8. Some common pests and disease in food crop fields of Mbinga district

Crop most affected	Disease/ Pest	1999/200 Cultivated area (Ha)	Affected Area (Ha)	1999/200 Cultivated area (Ha)	Affected Area (Ha)
Cassava	C-meal burg C-green mites C-white scale C-leaf mosaic	23674	473 *(2%)*	25711	514 *(2%)*
Maize	Grey leaf spot	40382	8076 *(20%)*	40836	8167 *(20%)*
	Maize stalk borer		5250 *(13%)*		5705 *(14%)*
Coffee	CBD	34498	5865 *(17%)*	34723	6000 *(17%)*

Source: (DALDO, 2001)

Fig. (17) shows that at present that number of village agricultural extension staff has been in constant decline since 1993/94. According to DALDO, presently, there are only 83 extension staffs serving the whole of Mbinga district. These 83 extension officers save about 72,373 farm families (95% of the entire total families in the district) scattered in about 180 villages in the

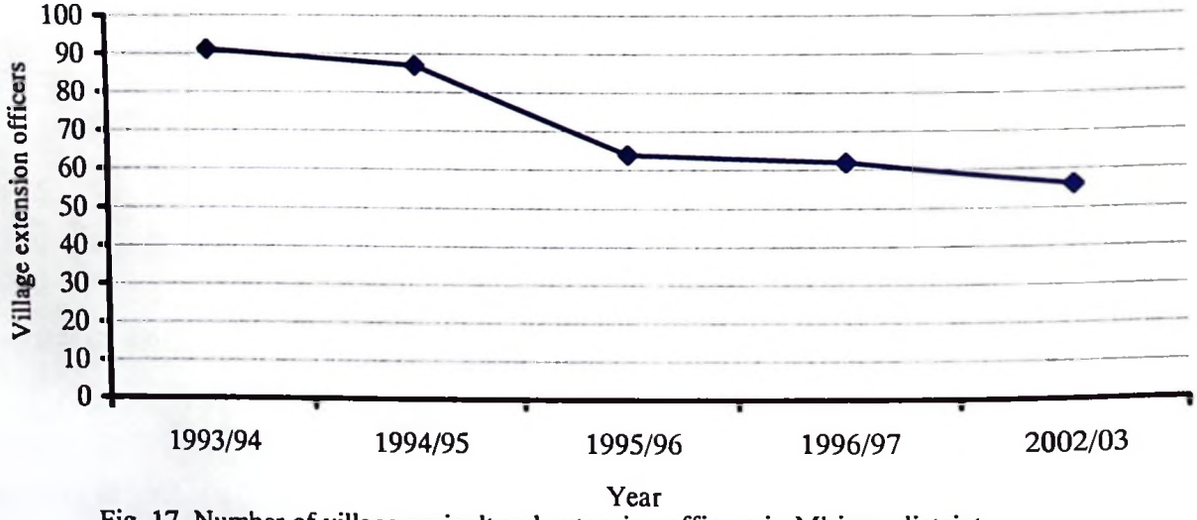


Fig. 17. Number of village agricultural extension officers in Mbinga district

Source: (DALDO, 2002)

entire district. This makes an average of 872 farm families being saved by one ill-equipped extension staff. With pathetic communication systems, the likelihood of such extension staffs to deliver their services to these farmers is highly questionable.

Fig. (18) presents scenarios that reveal limited supply of farm input and inaccessibility by most farmers to farm input such as fertilizers. The estimated average demand of fertilizer in district for 22 years stands about 21,230 tons whereas estimated average supply was on 3000 tons. Thus, from 1983/84 to projected 2004/05 seasons, the district had been facing an average shortage of fertilizer supply of about 86 percent. However, though supply of fertilizers has been short, the effective demand (accessibility of farmers to buy fertilizer) is also low. Although only an estimated average of about 14% of fertilizers has been supplied in 22 years, the estimated average effective

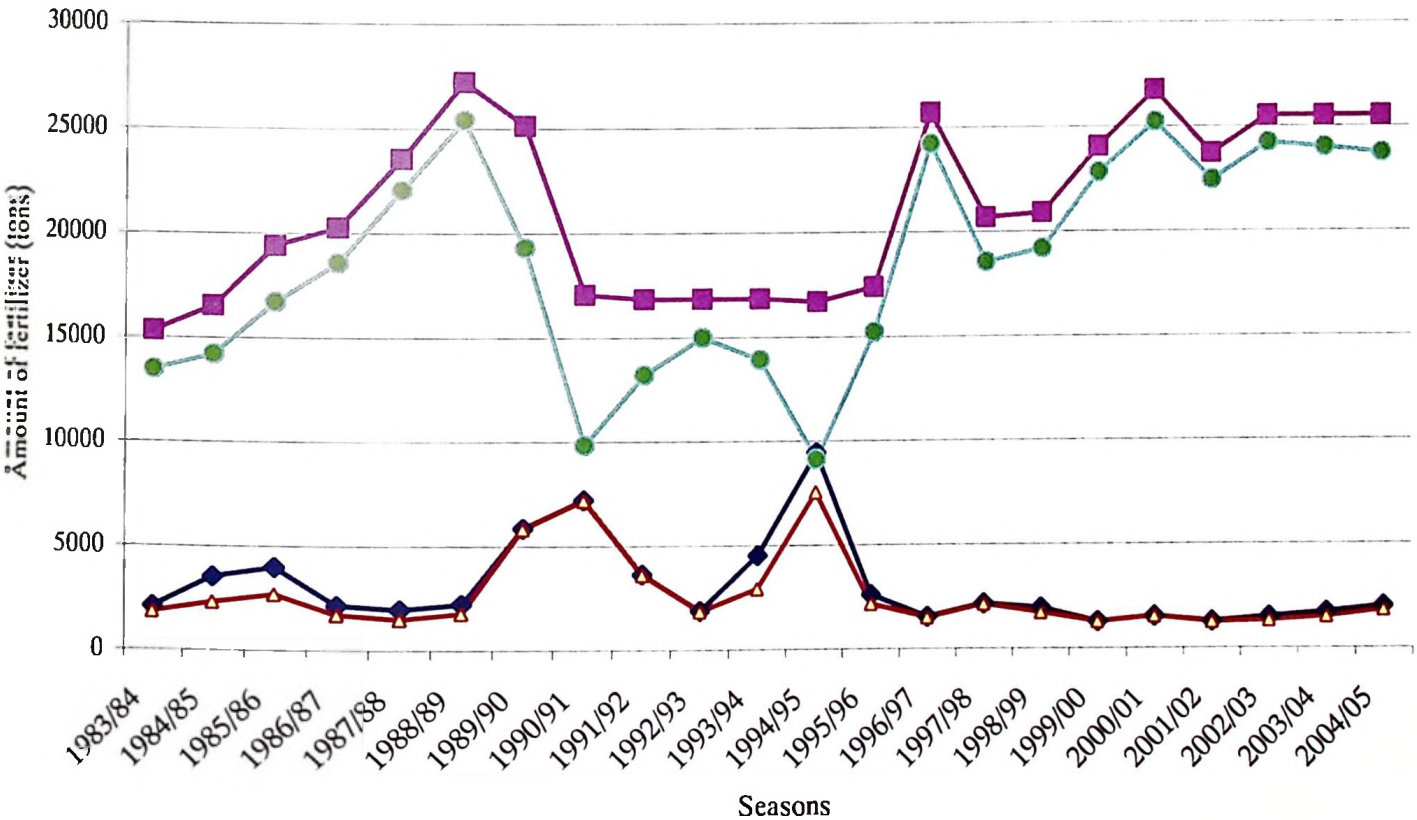


Fig. 18. Supply and demand of fertilizers in Mbinga district from 1983/84-2004/05

Source: Quarterly Report May-June 2001 Mbinga District Council Agriculture Dept AG/A.20/V

demand was only about 12%. This could be accentuated by a number of factors such as distance from district centre where most of fertilizers are found, debilitating farmers' income and high prices of farm inputs as shown in Table (8) and more opening up of new farms that need no chemical fertilizers.

Replacement of maize *ngolo* fields by cassava that need no application of fertilizer could also be the reason.

Table 9. Trends of agrochemical prices in Mbinga district

Season	Type of fertilizer	Price (Tsh)	Average price (Tsh)
1993/94	SA	2815.50	4219.05
	CAN	3605.90	
	UREA	4565.65	
	NPK	4720.75	
	DAP	5040.85	
	TSP	4565.65	
1996/97	SA	10000.00	10000
	UREA	10000.00	
	CAN	10000.00	
1999/00	CAN	9600.00	10700
	SA	9600.00	
	UREA	9600.00	
	DAP	14000.00	
2000/01	CAN	11000.00	11750
	UREA	11000.00	
	SA	10000.00	
	DAP	15000.00	
2001/02	UREA	10700.00	10433.33
	CAN	10700.00	
	SA	9900.00	

Source: Quarterly Report May-June 2001 Mbinga District Council Agriculture Dept AG/A.20/V

It shows in the Fig. (19) that more fertilizers were supplied and used in 1980s and 1990s than in 2000s. This is possible due to the fact that most fertilizer users in the district are Matengo farmers who used to buy fertilizer largely from the cash accrued from the sale of coffee. During 1980s to early 1990s supply and use of fertilizers was possible due subsidies and effect of MBICU that supplied it to coffee growers. By middle 1990s the use of fertilizers could be influenced by good price of coffee during early years of trade liberalization. From 1998/1999 season coffee prices started showing downward spiral (see coffee price trends in subsequent sections), which possibly imputed the ability of Matengo farmers to buy farm inputs. It could therefore be deduced that removal of subsidies on farm inputs, collapse of MBICU and crumpling of coffee economy had unconstructive impact the entire rural economy sector of Mbinga district.

Supply and demand of maize hybrid seeds Table (9) shows the district is short of supply of hybrid maize seeds. Despite pitfalls in supply side, effective demand has never exceeded this short supply in four consecutive seasons (1997/98 to 2000/01). In fact, this is contrary to real farmers'

demand of hybrid seeds. It shows from Table (9) that farmers' real needs of hybrid seed surpass both supply and effective demand (amount of seeds consumed or bought by farmers).

Supply and consumption of seeds in the Table (9) shows consistence falling possibly due to dwindling ability of farmers to buy and location of stockist that discourage farmers' accessibility as they are supposed to travel to Mbinga town to buy such inputs. It is also possible that private stockists couldn't reveal exact data of their merchandise due to tax reasons or poor business record keeping.

Table 10. Seasonal seeds requirements (tons) in Mbinga district

Season	1997/98			1998/99			1999/200			2000/01		
Seed type	Dd	Ss	Cons	Dd	Ss	Cons	Dd	Ss	Cons	Dd	Ss	Cons
Katumani maize	20	-	-	-	-	-	-	-	-	-	-	-
Vegetables	-	-	-	-	-	-	-	-	-	0.5	0.4	0.4
Coconuts	-	-	-	-	-	-	1.28	1.28	-	0.012	0.06	0.06
Maize	-	-	-	-	-	-	-	-	-	-	-	-
H6302	16	16	4.0	-	-	-	-	-	-	-	-	-
H625	-	-	-	55.0	53.0	53.0	25	3.0	1.5	25	3.0	3.0
H614	300	51.31	40.13	-	-	-	5.0	1.0	0.5	5.0	0.76	0.26

Source: Quarterly Report May-June 2001 Mbinga District Council Agriculture Dept AG/A.20/V

Dd-demand; Ss-supply; Cons-consumption (effective demand)

Fig. (19) show that price of food crops has been increasing for the last 19 seasons from 1983/84 to 2001/02. On the except of finger millet other major food crops have shown consistence higher increase in prices contrary to prices of major cash crop coffee that show great fluctuation and instability. Maize price rose from Tanzania shilling (Tsh.) 600 for 100 kg in 1983/84 to Tsh. 6000 in 2001/02 season, but this is without considering currency depreciation. Likewise, prices for rice, finger millet, cassava and sweet potato rose from Tsh. 1500, 5000, 250 and 1000 to 7000, 6000, 4000 and 8000, respectively. This corresponds to about 79, 17, 94 and 88 percent increase in price for respective crops across 19 seasons. It is apparent from these data that cassava is gaining unprecedented momentous in both its production volume and price.

Thus, reliance of Mbinga folks on cassava as both a food-cum cash crop is certainly growing at present. Cassava was increasingly become important at district level both in targets of cultivated acreage for about 87% and production for about 83% in 14 seasons from 1985/86 to 1998/99. This was once again related to falling soil fertility in Matengo highlands that makes production of maize worthless. Inaccessibility to chemical fertilizer due to dwindling income among Matengo households drove them to cultivating cassava in former maize/bean *ngolo* fields.

In rolling hills, it is becoming a common farming practice to planting cassava in flat plateaus or intercropped it in maize/bean *ngolo* fields. Hagati plateau once looked down because they had no enough maize is now becoming a popular place for life rescue to thousands of Matengo households. Cassava trading has gained unprecedented popularity in Hagati plateau since last decade due to tumbling of production systems in other parts of Matengo highlands.

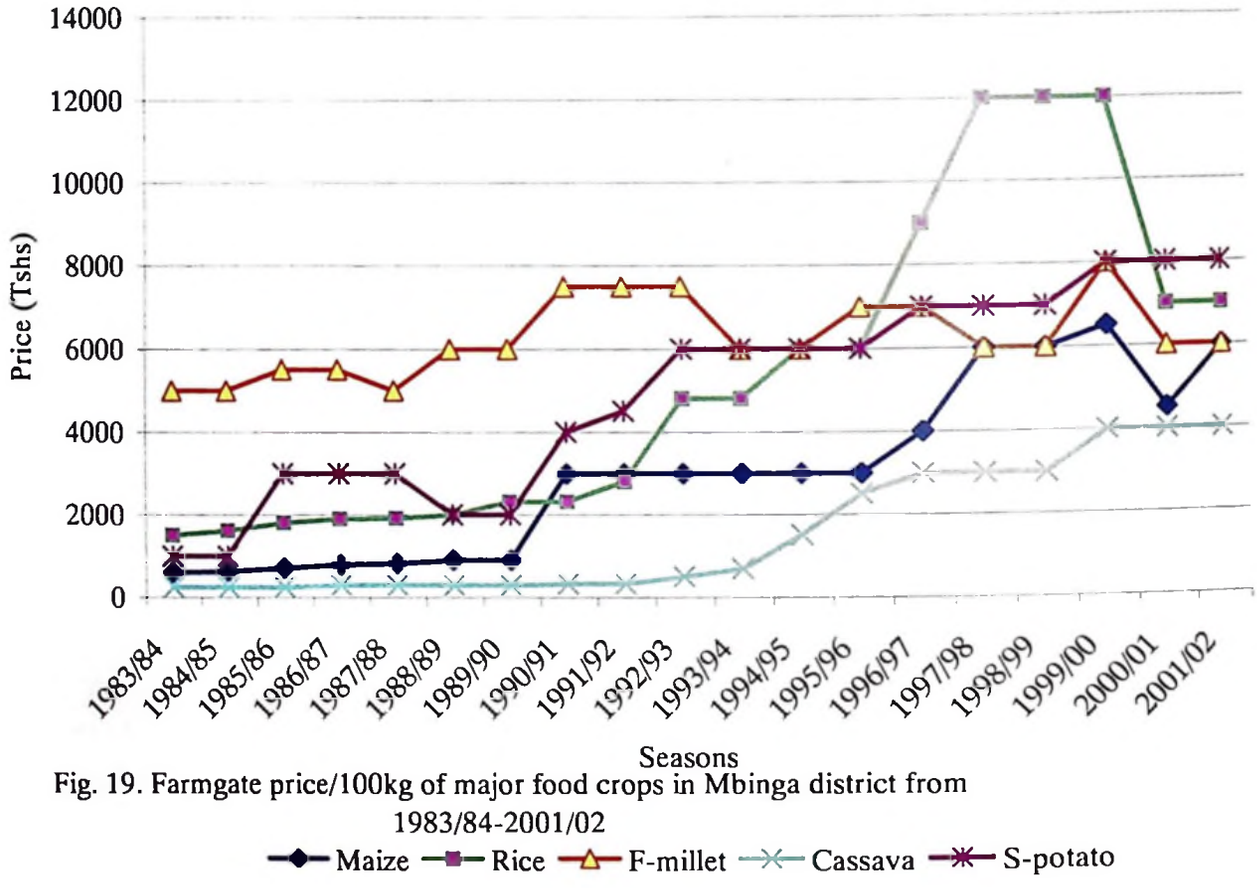


Fig. 19. Farmgate price/100kg of major food crops in Mbinga district from 1983/84-2001/02

Source: Quarterly Report May-June 2001 Mbinga District Council

4.1.2 Cash crop production trends

Largely, Mbinga district depends on cash crop coffee as her major source of revenue. Coffee is assumed to account for about 80% of district revenues and farmers income, respectively. Since it was introduced in the district, coffee has been supporting other farming systems and according to Hill (2002) has led to transformation of the basis of subsistence economy in the district. As a legacy of colonial mentality coffee production has been enjoying over emphasis in the district and the Matengo have received relative close attention than any other ethnic group in the district. Mbinga Cooperative Union for instance, it concentrated her activities mostly in coffee growing areas than anywhere else. The era of 1990s saw the Tanzania government enacting various transformation policies among which was trade liberalization to reform the country's

ailing economy. Trade liberalization brought mixed-grilled effect to the farmers of Mbinga and their district council.

