An Exploratory Study of Land Use, Management and Degradation

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1. Introduction

Agriculture is the dominant sector in the economy, which for the past ten years has accounted on average for 34 percent of real GDP, with small-scale agriculture having a 25-percent share of the GDP (Ministry of Economic Planning and Development 1995). Within the small-scale agriculture maize is a major component, contributing about 60 percent of the small-scale output. On the whole, agriculture contributes about 90 percent of export earnings and 85 percent of employment. Given the central importance of agriculture in the government's economic development strategy, any deterioration in land resources poses serious consequences for Malawi's future sustainable economic development and growth. Sustainable development does not necessarily mean complete conservation of the resource base. Indeed, a certain level of environmental degradation is an inevitable by-product of economic activity. The critical issue, however, is to ensure that the level of resource use remains consistent with society's development objectives. To achieve this in Malawi, there is need for an express understanding of the interactive forces that influence smallholder agricultural productivity and bring about soil erosion and deforestation. Thus some understanding of land use, management and land degradation is necessary to facilitate sustainable development. This necessitates an analysis not only of the spatial patterns of existing practices, their productivity and of the distribution of land degradation but also of the economic and social factors that affect the attitudes, perceptions and decision-making processes of the smallholders themselves.

1.1 Objectives of the Study

This study has the broad aim of exploring the degree of land use, management and land degradation.

The specific objectives of the study are:

(i) to survey and assess spatial and temporal change of land use pattern and the spatial extent of degradation;

(ii) to isolate socio-technical, political and environmental factors that influence land use decisions on smallholder land use activities;

(iii) to determine the level of productivity of smallholder land use activities; (Productivity in this study has been mainly measured in relation to landholding size and labour input.)

(iv) to study social aspects/factors in terms of knowledge, attitude and practice in land resource management and degradation.

1.2 Research Methodology

This study highlights the need for studying the development process thorough interdisciplinary research since development issues are complementary.

1.3 Specific Methods

1.3.1 Survey and Assessment of Land Use Pattern Changes and Spatial Extent of Land Degradation

Topographical maps covered under Number 1435 C1 and C3 for 1962 and 1976 and aerial photographs of 1:25,000 scale for years 1957 and 1982 were used to determine spatial and temporal changes of land use patterns in West Malombe Catchment. From the topographical sheets, classification of the area was already made and detail was extracted from a 1:50000-scale map, whose results are represented by figures 4 and 5. In the case of the 1957 and 1982 photography, the area had to be classified using 20 and 18 exposures, respectively. The extra two for 1957 include those that covered the waters of Lake Malombe. The results are indicated in figures 3 and 6. The categories used for the classification have been kept simple, but the results, however, give a clear picture of the main changes that had taken place in land use and vegetation cover between 1957 and 1982. Stereoscopic interpretation was carried out using ST4 photo-interpretation instrument and hand lens. This facilitated rapid stereo viewing and provided a magnification that could be varied from three to 15.5 times. Examination of each stereo-pair was carried out at a magnification of three times and sometimes at a much higher magnification. At the six times magnification, crop ridges could be clearly seen where they were not covered by dry season weed growth.

The spatial extent of land use problems was analysed through the same topographical maps and aerial photographs interpretations. Most erosion features were visible in direct stereoscopic viewing and were therefore identifiable by their form, shape and size, and their association with other features. To a lesser extent, tone, texture, shadow and pattern were also used. Thus notes on the erosion, sedimentation and other relevant features seen on each stereo overlap and a judgement of the severity of the erosion were made. As far as possible this was related to the physical environment of the area. Also physical observation or visual observation was used during fieldwork which was useful in the validation of the observation made during the photo interpretation. Views of the Land Husbandry staff on land resource use and mismanagement were obtained during these field visits.

Two other studies have provided data, namely, *Land utilisation study: Customary land sector 1996*, commissioned by the Government of Malawi, and the International Centre for Research in Agro-forestry (ICRAF) study of land use and cover for all the ADDs in Malawi 1996. The latter, which made use of the 1995 air photography, was particularly useful for TA Chimwala area, which was one of he enumeration areas, yielding some interesting results on land use and the nature of land degradation in the more recent past. These aerial photographs with a scale of 1:25,000 were taken between June and September 1995, and used in the assessment of erosion.

While the interpretation of aerial photographs is one valuable technique of evaluating environmental change, it is also crucial to note its weaknesses. For example, very old photographs have inferior resolution and ground-truthing is impossible. Scale differences between one set of aerial photographs and another, as well as scale distortion on individual photographs particularly in rugged terrain, bring to the fore the problem of compatibility.

Equally important, if aerial photographs were taken at different times of the year (different seasons), it is difficult to interpret environmental change during the intervening years.

1.3.2 Factors That Influence Land Use Decision

By targeting areas of Western Malombe Catchment, the study attempts to identify the reasons for the choice of land use and how it is reflected in the spatial arrangement of those uses. One hundred and forty seven household heads were interviewed using a questionnaire during the months of May, June and July 1995. This study had attracted the interest of the ADD officials, leading to one Land Husbandry Officer, two Land Husbandry Assistants and one assistant from the Evaluation and Monitoring Unit of the ADD being released to assist in the field collection of data. Thus the assistants were used as enumerators and the officer as a field supervisor. The importance of the various land use activities is based on the frequency response of the respondents. This approach in ranking is in line with the commonly used repertory grid analysis in human geography (Fransella and Bannister 1977; Shaw 1981; Hudson 1980; and Barker, Oguntoyinbo, and Richards 1977). The methodology has the most important advantages of flexibility and minimisation of interviewer interference. Some selected socio-economic variables concerned with respondents and their households were tested for association with the choice of land use activity, use of conventional conservation practices, and coping strategies for environmental hazards using chi-square (X^2). In particular, household land was measured for association with reasons for cultivating crops and rearing such livestock, attendance and level of education with following land conservation practices and coping ways against environmental hazards, and crops cultivated for land conservation measures. These activities in the study have revealed important patterns that surround the more complex decision-making process of land users.

1.3.3 Productivity on Smallholder Land Use Activities

The 147 household heads were interviewed with the major aim of somehow generating a full cost-benefit analysis of their land use activities. The results in this report, however, have been limited to crop and livestock yield of some selected land use activities. Productivity analysis as originally hoped for has not been undertaken because a detailed measurement of variables was not done. For example, if one was to measure crop productivity levels, it required the availability of data regarding actual crop output and actual amount of hectarage under that particular crop. These specificities were not possible under this study.

1.3.4 Social Aspects in Land Resource Management and Land Degradation

The social aspects of land degradation were analysed in relation to personal characteristics regarding mainly age, education, occupation and accessibility to information, through radio and extension service, land tenure, landholding size, enterprise lucrativeness and government's enforcement measures on better land use and management. The main source of the data for this aspect of the study has been responses of the 147 interviewees. However, official stance regarding land use and management and peoples' response to it through the visible practices have been used in the analysis of the effectiveness or otherwise of Government's efforts.

1.4 The Study Area: West Malombe Catchment

1.4.1 Choice of the Study Area

One basic and pragmatic factor for the choice of this area related to its proximity to Chancellor College. Secondly, the study area has experienced some of the worst ecological disasters through floods and visibly severe symptoms of land degradation in the form of soil erosion and deforestation. Conclusion with the Programme Manager and Land Husbandry staff of the Machinga ADD enabled the researcher to purposely focus on WMC as a critical site. The area is most appropriate as "field school" laboratory for Geography researchers interested in sustainable land resource management.

1.4.2. Location, Boundaries and Administrative Structures

West Malombe Catchment (WMC) forms part of Mangochi district, headed by a District Commissioner. However, from the point of view of provision of agricultural services, WMC area is in the Machinga Agricultural Development Division (ADD) spatial system, formerly known as Liwonde. The ADD shares borders with Mozambique in the east, on Blantyre ADD and Salima ADD in the southwest and west (fig. 1). An ADD is in charge of the Programme Manager. It is administratively broken down into Rural Development Projects (RDP), which are headed by the Project Officer and in turn split into Extension Planning Areas (EPA) under Development Officers.

Mangochi RDP (see fig. 2) is situated in the northern part of the ADD and has an area of 345,000 ha (Venema 1991). The RDP has five EPAs: MNG 1 in the north-west, MNG 3 in the south-west, NMG 4 in the south-east, MNG 8 in the east and MNG 9 in the north. The Project Offices are at Mangochi. WMC thus specifically lies within MNG 3.

Fig. 1. Machinga Agricultural Development Division

Fig. 2. EPA's and Agro-ecological Zones, Mangochi RDP

1.4.3 Topography, Precipitation and Agro-ecological Zones

Knowledge on topography, precipitation patterns and agro-ecological zones is important for understanding the agricultural activity and environmental change in general.

From the land resources appraisal by Venema (1991), MNG 3 falls in the natural region of Phiurilongwe Hills (PH) in an altitudinal range of 500 - 1000 masl, underlying a gneiss bedrock. The PH is thus an upland area, consisting of two agro-ecological zones which have different lengths of growing period (LGP), namely, North, East and South Phirilongwe Hills (PH1) and West and Central Phirilongwe Hills (PH2).

The PH1 is made up of two sections: rolling hill sand plains in the northeast and a ridge in the south. The zone is underlain by Basement Complex Rocks, which mainly consist of geniuses. Slopes vary within the range of 2-25 percent. Soils on the hills and ridges are mostly moderately deep, well-drained and medium textured and classified as Eutric Cambisols and Haplic Phaeozems (Rudic Phase). Deep soil, classified as Haplic Luvisols and Luvic Phaeozems, are found on the gently sloping footslopes. Mean annual rainfall is 800 - 1,200 mm and LGP around 135 days on the plains and around 150 days in the hills. Mean monthly temperature is 22.5^0C - 25^0 C in the growing period. The area is mostly covered by mixed low altitude savannah and Brachystegia woodland. Cultivation is sparse with maize, pulses, groundnuts, cotton and cassava as the main crops.

