AG : DP/MLW/85/011
Field Document No.24

LAND RESOURCES EVALUATION PROJECT

MALAWI

LAND RESOURCES APPRAISAL OF LILONGWE AGRICULTURAL DEVELOPMENT DIVISION

by

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Lilongwe, October 1991

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SUMMARY

This report describes the physical environment of Lilongwe ADD, and contains an assessment of land suitability for four major types of land use. An outline of present land-use is also presented.

The physical environment of the ADD is described in terms of agro-climate, soils and physiography, natural vegetation, and land units. The agro-climatic zones, soil families and vegetation types are described in the report, and the spatial distribution of these three aspects of the land are presented on 1:250,000 scale maps. Land units are a specific combination of a soil unit and an agro-climatic zone, and they are presented in Appendix I and on a separate 1:250,000 scale map. Agro-ecological zones, which provide a generalized but integrated inventory of the land resources, are described in the report and depicted on a page-size map.

Present land-use is described in terms of major kinds of land-use, such as rainfed cropping, natural vegetation and forestry. Cropping patterns and crop yields in the smallholder sector are described. Present land-use is presented, together with natural vegetation, on a 1:250,000 scale map.

Land suitability has been assessed for four major kinds of land use:

- Rainfed agriculture under traditional management (for 15 crops)
- Rainfed agriculture under improved traditional management (for 21 crops or crop variety groups)
- Wetland rice under traditional management
- Forestry (for 14 tree species)

The land suitability is described for each of the crops and trees considered, both in the report and in tables in Appendix II. A description of land suitability for each of the 31 EPAs is also given. The generalized land suitability appraisal shows that 57 percent of the total land area of the ADD is classified as good quality land for rainfed agriculture under improved traditional management, while 12 percent, 15 percent, and 16 percent of the ADD are classified as moderate quality land, marginal land, and unsuitable land respectively.

ACKNOWLEDGEMENTS

This study was carried out under the guidance of Mr. R. Kabwadza (Assistant Chief Agricultural Officer, Land Husbandry), Mr. R.I. Green (Chief Technical Advisor, LREP), and Mr. N.J. Mulenga (Principal Land Husbandry Officer, LREP).

The authors are indebted to Mr. P. Banda, Soil Surveyor, SSS, and his Field Assistants who surveyed the Ntcheu District.

The survey of present land use and vegetation was done by Mr. R.I. Green (Chief Technical Advisor, LREP) in collaboration with one of the authors.

Laboratory analysis of soil samples was carried out at Chitedze Agricultural Research Station under supervision of Mrs. D.D. Lakudzala and Mrs. Mzungu.

Maps were produced by the Department of Surveys in Blantyre under supervision of Mr. H.E. Gondwe (Senior Draughtsman, LHB). Final drafts were made by staff of the Air Photo Unit of the LHB in Lilongwe.

Management and staff of Lilongwe ADD assisted with the collection of existing information, and two Land Husbandry Officers assisted during the field surveys.

Fieldwork and mapping was executed and/or supervised by Mr. J.H. Venema (FAO Expert, LREP), while the compilation of the report was done by Mr. A.J.M. Lorkeers (Associate Professional Officer, LREP). The report was edited by Mr. R.I. Green.

Lilongwe, October 1991

Aloys Lorkeers

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LIST OF ABBREVIATIONS AND SYMBOLS

ADD	Agricultural Development Division
ADMARC	Agricultural Development & Marketing Corporation
ALES	Automated Land Evaluation System (computer programme)
ASA	Annual Survey of Agriculture
asl	above sea level
CEC	cation exchange capacity
DAR	Department of Agricultural Research
DM	dry months (i.e. months with <50 mm precipitation)
DO	Development Officer
DVO	Divisional Veterinary Officer
EPA	Extension Planning Area
EC	electrical conductivity
f	forestry (a major land use type)
FA	Field Assistant
FAO	Food and Agriculture Organization of the United Nations
itm	improved traditional management (in connection with rainfed cultivation; a major land use type)
K	potassium
LC	land characteristic
LGP	Length of Growing Period
LHB	Land Husbandry Branch
LRDB	Land Resources Data Base (computer programme)
LREP	Land Resources Evaluation Project
LQ	land quality
LUT	land use type
me	milli equivalent
mmho	unit of electrical conductivity
MOA	Ministry of Agriculture
N	nitrogen
P	phosphorus
P	precipitation
P-an	mean annual precipitation
PET	potential evapotranspiration
pH	soil acidity; soil reaction
PM	Programme Manager
PO	Project Officer
ppm	parts per million
r	wetland rice under traditional management (a major land use type)
RDP	Rural Development Project
SSS	Soil Survey Section, DAR
T	temperature
T-an	mean annual temperature
T-EGP	mean temperature during the end of the growing period
tm	traditional management (in connection with rainfed cultivation; a major land use type)
T-GP	mean temperature during the LGP
T-min	mean minimum temperature of the coolest month