Fig. (20) shows that total area under coffee cultivation has increased from 18262 hectares in 1984/85 season to 37170 hectares in 2002/03 an increase of nearly 51% in 19 seasons. Coffee

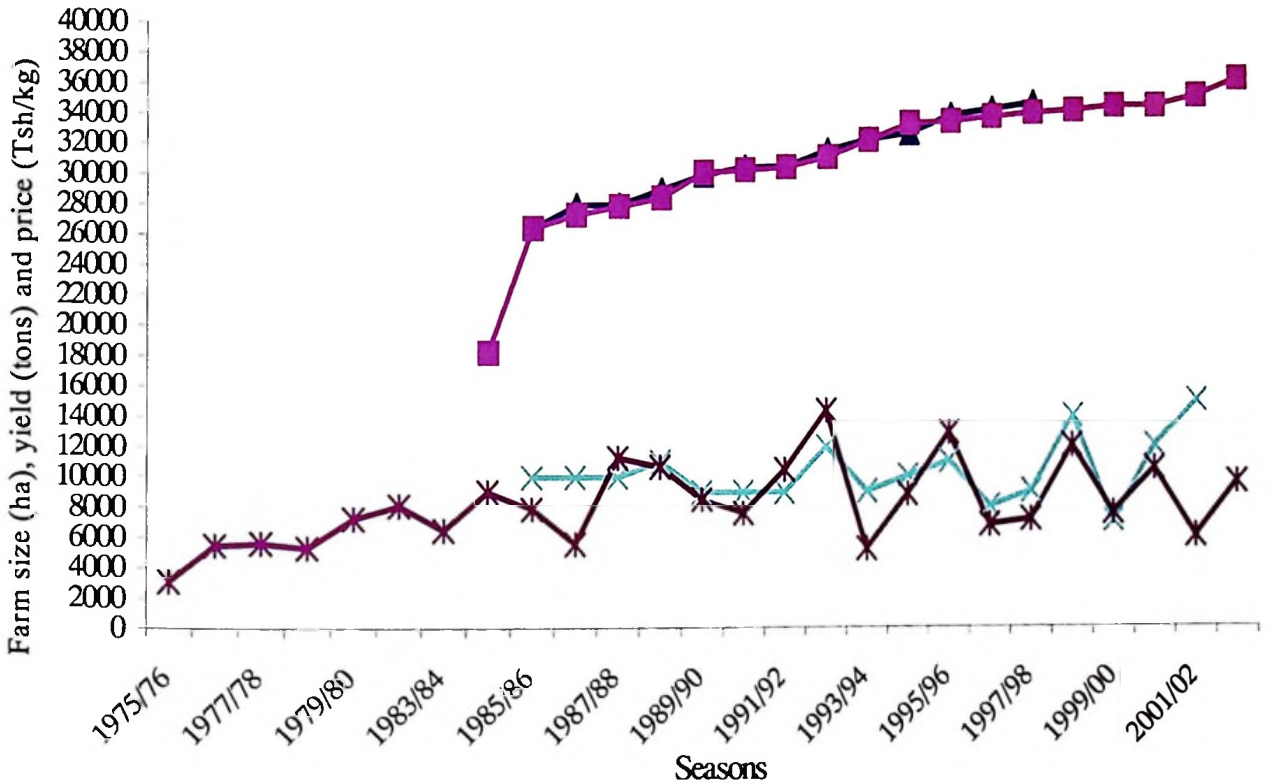


Fig. 20. Coffee production and price trends in Mbinga district from 1975/76-2002/03

Source: Quarterly Report May-June 2001 Mbinga District Council Agriculture

production has however, tumbled in different seasons despite increase in acreage. In 1984/85 season coffee production was 9038 tons from 18262 hectares (0.49 tons/hectare) and increased only to 9565 tons from 36270 hectares in 2001/02 season, which is in actual value a decrease production per hectare (0.26 tons/hectare). The Fig. (24) shows that in terms of quantity, coffee production has been on increase since 1975/76 season. Nevertheless, production has been increasing but at a more fluctuating trend. Actual production per hectare shows a downward spiral from 1993/94 to 20002/03 seasons.

Although coffee prices were higher during mid 1990s, production per hectare continued falling at the same time. Thus, incentive to increased production per farm family is not

ubiquitously influenced by price alone rather other factors such as extension services on good crop husbandry, and peoples' willingness to invest in the farm. Others include supply of farm input and its accessibility and timely application, farmers' behaviour on income expenditure and household range of choices.

It was found during my research that farmers reinvestment on farms dwindled since mid 1990s partly influenced by the collapse of MBICU. As already explained in the preceded chapters, MBICU among other functions it concentrated on supply of farm inputs and extension on crop husbandry to coffee farmers. Collapse of MBICU in 1990s, thus, it cut-off farmers from their common "provider" and the subsequent private buyers were inexperienced to saving farmers interests leave alone management of their farms. In this turnover, coffee production per unit hectare continue falling despite price incentives offered by private buyers. Thus, at initial stage though trade liberalization brought in price incentive but it was not enough to encourage neither production per hectare nor quality of coffee. Trends of coffee price are presented in Fig. 21 below.

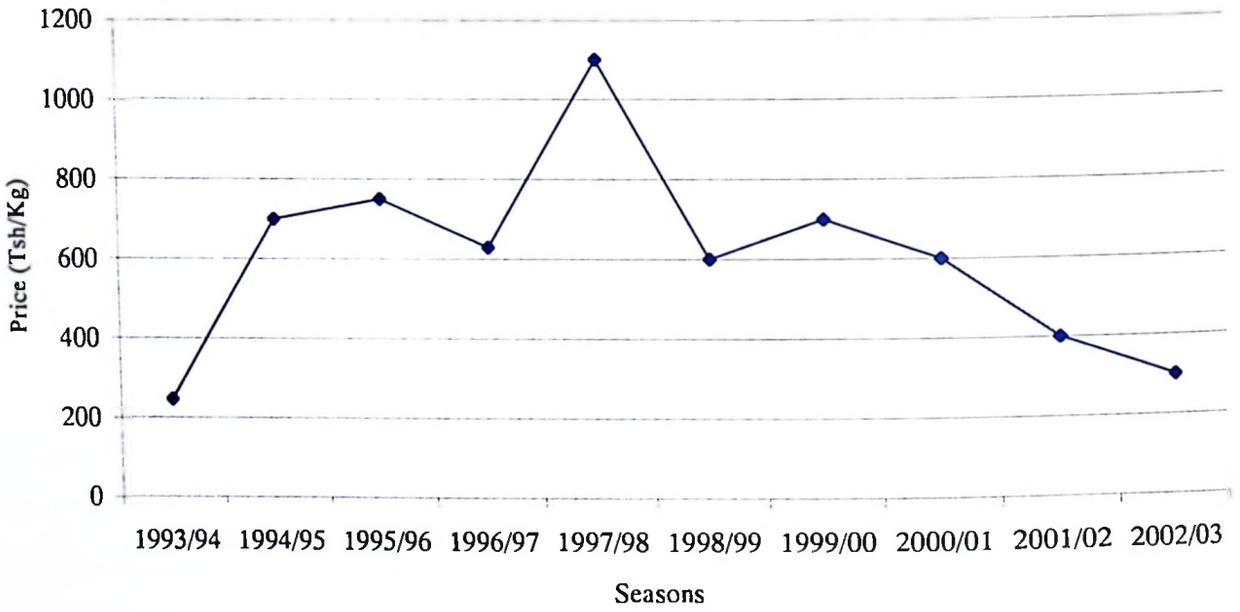


Fig. 21. Trends of coffee price in Mbinga district (1993/94 to 2002/03 seasons)

Source: Quarterly Report May-June 2001 Mbinga District Council Agriculture Dept

The failure of private buyers to accommodate complex farmer behaviour also led to deteriorating of rural economy and general people's livelihood especially among the Matengo. Coffee marketing during MBICU based on coffee quality, a theme received no attention during market liberalization. This provoked farmers to act on the quest of the present market, which biased on quantity than quality. Farmers found the pursuit of quantity rather than quality of coffee

by private buyers as a relief to further intensification as caring for good quality coffee accompanied with a chain of careful and labour intensive procedures. In other words, lack of reward to extra labour influenced farmers to diverge their energy and time for other activities than to waste it on non-rewarding coffee caring.

Private coffee buyer companies also brought in coffee buying agents whose knowledge on coffee husbandry was very remote and some moments non-existence at all. This tendency compounded by coffee companies payment system to their agents on amount of coffee collected, which prompted exertion of much efforts on quantity than quality. Consequently such poor quality coffee fetched a low market value at world market, putting the Matengo subsistence systems on suspense.

4.2 Forest Management

Special focus here will be paid on forest management at district level. According to Mbinga district natural resource officials, the district is undergoing severe forest degradation. The situation is rooted on various reasons including the absolute dependence on fuelwood as source of energy. Famous brick burning for modern housing, lumbering, wanton tree felling and staggering bush fires also contribute to the situation. Mbinga district rate of deforestation threatens the

Fig. 22. Impact of opening up more frontiers in Matengo highlands

national rate, for instance, firewood consumption per household in the district is between 2.6-4.2m^3 tons per annum and the national rate is 1.6m^3 ton per household per annum whereas afforestation in Mbinga is thought to be 1.2m^3 ton per household per annum (Abel Mwanga-Mbinga District Natural Resource Management -NRM-official, personal communication). The

official also pointed that migration into new land is not accompanied with afforestation rather cleansing of existing natural vegetation, of which the people perceive as still "plenty" of it. Fig. 26 shows the extent of forest degradation in Mbinga district.

According to NRM official the impact of forest degradation in the district includes declining forest cover and forest products e.g. timber, medicinal plants, honey, and fuelwood. Recent degradation in forest cover increased flood events during torrential rains that swept some bridges and, road banks, household properties and farms especially along Lake Nyasa where many rivers starting from Matengo highlands empty. Lakeshore folks speculated such adverse events as due to environmental degradation of Matengo catchments forests. To counteract such maladies of environmental degradation, the Mbinga district authority underwent various environmental conservation programmes most of which concentrated in the Matengo highlands alone.

4.2.1 Environmental Conservation Programmes

4.2.1.1 Ruvuma Region Development Programme (1980-85)

The project was under Ruvuma regional afforestation programme for tree planting at different villages. Districts were supposed to raise peoples' awareness on tree planting and make people plant trees from family, village, to institution levels so as to make tree products available within peoples' vicinity. This programme ended with remote success because people at the grassroots did not accept it as the government at regional level through development fund, raised seedlings and forced people to plant trees. Seedlings were distributed freely of charge among recipients so lacked sense of ownership. Thus, regional and district authorities failed to identify the need of the people and proper approach to environmental conservation so peoples' freedom of range of choices was conflicted. Such failure is common to many top-down projects. A few promising results were seen in schools, colleges and religious institutions as people in such institutions have little options to question their masters. Afforestation schemes throughout the 1980s met opposition, with stories of villagers planting seedlings upside down or throwing them away because their needs were for agricultural improvement or health care (Scheinman, 1993).

4.2.1.2 Village Afforestation Programme (1988-1990s -ILO project)

The project was also formulated at Regional level and funded by International Labour Organisation (ILO). Mbinga district implementation of the project focused on three pilot villages Mhekela, Kihereketi and Liparamba all in Matengo highlands. The aim was to establish woodlots for environmental conservation and enable villagers have close supply of forest products e.g.

fuelwood, timber and protect mountaintops. This programme had some recommendable impact and Mbinga district was praised by regional administration due to good performance. A total of 220 ha were planted with trees and to date there still exists woodlots that most farmers use in respective villages for timber and fuelwood. Success was possibly due to small area of implementation, conspicuous alarming rate of vegetation cleansing and its obvious effects that was even apparent among villagers and keen emphasis from different stakeholders.

4.2.1.3 Mbinga Agroforestry Project (MAP) 1991-1996

MAP emanated as a product from the success of ILO village afforestation programme however, it was European Community and Mbinga district council that funded the MAP. The project aimed at finding out best alternatives to curb the problems of population pressure, environmental degradation, and ever increasing demand of forest products, declining soil fertility and alarming soil erosion. The project aimed at establishing and fostering/promoting sustainable use of the soil for agricultural potential. As commonly been, this project also concentrated much of its efforts in the Matengo highlands.

The impacts of MAP in Matengo highlands amongst others include the planting of trees along road banks, fence and shed trees around homesteads, and *grevillea robusta* in coffee farms. Others were planting woodlots of eucalyptus, fins, pines and black wattle on mountaintops and in eroded/gullied lands and along crop field to rehabilitate exhausted soils. Although the project found the need to planting fodder grass along crop field boundaries, which is one of the prone areas for erosion, nevertheless, least efforts were spent on the motive. This was bottlenecked by the lack of diary cattle in the villages to substantiate such costly and risky exercise. A few contour bunds and waterways planted with grass were made in various villages such as Muhekela village.

Despite these projects' efforts to rehabilitate degraded environments, the degradation of forest environment in Mbinga mostly done by the Matengo is at presently very severe especially in the rolling hills and lowland areas. The rate of vegetation cleansing if not urgently abated it would be quite not uncommon to observe the fall of Matengo and neighbouring ethnic groups' civilization.

The officer lamented that casual and bush fires are problem especially in Liparamba Division. Local people assent their actions due to availability of wild animals. The area has huge forestland that justifies people's norms and culture of burning vegetation. In due of this, the MAP conducted intensive meetings and seminars in Liparamba area backed up by laws and by-laws to curb the problem of bush/casual fires. Part of the suggestions by MAP has led to the gazetting of the Liparamba forest as protected game reserve in 2001. Indeed, presently compromising with

bush/casual/arson fires is a headache in the district. The Natural Resource Management department largely depend on courts to settle natural resource encroachment disputes. However, the district recognise the need for more polite and participatory way to manage natural resources but participatory approaches need more logistics and time.

Another legacy after the phasing out of the MAP is that there is growing substantial individual efforts to afforestation observed as people increasingly coming for seeds and extension at district NRM office. But the district NRM section has few seeds and seedlings to cater for the growing demand. Visiting farmers for monitoring has become unbearable task by NRM officers due to lack of means of transport and other logistics. According to Mr. Mwanga within four month from December 2000 to March 2001 villages and individuals raised about 206,617 seedlings and institutions raised 147,233 (schools, churches and NRM) seedlings. The current trees flourishing in Mbinga town are credited to the work of MAP. During the project life hilltops of 24 villages accounting for about 500 ha were identified and designated as protected areas mainly from the highlands. This aimed at increasing future availability of fuelwood and building material needs.

Other merits of the project include the improvement of soil productivity through agroforestry and increased woodlots outside natural forest hence declined pressure on catchments and natural forests. Catchments and villages for environmental conservation programmes execution were identified. High fruit production for food security at household level and sale of surplus was registered. Extension to beneficiaries on the merits of agroforestry and problem identification on the wake of poverty alleviation was also realised. Farmers' indigenous knowledge in planning different research based on in *situ* Indigenous Knowledge such as soil characterization, vegetation, crops and relations among them was enhanced. Scheinman *et al.* (1993) cover a wide range of issues related to this project and the state of forest resource base in the district.

It is recommended that future sustainability of natural resource management largely depend on farmers/beneficiaries awareness on maintaining the resource base and/or their quest to rehabilitate degraded resources e.g. through afforestation. Schools, religious institutions and NGOs also need to be participated fully as they have shown success in different projects. For instance, in saving fuelwood demand the renowned CARITAS has organised women group through the church and schools and has developed projects such as improved cooking stoves to counteract massive use of fuelwood and the project has proved successful in Mkako, Luwaita and Kilimani villages. The challenges faced by the NRM should always be tacked in a multidisciplinary way as the society it intends to save is faced with different conflicting interests that may contradict the success of an isolated event.

However, the challenges facing the NRM are still gigantic ranging from institution incapacity to facilitate its own activities to local peoples' perception on natural resource. As larger parts of the forests are assumed as free God-given resource and the myth is interpreted as a no-mans property. Lack of defined land tenure on such resources also jeopardise the NRM sustainability. It has also been difficult to establish proper land use boundaries to be executed by village environmental committees, as boundaries between villages are not well known neither by villagers nor officials. This provoked the delay of establishment of land use map of Buruma village in the Matengo highland that had conflict with Nangombo village situated along Lake Nyasa shore zone.

In the same way, management of public land is difficult for NRM office since there is no legal binding on the use of such land thus, haphazard immigration cannot easily put under control. Such land is not directly protected under any existing land-use law. It is the duty of the village government to protect, distribute and manage such land. Mismanagement and ill decision by some village government officials has led to great environmental raping e.g. Buruma village which is experiencing rapid environmental degradation (see Fig. 26 above). To curb such maladies, the district and central government are increasingly demarcating more land into forest reserve to protect further destructions. The NRM office in collaboration with villagers and village authorities are increasingly identifying endangered hills for protection.

Similarly, extended procedures to acquire permit for lumbering sometimes provoke people to engage in wanton tree felling. For instance, by 2002 one needed to pay licence fee of Tsh 52,000, registration fee of Ths. 100,000 and buy each tree e.g. *Pterocarpus angolensis* for Tsh 20000 and a permit to fell down tree costing Tsh 6000/m^3. Each of these permits and licences are obtained from different scattered offices and/or officials, which make the whole exercise fatigue and tiresome, lamented Mr. Mwanga. Another challenge faced by NRM office in relation to lack of defined tenure is that some of the land in newly settled area distributed by village governments to new immigrants had already have legal land lease which prompt conflicts e.g. in Masimeli village the land leased to one Martin (the urban based petty bourgeoisie) was allocated to other immigrants. In general, according to NRM officials there is poor awareness on natural resource management possibly because people are largely encroaching for survival. In order to survive, every decision they made seemed rational to them.

Lack of land use planning/map at different operational levels (village to district levels) constricts the accomplishment of meeting sustainable land use management. Lack of definite land use map prompts many land use conflicts. Arson fires have persistently putting the NRM

department at stake. Farm boundaries especially in the highlands are disastrous and prone to erosive actions of intense and erratic rains common in Mbinga. Unprotected homesteads collects water that latter act as a timing bomb runs down to unprotected field boundaries.