The PH2 contains the Phirilongwe Hills proper and surrounding uplands. The hills are moderately steep with dominant slopes of 13 - 25 percent and have moderately deep, well drained, coarse to medium textured, gravely soils which have been classified as Eutric Cambisols and Haplic Phaeozems (rudic phase). The uplands around the hills have gentleslopes (2 - 6 percent) and have deep, well-drained, medium to fine textured soils, classified as Chromic and Haplic Luvisols. Mean annual rainfall range is the same as that of the PH1 area while the LGP ranges between 150-180 days. Vegetation and land use is similar to that of PH1.

In general the Phirilonge Hills (Ph1 and 2) have areas not only with steep slopes, which are not suitable for cultivation, but also with gentle to moderate slopes and deep soils, which are moderately suitable for various crops. In terms of forestry, PHG1 and 2 are moderately suitable for *Azadirachta indica, callitris Hugellis, Cassia siamea, Cordyla africana, Eucalyptus camaldulensis, Eucalyptus tereticornis and Malia azedarach.*

1.4.4 Population, Economy and Political Environment

Table 1 indicates that at district level, Mangochi represented about 5.7 percent, 5.5 percent and 6.2 percent of the national population in 1966, 1977 and 1987, respectively. The intercensal annual growth rate between 1966 - 1977 and 1977 - 1987 for the district stood at 2.4 percent and 5.0 percent, representing the population increase of 29.9 percent and 64.2 percent, respectively. The district growth rate was slightly below the national average of 2.9 percent in the period 1966 - 1977, but well above the 3.7 percent for the period 1977 - 1987. The proportion of males to females has been below the national average in the three censuses, probably due to out-migration of the male population for wage employment to urban areas in the country as well as to the mines in Southern Africa.

Table 1. Mangochi district population and TA Chimwala: Percentages, growth rates, sex and tribe, 1966 - 1987

Population Variable	1966	1977	1987
Totals	232,692	302,341	496,576
Percentage out of total national population	5.8	5.4	6.2
Percentage of population increase	(na)	29.9	64.2

Intercensal annual growth rate	(na)	2.4	5.0
(Malawi average)	(na)	(2.9)	(3.7)
Density	37	48	79
Sex ratio	80	84	90
TA Chimwala			
Totals	23,078	36,752	73,321
Intercensal annual growth rate	(na)	4.9	8.2
Density	24	48	95

SOURCE: National Statistical Office (NSO) (1980, 1993).

The population density for the district in the period 1977-1987 showed a dramatic rise, probably reflecting the rapid intercensal annual growth rate. Even more useful insights can be gained from the analysis of net migration, i.e., the difference between persons who moved into the place of enumeration and those who moved out. Such a movement can be either for a lifetime (those who moved since birth) or for a period (those who moved 12 months before census). By using the 1987 context, rates of internal migration can be estimated. Thus the lifetime net migration rate was +1.0 (Mwafongo 1993). The district was a net gainer of population. In the Malawian context, migration linkages have been associated with a tremendous structural change in the economy that occurred in the 1970s (Mkandawire, Jaffe, and Bartoli 1990; Kalipeni 1992). In particular, the examination of net migration of predominantly rural districts, Mangochi district included, reveal that they have experienced rapid expansion of the agricultural estate sector with its attendant result of creating job opportunities as tenants.

In the specific case of Traditional Authority (TA) Chimwala area, which constitutes WMC, increasing population densities in the two intercensal periods was associated with Government order to the TA and subordinates that they were to receive and allocate land to any immigrant from other districts looking for land to settle on, including those who were fleeing from the war perpetrated by the Portuguese and later by the guerrilla movement in Mozambique. The then President of the Malawi Republic used to go around and publicly declare that those who were fleeing from the war in Mozambique were their brothers and sisters, hence there was a need to welcome them and provide them with the necessary land for their survival. In fear of the Government directive, settlements have been established even in marginally suitable terrain.

The other school of thought is that before these aliens from either Mozambique or other districts were given portions of land for settlement in the WMC area, the indigenous communities used to have gardens there in an isolated manner. The main problem in having gardens in this area was that it was infested with monkeys and wild pigs, which used to devastate the crops grown there. The solution was for those who had gardens in this area to spend most of the rainy season there chasing monkeys and indeed tending their crops. However, it is important to note that people did not want to stay in this area which was isolated (Paseli 1984). Thus, for those who came to TA Chimwala area seeking land to settle, it was easy for the authority to allocate them land in this area in the hope of increasing the population in the catchment area to act as buffer zones against the crop-marauding animals.

Economic infrastructure investment in the area include a tarmac road running through the study area (fig. 1). Subsistence agriculture forms the main source of livelihood, with communities situated along Lake Malombe being heavily engaged in fishing. Malawi has just evolved from a single party rule of three decades to pluralistic politics. The study area is situated in the stronghold of the ruling United Democratic Front (UDF).

2. Theoretical and Conceptual Framework

Of major concern to most developing countries is how to increase food production in order to feed their ever-expanding populations. While some suggest there is scope for achieving this through expanding the area under production (Buringh 1979), with land being a finite resource, intensification of production is seen to be more appropriate and sustainable. The agricultural system falls into two types. In land-abundant agriculture, increases in production frequently occur at the so-called "extensive margin". This results from bringing more land into cultivation. It is noted that output-enhancing technological change is often in the form of labour-saving mechanical innovation. In this case, the key constraint is adequate agricultural labour. Alternatively, in situations of scarcity of productive land, output increases result on the "intensive margin" through increase of yields. Technological change is deemed to be land-saving and often biological (Hayami and Ruttan 1985).

An initial blind faith, however, in modernisation along western lines and a top-down planning model, associated with grandiose schemes frequently economically and spatially isolated from the majority of the rural economy and its inhabitants, is gradually being replaced with a broad-based model of rural development which tries to incorporate more people into the planning process (World Bank 1981; Stohr and Taylor 1981; Chambers 1983).

Today "development from below" (Stohr and Taylor 1981), or "development from within" (Taylor and Mackenzie 1992), or "sustainable development" (Redclift 1987), or "green development" (Adams 1990) are frequently encountered and advocated as the theoretical frameworks in the development process. This takes a more behavioural approach, recognising that the rural inhabitants possess a fund of ecological and economic knowledge of proven value to agriculture at the micro-scale. In Rau's *From Feast to Famine*, (1991) Chapter 10 and 11 provide the rare opportunity for researchers and so-called experts:

> to listen and to discover the strong and viable countervailing pattern at the village and community levels as peoples have applied their knowledge, skills and resources to attain food security. Peasant farmers, artisans and pastoral people have struggled for over a century to retain the integrity of their lives against external forces that have threatened their lives against external forces that have threatened their well being. That struggle has been at great odds and cost, but the challenge made by common people to survive and develop integral social and economic systems is a powerful alternative to the exploitative agricultural and rural development programmes of governments and external "aid" agencies (145-6).

In pursuit of the desire to understand the dynamics behind land use and preference, Briggs (1985) used a repertory grid analysis technique to evaluate farmers' choice of crops in central Sudan. One of the many interesting insights he found was the apparent limited use of extension workers, in the smallholders' evaluation of their own decision-making process. While such findings do not necessarily have universal applicability, Briggs did call for other comparative studies to be undertaken. Clearly such findings have major policy implications for proper land use and management.

In Malawi there has been some work undertaken to find out why farmers adopt particular agricultural innovations. Kinsey (1984), for example, suggests that the gross margins involved in growing hybrid maize as compared to local varieties was not a sufficient incentive for farmers to risk the economic investments needed for hybrid maize as compared to local varieties. This work was carried out in Lilongwe ADD and analysed the situation from a purely economic viewpoint, taking a basic input-output approach. Nankumba's research (1985) went further and investigated variations in the motive and extent of technical utilisation among smallholder farmers operating under different farming systems in the Lilongwe ADD. He recommended that there was need for more research in this very important field. In a gender approach to adoption of agricultural innovation introduced through rural development programmes in Malawi, Chipande (1987) found out that there was very limited adoption by female-headed households. He pointed out that these households had severe labour constraints and small holding units. He remedially called for a greater understanding of the constraints of labour supply to innovation adoption in the country.

It is increasingly becoming an acknowledgeable fact that resource utilisation, particularly land, is essential in order to ensure continual supply. Thus resource exploitation should be in line with achieving maximum sustained yield (Blaikie and Brookfield 1987; Tait, Lane, and Carr 1988). The land resource should be exploited to ensure high productivity and high stability. However, for some time now it has become abundantly clear in Malawi that land use has gone contrary to the cause for its conservation. Land degradation has become a widespread phenomenon particularly in ecologically vulnerable areas (DREA, NEAP 1994). There could be several explanations for this. Among policy makers, resource degradation is in general regarded primarily as an environmental problem with environmental solutions. Such thinking has led to the non-inclusion of the role of concomitant changes in the social spheres in conservation policy options (Blaikie 1985).

Mismanagement of the environment is blamed on the land-users themselves on account of lack of their environmental awareness, ignorance, apathy, or just plain laziness. Thus, the root of the problem is perceived to be the cultivators or pastoralists themselves, and the blame originates from land use. It is believed that if they can be made to change by either education or compulsion, problems of soil erosion and deforestation can be solved. Such judgement from policy makers is quite often the outcome of their ignorance of the underlying facts.

The colonial Government in Malawi (then Nyasaland) put the blame for the mismanagement of land on the natives. Poor farm husbandry, including the traditional methods of growing crops on the flat ground or in separately circular mounds, did little to check run-off and erosion (Kettlewell 1965). The official approach was to use forceful measures to let natives adopt resource conservation and improvement innovations (Mlia 1987). Such an approach to land

conservation was not one of the land-users' choices but rather of their rulers'. Indeed little or nothing at all on "social factors" was known or coherently analysed in explaining land degradation.

Over the years, the Malawi Government has acknowledged that there is a real threat of serious degradation of the natural resources through the misuse of the land. To combat this in relation to the smallholder or peasant production, several activities needed carrying out by the agricultural extension service. These include among others:

· undertaking a number of special promotional campaigns which will include soil conservation;

· carrying out special farmer training courses on soil conservation; and

· developing extension messages, which integrate soil conservation with other agronomic practices.