In 1992 the district council passed different by-laws (Mbinga district council, 1992) for sustainable use of the natural environment. The by-laws among other directives it gave mandate to village governments to formulate village environmental committees. However, the effectiveness of village environmental committees is hampered by their failure to deal with their fellow villagers who contradict district by-laws. In case of casual burning for instance most committees end up of reporting as the fire was caused by children or mental-retarded people who by the virtue of the existing laws of the land cannot stand trial.

4.2.3 Future district plans on environmental management

The NRM is subsequently supervising village governments on proper land use planning. This include proper distribution of land and appropriate size to immigrants leaving other areas as village greens through the use of simple village land use map. It is advised by NRM that immigrants should not be allocated land more than 6 acres/immigrant. It is advised by NRM that at least 1/3 of mountaintops should be left interact and this need to be under the overseer of village environmental committee (VEM), though it is ambiguous for villagers to identify the 1/3 measurement unit. Identify water sources and protect them from encroachment and enhance the capacity of VEM to bring more awareness to the fellow villagers and identify contact farmers and fight bush fires.

Future plans also earmarks on educating the future generation especially in schools. At least each school should have a tree nursery e.g. of black wattle, *Pterocarpus angolensis* (Mgwina) and Cinderella. In future, the need to establish catchments forest reserves with known stakeholders and their responsibilities and which give local people more ability to manage forest resource and protect it would be made effective through restructuring district and village by-laws that should outcrop from the beneficiaries. Thus, local people's participation should be given an upper hand in planning and implementation of NRM strategies. Indeed, environmental management strategies in Mbinga should in future also focus those people along the lowland and Lakeshore who have been persistent victims of the actions of highlanders than present stereotype of concentrating in Matengo highlands alone.

CHAPTER FIVE

LAND USE CHANGE AND ENVIRONMENTAL MANAGEMENT UNDER ECONOMIC LIBERALISATION

5.1 Influence of Mbinga Cooperative Union (MBICU) on Land Use in Matengo Highlands

Tanzania government reinstated cooperative movements in 1984 after it was formally abolished in 1976. The Ruvuma region, which Mbinga is one of her districts, established Ruvuma Cooperative Union (RCU) after re-introduction of cooperative movement in 1984. Later Mbinga Co-operative Union (MBICU) split from RCU among other reasons to facilitate management of coffee production and marketing in the Matengo highlands. One of the major activities of MBICU was the supply of agro-chemicals, micro-credit facilities, and extension to farmers in the Matengo highlands. Likewise, coffee marketing and quality control were altogether under the control of MBICU. Thus, MBICU ensured transportation of coffee production facilities to farmers located in Matengo highlands as well marketing of their coffee (Fig. 23).

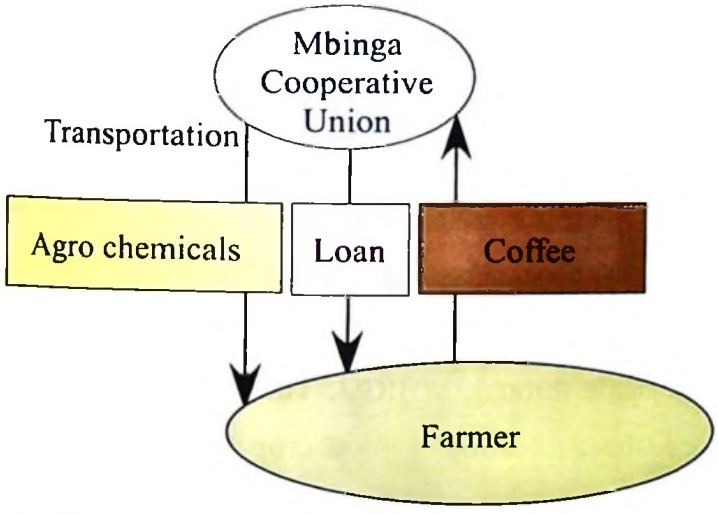


Fig.23. Functions of Mbinga Cooperative Union

Agro-chemical supply was important to Matengo farmers as coffee required intensive application of such agrochemicals. Normally, Matengo farmers apply agro-chemicals in coffee farms about 4-6 times per year. Also food crop production using agrochemicals was already popular until that time after the experience of green revolution during National Maize Project since mid 1970s. Maintenance of coffee economy was also very important for the Matengo food crop production system since most of the food crop farm inputs were bought from coffee income. This allowed intensification of both coffee cultivation and *ngolo* farms in the Matengo highlands. Thus,

agricultural intensification in Matengo highlands largely depended on agrochemical supply, the system that MBICU painstakingly tried to manage until when it collapsed latter in 1996.

Under MBICU umbrella there were several primary cooperative societies that ensured swift procurement of farm inputs, coffee marketing and other related services to farmers in the Matengo highlands. Credit facilities from MBICU to Matengo farmers included supply of agrochemicals, which were paid on later dates after coffee has been sold. Thus, Matengo farmers were not obliged to have cash to buy farm input, rather their coffee farms acted as guarantor. Most of farm inputs were supplied at village level especially at the offices of primary co-operative unions that were scattered in various villages in the Matengo highlands. On that reason, MBICU facilitated transportation of farm inputs in Matengo highlands where problem of transportation is chronic partly due to its natural landscape and lack of all weathered roads. Credit on cash for families in need was possible under MBICU to help families meet some immediate problems or emergencies such as paying medical fees, school fees and other household problems.

MBICU also paid money to coffee farmers on instalments and according to farmers the money that was paid to them during rainy season (lean months) helped the Matengo from possible hunger and starvation. Normally, rainy months in Matengo highlands are considered are hungry times because most food crop stocks harvested during one harvest season hardly persist to cross up to next harvesting time. Thus, money paid by MBICU at such lean months was partly used to purchase foodstuffs from other areas or Mbinga town. Later, to improve food security in the Matengo that could allow Matengo produce more coffee under stable environment, MBICU also supplied maize and beans on credit to the farmers in the Matengo highlands. Payments were deducted from the sale of coffee the household made through MBICU. Thus, MBICU not only maintained coffee production but also influenced intensification in food crop farming system as well as resolving some household difficulties.

Intensification of land use in the Matengo highlands under MBICU checked out-migration tendencies though normal migration due to population increase within *ntambo* continued but at stead level. Production of food crops in small plots of *ngolo* in Matengo highlands was made possible through intensive use of chemical fertilizer and supply of foodstuffs during lean months further improved life in the Matengo highlands. The role MBICU played in maintaining land use in the Matengo highlands faced with stiff challenge after Tanzania government introduced economic liberalisation under Structural Adjustment Programmes (SAPs) the country enacted later in 1980s.

5.2 Mbinga Cooperative Union during Economic Liberalisation

With weakening national economy in the last decades, Tanzania government embarked on economic liberalisation under Structural Adjustment Programmes (SAPs) in the second half of 1980s. Economic liberalisation among other adjustments included trade liberalization of coffee, removal of subsidies to farm inputs and retrenchments of civil servants. However, evidences mounted in the late 1980s and early 1990s show that structural adjustment programs in Africa were frequently accompanied by deepening poverty and accelerated depletion of natural resources (Berry, 1998).

The trade liberalization of coffee that was introduced in Mbinga since 1993 affected the agricultural change in a mixed style in the Matengo highlands. The Matengo highlands being one of the famous producers of coffee in the country it attracted private coffee buyers as free market was launched in 1993. At that time private coffee buyers were allowed to compete with MBICU on coffee marketing. Since then coffee farmers had the right to choose where to sell their coffee whether to private coffee buyers or Mbinga cooperative union (Fig.24).

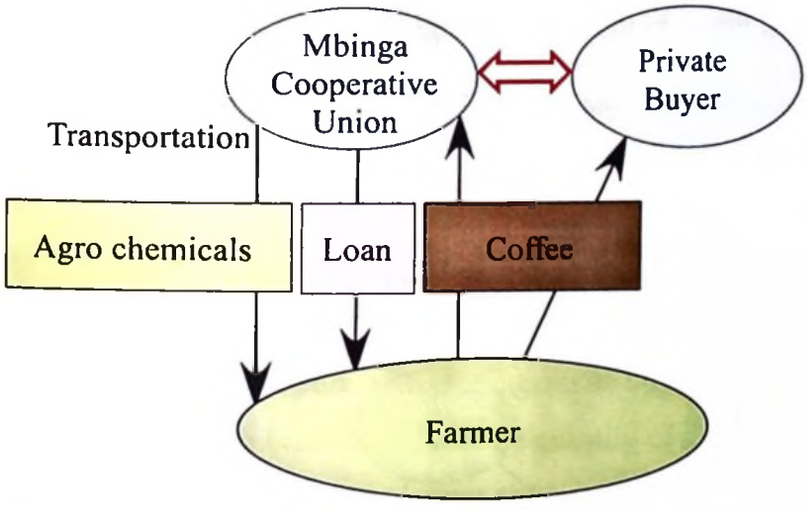


Fig. 24. Coffee marketing in Mbinga during economic liberalisation

Farmers preferred selling their coffee to private coffee buyers partly because private coffee made their payments to farmers on lump sum normally on the same the day farmers sold their coffee. This was contrary to normal instalments payment system commonly done by MBICU. Abrupt change in payment system introduced by private buyers brought farmers into uncommon financial management sphere. The new situation was not used by most coffee farmers in Matengo highlands. Sluggish spending was partly a consequence and when coffee prices stormed down after few years later, the farmers and their farming systems suffered severely.

The trade liberalization also brought in fierce competition between private coffee buyers and toddler cooperative unions. Partly because of stiff competition with private buyers, many cooperative unions that had supported production systems in rural areas of Tanzania collapsed. Mbinga Cooperative Union (MBICU) was one of the victims of undue pressure exerted by the free market economy. Collapse of MBICU in 1996 means crumpling of services it provided to Matengo farmers such as provision of micro-credits to farmers, supply of farm inputs, extension services and marketing of coffee. These services crippled off during trade liberalisation, the corollary of which include the crumpling of Matengo farming systems, the environment and general livelihood.

After collapse of MBICU in 1996, private coffee buyers dominated coffee marketing in Matengo highlands. Private agrochemical shops in Mbinga town centre wiped out the supply of agrochemicals that was made under MBICU up to the village (Fig. 25). Credit facilities to secure such farm inputs seized and Matengo farmers were obliged to pay in cash when buying agrochemicals from private shopkeepers. Transportation of farm input by Matengo farmers from Mbinga town centre to steep sloped Matengo highlands became a common problem. Such situation made the inaccessible of inputs in the Matengo highlands, which as well affected land use systems in the area.

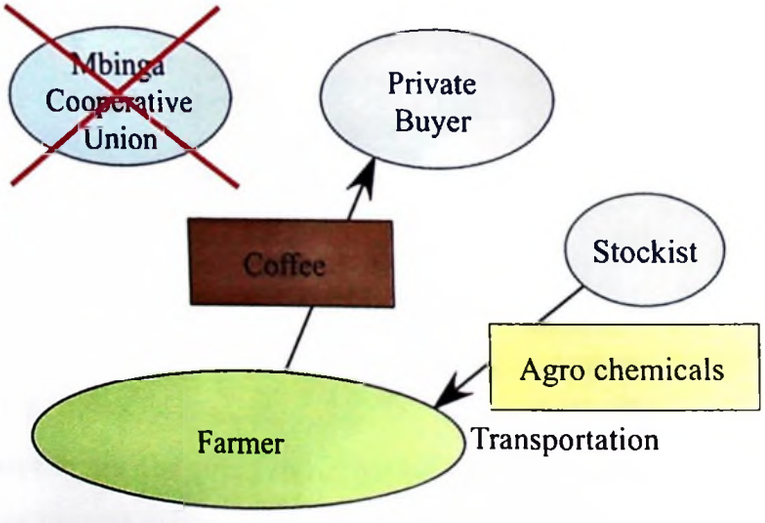


Fig. 25. Coffee marketing and input supply system after collapse of Mbinga Cooperative Union

Another situation during the first years of coffee market liberalisation was an unprecedented rise of the coffee prices (see data in Fig. 26). The rise in coffee price was, however, a short-lived phenomenon. By 1998/99 season farmers experienced crumpling coffee prices just a year after they registered highest coffee price of about 1200 Tsh/kg (about 1 US$) in 1997/98

season. Drastic fall of coffee price in Matengo highlands was accentuated by a number of factors such as the fall of coffee prices in the world market partly due to increased supply of coffee in the world market especially from industrial coffee produced in countries such as Vietnam.

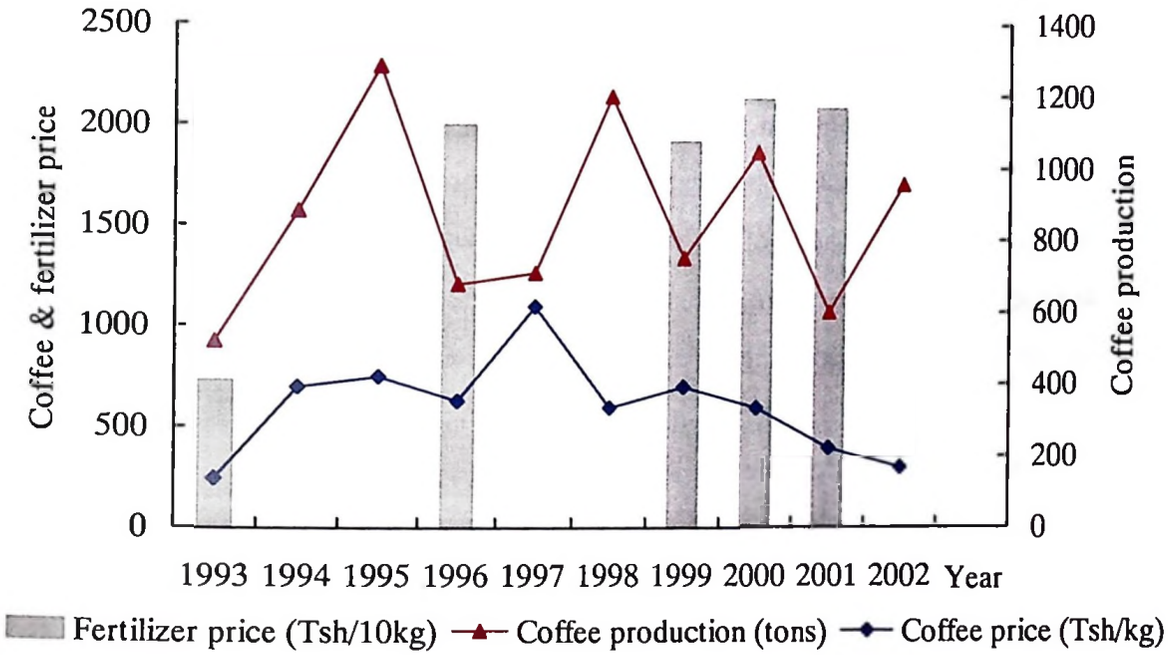


Fig. 26. Coffee production and prices of fertilizer and coffee trends after economic liberalisation
Source: Quarterly Report May-June 2001 Mbinga District Council Agriculture Dept AG/A.20/V

At local level, the quality of Matengo coffee also fell tremendously. During free market farmers were made not to care about the quality of coffee rather the quantity alone. Private buyer companies used unqualified commissioned agents to buy coffee direct from farmers. These agents were paid on commission basis respect to the quantity of coffee they have collected from farmers. Such a situation drove farmers to plunder the systematic procedures of preparing and caring for good quality coffee e.g. instead of fermenting coffee beans, farmers just boiled the coffee beans. This led to falling of coffee quality and hence its price at the world market.

Economic liberalisation also led Tanzania government to remove subsidies on farm inputs in 1991, devaluation of Tanzania shilling (Tsh) and subsequent inflation, which drove fertilizer prices beyond most farmers reach. However, MBICU ensured fairly stable supply of farm inputs to the Matengo though at new high price. Later, with collapse of MBICU in 1996 and new rise of farm input price on the same year, accessibility and supply systems of farm inputs dwindled altogether. A new rise of chemical fertilizer in 1996 as shown in Fig. 26 above meant that while coffee prices were continually falling (especially after 1997/98 season), the price of chemical

fertilizer kept on raising. Likewise, transportation of farm input became increasingly problematic, as private agrochemical traders were not available at village level. The situation affected sustainability of both the land use systems and the environment in Matengo highlands. Thus, farm input inaccessibility for farmers was due to both in terms of high price and remoteness as they were now supposed to buy them from private shops located in Mbinga town.

Tonnage of coffee production also kept on fluctuating at declining trend especially from 1995/96 season. With unrest in major production unit, the Matengo had to adjust their land use systems as well as other livelihood strategies. Some of the adjustments they made in land use systems had changed the state of the environment as will be discussed in the next chapter. Below are some of the adjustments in terms of land use change made by the Matengo farmers after collapse of MBICU and tumbling rural economy in the Matengo highlands.

5.3 Influence of Economic Liberalisation on Land Use Change

As indicated in previous section, MBICU helped maintain land use systems in the Matengo highlands by providing external inputs until it collapsed in 1996. Private coffee buyers under private liberalisation were neither prepared to provide such systems to farmers nor had enough experience to deal with complex farmers behaviour, which interrupted general livelihood of Matengo farmers. Thus, disruption in supply systems of basic farm inputs to farmers in Matengo highlands after collapse of MBICU might have impacted on indigenous land use systems and environmental management in the Matengo highlands where until that time intensive agricultural systems had been already developed through the use of agrochemicals. The following are some of the land use system adjustments in the Matengo highlands under the influence of trade liberalisation.

5.3.1 Expansion of cassava cultivation

After collapse of input supply systems in the Matengo highlands due to collapse of MBICU, followed by increased price of input and decline of coffee price since 1998/99 season, the Matengo had to adjust their several livelihood strategies including their land use system. Some farmers opted to plant root crops such as cassava (*Manihot esculenta*) and sweet potatoes (*Impomea batatas*) in such worn out soils instead of just leaving the fields under fallow. Expansion of cassava cultivation in Kipololo and Mapelele *ntambo* in Kindimba village (Mountain Area) has been through conversion of former *ngolo* farms that used to grow maize and beans (Fig. 27). This tendency was influenced by the fact that *ngolo* farms in Matengo highlands could hardly worked

out without chemical fertilizer. Thus, change in land use was influenced by both as means for food security as well as conservation of worn out soils.

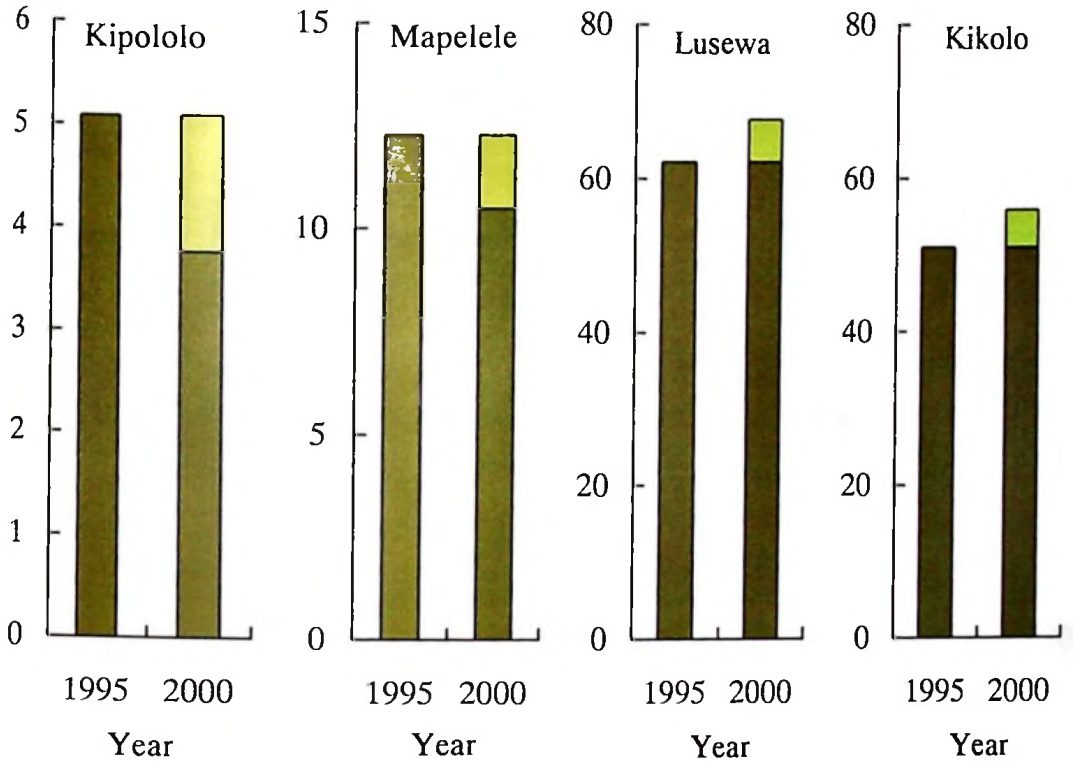


Fig. 27. Expansion of cassava cultivation in studied *ntambo*

In Rolling Hills *ntambo* (Lusewa and Kikolo) in Kitanda village the expansion of cassava cultivation has been through opening up new farm fields rather than conversion of existing farm fields as indicated in the same Fig. (27). This is possibly due to availability of extensive unutilised land in Rolling Hills than limited land size for expansion in the Mountain Area. Cassava fields in Rolling Hills were largely made on conventional ridges. Cassava is also increasingly replacing maize as a staple food both in the Mountain Area and Rolling Hills and also as an important source of income in latter sub-agroecological zone. Thus, whereas expansion of cassava cultivation is both a conservational and food security strategy in the Mountain Area, it is an outstanding source of income as well as food security in the Rolling Hills.

According to Meertens *et al.* (1995), the tendency of expanding root crops cultivation in worn out soils could be ascertained by the fact that cassava is able to produce higher yields of carbohydrates per acre in worn out soils like those of Matengo highlands and can be stored in the soil for more than a year. Under cassava fallow, the field is left unwedded, a situation that can influence improvement in soil fertility. Also the cultivation system is relatively less labour

intensive especially when planted on ridges. Similarly, drought can be tolerated to a certain extent by cassava because it stops growing during such a period.

Another root crop that gained importance in the Matengo highlands after crisis in major crop production systems is the cultivation of sweet potato (*Ipomoea batatas*). Sweet potato is also preferred because it is as well considered as a food security crop. Sweet potatoes matures quickly, in 2-4 months and its harvest is in very "crucial times" when the Matengo have no food stocks mainly from December to April. Thus, it provides food security when stocks of the last season are at a blink and before cereal harvest. It can besides be planted and harvested more than once per year, and can tolerate drought and be planted quickly after dry spell, and utilize idle land. Application of chemical fertiliser as well is not necessary in sweet potato farms. The root crops are thus, utilize the otherwise less arable land and intensify its use hence soil rejuvenation and food security as well as income are improved within household.

According to village government officials in Kindimba and Kitanda villages, cassava has become increasingly grown in worn out soils and it is steadily replacing maize as a staple food. Since 2000/01 every household was compelled by village by-laws to cultivate at least 250 *ngolo* (0.5 acre) of cassava each year. This was done under the district slogan of directing village governments to insist growing of crops that strive in poor soils in their respective villages.

5.3.2 Active use of valley bottom

Another adjustment by farmers in 1990s includes the intensive utilization of the valley bottoms, which until this time were only extensively used (Fig. 28). Indeed, intensive valley bottom cultivation is not new among the Matengo. The active valley bottom cultivation system dates back as early as when they settled in the Mountains and their ethnic identity was established. However, active valley bottom cultivation practice was not so famous in the last few decades. This was partly due to bubble coffee economy and intensification in *ngolo* farms due to the use of chemical fertilizer hence the Matengo had enough food or had ability to buy food from coffee income. Thus, as far as coffee and *ngolo* cultivation systems produced enough for subsistence, the Matengo kept valley bottoms idle to relieve them from another intensive cultivation system. But when coffee and *ngolo* failed to satisfy even subsistence needs, the Matengo went back to the old system of actively cultivating the valley bottoms since it required no fertiliser.

Active valley bottom cultivation is thus linked to declined food crop production in *ngolo* fields due to failure to purchase chemical fertilizer after the crisis in coffee economy. Revived valley bottom cultivation both in Rolling Hills and Mountain Area is basically for food security as

1997

2001

Fig. 28. Trends in valley bottom cultivation in the Matengo highlands

well as income diversification. Maize (*Zea mays*), taro (*Colocasia esculenta*) and beans (*Phaseolus vulgaris*) in valley bottom gardens are harvested during rainy months when food security is at a blink among most Matengo households. Taro and sugarcane (*Saccharum* sp.) have also become important crops for income generation along with tomato (*Lycopersicon esculentum*) and onion (*Allium cepa*). It is not uncommon to see petty traders from Mbinga town visiting Kitanda village looking for taro due to its high demand in Mbinga town market. Increased market demand for taro influenced the farmers changing the old taro variety (whitish) that produced numerous but small-sized and less weight taro to reddish variety that produces large sized and heavier taro for fetching high price in Mbinga market.

It was also unfortunate that when initial impacts of economic liberalisation were heightening in Matengo highlands it coincided with other major natural calamities. In 1995/96 season the Matengo highlands experienced serious outbreak of maize viral pathogen, which caused a disease known as maize leaf blight. Maize leaf blight severely affected maize production in *ngolo* fields. Again in 1997/98 season the Matengo highlands like the rest of Tanzania was affected by El Nino rains that destroyed the farms and transport infrastructure. At this time Matengo highlands and the rest of the district declared a hunger stricken zone and food relief were to be provided to the people, a phenomenon commented by the Matengo as quite unusual.

After the outbreak of the maize leaf blight in mid 1990s the planting of maize in *ngolo* fields using local varieties became a useless exercise because they became prone to the maize leaf blight pathogen. Farmers were advised by district agricultural and livestock development department to plant maize using hybrid seeds such as Kenya H6302, H625 and H614. The prices of these seeds were once again inaccessible to the majority of farmers due to falling income of coffee and supplies were only possible if someone visits Mbinga town. Matengo opted among other innovations to actively cultivate valley bottoms where the need for both chemical fertilizer and improved seeds was less. Valley bottom farms also appeared less affected by maize leaf blight pathogen possibly due to different cropping season with that upland of *ngolo* fields.

Following declining performance in rural economy, the Mbinga district council has continuously giving out directives to village governments, ward and division officers as well as district agricultural development office on alleviating the situation. Village governments in the Matengo highlands have been ordered to make sure every household cultivate the valley bottom gardens and cassava plots to alleviate the hunger situation and reduce dependency on chemical fertilizer.

Village governments in both villages also intervened by putting by-law that all households should engage in valley bottom cultivation during dry season (*kilimo cha kiangazi* or *kilimo cha kujinusuru*). Each household was obliged to cultivate at least 0.5 acre of valley bottom garden. In Kitanda village, the village government gave directives to villagers that individuals with unutilised valley bottom gardens would their valley bottomlands be given to others without land in the valley bottoms for free for 5 years. In Kindimba, the village government declared to villagers that individuals with unutilised valley bottomland, their land would be taken by the village government and given for those without it for effective utilisation of valley bottomland. These challenges increased valley bottom cultivation and those with plenty of valley bottomland sold or rented part of it. Theft of valley bottom crops declined because almost every household engaged into cultivating it. Village officials' in both villages argued that valley bottom cultivation has been important source of food security during hungry months in rainy season normally from December to April. Harvests from valley bottom gardens during lean months made the labour intensive *ngolo* cultivation possible in March as more food is needed at that time to ensure body energy supply to make *ngolo*.

5.3.3 Continuous expansion of coffee farms

Expansion of coffee farms within *ntambo* is not unusual in the Matengo highlands. Ever since coffee was introduced in the area the Matengo have been cultivating it within homestead for easy management of series of farm activities it requires. Monetary value attached to coffee also influenced intensive management. As a common practice, male kid establishes his independent home after inheriting land from his parents he cultivates coffee around homestead and remaining part of land he cultivates food crop using *ngolo* cultivation slightly away from his homestead. He maintains production in *ngolo* field using chemical fertilizer, which he buys normally from coffee income.

Collapse of farm input supply system and its inaccessibility due to high price and distance from supply centre and dwindling coffee price during economic liberalisation have not deterred the Matengo from expanding their coffee fields. However, the new tendency among farmers in Kipololo and Mapelele *ntambo* in Kindimba village (Mountain Area) is not only continued expansion of coffee fields through converting *ngolo* fields into coffee farms but also the sudden increased tendency of opening up new farms for food crops in distant areas. Thus, land within *ntambo* is continually being covered by coffee pushing food crops in distant villages where they could visit on temporal basis. This is possibly due to fact that new generation finds it harder to divide small-inherited plots into *ngolo* and coffee farms hence decide cultivate coffee only as it would be difficult to cultivate food crops in small plots of *ngolo* without applying chemical fertilizer. Fig. (29) shows that farmers are continually expanding coffee farm size despite falling trend of coffee prices. Thus, current coffee expansion is not necessarily due to farm expansion by new generation rather even the old generation are on the move to replace their fertility stricken *ngolo* fields by coffee. Also it should be noted that current expansion tendency is not influenced by monetary gain as was used to be but by utilising fertility stricken small plots of *ngolo*.

In Lusewa and Kikolo *ntambo* of Kitanda village (Rolling Hills) expansion of coffee farm was done in woodland or fallow land. It was not necessary in Lusewa and Kikolo to replace food crops by coffee farms due to availability of ample land for expansion due to small population density and the village is relatively new compared to Kindimba. Likewise, application of chemical fertilizer in food crop fields is yet to gain popularity in the woodland zone.

Thus, Mountain Area farmers have developed two major cropping zone, the Mountain Area for cultivating coffee and distant villages (normally in the woodland) for cultivating food crop. It became possible to displace food crop farms into the woodland because opening farms in frontiers requires no fertilizer application.

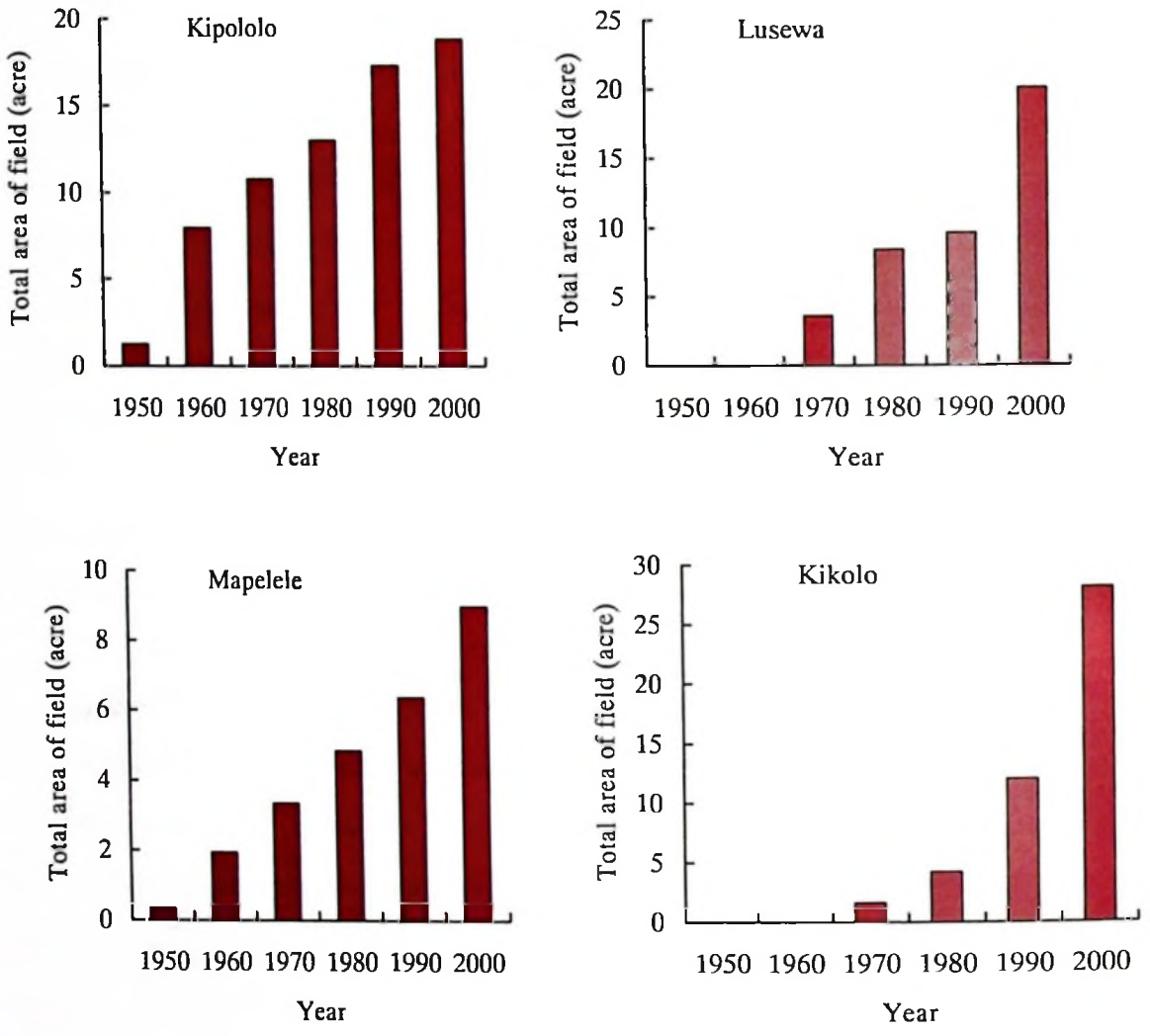


Fig. 29. Expansion of coffee fields in studied *ntambo*

5.3.4 Cultivation of distant farms

Land use within *ntambo* as shown in Kikolo aerial photo in Fig. (30i) indicates that in a new village or in early *ntambo* establishment most of land use activities concentrates within *ntambo*. Normal or steady trend of land use change in *ntambo* in the Matengo highlands follows the trend that population increase within *ntambo* coincides with land division through inheritance. This situation leads to increased coffee farms within *ntambo* and dispersion of food crop farms outside *ntambo* as indicated in Kipololo aerial photo (Fig. 30ii). As population heightens and further land division among family members become impractical, it is common that after 3-4 generations some members of the clan would move out to settle permanently in other areas where they start a new *ntambo* land holding system. This kind of emigration has maintained *ntambo* as a socio-geographic and economic production unit for quite a long time. Table () shows area, population and population density of studied ntambo. It is clear