Again on a more specific policy note, the Ministry of Agriculture strategy relating to Land Husbandry is outlined in the Guides to Agricultural Production, for the various years. The objectives of land husbandry are defined as ensuring a "balanced and sustainable utilisation of land and resources (mainly soil and water)...". Most recently, the policy objective of agriculture and livestock sector is "to promote environmental sound agricultural development by ensuring sustainable crop and livestock production through ecologically appropriate production and management techniques, and appropriate legal and institutional framework for sustainable environmental management" (MOREA 1996, 25).

The policy advises the support of basic good farming practices with biological and physical conservation measures to increase and sustain crop, fuel-wood and livestock production. These measures would also assist in conserving soil moisture. The biological measures include practices such as early garden preparation, early planting, correct plant population, use of manure and inorganic fertilisers, crop rotation, afforestation, controlled bush fires and grazing. The major physical features with the farming systems are bunds, waterways, terraces, storm water drains, marker ridges and box ridges. These measures should be promoted on a catchment basis, through an integrated approach to land use, whereby a farmer integrates the production of annual crops, pasture, livestock and tree crops within the same land area.

A close look at various land use practices underlying official rhetoric in West Malombe Catchment area does not show any direction towards an understanding of the peasantry's land use decisions. This research attempted to investigate the peasantry's land use decision-making process in order to come up with appropriate land use and management recommendations. One of the conventional frameworks for land use planning is the Farming Household Categorisation Matrix (FHCM) (Chimphamba 1990). The FHCM recognises that appropriate land use planning can be realised only when the farmers' primary production resource endowment of land, labour, capital and management are thoroughly understood. Again, the framework underscores the importance to be attached to the rationality of smallholder farmers in their selection of land use and management options. Thus, it is contended that the ability to implement a land use and

management technology in the FHCM framework is viewed as being positively related to its adoption. Land users are therefore categorised as low, medium and high resource endowment farmers, The low resource endowment users are those who rely on their own experience with their local society in the choice of a land use option. The medium resource endowment farmers are those who depend on both their own cultural roots and from the agricultural extension service on arriving at a land use decision. Finally, the high resource endowment farmers wholly depend on the agricultural extension for guidance in their land utilisation and management.

3. Profile of Land Use Pattern Changes and Spatial Extent of Degradation

3.1 Changes in Land Use Patterns

On a general note, the results of the 1988/90 land use inventory (Land Resources Evaluation Project (LREP) 1991/92) and those of a 1965/67 study by Stobbs and Jeffers (1985) indicate significant changes in land use patterns in Malawi. In 1965/67, some 3,532,000 ha (or 37.5 percent) of Malawi's total land area was under cultivation and fallow. In 1988/90, the figure rose to 4,641,350 ha (or 40.2 percent). At the national level, it means that agriculture grew by 1,108,550 ha or 31.4 percent. This gives an average rate of expansion of land for rained cropping of about 1.4 percent per annum over the past 23 years. At a regional level, agriculture grew by 326,900 ha (or 56.6 percent), 734,250 ha (or 49.7 percent), and 47,400 (3.2 percent) in the North, Central and South, respectively. These expansions represent 2.5 percent, 2.2 percent and 0.14 percent average growth rates over the past 23 years for the three regions. Eschweiler (1993) notes that because areas under recent fallows are included in the figures above, the growth in cultivated land must have originated from clearing indigenous virgin forest and woodland. Thus these fires might also reflect the average annual deforestation rates for the nation as well as for regions.

From a recent study of all ADDs in the country by ICRAF, it is indicated that significant changes have taken place in the area under cultivation. Thus in 1972, around 32 percent of all selected ADD land was cultivated while in 1995, the figure rose to about 50 percent (table 2). All ADDs have experienced rapid growth of land under cultivation.

Table 2. Changes in area under cultivation in selected ADDs

ADD	1972 (ha)	1972 (%)	1995 (ha)	1995 (%)
Mzuzu	5,734.0	14.8	10,624.0	27.4
Kasungu	7,641.0	46.1	13,963.0	84.2
Salima	763.0	34.5	1,660.0	74.9
Lilongwe	5,823.0	75.0	6,497.0	83.7
Machinga	2,556.0	34.9	3,126.0	42.7

Blantyre	1,967.0	54.1	2,185.0	60.1

SOURCE: ICRAF (1996).

Note: Cultivated land includes land use codes A-t1 to A-t5, B, C, and D (see Appendix).

One of the selected enumeration areas in Machinga ADD under the ICRAF study was TA Chimwala area, under which WMC falls. Land use and vegetation cover is presented in table 3 and figure 3.

The most noticeable feature from table 3 is that there has been a tremendous increase in seasonally wet grassland of floodplains and lake margins marshes as well as in built-up area. The area of seasonally wet grassland of floodplains and Lake Malombe margins increased from about 39 percent in 1971 to about 75 percent, representing a percentage change increase of about 36 percent. This situation consolidates latter assertion that there has been excessive erosion from the WMC area which has led to significant siltation/sedimentation of the littoral plain. The total amount of rain-fed cultivation with less than 2 to 10 percent tree canopy cover declined from about 22 percent in 1971 to around 10 percent in 1995. This represents a decrease of about 12 percent. This decline in area under cultivation could partly be explained in terms of the loss to seasonally wet grassland area. It is worrying to observe though that this cultivation occurs in almost bare land, with less

Table 3. Land use and cover in TA Chimwala, Machinga ADD

Land use code	Area (ha)		Area (%)		Change	
	1971	1995	1971	1995	Ha	%
A-t1	103.0	80.0	11.1	8.7	(23.0)	(2.4)
A-t2	85.0	12.0	11.1	8.7	(73.0)	(7.9)
A-t3	12.0	0.0	1.3	0.0	(12.0)	(1.3)
EF	364.0	697.0	39.4	75.4	333.0	36.0
GW-t1	49.0	0.0	5.3	0.0	(49.0)	(5.3)
GW-t2	148.0	72.0	16.1	6.7	(86.0)	(9.4)
GW-t3	32.0	8.0	3.5	0.9	(24.0)	(2.6)
GW-t4	28.0	6.0	3.0	0.7	(22.0)	(2.3)
GR-t1	30.0	0.0	3.2	0.0	(30.0)	(3.2)
Gr-t2	2.0	0.0	0.2	0.0	(2.0)	(0.2)
M	72.0	20.0	7.8	2.2	(52.0)	(5.6)
Z	0.0	40.0	0.0	4.3	40.0	4.3

Total	925.0	925.0	100.1	100.0	0.0	0.1

SOURCE: ICRAF, 1996.

Note: The figures in parentheses represent the loss in land area under that use.

than 5 percent tree canopy cover. Such environmental conditions warrant excessive soil loss to the lakeshore. Furthermore, all crown cover categories of the woodlands and tree savannahs reveal a decline between 1971 and 1995. This could suggest that the woodlands have experienced some form of deforestation. In other words, the loss in land area under natural forests and woodlands could be a clear testimony of the opening up of the areas to cultivation and fuel-wood collection. The booming traditional fishing industry along Lake Malombe could be contributing to deforestation in the area, in the context of fish preservation methods which utilise fuel-wood and the over reliance on dug-out canoes. The built-up environment had increased in area by about 4 percent between 1971 and 1995. This is largely a reflection of increasing population density in WMC area as earlier indicated. Figure 3 represents land use patterns for the northern part of WMC area from the 1957 aerial photography. No aerial photos for the same year could be found for the rest of WMC area. The map area covered in the photography was about 44.7 km^2, of which about 28.2 km^2 (63 percent) was under cultivation and around 2.7 km^2 (6 percent) under settlement. The cultivation took much of the floodplain area, drained largely by Nasenga River and several rivulets. The settlements aligned themselves along the main road but closely outflanking Lake Malombe. The marshland was used for cultivation. This lakeshore area is subjected to severe flooding almost every year.

Figures 4 and 5 capture land use patterns from the 1963 and 1976 topographical map sheets of the central and southern part of WMC area. The 1963 map coverage

Fig. 3. West Malombe Catchment: Land Use Pattern, 1997

Fig. 4. West Malombe Catchment: Land Use Pattern, 1963

Fig. 5. West Malombe Catchment: Land Use Pattern, 1976

Fig. 6. West Malombe Catchment: Land Use Pattern, 1982

was around 27.6 km^2, of which about 9.2 km^2 (33 percent) was under cultivation and about 2.6 km^2 (9 percent) was for settlement. Much of human activity in terms of farming and built-up area was concentrated in the flat area, with some isolated pockets in the hilly area. The settlements

centred along the main road. The 1976 map is much wider in coverage as it includes more settlements than the 1963 map. The conspicuous feature on this map is that smallholder agriculture and settlements extended into much of the hilly WMC area. The map coverage was 235.3 km^2 , of which about 20.3 km^2 (8 percent was under smallholder agriculture and about 30km^2 (about 13 percent) was occupied by human settlements. Figure 6 represents land use patterns for the same central and southern part of WMC area from the 1982 aerial photography. The area of about 114.3 km2 was captured in the photography, with approximately 6.9 km^2 (6 percent) and 4.1 km^2 (4 percent) coverage for smallholder agriculture and settlements, respectively. The photography reveals much of cultivation taking place in the hilly area and settlements being centred along the main road in the flat area.

3.2 The Process and Spatial Extent of Soil Erosion

Soil erosion is a major issue in Malawi. In the context of overall land degradation, soil loss poses the greatest threat to sustainable agricultural production as well as to physical contamination of water resources. However, the present knowledge about the extent and significance of soil erosion is essentially qualitative.

The results of the various attempts that have been made to obtain information on the amount of soil loss which occurs on different land classes and under different uses have been reviewed in Saka, Green and Ng'ong'ola (1995). For example, results from spot trials of soil erosion under various cover and farming practices have shown that soil loss in Malawi ranges from 0.50 t/ha/yr (Amphlett 1986; Kasambara 1984). The data obtained from a more recent study of four small catchments at Bvumbwe (Vitsitsi 1991) are also often equally cited. The results from this work are remarkable in that the catchment with the worst management only recorded an average annual soil loss of 8.8 t/ha over an eight-year period, and the other three negligible results. The sediment yield from the worst catchment would be considered well within the soil loss tolerance for this area and one, which only the most intensive conservation system might hope to achieve. The figures are at variance with those from other countries with a somewhat similar environment (Stocking 1986). However, it was noted in the report that the sampling of late rainstorms did not take place if a former one had already exhausted all the sampling bottles. Similarly, when rainstorms were frequent, power failure due to insufficient battery capacity occurred.

The World Bank (1992) estimated aggregate soil loss in Malawi from cultivated land at 20t.ha.yr. It was partly based on erosion hazard maps prepared by the Land Resources and Conservation Branch (Khonje and Machira 1987). Erosion rates were found to vary significantly throughout the country. However, it is important to emphasise that quantitative data on different aspects of soil loss and for determining critical land use management alternatives, is not readily available (Chimphamba 1993).

In the specific context of WMC, the most obvious features observed area through stereoscopic viewing were the general standard of cultivation, rills, gullies and stream bank erosion, and areas where soil tones indicated exposure of the subsoil. Areas of soil deposition were also clear.

The erosion process in general terms is influenced by rainfall intensity and amount, topography and type of soil, but above all by land use. It is not so much what the land is used for as the

standard of management that is important. For example, maize grown under a high standard of management following the recommended practices is fairly quick to give a good ground cover, and with correct ridging erosion can be kept to an acceptable level, provided the land on which it is being grown is suitable.

In WMC area, erosion on cultivated land in the form of soil detachment by raindrop impact, rills and gullies is widespread. The results of erosion by raindrop impact were seen in the form of erosion pedestals and pavements, sand mulching and sediment deposits. Gullies were clear for all to see and most commonly occurred under the following circumstances: paths representing garden boundaries, often running up and down slope; where cultivation had taken place across natural drainage lines; where runoff from above the cultivated area had concentrated and discharged through the cultivated land, carrying away mainly the clay fraction of the soil in suspension. It must also be borne in mind that a gradual deterioration in organic matter, soil structure, water holding capacity and the availability of nutrients increases the susceptibility of the soil to further erosion. It also makes the soil less suitable as a medium for plant growth resulting in reduced future crop productivity.

Significant gullies were found mainly in natural drainage lines through which cultivation had taken place as well as in those parts of the catchment which had been degraded leading to high run off which destabilised the waterways. Many of these gullies had reached the heads of their catchments. Furthermore, the streams from the catchment appeared to be unstable due to their rapid down-cutting as part of the rejuvenation process, giving rise to deeply incised stream beds. The resulting vertical banks were also unstable and liable to slumping.

Conservation measures through correctly aligned crop ridges, box ridging and making of bunds were fairly common on cultivated land. However, areas of the catchment which were more recently opened for cultivation showed signs of more rapid deterioration than those which had been in use for a long period. The latter had some conservation structures on them, e.g., survival of correct crop ridge alignment. It would appear those farmers opening up new land in the catchment area did not have any guidance on layout. Erosion due to livestock overgrazing and trampling was also limited.

4. Decision-Making, socio-economic Aspects OF Land Resource Use and Degradation

4.1 Social Characteristics

The average age of the sample stood at 47 years, long enough for some greater depth of environmental knowledge of their area. Eighty-five percent were married and 36 percent of the respondents had received some formal education (see table 4).

Table 4. Percentage of marital status

Married	85.0
Widowed	7.5
Divorced	6.8
Separated	0.7

The highest level attained by the majority was limited to primary education, registering about 97 percent of the responses (see table 5).

Table 5. Percentage of level of education

Primary school	96.6
Form 1	0.7
Form 2	0.7
Form 4	1.4
Form 5	0.7
Total	100.0

This low level of educational achievement is consistent with the fact that Mangochi is one of the districts with the lowest levels of school attendance. In part this is a function of the culture of the area where there is a high preponderance of Muslims who have been reluctant to send their children to school, given that many of the schools were originally run by the missionaries and that a Christian bias still exists today in the educational system (Pachai 1978).

4.2 Economic Characteristics

4.2.1 Occupation and Radio Ownership

Most of the respondents were farmers, as registered by a response rate of about 89 percent (see table 6), and 50 percent owned radios in working condition.

Table 6. Percentage of respondents' occupation

Occupation Type	Percentage
Farmer	89.1
Fisherman	2.0
Tenant	1.4
Tailor	0.7
Farmer /fisherman	2.0
Farmer /businessman	3.4
Farmer /bricklayer	0.7
Farmer /employee	0.7
Total	100.0

4.2.2 Access to Land and Tenure

Household land ownership is highly skewed, with over 70 percent of the respondents possessing holding units of less than 2 ha (see table 7). From the NSSA 1992/1993, about 77 percent of the households in Machinga ADD cultivated land holding units of less than 2 ha (NSO 1994). Land allocation follows customary arrangement, in which case one either accesses land by inheriting from parents or being allocated by a village headman. Results in this study show 54 percent and about 39 percent of the sample got their land units through inheritance or village headman, respectively. Under customary land tenure, one can only exercise usufructory rights through inheritance of property, including land, left by parents.

Table 7. Size of distribution of household land ownership

Category size (ha)	Percentage
Less than 1	34.8
More than 1, less than 2	38.8
More than 2, less than 3	14.1
More than 3, less than 4	5.4
More than 4, less than 5	1.4
More than 5, less than 6	1.4
More than 6, less than 7	0.7
More than 7*	3.4
Total	100.0

* The `more than 7' hectare category consisted of four individuals, solely owning 9.23 ha, 15.0 ha, 89.0 ha, and 170.0 ha, respectively.

4.2.3 Type and Cost of Labour Supply

Table 8. Percentage of labour supply

Type of labour	Percentage
Family labour	65.3
Hired labour	2.0
Family / Hired labour	32.7
Total	100.0

Ninety-six respondents (about 65 percent) used family labour, while only two individuals (2 percent) made use of hired labour. Forty-eight (about 33 percent) utilised both family and hired labour in their farm operations. These results show the role of family labour in a predominantly subsistence economy. Thus, even a small commodity producer who hires workers relies on inputs from his family and kin.

In terms of money spent on labour supply, 102 respondents (about 69 percent) did not spend anything. Nine respondents (about 6 percent) spent in the range of MK30.00 to MK90.00, while the expenditure of a third category of thirty-two respondents (about 22 percent) ranged from MK100.00 to MK800.00. On the extreme high side, one farmer spent MK1,000.00, another MK7,000.00, another MK23,000.00 and yet another MK120,000.00. These latter four were highly commercialised, though exaggeration on the part of the farmers could not be ruled out. A careful examination of returns to labour appear to elude many researchers simply because the accurate measurement of labour requirements and their timing is quite difficult. Labour inputs vary significantly from day to day during the farming season depending on the arduousness and urgency of the specific tasks. Given a wide range of crops that are cultivated in WMC area, bottlenecks in the supply of labour could pose a major problem. In a review of feasible land use/management options to alleviate food shortage in Songani area within Machinga ADD, Chimphamba and Kapila (1994) indicate that one hectare of local maize with and without inorganic fertilisers would require a labour resource of 119 and 112 man- days to yield 1,090 and 600 kg respectively. An intercrop of local maize with a variety of pulses on a one-hectare option would need 137 man-days to realise in the range of 910 - 1,200 kg while with groundnuts the resource labour would rise to 156 man days for 990 kg. It is also interesting to note that a hybrid maize with inorganic fertiliser, without fertiliser and intercropped with pulses would require 152,112 and 168 man days to produce 300,750 and 4,385 kh/ha respectively on one hectare of land. This study of Songani area underlines that there are fluctuating demands for farm labour. However, the data on labour supply for WMC area cannot allow an analysis of gross margins of productivity. It is otherwise an integral objective of small farmers in pursuing an adequate coping strategy related to structural imperfections in the system of supply and demand for farm labour.

4.2.4 Major Marketing Outlets and Pricing

Table 9. Percentage of marketing channels

Outlet	Percentage*
No response	40.8
Local markets	42.2
Urban markets	2.7
External markets	2.0
Auction Holding	4.0
Admarc	19.0
Other	2.0

*Figures do not add up to 100 percent because some respondents gave more than one of the outlets. Local markets and Admarc are the main marketing channels for agricultural products in the

study area.

In terms of respondents' experience, about 46 percent did not state anything. Two percent of the sample indicated that people were angry with the low prices their products fetched in those market outlets. Furthermore, about 25 percent, as opposed to 19 percent, found the markets reliable. One response indicated that the price of his/her products was decided by the buyers, and more likely, this is in reference to auction holdings. About 5 percent of the respondents did not find anything wrong as people came to buy directly from them while two individuals were undecided on the reliability or otherwise of these outlets.

Sixty respondents (about 40 percent) did not indicate their opinion about prices. Fifty respondents (about 34 percent) felt the prices were fair and thirteen individuals (about 9 percent) indicated that they got very good prices from sale of their products. However, on the negative side, twenty-five responses (about 17 percent) registered that prices were very low. Generally, one could brave to interpret the responses as being basically low, bearing in mind the large combined percentage on no responses and very low variables. Furthermore, one should understand the nature of responses under the backdrop of a silent culture the people had developed over the past thirty years on matters that would be seen to be conflicting government or political standpoint. The general outlook though on marketing opportunities for farmers products appear good. Furthermore, the producer prices for a variety of crops is revised each year by Government and farmers tend on the whole to respond favourably to higher producer prices (Mwafongo 1994).

4.2.5 Diversity of Crops Cultivated

Cropping patterns are increasingly viewed as an important part in the farmers' strategies to maintain an adequate level of output in the face of socio-economic and environmental risks. Table 10 indicates that people cultivate a variety of crops in WMC area. Most of these crops are grown for subsistence, with the exception of cotton and tobacco. In Malawi, to a large extent, decision-making in farm households is motivated by the need to provide the annual staple food supply, maize, so that much of the arable land is planted with maize each year (Smale et al. 1991). Thus in table 10, the cultivation of local and improved (hybrid) maize underscores its importance as the main food staples. There is a Malawian adage about maize: "*Chimanga ndi moyo* (maize is life)". The predominance of maize as a major land use enterprise has its own ecological problem. Local maize cultivation, in particular without the application of inorganic fertilisers, has a low soil fertility improvement capacity. It is a poor cover crop during the early period of growth and in the event of heavy early rains, this leads to soil deterioration through soil loss. Few farmers had the opportunity to grow tobacco, especially burley tobacco, as its cultivation used to be regulated through the government quota system. Burley tobacco growing has been fully liberalised now to allow small farmers to participate in the industry.