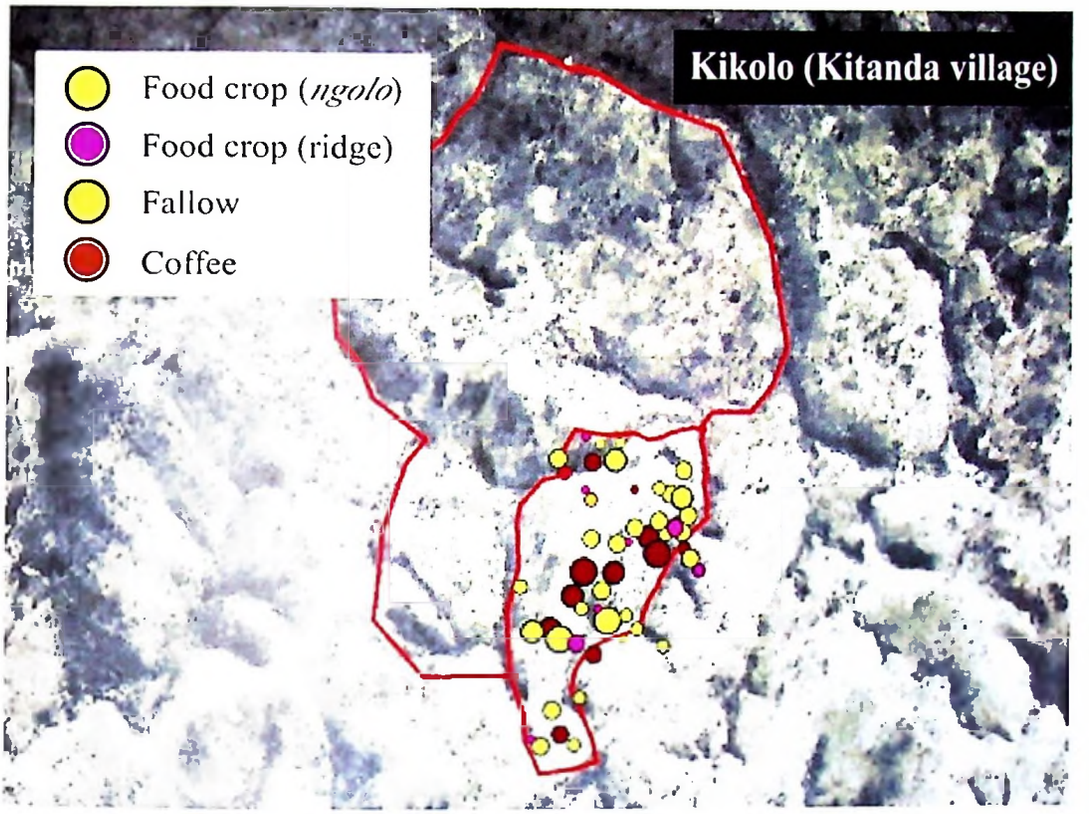


Fig. 30i. Land use during early establishment of *ntambo* (Kikolo *ntambo* Kitanda village)

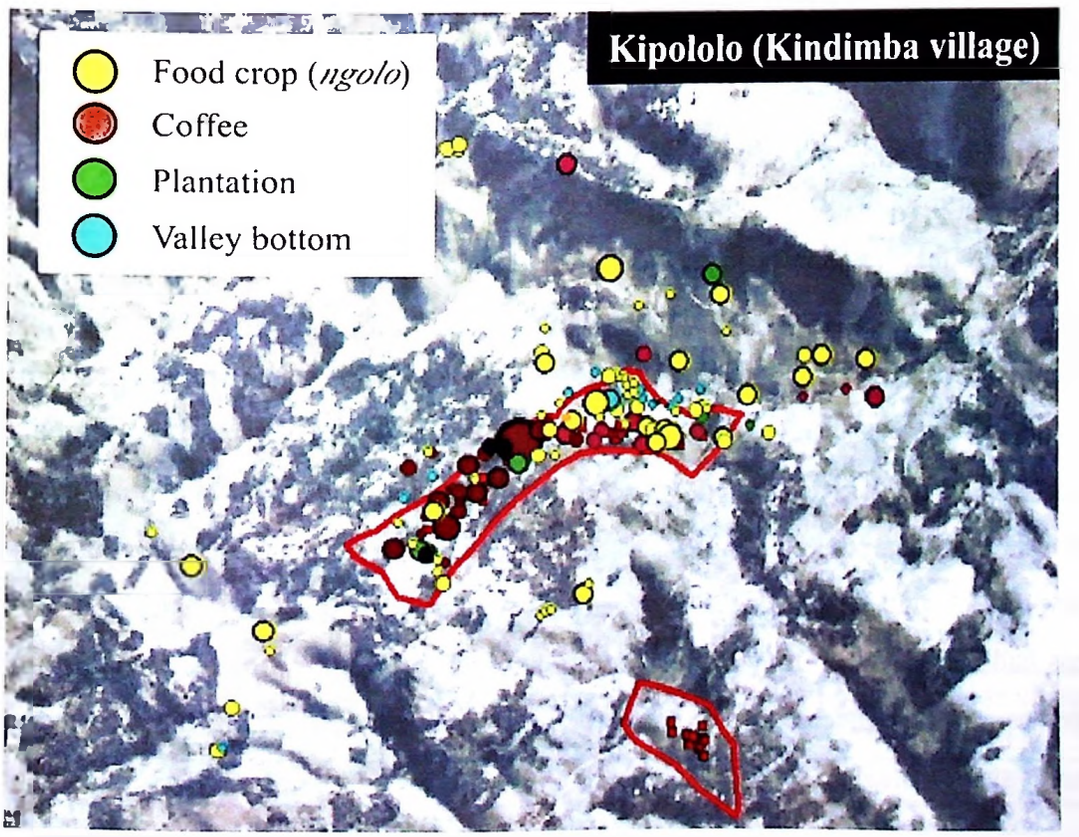


Fig. 30ii. Dispersion of land use in old established *ntambo* (Kipololo *ntambo* Kindimba village)

Table: 11. Area, population size and population density in studied ntambo

Village	Ntambo	Area (km^2)	Population size	Population density (person/km^2)
Kindimba	Kipololo	0.3	137	457
	Maplele	0.1	70	700
Kitanda	Lusewa	1.3	67	52
	Kikolo	0.8	65	81

population density is souring in Mountain Area villages compared to Rolling hills villages. This is partly because despite stead out-migration to woodland area there is a tendency that some members especially the young generation refrain migrating to woodland. This is contributed by the fact that they are not used of clearing dense vegetation and increased events of malaria in the woodland areas. Other reasons for remaining in the Mountain include the influence of well-established coffee economy in the mountain area as well as improved transportation infrastructure. Also Mountain Area is a place where their ancestors were laid to rest so it remains their important place for customary practices.

Appendix 3 shows a case of one extended family known as Ndunguru in Kikolo *ntambo* (Kitanda village) on how inheritance steadily squeezes clan landholding in Matengo highlands, which leads to out-migration of some clan members after 3-4 generations. The Appendix shows that extended families, which eventually influence out migration. It was revealed during my household survey that the clan head of Ndunguru clan Mr. Dominicus Ndunguru an immigrant from the Mountain Area arrived in Kikolo *ntambo* in 1964. At that time he secured about 150 acres of land. During that time all of his cultivation activities were concentrated within the *ntambo.* With population increase and continued divisibility of land among family members through inheritance, cultivation of fields outside *ntambo* became necessary. After continual distribution of his land to his offspring, Mr. Dominicus was by 2002 left with about 7 acres of land. In 2002 he bought new *ntambo* outside village where he expects to transfer some of his siblings. By 2002 Mr. Dominicus had already established four generations, which is common in Matengo highlands to start migration to other places. Fig. 31 tries to illustrate the meaning of within *ntambo*, outside *ntambo* and outside village.

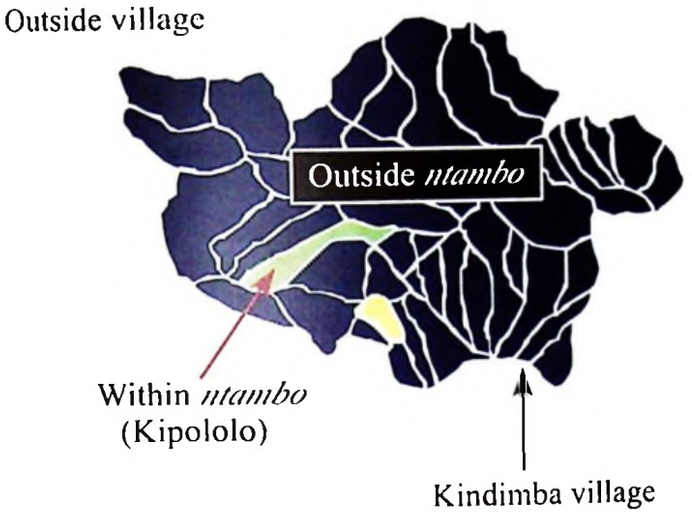


Fig. 31. Illustration of within/outside *ntambo* and outside village

Recent phenomenon, however, especially in old village Kindimba (Kipololo and Mapelele *ntambo*) shows increased tendency of concentration of coffee fields within *ntambo* and dispersion of food crops in distant farms outside the village (Table 30). I observed during my study that some of the food crop farms located in distant villages require up to two days walk to arrive. Separation of cultivation zone (food and cash crop zone) is a result of converting maize and bean *ngolo* fields by coffee farms within *ntambo* mainly in the Mountain Area. This tendency is influenced by the

Table 12. Farmland distribution (acreage %) among households in studied *ntambo*

Table. Farmland distribution (area%)

Coffee

		Within *ntambo*	Outside *ntambo*	Outside village
Kindimba	Kipololo	80.5	18.6	0.9
	Mapelele	61.2	38.8	0.0
Kitanda	Lusewa	92.0	0.0	8.0
	Kikolo	100.0	0.0	0.0

Food crop

		Within *ntambo*	Outside *ntambo*	Outside village
Kindimba	Kipololo	12.4	44.0	43.5
	Mapelele	26.5	50.4	23.1
Kitanda	Lusewa	77.0	17.4	5.6
	Kikolo	84.8	8.4	6.8

fact that management of *ngolo* fields without using chemical fertilizer is becoming difficult especially in Mountain Area zone.

Likewise, expansion of cassava cultivation in the Mountain Area also influences the increased tendency of cultivating food crops (maize and bean) in distant villages. This is precisely because cassava takes up to three years to mature in the Mountain Area. Thus, while *ngolo* fields within *ntambo* is continuously being converted to coffee and cassava, people in Kipololo and Mapelele have developed tendency of cultivating bean and maize farms in distant farms where it takes one or two days walk to arrive. In distant areas, mainly in the woodland (Rolling Hills) new farms are opened up mainly made of ridge or flat seedbed which may possibly provoke soil erosion in undulated slopes in the Rolling Hills.

Number of households and period (year) they started cultivating distant farms as indicated in Fig. (32) clearly shows unprecedented increase of number of households engaged in temporal distant field cultivation since 1990s. Thus, the old tendency that some clan members would emigrate permanently to woodland after 3-4 generation is increasingly being replaced by temporal cultivation of distant farms in the woodland while their residence is maintained in the Mountain Area. This leads to the creation of two separate crop production zones; one in the Mountain Area for producing coffee and another in the Rolling Hills or woodland for food crop cultivation. Since the residence of households cultivating distant fields remain in the Mountain Area, this certainly

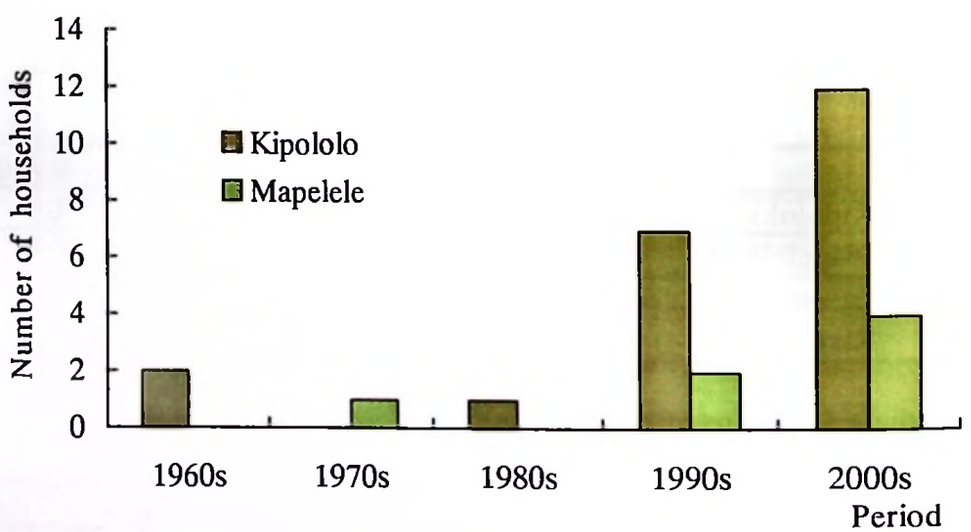


Fig. 32. Number of households in Kindimba village and period they started utilising distant farm cultivation

Note: The total number of household in Kipololo and Mapelele were 32 and 13, respectively in 2003.

provokes more population density in the Mountain Area whereas food crop farms are increasingly dominating woodland without residential pattern around.

The increased tendency of utilising distant farms common since 1990s coincides with the time of trade liberalisation of coffee and declining rural economy in the Matengo highlands. Thus, farmers in the Matengo highlands responded by cultivating distant farms in the woodland that needed no chemical fertiliser application. Also this new tendency could be interpreted as a failure to buy new *ntambo* in the new village where they could settle permanently after collapse of coffee economy. Hence, they opted for leasing or borrowing land in distant areas where they could attend them on temporal basis.

Fig. (33) shows means of land acquisition for land acquired within *ntambo*, outside *ntambo* and outside village. The figure reveals that while most of the land within *ntambo* was obtained through inheritance, distant farms were obtained through lease, which is normally a two to three year contract. This ascertains deteriorating ability of the Matengo to purchase new *ntambo* in distant areas where some clan members would have migrated. Continuous change in landholding from inheritance to lease landholding system had drifted conceptualisation of landholding from

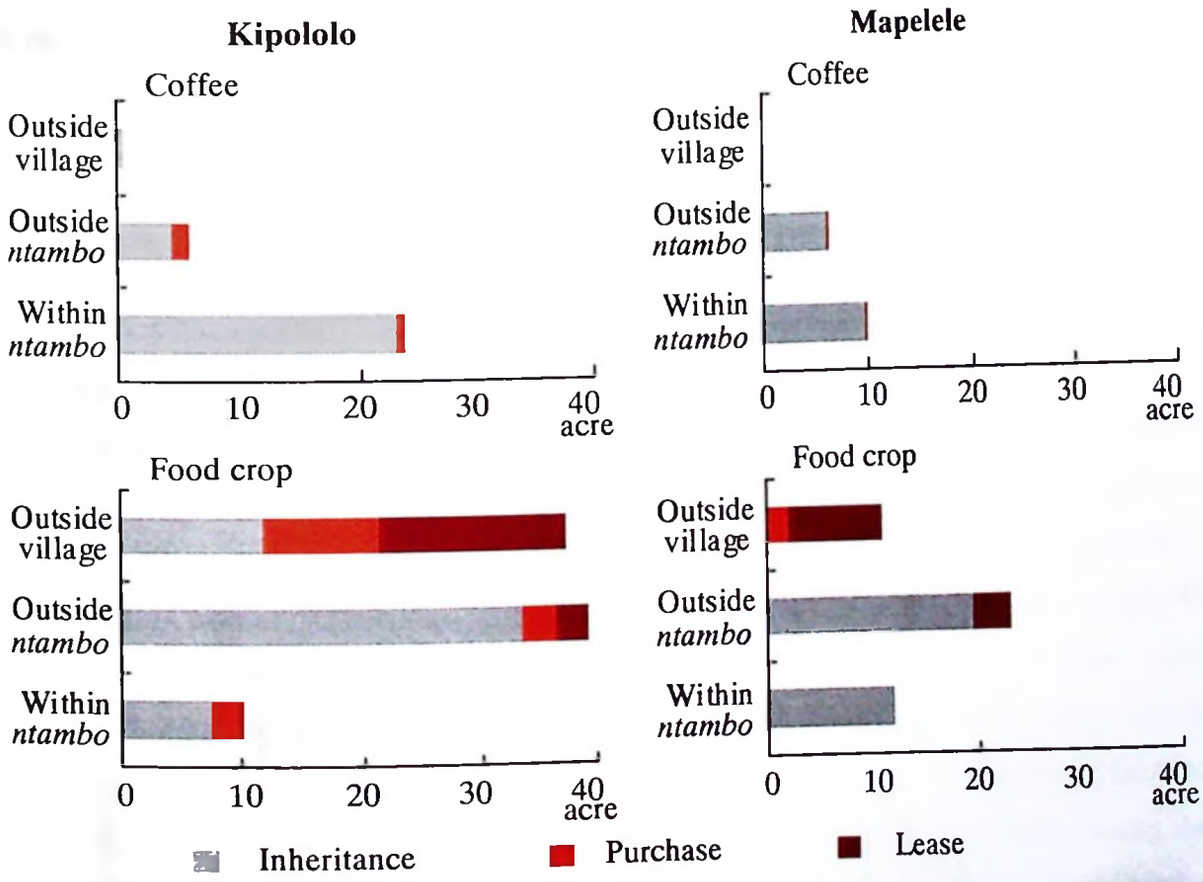


Fig. 33. Means of land acquisition in Kipololo and Mapelele *ntambo* in Kindimba village

'my land' to 'someone's land' that certainly affect conservation and care in leased land. It should be noted that the purchase and lease of land are normally transactions between individuals and not between government individuals.

Influence of economic liberalisation on land use change in Kindimba village in the Mountain Area and Kitanda village in Rolling Hills have so far discussed. Though both villages have shown similar trends of change, however, there were some differences in the direction and extent of change. Land use in Kindimba village seem to have been highly impacted possibly because the village had until the time of introduction of trade liberalisation had already developed strong mono-cash crop economy through coffee cultivation. Tumbling of coffee economy therefore resulted into various modification of peoples' livelihood in Kindimba village. Similarly, lack of ample land where could extends their farms also obliged them to change their land use systems. The direction has been towards cultivation of distant farms in the woodland for planting food crops.

In Kitanda village much of the modifications in land use was converting fallow or woodland to crop farm within *ntambo* rather than converting existing crop fields or utilising distant farms. This was so because of prevalence of extensive unutilised land in Kitanda village partly due to low population density. Thus, despite difference in the extent and direction of change, both villages experienced land use changes under the strong influence of trade liberalisation.

From this section the most striking trend after trade liberalisation especially among Kipololo and Mapelele *ntambo* household was the cultivation of distant farms. Lack of conceptualisation of environmental management issues by temporal immigrants from Mountain Areas in distant farm destinations (in the woodland) pose issues of further debate to manage both the land use and the environment in the Mountain Area and Rolling Hills of Matengo highlands. These is therefore increasing need of considering an integration both zones in terms of management rather than treating them separately. The effect of attending distant farms and changing means of landholding on the environment will be discussed in the next chapter.

CHAPTER SIX

IMPLICATIONS OF LAND USE CHANGE ON ENVIRONMENT UNDER TRADE LIBERALISATION

6.1 Change of Land Cover in Kitanda Village

Decline of income in Matengo highlands after crisis in coffee economy among other impacts led to drastic increase of opening up new food crop farms in the woodland by both farmers from the Mountain Area as well as those already reside in the woodland. Thus, the miombo woodland was under new pressure from not only the Mountain immigrants but also the Rolling Hills inhabitants.

The tendency of visiting distant farms on temporal basis by Mountain dwellers leave a lot to be desired in terms of the state of the miombo environment. Unregulated deforestation in miombo woodland has become common as shown in satellite images of Kitanda village in Fig. (34i). This could be suspected due to a tendency of unregulated cutting down of trees for opening up new farms by temporal Mountain immigrants because their primary goal is to get a farm rather than to conserve the environment as they used to do in the homeland. In the homeland the Matengo normally leaves some trees for fuelwood, conservation and, or other social values. But in distant farms the notion of managing the tree cover becomes out of their scope. Hence, unregulated deforestation becomes common places.

The new trend also contradicts with the old custom when *ngolo* fields were located within *ntambo* or just outside *ntambo*. The old custom show that the Matengo had a tendency of visiting their *ngolo* fields after heavy down pour to see if there is any broken *ngolo* ridges that need maintenance. Recent phenomenon of cultivating food crops in distant areas where they visit only on temporal basis affect the maintenance of land use as used to be when they cultivated within the *ntambo*.

With failing household income in 1990s some households especially in Kitanda village are engaged in charcoal making for sale in Mbinga Township to enable household attain some necessary household daily needs. Flourish of charcoal making as a source of income after collapse of coffee economy in 1990s among the Rolling Hills people also led to deforestation of miombo woodland in the area. Before trade liberalisation charcoal making was not so popular among the people in the Rolling Hills. The activity of charcoal making was done by urban people and nearby prison staff. After dilemma in coffee, charcoal making became popular among Kitanda residents

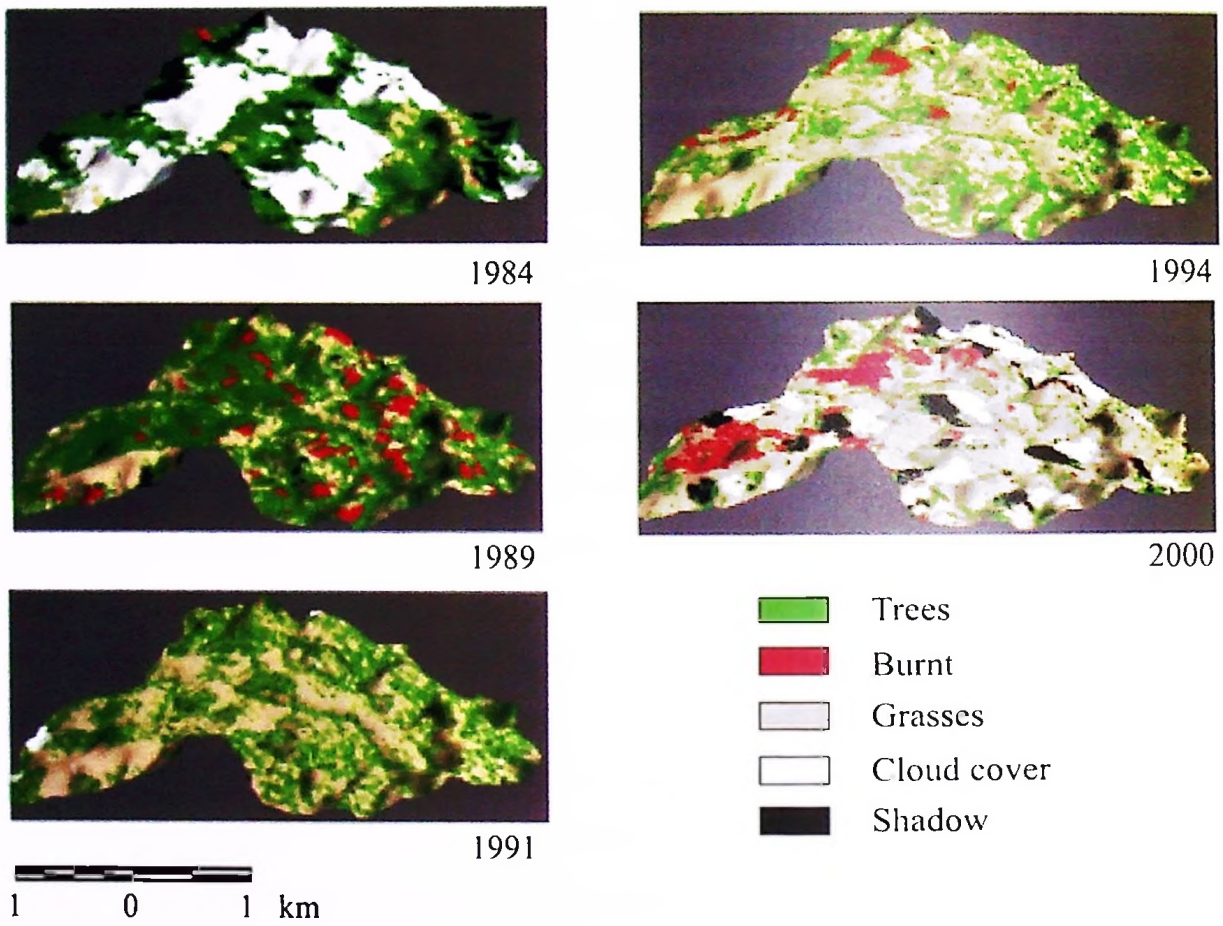


Fig. 34i. Satellite images showing trends of land cover change in Kitanda village

and it became difficult for urban traders to make it by themselves in Kitanda because owners of the woodland could not allow them. Instead, woodland owners were interested in being contracted by urban traders to make charcoal and paid for their job. It also became common among Kitanda charcoal makers to sell it in town directly for fetching up high market price. Degradation of tree covers due to search for firewood was also common in the Rolling Hills. This could be due to the fact that most fuelwood supplied in Mbinga Township came from Rolling Hills besides villagers' own consumption.

Satellite image analysis in Fig. (34ii) of Kitanda village from 1984 to 2000 explains clearly the prominance deforestation activities in miombo woodland. The figure shows that the village had maintained about 85 percent of tree cover (largely miombo and small part of agroforestry in coffee) by 1984 although the area had been inhabited even before 1960s. However, deforestation has mounted in less than twenty years from 1984 to 2000 thereby tree cover has dropped from about 85 percent in 1984 to less than 20 percent in 2000. Thus, highest deforestation seems to occur in time corresponding to economic liberalisation, the time when Matengo rural economy faced many difficulties and many land use adjustments were made at that time.

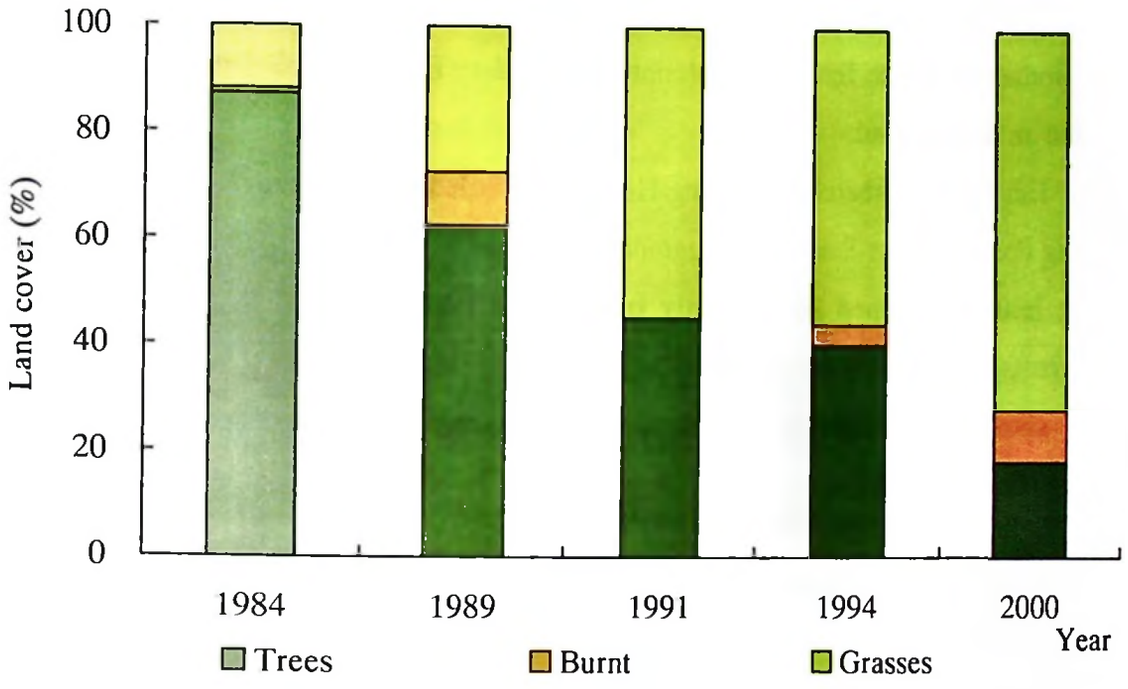


Fig. 34ii. Satellite image analysis of Kitanda village

The same satellite image analysis also shows tremendous increase of grass cover, which largely includes farm fields and other areas converted from woodland to grassland. This is perhaps due to increased tendency of opening up new farms or cutting down trees for charcoal burning or due to casual burning.

It must however, be acknowledged that *miombo* woodland is a vegetation type that contributes little to the soil in terms of fertility. Once, disturbed, its contribution disappears quickly and it cannot be replenished hastily. Thus, utilization of such fragile ecosystems calls for careful conservation strategies that will permit long-term use of such fragile environments. Dominance of extensive infertile soils (*lipusa*) in rolling hills village such as Kitanda meant that immigrants from Mountain Area had to open up vast areas of land to produce satisfactory for their subsistence. If it remain the same therefore, more clearing of the miombo woodland would persist for sometimes to come.

Ecological tendency in Lusewa and Kikolo *ntambo* was the dominance of extensive flat plateaus (*lipusa*) that has been under fallow for years. The soils in *lipusa* are locally called *tifutifu* and the ecology as *lipusa*. *Tifutifu* soils on stable flat plateaus are supposed to be extremely weathered. This limits the soil ability to hold soil nutrients hence increased leaching of basic soil parameters to support crop growth, hence its infertility. *Tifutifu* soils are classified into Oxisols whereas reddish soils in *ngolo* field on slopes are classified into Ultisols (Msanya *et al.*, 1996). Commonly, phosphorus combines easily with iron (Fe) in Oxisols and crops cannot absorb the compound. Thus, though in

Kitanda still exits large flat plateaus covered with Oxisols, local people hardly utilise such land for crop production due to fertility constraint. Instead they utilize a few patches of arable lands (Ultisols) situated on sloping land.

During my research in Rolling Hills, households also lamented the cutting down trees for opening up new farms lead forest degradation in their area as shown in Table (10). New farms in rolling hills are opened up not only by the inhabitants of the Rolling Hills alone but also immigrants from Mountain Area and Mbinga Township. According to Mbinga District Council (1997) about 64% of Mbinga town dwellers were farmer-based and utilized much of farms in the Rolling Hills.

Table 13. Percentage factors affecting tree cover in Kitanda village

Factors	Lusewa *ntambo*	Kikolo *ntambo*
Opening of new farms	46	35
Casual burning	14	20
Fuelwood demand	17	27
Lumbering	16	07
Others	07	10
Total	**100**	**100**

Source: Own survey (2001-03)

Other factors for declining tree cover in rolling hills was explained as the expansion of Mbinga Township in the last few decades (Table 11). Expansion of Mbinga town has direct relationship to declining tree cover in the rolling hills due to lack of electrification and dominance of farmer-based population, which increase demand of tree products and land for farming in rolling hills. By 1995 residents of Mbinga town were 86% immigrants (Mbinga District Council, 1997). This increase of Mbinga town population in 1990s partly due to increased number of petty traders and artisan-mining activities that concentrated in the district since late 1980s. Economic liberalization as well allowed free trading a circumstance that brought number of petty traders of second hand clothing (*mitumba*), shops, kiosk, and restaurants in Mbinga Township. Large population of traders in this category are *Kinga* ethnic group hailed from Njombe and Makete districts in Iringa region who have recently emerged as potential businessmen in Tanzania. Such an abrupt influx of immigrants in a non-electrified town of Mbinga possibly influenced unregulated deforestation in the woodland. It could therefore be surmised from above that environmental degradation in Matengo highlands is also an interlay of urban-rural relationship than an exclusive rural-rural problem.

Table 14. Population trends in Mbinga Township

Season	Population size
1978	7,308
1988	12,665
1995	16,000
2002*	25,416

*Source: Mbinga Town Master Plan: Mbinga District council (1997) * Bureau of Statistics (2002)*

A cross section of ten elders of Kitanda village lamented at different times that larger part of river line dense forest (*kitengo*) was languished between 1980s through 1990s largely by lumbering and construction poles in Mbinga town. The village elders mentioned most tree species ruined for lumbering were Muwawa (*Khaya anthotheca*), Mchai (*Harungana madagascariensis*), Mpuga (*Erythrophleum africanum*) Mgwina, (*Breanardia africana*) and Muwanga (*Pericopsis angolensis*). Tree species affected through charcoal making in recent years include Mbuni (*Parinari curatellifolia*), Mnyonyo (*Syzygium cordatum*), Muwanga (*Pericopsis angolensis*), Mzombo (*Brachystegia spiciformis*) and Mteteleka (*Faurea speciosa*). One elder also commented that intense deforestation, now people do even make charcoal out of mango trees (*Mangifera indica*).

Appendix 4 indicates that in original *miombo* woodland quadrate in Lupilo village in rolling hills diameter of trees were larger than in neighbouring village Kitanda where trees have been subjected to intense human activities. As forest deforestation proceeds, Msuku (*Uapaka kirikiana*) becomes dominant due to the fact that it is hardly used for either fuelwood or building material. Msuku also grows in poor soils where it can evade the impact of unregulated deforestation due to opening up new farms. It can also be kept because it produces edible fruits.

As far as Mountain Area-Rolling Hills interrelations is concerned, falling household income and/or declining accessibility to farm inputs observed since 1990s could possibly influence unregulated deforestation in rolling hills through opening up new farms in rolling hills as well making of charcoal.

6.2 Changes in Land Cover in Kindimba Village

Natural vegetation in Kindimba village, which was classified as Afro-Montane or Moist Montane Rain Forest have completely disappeared in the village long time ago. Eucalyptus woodland and agroforestry in coffee have maintained tree cover to certain level in Kindimba

village. The village has a long history of planting eucalyptus trees ever since 1940s when colonial government introduced it. Patches of eucalyptus woodland are commonly found on mountaintops and along river valleys.

Satellite images of Kindimba village (Mountain Area) presented in Fig. (35i) show that tree cover seemed to have stabilised for long time though at low level. Equilibrium had been reached through long time habitation largely due to agroforestry in coffee farms and establishment of eucalyptus woodland. Tree cover of Kindimba village in satellite images, thus, represents agroforestry in coffee as well as eucalyptus woodland or other isolated trees. The images also show limited events of bush fire in the village. The legend grass included food crop fields, valley bottom gardens farms and newly established coffee fields as the satellite could not differentiate them.