Table 10. Diversity of crops cultivated

Crop	Percentage*
Local maize	58.5

Improved maize	51.0
Rice	6.1
Root crops	19.7
Tobacco	12.9
Cotton	2.0
Groundnuts	29.9
Pulses	24.5
Other	0.7

*The percentage does not add up to 100 because the values represent individual respondent's participation in a variety of farming activities.

Seventy one respondents (48.3%) had access to a dimba. Forty-six (31.3%) respondents grew vegetables and fruits, less the number of those who had lack of manpower and scarcity of seed. However, crops that gave good yield and were easy to manage offered an important decisive factor. Chi-square (X^2) analysis was undertaken to measure whether there is no association between the decisive factor for cultivating a particular crop and household land at 0.05 significance level. The observed X^2 was 22.62407 at 12 degrees of freedom (d.f) and the tabulated value in a X^2 distribution matrix stands at 21.0261. Alternatively, it is observed that the P-value stands at 0.034 on the distribution with 12d.f., which is less than 0.05 significance level. The result of the X^2 test statistics leads to the rejection of the Null Hypothesis (Ho). In other words, there is an association between the decisive factor for crop choice to be cultivated and the amount of land available to a household. It is revealed, however, in Table 11 that about three percent of the respondents were guided by land scarcity in their choice of a land use enterprise. This result does not alter the real bearing of amount of land available to a household to venture in a particular land use option. Its criticality is subsumed in the range of other pressing problems related to technical efficiency of other variables, including the availability of labour or the ease with which to manage a particular crop production when confronted with a range of taxing land husbandry operations at a particular time. In many cases, this clashes with smallholder farmers' experience of labour requirements when they cultivate two or more crops at a certain time of their farming calendar year. This might be more decisive in their choice than the mere size of their land holding units.

Table 11. Percentage of choice factor for crop cultivation

Choice factor	Percentage
Reason not given	2.0
It was a gift	5.8
Land scarcity	3.4
Easy to manage	10.2

For food and cash	7.5
Scarcity of seeds	10.2
Lack of manpower	17.7
No rain	6.1
Crops grow well	2.7
A lot of experience with crop	0.7
It is grown here always	1.4
Crops give good yield	15.3
Easy to grow the crop	1.4
Gift/easy to manage	2.0
Gift/good and cash	2.0
Gives good yield	1.4
Good yield /easy to grow	6.1
Good income/easy to grow	3.4
Easy to grow but no money to buy seed	0.7
Easy to grow and family like it	0.7
Animal resistance and family like it	1.4
Friends grow it	.7
Easy to manage and it is good for food	2.7
Lack of manpower and scarcity of seed	0.7
Total	100.0

4.2.6 Types and Decision Factor of Livestock Reared

In many parts of the country, apart from crop production, many smallholder households base their livelihood on livestock. Results of the analysis indicate that a variety of livestock is reared in WMC area. Livestock ownership is generally positively correlated with income. For instance, the 1992.93 NSSA revealed that the average number of poultry owned by households in the first two income deciles was about half the number owned by the upper decile. Cattle ownership was three times higher in the highest decile than in the lowest decile. Statistical analysis was carried out to show whether or not there is a relationship between the decisive factor for rearing or keeping a particular type of livestock and the household land. It is observed that the X^2 is 18.04148 for a distribution whose d.f. is 14 at 0.05 significance level while the actual X^2 value stands at 23.6848. Alternatively, the observed p-value of 0.2049 is greater than 0.05. This scenario reveals that the Ho has to be accepted. In other words, there is not enough evidence to reject the Ho that there is no association between the decisive factor of the livestock reared and the amount of land that is at the disposal of a household. This makes sense when one considers that keeping of poultry, for instance, does not really require huge amounts of land while, on the other hand, livestock grazing is largely done on communal grazing land.

Table 12. Percentage of livestock reared

Types of livestock kept	Percentage
Cattle	4.8
Goats	29.3
Sheep	7.5
Rabbits	1.4
Pigs	0.0
Chickens	40.1
Ducks and Pigeon	21.2
Any other	1.4

Results in table 12 indicate that poultry in the form of chickens, ducks and pigeons are kept by most people. This might be a reflection of the less effort put in caring for them as in most cases they are on a free-range feeding system. The labour expended on them is only during the construction of their *kholas* (houses). Of the ruminants kept, goats are widely reared. This could be underlining the fact that goats are mostly kept by Muslims for ceremonial purposes. From the conservation point of view, the keeping of goats is better than other livestock, e.g., cattle, because goats survive well on any kind of roughage and are more resistant to the effects of drought. Nutritionally, it has been shown by modifying existing husbandry practices, milk can be produced from indigenous goats for human consumption (Cooper, Kirk, and Kamwanja 1993). Furthermore, goats are normally tethered during the crops growing season and they are only allowed to free range during the post-harvest period. However, this study reveals that only six respondents derived some milk from their livestock. This could be from cattle only and the keeping of cattle in WMC area could be limited due to shortage of landholding. The prevailing landholding sizes cannot allow for the growing of pasture. No one kept pigs just to show that the area of study is largely a Muslim community. Even the much broader 1992/93 NSSA study recorded nothing on the ownership of pigs in Machinga ADD. The underlying feature of the mixed stock of animals reflects the fact that they have different economic and ecological characteristics.

4.2.7 Decision Factor for Kind of Livestock Kept

The data in table 13 shows that the majority of respondents kept livestock for food and as source of income.

Table 13. Percentage of decision factor

Decision factor	Percentage
Reason not given	34.7
For food	9.5
For sale	8.2
For food and sale	25.2

Easy to keep	6.1
Lots of experience	0.7
Friend suggested keeping livestock	0.7
For high economic returns	6.2
Source of manure	0.7
High economic returns and source of manure	5.4
For food and easy to manage	0.7
Other	1.4
Total	100

5. Crop and Livestock Production levels and Cash Incomes

5.1 Level and Cash Income of Crop Production

Agricultural productivity is an important measure of the quality of life in any economy where agriculture is the backbone and where locally grown food forms the main basis of family nutrition. Output per hectare is similarly an important measure of productivity, and also of sustainability, since falling output might indicate a deterioration in the resource base. The production results simply give a general gross output per individual farmer without relating it to the amount of land under his/her ownership. Hence it has been impractical to generate productivity levels against any of the production variables, including land, labour, capital resource, management or technical possibility as yields are a matter of the production function where several factors come into play.

5.2 Production Output from Local and Improved Maize

Over 70 percent of the respondents got less than 500 kg from local maize and improved maize (see table 14 and 15, respectively). This level of production, in both cases, is to some extent consistent with the desire by the majority of smallholder sector to alleviate their critical problems of food shortage.

Table 14. Percentage of yield obtained from

local maize

Yield category (kg)	Percentage
Less than 500	72.8
More than 500, less than 1000	10.9
More than 1000, less than 1500	4.7

More than 1500, less than 2000	2.1
More than 2000, less than 2500	3.4
More than 2500, less than 3000	2.1
More than 3000, less than 3500	2.8
More than 3500	1.4
Total	100.0

It is important to note that fifty-one respondents (40.1 percent) did not grow local maize. The more than 3500 kg yield category comprises two respondents, one obtaining a total yield of 3,500 kg, and the other 18,000 kg.

Table 15 Percentage of yield obtained from improved maize

Yield category (kg)	Percentage
Less than 500	81.0
More than 500, less than 1000	9.5
More than 1000, less than 1500	3.5
More than 1500, less than 2000	0.0
More than 2000, less than 2500	1.4
More than 2500	2.8
Total	100.0

Ninety-one respondents (61.9) percent did not grow improved maize. The more than 2,500 kg yield category was composed of three farmers whose yield shares were 6,000 kg, 6,300 kg and 21,000 kg. It is worth pointing out that the more than 1,000 kg output in both tables 14 and 15 constituted a small proportion of the respondents and reflects a medium level of management to be attained by medium resource endowment farmers in the FHCM.

5.3 Product Output from Other Food Crops

One hundred and thirty nine respondents (94.6 percent) did grow rice. The average yield for growers stood at 117.125 kg. For root crops, about 98 percent did not cultivate them while the three growers recorded yields of 180 kg, 270 kg, and 360 kg, hence an average yield of 270 kg. The groundnut crop was not grown by 84 percent of the sample population. The yield range for the growers is presented in table 16.

Table 16. Percentage of yield obtained from groundnuts

Yield category (kg)	Percentage
Did not grow	84.0
Less than 100	10.4
More than 100, less than 150	1.4

More than 150, less than 200	2.1
More than 200*	2.1
Total	100.0

*For the more than 200 kg yields category, it constituted only three farmers,

with individual output of 270 kg, 360 kg and 540 kg.

Pulses form an important part of a subsistence farmers' cropping activity. In this study, very few were engaged in the cultivation of pulses (see table 17).

Table 17. Percentage of yield obtained from pulses

Yield category (kg)	Percentage
Did not grow	93.7
Less than 100	3.5
More than 100 less than 200	0.7
More than 200*	2.1

*The last yield range constitutes only two farmers with product outputs of 360 kg and 1,910 kg each.

5.4 Production Output from Non-food Crops

The non-food crops are particularly crucial for income generation as they are mainly for sale. These crops are tobacco and cotton. Table 18 represents the tobacco product output.

Table 18. Percentage of yield obtained from tobacco

Yield category (kg)	Percentage
Did not grow	89.0
Less than 200	6.2
More than 200, less than 400	1.4
More than 400, less than 600	1.4
More than 600	2.0
Total	100.0

Tobacco is a high value crop in Malawi and it is capital intensive. The last yield range was composed of three farmers whose individual output levels were 11,700 kg, 26,000 kg, and

62,000 kg. This level of output can only be realised by large-scale farmers on estates with the necessary resources.

The cotton crop was grown only by three respondents (2.1%) of the sample who obtained 135 kg, 150 kg and 2,000 kg each. It is a capital and labour intensive crop with high monetary value.

5.5 Monetary Returns from Sold Crops

Only thirty-one respondents (21.1 percent) sold their cultivated crops. From the cultivation of local maize, only two individuals (1.4 percent) sold with cash income amounting to MK 360.00 and MK 787.50 in between them. This could probably be underlining the belief that local maize is cultivated solely as a food crop. Actually eighty-six respondents (58.5 percent) indicated that they had grown local maize.