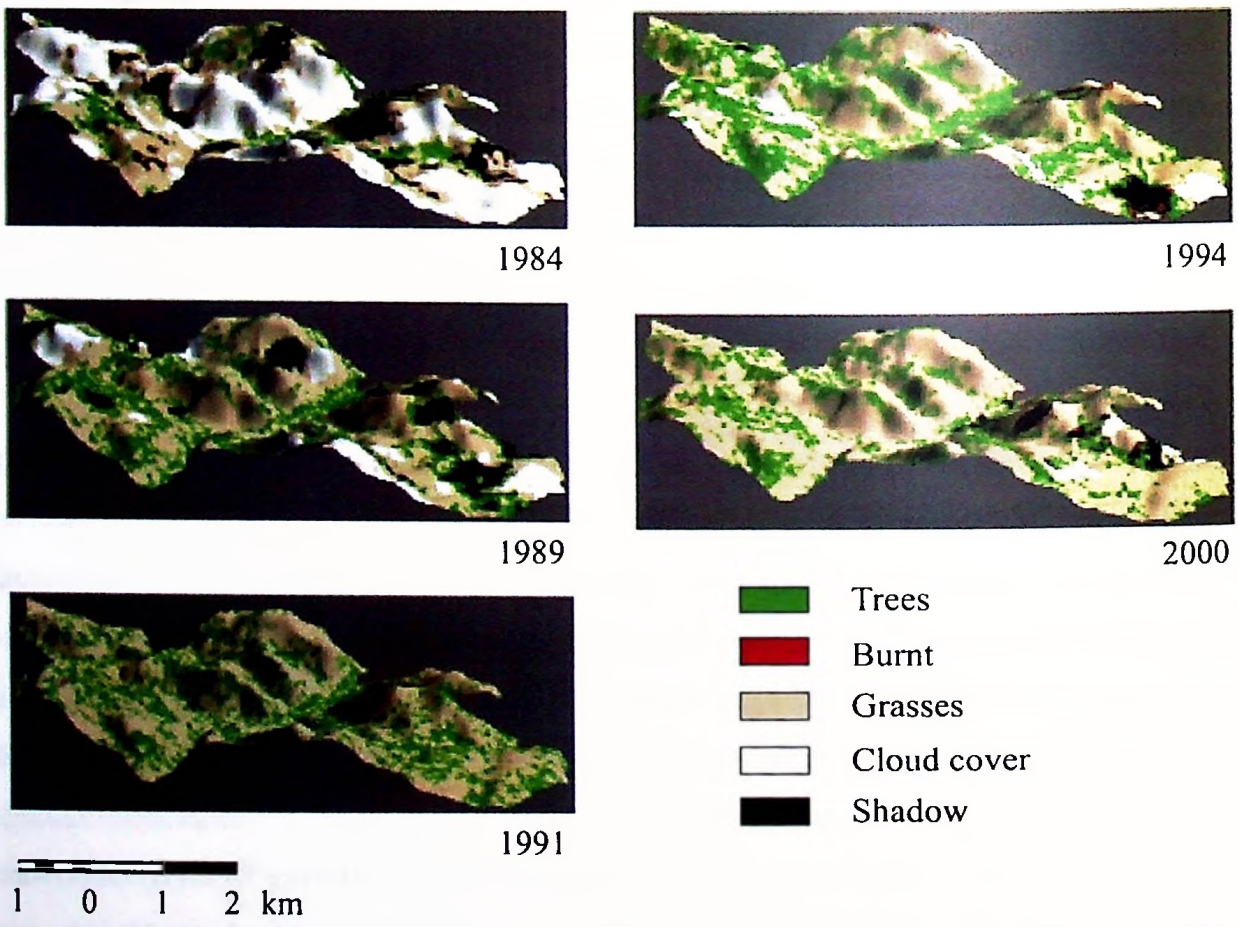


Fig. 35i. Satellite images showing trends of land use change in Kindimba village

Satellite image analysis of Kindimba village in Fig. (35ii) indicate that from 1994 tree cover started declining perhaps due to conversion of a few remained fallow and woodland to crop fields after economic crisis in Matengo highlands since 1990s. After cutting down woodland for planting coffee, the satellite resolution could not differentiate young coffee field and grassland.

Similarly, valley bottom farming also rejuvenated with a full force during 1990s, which resulted into intensive vegetation cleansing along river valleys. Thus, land use dynamics in recent decades also embraces rejuvenation of the Matengo to some of their old land use systems such as active valley bottom farming practices.

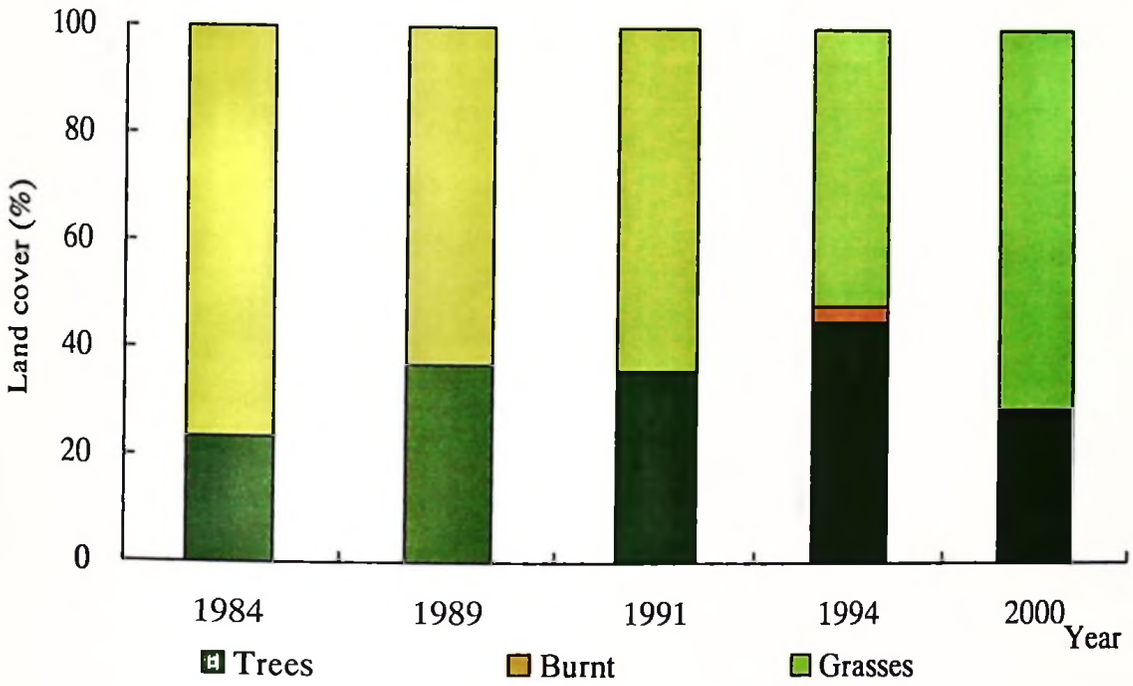


Fig. Satellite image analysis of Kindimba village

It can be summarised from satellite images of both Kitanda and Kindimba villages that tree cover degradation has been recently been very severe in Rolling Hills Kitanda village than in mountain area village Kindimba. The most influential factor to fast deterioration of tree cover in the rolling hills could therefore be agreed as due to tendency of opening up new food crop farms especially by mountain immigrants who attend such farms on temporal basis. This could be ascertained by increased percentage of grass cover, which also represents food crop farms. However, the tendency of converting *ngolo* fields into coffee farms would in future conserve the environment in *ntambo* in the Mountain Area through agroforestry in coffee. Fig. (36) shows that while tree cover are somewhat stabilized though at low percentage in Mountain Area due to agroforestry in coffee and eucalyptus woodland, miombo woodland in rolling hills continues to diminish fast.

Fig. 36. Increase of coffee fields in Mountain Area and decrease of tree cover in Rolling Hills

It could be summarised from chapters five and six (Fig. 37) that economic liberalisation influenced expansion of both cassava and coffee farms cultivation. In Mountain area Kindimba village coffee and cassava expansion was through conversion of food crop bean and maize *ngolo* fields. Such bean and maize *ngolo* fields were converted because they could no longer easily been cultivated without chemical fertilizer as farmers' income to purchase fertilizer declined after crisis in coffee economy at economic liberalisation. In Kitanda village in rolling hills expansion of coffee and cassava cultivation was at the expense of either fallow or woodland. Thus, while total cultivated acreage was increasing in Kitanda village, it remained nearly the same in Kindimba village. This was because of ample land available in the Kitanda village partly due to lower population density than that of Kindimba. Cassava in Mountain area Kindimba village was largely for food security whereas in Kitanda was both for food security and as an alternative source of cash income. Active cultivation of valley bottom during dry season for both food security and income was famous in both villages.

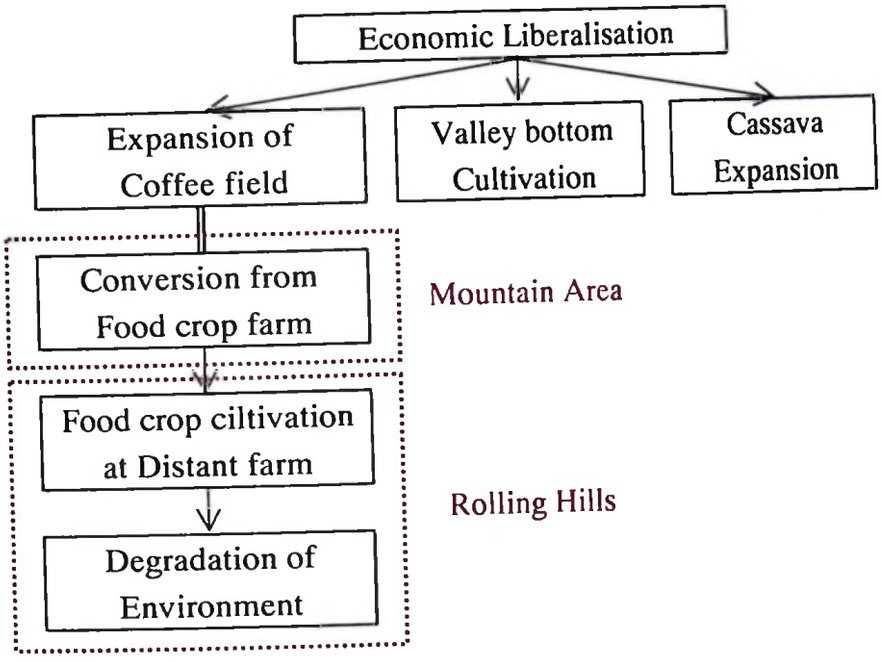


Fig. 37. Summary of situation in Matengo highlands after economic liberalisation

Conversion of food crop farms to coffee fields necessitated households in Kipololo and Mapelele ntambo in Kindimba village (Mountain Area) to cultivating food crops in distant villages, largely in rolling hills where they visit on temporal basis. It was thus possible to find series of food crop farm plots in rolling hills without settlement around. This tendency has influenced unregulated deforestation of miombo woodland in the rolling hills. Regular maintenance of such isolated distant farms is also difficult. Likewise, cultivation of ridges or flat seedbed characterise distant farms in undulated rolling hills slopes. This may lead into soil degradation especially under the influence of intense rains that characterise the Matengo highlands.

6.3 Conservation of Tree Cover in Kindimba and Kitanda villages

Conservation of degraded forest cover has been one of the painstakingly activities in Kindimba and Kitanda villages. Nevertheless, households in respective villages, sometimes with collaboration with rural development agents such as Sokoine University Centre for Sustainable Rural Development (SCSRD) have been trying hard to conserve the environment using indigenous knowledge and local resources available. Inhabitants in both villages, for instance, have at different times planted *eucalyptus* trees as a source of fuelwood, timber and conservation of mountaintops. Planting of *eucalyptus* trees in Kindimba village (Mountain Area) has been one of their long experiences since the tree specie was introduced in the mountain area in 1940s by

colonial influence. It was thus not surprising to find *eucalyptus* extension even in Rolling Hills because most Rolling Hills inhabitants are essentially immigrants from Mountain Area.

Unfortunately, Mbinga afforestation programmes as discussed in chapter four hardly involved the two villages. However, the two villages have established cooperation with SCSRD in a wake to bringing sustainable rural development in Kindimba and Kitanda villages as model sites. Collaboration between SCSRD and Kindimba and Kitanda villages dates back to early 1990s when Sokoine University of Agriculture and Centre for African Area Studies of Kyoto University launched an integrated agro-ecological research of the *Miombo* woodland in Tanzania under Japan International Cooperation Agency (JICA) financing.

After initial in-depth study to understand rural realities in villages of Mbinga district, Kitanda and Kindimba were selected to act as model sites for trials and experiments. Most trials and experiments focused on environmental management and general improvement of rural livelihood. The mission is that if these trials become successful they would be interpolated in wider scale to other villages of the Matengo highlands. Among joint activities carried out between SCSRD and Kindimba and Kitanda village include tree planting in both villages and construction of hydro-mill machine in Kindimba village. Other trials are beekeeping (apiculture) in both villages, construction of fishponds and raising fish (fishculture) in Kitanda village. Various farmer-farmer and farmer-technician exchange visits and seminars and workshops have been conducted. SCSRD staffs have developed a culture of living in the villages for long time trying to understand reality at local level as well as to be part of the rural community. Meteorological stations and field stations have also established in the area to facilitate data collection and exchange of ideas.

Total number of trees planted in Kindimba and Kitanda villages in 2002 was 5,000 and 3,500, respectively. Planting of trees involved community participation at all stages from planning to implementation. In Kindimba village, *Sengu* group in collaboration with sub-village leaders mobilized village community in tree nursery management through tree planting stage and subsequent management. Later in 2003 some Kindimba farmers started farmer-groups namely *Ondoa Umaskini* (Poverty Eradication) and *Jiokoe* (literally Save Yourself) also joined hand in tree planting and advocacy on environmental conservation. In Kitanda village, farmer-groups called *Ujamaa* pioneered tree planting exercise and its management in Muungano sub-village. According to SCSRD staff, *Ujamaa* group provided enormous advice and education to the newly formed farmer-groups namely *Umoja Endelevu* (Sustainable Unity), *Mwamko*, (Reanimate) *Familia* (Family), and *Vumila* (Stayhard) that also established tree nurseries. In addition, *Ujamaa*

[illegible]up involved Muungano sub-village households to plant trees in water source areas and in long [illegible]owed plateaus (*lipusa*) that has been affected by long-term weathering processes. Table (12) [illegible]ow shows some of the tree species planted in Kindimba and Kitanda villages by mutual [illegible]ership with SCSRD.

[illegible] 15. Some of the tree species planted in Kindimba and Kitanda villages in 2002

[illegible]al name	Botanical name	Uses
[illegible]hambarau pori	*Syzygium guineense*	Conservation of water sources
[illegible]anga	*Albizia schimperiana*	Soil fertility conservation and shade in coffee plantation
[illegible]awa	*Khaya anthotheca*	Conservation of water sources
[illegible]enda	*Bridellia micrantha*	Conservation of water sources
[illegible]a wa mbamba	*Rauvolfia caffra*	Conservation of water sources
[illegible]aranga mti	*Macadamia spp*	Income generation (alternative cash crop to coffee)

Source: SCSRD records and own field data

According to Kindimba village government chairman, since 2000/01 season, Kindimba [illegible]age government carried out a plan to enable every household to plant at least 250 trees per year. [illegible]hose with no enough land for the exercise would be provided with bare mountaintops owned by [illegible]age government. By 2003 about 10,000 trees were planted on mountaintops and other areas in [illegible]indimba village. Kindimba village government is also strict on bush fires, those found setting it [illegible] liable to a fine totalling up to Tsh 300,000 (US$ 300) plus paying compensation of damaged properties, if any. The village has also directed farmers to cultivate valley bottom gardens at least [illegible]m away from the river course so as to conserve river line vegetation. Both Kindimba and Kitanda [illegible]illage governments have prohibited all farming activities in catchments and water, those disobeying it are liable for penalty that sometimes goes up to prosecution.

During village elders interviews in both villages, it was revealed that during *sengu*, their forefathers told descendants to leave some tree species in *ngolo* fields such as Mhopa (*Dombeya sasp.*), Mbalamono (*Bersama abyssinica*), Mtanga (*Albizia schimperiana*), Mpugapuga (*Markhamia obtusifolia*) and Mwao (*Acacia sieberiana*). This natural trees were important in soil fertility conservation, despite that such a system has been long forgotten by contemporary generation. Village elders recommended at different occasions that maintenance of such fertility-related trees could warrant not only soil fertility conservation but also raise tree cover.

group involved Muungano sub-village households to plant trees in water source areas and in long fallowed plateaus (*lipusa*) that has been affected by long-term weathering processes. Table (12) below shows some of the tree species planted in Kindimba and Kitanda villages by mutual partnership with SCSRD.

Table 15. Some of the tree species planted in Kindimba and Kitanda villages in 2002

Local name	Botanical name	Uses
Mdhambarau pori	*Syzygium guineense*	Conservation of water sources
Mtanga	*Albizia schimperiana*	Soil fertility conservation and shade in coffee plantation
Muwawa	*Khaya anthotheca*	Conservation of water sources
Mnyenda	*Bridellia micrantha*	Conservation of water sources
Mtela wa mbamba	*Rauvolfia caffra*	Conservation of water sources
Mkaranga mti	*Macadamia spp*	Income generation (alternative cash crop to coffee)

Source: SCSRD records and own field data

According to Kindimba village government chairman, since 2000/01 season, Kindimba village government carried out a plan to enable every household to plant at least 250 trees per year. Those with no enough land for the exercise would be provided with bare mountaintops owned by village government. By 2003 about 10,000 trees were planted on mountaintops and other areas in Kindimba village. Kindimba village government is also strict on bush fires, those found setting it are liable to a fine totalling up to Tsh 300,000 (US$ 300) plus paying compensation of damaged properties, if any. The village has also directed farmers to cultivate valley bottom gardens at least 5m away from the river course so as to conserve river line vegetation. Both Kindimba and Kitanda village governments have prohibited all farming activities in catchments and water, those disobeying it are liable for penalty that sometimes goes up to prosecution.

During village elders interviews in both villages, it was revealed that during *sengu*, their forefathers told descendants to leave some tree species in *ngolo* fields such as Mhopa (*Dombeya ssp.*), Mbalamono (*Bersama abyssinica*), Mtanga (*Albizia schimperiana*), Mpugapuga (*Markhamia obtsusifolia*) and Mwao (*Acacia sieberiana*). This natural trees were important in soil fertility conservation, despite that such a system has been long forgotten by contemporary generation. Village elders recommended at different occasions that maintenance of such fertility-related trees could warrant not only soil fertility conservation but also raise tree cover.

Indeed, tree cover reclamation remains one of the serious environmental challenges in Matengo highlands especially after economic liberalisation hence, threatens the basis of human and environmental existence. The stability of the Matengo had been nourished by coffee and production of food crops in *ngolo* but when the two farming systems are affected, the impact is not only to household income but also to changing land use systems and stress to the environment. There is therefore an urgent need to integrate both zones as a single unit of analysis to enable implementation of strategies that would ensure sustainability of Matengo land use system and environmental management in a wider context.