Only ten respondents (7 percent) sold from improved maize, with an income range of MK 100.00 to MK 10,080.00. Yet again about 51 percent of the sample had indicated that they had grown improved maize (see table 19). The indication from the results seem to suggest that improved maize, which is mainly advocated as a cash crop by Ministry of Agriculture and Livestock Development, is treated as a subsistence crop by farmers.

Table 19. Percentage of cash income from improved maize

Income category (MK)	Percentage
Did not sell	93.0
Less than 250	1.4
More than 250, less than 500	2.1
More than 500, less than 750	0.7
More than 750, less than 1000	0.0
More than 1000, less than 1250	0.7
More than 1250	2.1
Total	100.0

From rice production, only two individuals (1.4 percent) had sold, each receiving MK 15.00 and MK 200.00 while about 6 percent of the respondents had grown this crop. Four individuals (2.8 percent) had income from groundnuts, ranging from MK 100.00 to MK 990.00, yet forty-four (29.9 percent) were reported growers. Four respondents (2.8 percent got some income from sale of their pulses in the income range of MK100.00 to MK3,000.00, with one individual getting the maximum and the other three not exceeding MK300.00. About twenty four percent of the sample though grew these pulses. Monetary return from root crops was realised by only five respondents (3.5 percent) with an income range of MK40.00 to MK300.00. It is also interesting to note that twenty-nine respondents (19.7 percent) had indicated having cultivated these root crops.

Thirteen tobacco growers (9.1 percent) had sold their crop, with an income range of MK50.00 to MK 620,000.00 (see table 20). The more than MK7,000.00 income category, made up of four farmers, had individual incomes of MK7,000.00, MK99,450.00, MK520,000.00 and MK620,000.00. It is important to note the contradiction that arises from the fact that nineteen respondents (12.9 percent) had indicated that they had grown tobacco. One should expect all tobacco to be sold, yet here six did not sell. The other plausible explanation is that there is a tendency by small-scale farmers to grow the crop but because of the regions and requirements of sale at the Auction Floors they end up selling their tobacco to authorised farmers with access to the Auction Floors. It is sale by default, so to speak, and these small-scale farmers cannot produce records of sale for fear of being discovered growing and selling tobacco illegally.

Table 20. Percentage of cash income from tobacco

Income category (MK)	Percentage
Did not sell	91.2
Less than 1000	2.1
More than 1000, less than 2000	2.1
More than 2000, less than 3000	0.7
More than 3000, less than 4000	0.0
More than 4000, less than 5000	0.0
More than 5000, less than 6000	1.4
More than 6000, less than 7000	0.0
More than 7000	2.8
Total	100.0

Only three farmers (2.1 percent) had some income from cotton, each receiving MK480.00, MK600.00 and MK2,600.00, with no one `defaulting' from the reported growers. Ten respondents (7.0 percent) had reported having sold from their growing vegetables and fruits with an income range of MK10.00 to MK500.00 and MK 1.00 to MK2, 400.00, respectively.

The modal total cash income range from sold crops is that of some few *Kwachas* to less than MK500.00.

5.6 Livestock Production

Milk output was very low for the six farmers. On average, two litres were produced per day. Twenty-three respondents (about 16 percent) indicated that they got eggs of varying numbers in a day. The average was 3 eggs per day. Only one hide was obtained from the livestock kept.

5.7 Cash Income and Expenses on Livestock Rearing

The general cash income outlook from livestock is that many farmers earned less than MK500.00, as registered by eighty-three percent of those who had got income from sale of

livestock and its products. One hundred and twenty four respondents (about 84 percent) did not spend anything on the upkeeping of livestock. Even those who incurred some expenses, about eleven percent, spent less than MK70.00, two individuals in the range of more than MK100.00 and MK200, and the other three spent in the region of more than MK200 and less than MK400.00. A further two farmers exceeded MK1,000.00 but less than MK2,000.00.

5.8 Farm Implements and Other Input Expenses

Over 90 percent of the respondents used hoes in their farm cultivation operations (see table 21). Similarly, the 1992/93 NSSA revealed that about 95 percent of the Malawian smallholders owned a hoe followed by a watering can and a bicycle.

Table 21. Percentage of farm implements used

Implements used	Percentage
None	1.4
Hoes	89.8
Hoe/axe/pangas	6.8
Hoe/axe/sprayer	0.7
Hoe/axe/tractor/harr	0.7
Hoe/plough/tractor/harr	0.7
Total	100.0

Seventy five respondents (51 percent) did not apply any of the inputs to their gardens, while around 46 percent applied only fertiliser. Only one individual (0.7 percent) put manure to his/her garden, thus portraying the dim prospects of sustainable agriculture through organic manure (see table 22)

Table 22. Inputs applied to gardens

Inputs application	Percentage
None	51.0
Fertiliser	45.6
Manure	0.7
Pesticides	0.7
Fertiliser /Manure	1.4
Fertiliser / Pesticides	0.7
Total	100.0

In general, Malawi smallholders do not use modern inputs or credit. Poorer smallholder households are less likely to use modern inputs. According to a more recent National Sample Survey of Agriculture (NSSA), approximately 42 percent of smallholder households, of which

31 percent and 33 percent were below the 20t^{h} and 40th percentiles by income respectively, used fertiliser (NSO 1994).

5.9 Money on Farm Implements and Other Inputs

Sixty-three respondents (around 43 percent) did not spend anything on farm implements and other inputs. Forty-six individuals (around 38 percent) of the sample spent in the range of MK3.00 to MK98.00. This could imply purchasing inputs in smaller packages. Twenty-three (around 16 percent) spent in the region of MK105.00 to about MK968.00. Four individuals (2.8 percent) bought farm implements and other inputs in the range of MK1,000.00 and less than MK5,000.00, while in the extreme case, one farmer incurred MK30,000.00. In a study by Conroy (1992), it was found out that out of 685 households from Mzuzu, Kasungu, Lilongwe and Liwonde (now Machinga) ADDs, 55 percent of fertiliser consumption was accounted for by 10 percent of the households with incomes greater than MK700.00 per annum. A further 15 percent of Conroy's sample with income range of MK699.00 - MK350.00 per annum accounted for 23 percent of fertiliser consumption.

6. Knowledge, Attitude and Practice in Land Resource Management

6.1 Land Husbandry Information and Dissemination

6.1.2 Sources of Land Husbandry Information

To assess the various channels of spreading land husbandry information it became a useful idea to review how farmers in the area rank them

Table 23. Ranking of sources of land husbandry information

Source	Ranking (%)			Total
	Primary	Secondary	Tertiary	
Individual advice from extension staff	34.7	2.0	9.5	46.2
From other farmers or friends	10.2	9.5	12.2	21.7
Residential training centres /Farmers' blocks demonstrations	16.2	9.5	2.0	27.7
Publications or Newspapers	3.4	16.3	8.2	27.9
Radio	15.0	4.8	2.7	22.5
Total	79.5	42.1	34.6	

Table 23 underlines that individual advice from extension staff is the major source of land husbandry information transfer, with around 35 percent of the respondents ranking it as their primary source. The second position in terms of their relative importance is taken up by

residential training centres or farmers' blocks demonstrations at about 16 percent response rate for being a primary source. However, it is interesting to note that in terms of the overall response, residential training centres or farmers' blocks demonstrations and publications or newspapers tally at about 28 percent as vehicles of land husbandry information. It is also surprising to note that state extension services rank highly when they are generally associated with many deficiencies (Botha 1995). Central to the argument is the fact that state extension services are in essence weak and ineffective because they mainly cater for the needs of the larger, more commercialised farmer rather than for the small, resource poor farmer. Furthermore, state extension messages tend to be more focussed, and fit in well with the needs of large farmers. Small farmers who are more heterogeneous, with few resources and non-commercial would require varied extension methods and messages. Low, Seubert, and Waterworth (1991) examined the link between extension methods and messages. They found out that while demonstrations, for instance, were seen by some as the most appropriate method of introducing proven recommendations to farmers, they were particularly inappropriate for disseminating information about technically sub-optimal practices. Thus, the small resource endowed farmers do not require the so-called `recommendation domain' but rather land use and management options that would permit them to alleviate constraints. In this connection, extension services have to concentrate on developing the skills of farmers to comprehend and adopt more complex recommendations. The knowledge and skills transfer approach for the small-scale land user, unlike in the `technology transfer' paradigm, should focus on the methods, principles and a range of land use and management options. In the context of Malawi, the results of the National Sample Survey of Agriculture (NSSA) of 1980/81 supported the impression that the extension advice was focussed mainly on farmers with large landholdings and who were, in many ways, best equipped to successfully adopt the improved agricultural practices, re-pay the agricultural loans, and increase their production. The 1992/93 NSAA has revealed the same trends.

6.1.3 Reception of Extension Advice on Land Resources and Farming Systems

Slightly above 50 percent acknowledged having received extension expertise advice on the issue. In terms of the frequency of visits by the extension staff, it is interesting to note that some significant number of respondents were visited more than once.

The result portrayed in table 24 is against the prevailing contrary view that extension staff do not visit their clients on a regular basis or time spent is very limited. State extension staff are bound to spend the limited time at their disposal to high resource endowed farmers because it is asserted that the articulation of their needs is prompt and lucid.

Table 24. Percentage of extension staff visits

Number of times	Percentage
Never visited	49.7
Once	2.7
Twice	4.1
Three times	2.7
More than 4 times,	40.8

inclusive	
Total	100.0

6.1.4 Relevance of Extension Service

Seventy-seven respondents (52.4 percent) of the sample found the advice they got from the extension staff relevant, and enumerated a variety of ways. Advice on contour ridging, crop residue incorporation as compost manure and contour ridge spacing was most prominent as table 25 below indicates.