CHAPTER SEVEN

CONCLUSIONS AND RECOMMENDATIONS

7..1 Conclusions

Land use change under the influence of economic liberalisation has been overshadowed by separation of cropping zones. As chemical fertilizer has become beyond reach of most farmers, Mountain farmers have continuously switching food crop *ngolo* fields within *ntambo* to coffee fields. They did so by cultivating food crops into distant villages, largely in the woodland in rolling hills where they can cultivate without chemical fertilizer. This is also because farmers have no tendency of selling food crop or using a little income from food crop to buy fertilizer, but they largely depend on income from coffee. Thus, the decline of income in coffee farming impacts also in food crop production. Through increased coffee farming, the environmental conservation in the Mountain Area can be achieved through agroforestry in coffee. However, the environmental implications are different to the woodland area where unregulated deforestation became common places. This tendency reveals that the Matengo who have for long time stabilised their living within *ntambo* no longer depends on production within *ntambo* alone but integrative production with other *ntambo*. Thus, the Matengo are now continuously having more than one *ntambo* to manage. These distant *ntambo* now they have to manage are normally located in varying physical landscapes as well as different climate and soils.

Thus, though pioneer studies such as that under JICA (1998) on land management in the Matengo highlands have for long time considered land use and environmental management in the Matengo highlands from *ntambo* perspective, this study shows a new trend that calls for re-devising or integrating the old conception with new trends if sustainable rural development has to be realised. In other words, consideration of *ntambo* as a unit of analysis in dealing with land use and environmental management issues in Matengo highlands seems not sufficient enough to cater for current land use change. Thus, considering management in a wider area would save the lands use systems and environmental management in the Matengo highlands much better than just within *ntambo*.

It is also possible to conclude that the traditional *ntambo* management system based on permanent out-migration of some clan members after 3-4 generations after first settlement is continuously being replaced by temporal lease of distant farm after economic liberalisation. Decline of Matengo economy due to disturbances in coffee market also debilitated the ability of the Matengo to buy *ntambo* in distant villages for emigrating permanently. Instead, they opt to lease land in distant villages on temporal basis. This change in land tenure brings both increased

population in the mountain area as well as unregulated deforestation in woodland zone. Increased population in the mountain means further opening up of distant farms for cultivating food crops and increased coffee cultivation in Mountain areas. The motive of temporal mountain migrants of utilising distant farm plot for crop cultivation only lead to failure of conceptualisation of the need to maintain the environment at distant leased farms hence unregulated deforestation of the miombo woodland in rolling hills. Similarly, failure to attend distant farms regularly due to distance has severely impacted on the environment in the rolling hills.

So far the influence of economic liberalisation on land use change and environment management in the Matengo highlands has been made clear. The situation in the Matengo highlands after economic liberalisation clearly shows the testing of sustainable development now widely debated especially after the Brundtland Report (*Our Common Future*) of 1987 and the impetus brought in by The Agenda 21, established at the 1992 United Nations Conference on Environment and Development, or "Earth Summit", in Rio de Janeiro, Brazil, which saves as a blueprint for sustainability in the 21st century. Results from Matengo highlands show the likelihood that there still over emphasis of economic development strategies without critical analysis of environmental implications at the local level. To realise sustainable rural development there is a need to balancing between economic development and its influence on the environment should further emphasised especially when it comes to application of global policies into specific local environment.

7.2 Recommendations

This breakdown of the *ntambo* management has so far accelerated environmental degradation especially at Rolling Hills. It is thus worthwhile to recommend that land management measures that aims at combining both Mountain Area and Rolling Hills should be created. Previous accumulated knowledge on land management within *ntambo* would better saved if could be integrated with new trend that seeks to integrate both zones as single unit of analysis. Such information to stakeholders chanting out methods for sustainable rural development such as Sokoine University Centre for Sustainable Rural Development (SCSRD) would enable providing basis for developing a methodology for sustainable rural development that covers a much wider context.

Likewise, environmental conservation on the Rolling Hills should be emphasised. The zone has demonstrated severe environmental stress at economic liberalisation. Soil conservation methods in fertility-stricken mountain food crop fields would possibly minimise influx of

mountain inhabitants in Rolling Hills for temporal cultivation activities. Integrated debates with farmers across *ntambo* (in Mountain Area and Rolling Hills) would certainly produce some grounded facts that are important for in-depth understanding of rural dynamism and for devising methods that would possibly lead to realisation of sustainable rural development.

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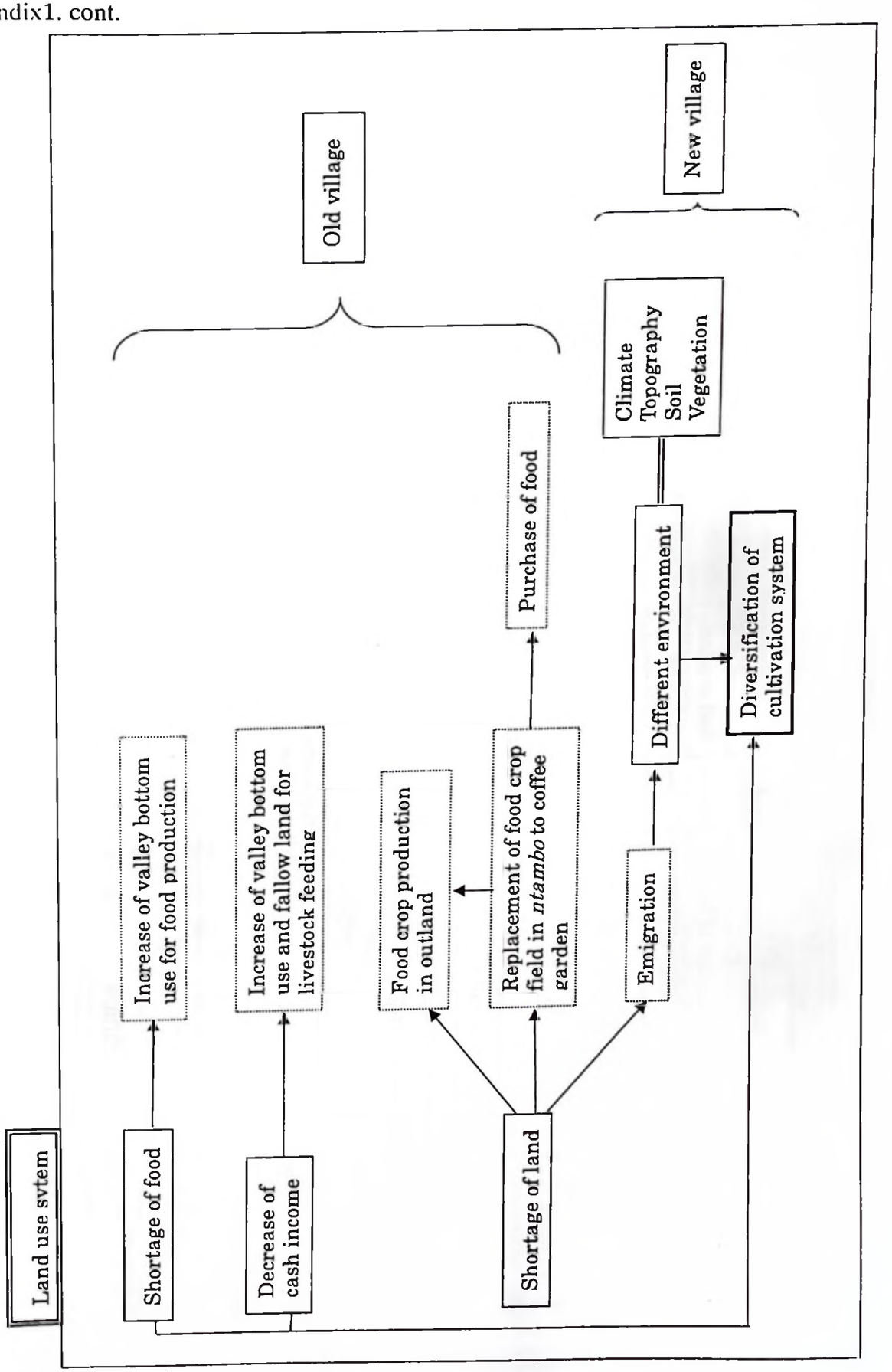
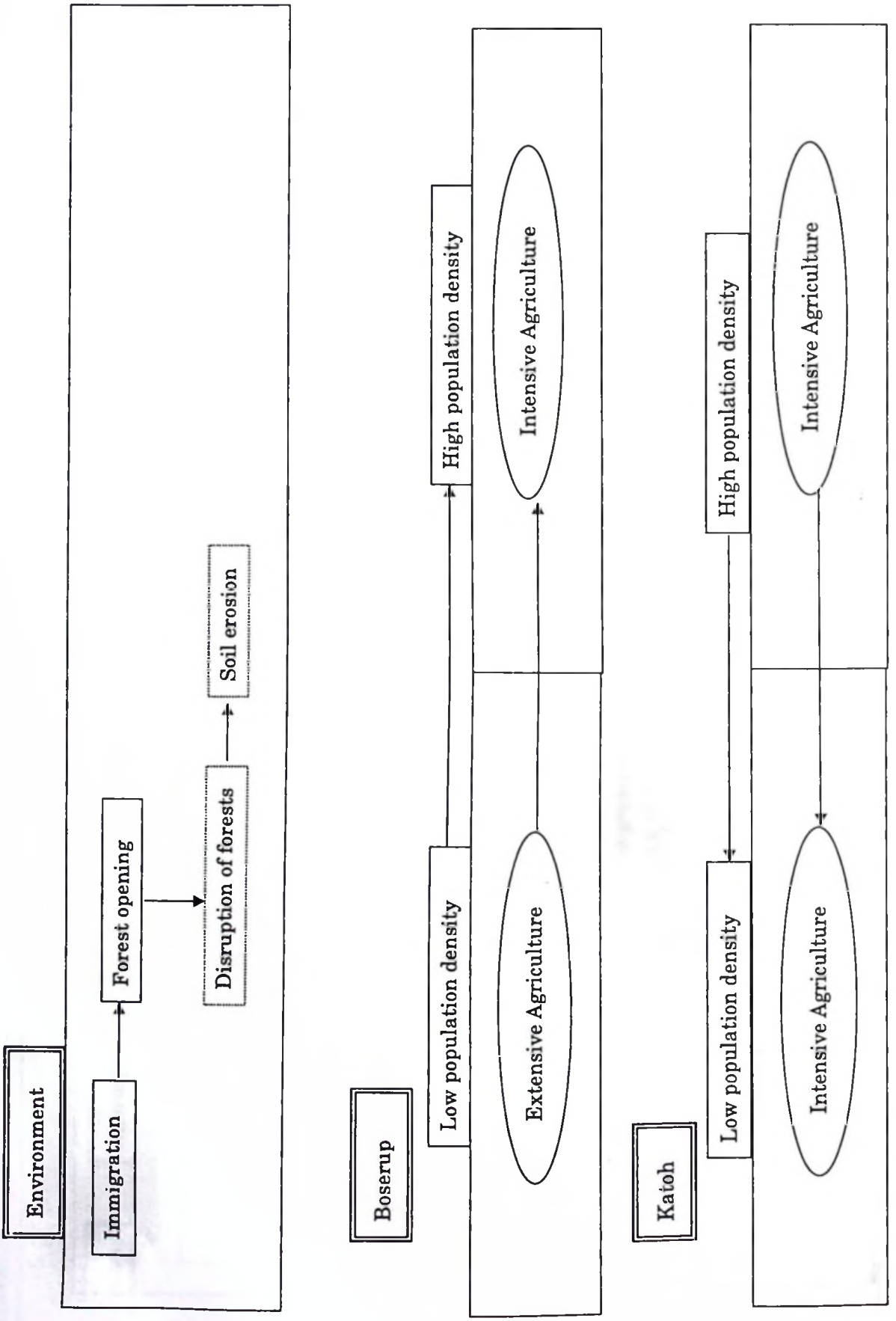
APPENDICES

Appendix 1.

Appendix1. cont.



Appendix1. cont.



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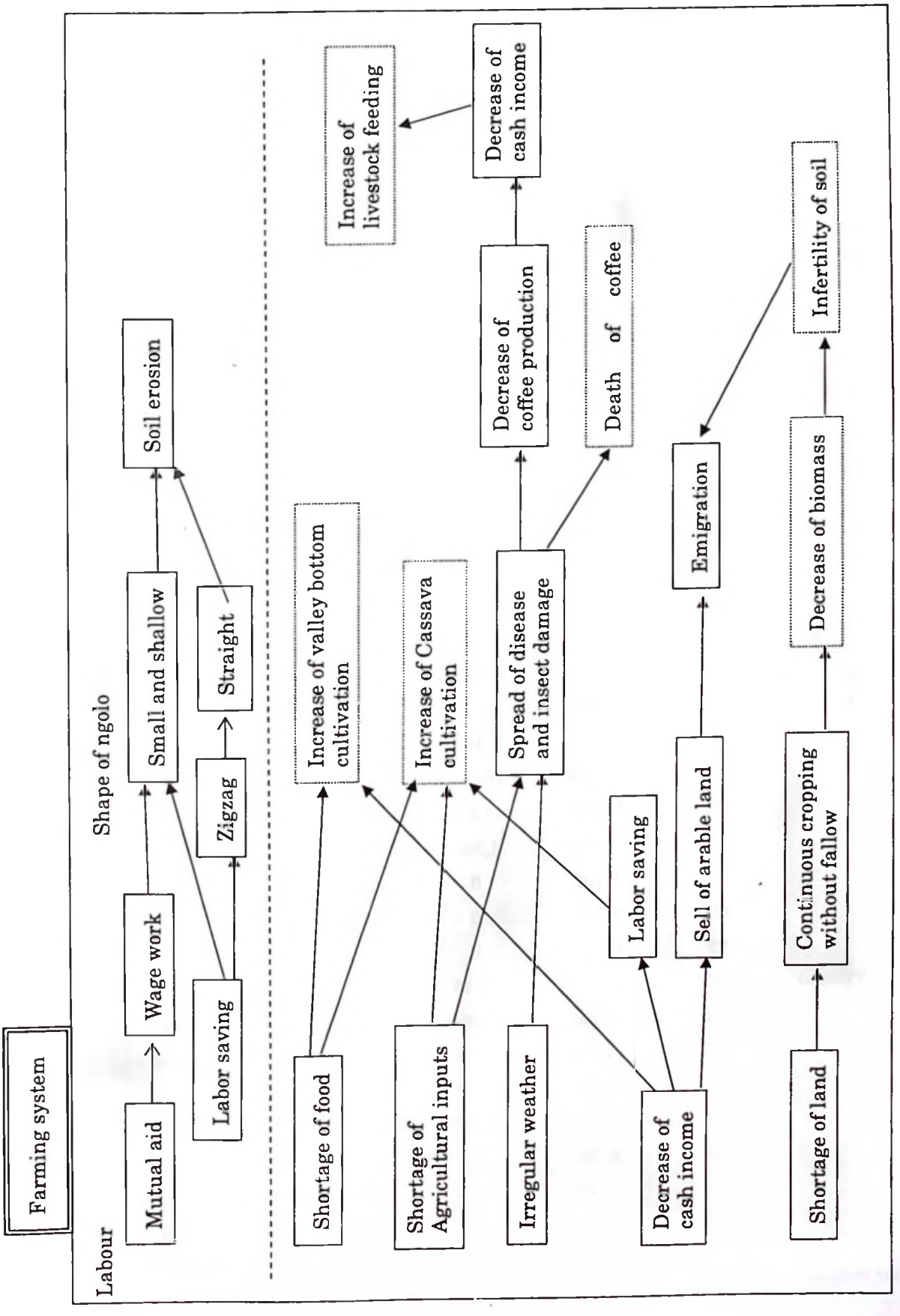

Appendix 2.

The Diffusion of coffee cultivation in Umatengo

	Number of growers/planters							no. of trees
Year/no. of village	1929	1930	1931	1932	1933	19334	1935	1934
Myangayanga	6	6	8	8	22	22	72	2,954
Lipumba	2	2	3	3	5	5	8	79
Walanzi	0	1	1	1	1	3	44	2,124
Litembo	0	0	1	1	6	8	51	3,338
Pilikano	0	0	0	2	7	7	55	1,870
Total	**8**	**9**	**13**	**15**	**41**	**45**	**230**	**10,365**

Source: Data compiled from TNA/A3/22 after Schmied (1989)

Coffee tree census in the *U*Matengo area in 1952

Village/ Area	Coffee Growers	Old trees	Trees planted in 1950	1951	1952	Total of Trees
Lituru	355	22,401	9,455	9,019	23,682	64,557
Litembo	97	11,759	6,522	6,522	10,107	34,910
Mhagawa	220	30,901	13,069	15,063	10,107	69,140*
Mbuji	181	11,263	12,629	14,863	17,905	56,660
Langiro	1,045	35,412	23,527	73,067	81,088	213,094
Mpapa	251	4,715	7,345	14,336	31,224	57,620
Litinda	84	534	417	4,580	8,117	13,648
Tingi	9	0	0	433	1,445	1,878
Kindimba	259	25,278	10,919	14,367	28,989	79,553
Walanzi	129	11,440	11,878	5,389	14,584	43,291
Lubino	83	5,999	1,366	908	4,273	12,546
Lipumba	92	1,500	0	971	7,255	9,726
Lilumbalero	150	6,922	0	2,151	1,179	10,252
Linda	95	16,550	0	8,216	10,125	34,891
Longa/Lugali/Pilikano	243	32,918	3,445	15,341	8,693	60,397
Ngima	266	7,686	26,066	13,539	5,843	53,134
Wukiro	100	11,715	3,871	5,782	5,277	26,645
Gumbiro	163	978	2,121	1,641	19,170	23,910
Mbinga	180	2,520	12,555	12,817	2,513	30,405
Myangayanga	126	8,910	0	7,370	6,846	23,126
Lupitigu	66	19,008	1,751	8,987	17,928	47,674
Ugano	226	3,500	400	831	900	5,631
Total	4,420	271,909	**147,336**	**236,193**	**317,250**	**972,688***

Source: Data compiled from TNA/A3/22 after Schmied (1989), * own correction