Table 25. Percentage of relevant ways of extension service

Relevant ways	Percentage
Did not find them relevant	47.6
Making storm drains	0.7
Contour ridging	10.9
Crop residue incorporation	8.2
Early garden preparation	1.4
Correct ridge spacing	8.2
Methods of feeding livestock	0.7
Planting trees	4.1
Proper land use	2.0
Fertiliser application	1.4
Making a dip tank	0.7
Strip cropping	0.7
Application of *khola* manure	1.4
Storm drain and correct ridge spacing	0.7
Contour ridging and early garden preparation	2.7
Contour ridging and correct ridge spacing	3.4
Contour ridging and tree planting	2.0
Crop residues as manure and tree planting	0.7
Correct ridge spacing and tree planting	2.0
Tree planting and proper land use	0.7
Total	100.0

Amongst those who found the extension irrelevant cited that the extension worker was not competent as in the case of giving incorrect advice on plant spacing.

6.1.4 The Practice and Cost of Tree Planting

Table 26. Percentage of trees planted

Type of tree planted	Percentage *
Bluegum, Gmelina and Pine	19.7
Cassia/ India	5.4
Mango	21.8
Pears and Pawpaws	12.2
Citrus eg guava, mapoza	11.6

*The percentage does not add up to 100 because, for each type of trees,

the response rate is calculated out of the total sample size.

The results seem to show that the practice of planting trees, and citrus trees in particular, is a common thing (see table 26 above). The horticultural trees grown are compatible with the hot climatic conditions of the area.

Twenty-three respondents (about 16 percent) indicated that it cost them something to grow their trees. However, only eleven interviewees (about 7 percent) pointed out the purchase of planting materials as a source of cost. This very low percentage as regards the nature of the cost probably underlines the fact that people do not consider or value trees as economic products. Leach and Mearns (1988) state tree growing will make sense where there are well developed markets for wood products, whether locally or in nearby urban areas. It is also most suited to farmers who are short of capital or labour, or both, since tree management for saleable output tends to be cheaper to start and is less labour intensive than cash cropping.

In terms of the actual cost of tree growing, it ranged from as low as less than MK1.00 to MK250.00. About 12 percent of the respondents spent less than MK75.00 on tree cultivation. One individual paid MK200.00 for his/her cultivation while the other MK250.00. The whole 87 percent of the respondents did not actually incur anything at all.

An interesting observation was that most of the upper lakeshore plain is predominantly vegetated with a *Msangu* tree (Faildberbia Albida). This tree is cut and its fat stems used by the local people for making canoes. This tree, however, is not used for canoe making in the Nansengwa River floodplain on account of the fact that its stems are thinner than in the upland plains. Today under the Malawi Agro- forestry Extension Project (MAFE), the Msangu tree is rigorously promoted to be grown by smallholder farmers on account of the fact that its nutrient-rich leaves dropping during the rainy season add fertility to the soil. In particular, it is claimed that the tree replenishes nitrogen and phosphates in the soil. The other school of thought that is advocated by the International Centre for Research in Agro-forestry (ICRAF) is that the Msangu tree simply adapts to the alluvial soil that is deposited through river floods. However, in WMC area, it was noted that it was growing even in the Phrilongwe uplands where much of the soil is eroded down the rivers or streams. Another observation is that wherever it is growing, be it in the higher areas or lowlands, crops cultivated under it, especially maize, display a vigorous growth and there is high output.

Other observed indigenous trees of use to the local communities in WMC area include the *Mbalika* (Ricinus Communis), *Chingulumwamba* (Trichodesma Physaloides or Trichodesma Zeylanicum), *Mashalele* (could not be identified at National Herbarium), *Njelenjele Msanga* (Sesbania Macrantha), *Mgoza* (Sterculia Africana), *Mbvunguti* (Kigelia Africana), etc. It was pointed out that the location where *Mbalika, Mashalele* and *Msangu* trees were found was an indication that the water table there was high. *Mbalika* is used as an ointment and medicine for the ruptured skin, which is called *Masilu* in the native language. The same plant is also used as one of the ingredients in the traditional initiation ceremony called *Msondo,* which is for the virgins only. *Chingulumwamba* tree is found near the river banks , particularly along Nansengwa River, and is used for removing some itchings on the body and as medicine for wounds. *Mashalele,* which has round fruits, is used as a substitute for soap by some people. It produces foam-like soap and is used for washing and bathing. *Njelenjele Msanga*, growing naturally in the area, is used by the ordinary people as one of the ingredients of vegetables. Mgoza has a thick bark. When dry, this tree is very light and is used for building fences. The Baobao tree is spotted throughout the plain in WMC plain area. The palm tree, especially at the Nansegwa River mouth, is evidently found in the area.

6.1.5 Land/ Resource Management Practices

6.1.5.1 Utilisation of Indigenous Knowledge on Resource Management Practices

The study of rural people's knowledge as being more superior to that of the technocrats in land use and management is well documented (Chambers 1933; Richards 1983; Watts 1982, 1987). Exemplification of use by small farmers of various techniques to conserve or improve the physical properties of the soil through such activities as manuring, mulching, ridging, minimum tillage, rotation, terracing, complex land-use mix and intercropping is common. Similarly, the adaptive capability through complex sequenced decision-making processes of small-scale land users and managers against problems of drought or soil deterioration has also been documented. Table 27 below provides a repository of indigenous resource management use in WMC area.

On use of indigenous resource management practices regarding mainly crop cultivation, such as intercropping, staggered planting and drought-resistant crop varieties have featured highly as shown in table 27. The usage of intercropping permits a more effective utilisation of the land, in relation to water, light and nutrients. The diversity of cultivated crops of different height and root systems leads to an increase in the utilisation of nutrients and water. It is even an advantageous cropping pattern on account of land economy in the event of small landholdings available to households. Intercropping reduces vulnerability. Thus the greater the diversity of crops, the smaller the risks. The other advantage with this practice is that the canopy is denser, which results in less leakage, run-off and consequently also erosion. Maize, pulses and groundnuts are the most commonly intercropped crops in WMC area. However, the high percent frequency on the negative response could be signifying lack of knowledge, which is a disturbing situation for some practices. In particular, one would expect that many would use drought tolerant crop varieties. It is possible to speculate that this also reflects failure or inadequacy in generating appropriate technologies from agricultural research institutions.

Table 27. Percentage of utilisation of indigenous resource management practices

Practice	Percentage		
	Positive	Negative	No response
Growing day light-sensitive crop varieties	1.4	96.6	2.0
Growing drought-tolerant crops	25.9	72.8	1.4
Delayed germination techniques	2.7	95.2	2.0
Biological weather forecasting	7.5	90.5	2.0
Staggered or staged planting	23.1	76.2	0.7
Burning of vegetation	5.4	93.2	1.4
Intercropping or ley farming	46.9	51.0	2.0
Others	6.1	91.8	2.0

The puzzling situation from the above table is that intercropping is practised by the majority of the people in WMC area. The contradiction comes from the fact that nationally there is an apparent decline in diversity in smallholder crop production as measured by intercropping between the 1968/69 and 1980/81 National Sample Surveys of Agriculture, the proportion of maize area intercropped declined from 94 to 28 percent. Even if allowance was made in terms of significant changes in definitions or statistical error, the drop is striking. If intrercropping is more intensive than monocropping, intercropping in the face of land scarcity would have increased. What the results show from table 28 is fact that land is becoming increasingly scarce and hence people opt to intercrop for land economy.

6.1.5.2 Following Conventional Land Conservation Practices

Results of the analysis in Table 28 indicate that around 52 percent of the respondents followed terracing, box-ridging, bund-*ing* and ridging, while 42 percent of the interviewees cited incorporation of crop residue as manure in their gardens. However, the comparison between the positive and negative responses seem to suggest not much has been instilled on the people on these conventional land conservation measures. From the statistical analysis on the correlation of following of land conservation practices and school attendance, it was observed that the X^2 value was 3.42988 with d.f. of 9 at 0.05 significance level, which was less than 16.9190 on the tabulated values of the X^2 distribution. On the other hand, the observed p-value of 0.9448 was much greater than 0.05 significance level.

Table 28. Percentage of followers of conventional practices

Conservation Practice	Percentage		
	Positive	Negative	No response
Selecting land management			

practice			
according to soil type	24.5	74.1	1.4
Cover crop	12.2	86.4	1.4
Shorter fallow period	17.0	81.6	1.4
Optimum planting time	29.3	69.4	1.4
Adequate fertilisers	14.3	84.4	1.4
Crop residue incorporation	42.2	57.1	0.7
Improved tillage practices	2.7	95.9	1.4
Soil amendments	8.8	89.1	2.0
Improved rotation	7.5	90.5	2.0
trip cropping	5.4	92.5	2.0
Contour cultivation	11.6	85.7	2.7
Graded contour	8.8	89.1	2.0
Grassed waterways	7.5	90.5	2.0
Gully stabilisation	11.6	86.4	2.0
Terracing, box-ridges, bunds and ridging	51.7	44.2	4.1
Stall feeding or zero grazing	3.4	93.9	2.7
Others	2.7	94.6	2.7

There is not enough evidence therefore to reject the Ho. No association between following of conservation practices and school attendance exists. However, these findings vary from the observations that are made in reality. The statistical explanation is that there was 75 percent of cells with expected frequency of less than 5. Similarly, a X^2 test analysis of possible association between following land conservation measures and highest level of education attained leads to the acceptance of the Ho. Thus, the observed value of the X^2 was 11.77866 at d.f. of 36 at 0.05 significance value while that on the X^2 distribution matrix at d.f. of 30 stands at 43.7730, implying that it is even much greater at d.f. of 36. Again, it was observed that over 90 percent of the cells with expected frequency were less than 5. Following land conservation practices was also tested for no association with the crops that were cultivated the previous year. The rationale was that the type of crop cultivated could be an indicator of the level of income that farmers realise and were able to invest from it in some conservation efforts. The observed X2 value at 0.05 significance level of 73.87457 at 72 d.f. was lower than 90.5312 at 70 d.f. and even much lower than 101.879 at 80 d.f on the X^2 distribution value matrix. The observed p-value of 0.4167 is much greater than 0.05 significance level. The Ho is accepted. There is no association between following land conservation practices and the diversity of crops that were cultivated.

6.1.5.3 Experience of Environmental Problems or Production Hazards

Table 29. Percentage of respondents experiencing environmental and production problems

Environmental problem or production hazard	Percentage		
	Positive	Negative	No response
Soil erosion	71.4	27.9	0.7
Deforestation (Fuel wood scarcity)	36.1	63.3	0.7
Drought	65.3	34.0	0.7
Water logging /Salinity	12.9	85.0	2.0
Outbreak of pests and diseases	28.6	68.7	2.7
Others	6.8	89.8	4.4

Soil erosion and drought registered about 71 percent and 65 percent positive responses, respectively, as shown in table 29 above. Results simply vindicate that farmers are aware of the various environmental problems or production hazards.

6.1.5.4 Coping ways with Environment Problems or Production Hazards

To design appropriate strategies of land use and management, symptoms and causes of land degradation through both scientific methods and from the perspective of the inhabitants of WMC area need to be determined. Responses in table 30 below suggest that local people were aware of the deterioration in soil and hydrological conditions, and hence their largely appropriate course of actions against such environmental vicissitudes.

Table 30. Percentage of coping ways

Ways	Percentage
No response	42.9
Made *mgelo* for soil erosion	15.6
Made bunds	9.5
Made box ridges	6.8
Planted trees	5.4
Contour ridging	7.4
Maize stalks for fuel wood	3.4
Applied pesticides	0.7
Early planting	0.7
Cultivated another piece of land	2.0
Crop rotation	1.4
Relied on Government food relief	6.8

Results in table 30 above indicate that people engage in a variety of coping mechanisms when hit by environmental hazards, but about 43 percent of the respondents did not indicate anything. The high percentage in the making of waterways (or mgelo) confirms the fact that soil erosion is the major environmental problem faced by the communities in WMC area. On an approximately 7 percent response rate on people's reliance on Government food for relief as a coping strategy is worth noting. The Government from time to time in the event of disaster like floods which are frequent in WMC area has donated relief food. It is now more than clear because a Ministry of Relief and Rehabilitation Affairs has been created for environmental hazards and other national calamities. A X^2 statistical analysis was undertaken to determine if there was no association between the coping strategies and school attendance on one hand, and the level of education achieved, on the other. The observed X^2 value of 23.61936 at 12 d.f. at 0.05 significance level was greater than 21.0261 on the X^2 distribution value table. The observed p. value of 0.0229 was lower than 0.05 significance level. Thus the Ho is rejected. When a statistical relationship was sought between the coping strategies and the highest level of education attained, it was observed that the X^2 value of 192.53703 at 60 d.f. was far more greater than 79.0819 at 0.05 significance level. This is an outright rejection of the Ho. The two results show that there is an association between the strategies followed and attendance of school in the fist place and the level of educational achievement on the other.

7. Conclusion and Recommendations

7.1 Conclusion

One of the features in WMC area is the ever increasing growth of population, which is inadvertently contributing to population pressure on the limited land resources. This is endorsed through a realisation that now much of WMC area with less than five percent canopy cover is under cultivation and that most of the upland catchment areas have recently become smallholder farmlands. The opening up of the unsuitable land which had natural vegetation is partly a factor in the widely conspicuous gullying scenario in the area. This obviously has led to excessive loss of soil, causing increased sedimentation along the shores of Lake Malombe.

The research findings identify a variety of land use activities and a range of choice decision factors. The diversity of crops and mixed stock is shown to respond to good yields and easy management. The socio-economic characteristics of the sample seem to underline that the people are greatly constrained to engage in more lucrative activities. Formal education is limited to primary level, which could make the farmers less amenable to land use and management innovations. Landholding units are small and labour is in short supply. Application of inputs, especially inorganic fertilisers, is limited. The majority of the populations are basically subsistence farmers with very limited prospects for adoption of a more lucrative land use option. Decline in land availability in particular entails that maize becoming the dominant crop, with no or little option of practising rotation.

The agricultural extension service is the major conduit of land husbandry information transfer. The agricultural extension staff, peculiar though to WMC area, maintain a high level of contact with most of the farming families. It would appear that the agricultural extension workers have demonstrated fairly well in the specific area of soil conservation related to terracing, box-ridging,

bunding, ridging, contour cultivation and gully stabilisation. This emphasis, however, does very little to improve soil fertility *per se*.

The study also reveals that people utilise both indigenous and conventional environmental management practices and that they are aware of the pressing environmental problems or production hazards, mainly soil erosion, drought and fuelwood scarcity. Intercropping is most visible as an indigenous resource management practice. Similarly some indigenous tree species, for example, Msangu, have potential soil fertility enhancement capacity while others have medicinal and nutritive value.

7.2 Recommendations

From the outset, it is strongly contended that location-specific research can yield more information and that more appropriate land use and management practices can be advocated and implemented. In an exploratory study of a basically subsistence agrarian economy of this nature, very limited set of recommendations alongside the goals of achieving adequate food production, improving farm incomes, enhancing soil fertility, reducing soil loss, maintaining sufficient supply of domestic fuelwood and disseminating land husbandry extension messages can be postulated. Further research could be suggested.

7.2.1 Adequate Food Production

Most of the people in WMC area are low resource endowed farmers. A low cost resource option that would probably be required in achieving adequate food production entails an emphasis by MOALD on local maize to be in rotation with pulses or local maize, intercropped with pulses. For medium or high resource endowed farmers, improved (hybrid) maize with inorganic fertilisers or intercropped with pulses should be vigorously promoted.

7.2.2 Improvement of Farm Incomes

Local maize, in rotation with pulses and the growing of various fruit trees, would seem to be a low cost land use option to be able to generate a moderate amount of income. It was also observed in WMC area that people mainly rear goats with minimum amount of management effort. It is recommended that the MOALD should consider cross-breeding the indigenous goat in the area with an exotic one, a by-product which can generate high income through sale of milk, beef or the improved live goat itself.

7.2.3 Enhancement of Soil Fertility

The majority of the farmers in WMC area do not apply inorganic fertilisers to their gardens. However, it was noted that a good percentage of the respondents were able to intercrop and incorporate crop residues in their farm fields. A logical extension would be to encourage farmers to practice intercropping and crop rotation with leguminous crop. Also, systematic inter-planting of Faidherbia Albida (Msangu Msangu) tree with crops like maize should continue to be promoted. Application of chicken droppings and goats' manure could be a relatively low-input cost option for the smallholder farmers with limited resources. Farming families endowed with

sufficient resources could be advised to utilise a particular type of inorganic fertiliser that best suits their farm land.

7.2.4 Reduction of Soil Loss

The prominence of gullying, rill formation and sedimentation along the Lake Malombe shore is indicative of excessive soil erosion taking place in the study area. Noting also that over fifty percent of respondents were already involved in conventional land or soil conservation measures, it would be expedient to continue with a more vigorous campaign on adoption of such measures. Thus constructing marker ridges for guiding ridge alignments in the fields, box ridging, use of cover crop and vetiver grass on contours could be low-cost effective measures in the reduction of soil loss. However, for farmers with medium or high resource endowment, they could be encouraged to establish buffer strips above contour marker ridges or construct narrow contour bunds in their fields which could be vegetated with nappier grass or hedgerows of woody leguminous plant. These farmers could as well construct and maintain graded bunds and storm water drains in their fields.

7.2.5 Maintenance of Sufficient Supply of Domestic Fuelwood

One of the major environmental problems experienced by he people of WMC area is fuel wood scarcity. Farmers with low resource endowment could be encouraged to plant appropriate tree species which are high yielding around their homesteads as well as multipurpose or agroforestry trees around farm boundaries. On the other hand, those with medium or high resource endowment could establish woodlots.

7.2.6 Dissemination of Land Husbandry Extension Information

This study has revealed that the land husbandry extension service is the main channel for information dissemination through direct individual contact in WMC area. Given the general low extension staff to farmer ratio, maintaining individual visits to farmers' fields, though the most effective way, may not be sustainable. Thus, it is recommended that demonstrations at Block and Day/Residential Training centres' gardens on recommended land use and management practices should be mounted for the invited farmers so that they may later them try in their own gardens.

7.2.7 Further Research

This study was one of exploration on land use, management and degradation in one of the most critically degraded catchment areas in Malawi. Enough data at an exploratory level has been generated and these have guided the author to make some generalised recommendations. There is a need for a more detailed study in the same area on: (a) establishing gross margins for various land use and management options, (b) the utility of indigenous ecological knowledge practices, for example, intercropping as one mostly commonly used method, (c) the cost effectiveness and adoption of conventional land conservation measures, and (d) the general survival strategies in the wake of adverse impact of environmental calamities.

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APPENDIX

PRESENT LAND USE AND VEGETATION COVER CODES

Cultivated Land (including recently fallow land)

A - Rainfed (dry land) cultivation

A.t1 - Rainfed cultivation with less than 2% tree canopy cover

A.t2 - Rainfed cultivation with 2 to 5% tree canopy cover

A.t3 - Rainfed cultivation with 5 to 10% tree canopy cover

A.t4 - Rainfed cultivation with 10 to 20% tree canopy cover

A.t5 - Rainfed cultivation with 20 to 40% tree canopy cover.

B - Wetland cultivation: rice grown under naturally flooded conditions

C - Dimba cultivation

D - Irrigated cultivation: land being cropped within a controlled irrigation scheme.

Grassland

EM - high or low montage grassland

EG - dry grassland/scrub (usually secondary, having been cleared from woodland or previously cultivated.

EF - seasonally wet grassland of floodplains and lake margins

ED - seasonally wet grassland associated with upland drainage systems (dambos)

Plantation Forests

F - forest plantation of mainly exotic species

Natural Forests and Woodland

GE - evergreen forest

GE - t1 - normally stocked

GE - t2 - depleted (less than 60%)

GW - Woodlands, woodland and tree savannahs (average height> 4m)

GW - t1 open 2-20% crown cover

GW - t2 medium: 20-40% crown cover

GW - t3 dense: 40-60% crown cover

GW - t4 very dense: over 60% crown cover

GR - recent regrowth of woody vegetation: thickets (average height < 4m)

GR - t1 open : 2-20% cover

GR - t2 medium: 20 - 40% cover

GR - t3 dense: 40 - 60% crown cover

GR - t4 very dense: over 60% crown cover

Marshes

M - marshes (reed and sedge communities)

Rock

R - bare or sparsely vegetated rock outcrops

Water

W - Open water (lakes, ponds, dams and rivers)

Built-up Areas

Z - Towns, villages and other significant buildings.