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CHAPTER 1

INTRODUCTION

1.1 PURPOSE OF THE STUDY

The present study provides an up-to-date and comprehensive inventory of land resources, present land-use and agricultural potential of Lilongwe Agricultural Development Division (Lilongwe ADD). It is meant as an instrument for agricultural planners, at national, ADD, and Extension Planning Area (EPA) level, as well as an information base for researchers and planners in related disciplines.

In particular, it is hoped that this study will contribute to the achievement of increased agricultural production on a sustainable basis, to the maintenance of self-sufficiency in food, to the expansion and diversification of agricultural exports, and to the fight against environmental degradation, in keeping with Government policy.

1.2 DESCRIPTION OF METHODS

A brief description of methods is given below. More information on each of the activities is given in the relevant sections in this report.

1.2.1 Preliminary desk studies

The following existing information was used in the preparatory activities for the various outputs:

- Existing reports and maps giving details of soils, physiography, geology, vegetation and land use. A summary of available studies is given in Appendix IV.

- Black and white aerial photographs. Three different sets of photographs (1982 at scale 1:25,00 and 1986 and 1990 at scale 1:40,000) covering the whole area, were studied under a mirror stereoscope to assist both the inventory of soils and physiography and the inventory of land-use and vegetation. Details of the aerial photograph coverage are given in Appendix III.

- Landsat satellite false colour composites at scale 1:250,000. Details are given in Appendix III.

- Topographical maps. The 1:50,000 and 1:250,000 scale map series were used; the first for the study of topography and for orientation in the field, and the second as a base for the final maps. A 1:100,000 scale map - a photographically reduced copy of the 1:50,000 series - was used as a base for the draft Soils and Physiography map. Details are given in Appendix III.

1.2.2 Fieldwork

The area was surveyed by two teams during the second half of 1990, each team spending six weeks in the field. The survey teams included one FAO Specialist, one Soil Surveyor (from Soil Survey Section, MOA), several Field Assistants (from SSS), two Land Husbandry Officers (from LADD) and four or more casual labourers per team.

Soils, land-use and vegetation were studied and described. A free survey method (not following a grid or transect system) was used, making as much use as possible of existing tracks and limiting the number of expeditions on foot.

In total 310 observation sites were described in detail on standard description sheets (see Appendix V for example), and their locations were recorded on 1:50,000 topographical maps. Two hundred and fifty two soil samples were collected from 89 soil profiles. If present in their fields, farmers were asked for information on land use, management practices and specific problems.

Visits were paid to each secton within Lilongwe ADD offices to collect background information. Other institutions from which essential information was collected are: ADMARC, the Regional Forestry Office, the Regional Health Office, the Regional Education Office and the Fisheries Department, all in Lilongwe.

1.2.3 Laboratory analyses

The soil samples collected in the field were analyzed at Chitedze Agricultural Research Station. The samples were analyzed for particle size, pH, organic Carbon, Nitrogen, Phosphorus, exchangeable bases, Cation Exchange Capacity, Copper, Zinc and Sulfur. Methods of analysis are given in Appendix VI.

1.2.4 Inventory of soils and physiography

Aerial photography at scale 1:25,000 and 1:40,000 were interpreted under a mirror stereoscope, and the boundaries transferred to 1:50,000 scale topographical maps, and later verified in the field. After fieldwork and laboratory analysis, on the basis of all data collected, the final legend for the Soils and Physiography Map was designed. This legend includes all the information on physiography and soils needed for land suitability evaluation. With this legend a draft of the soils and physiography map was produced at scale 1:100,000. For this purpose the 1:50,000 scale topographical map series, photographically reduced to scale 1:100,000, was used as a base. The final Soils and Physiography Map was produced at scale 1:250,000, with soil boundaries and symbols superimposed on the topographical detail of the 1:250,000 topographical map series. Correlation with soils found during previous surveys in other ADDs was carried out.

1.2.5 Agro-climatic inventory

The agro-climatic resources inventory of the Central Region was carried out by LREP (Nanthambwe, 1990), and has provided the basis for the Agro-Climate Map at scale 1:250,000. The Agro-Climate Map was produced by combining the information of two maps showing different sets of agro-climatic characteristics. Furthermore, for each resulting mapping unit, additional temperature characteristics were established. The agro-climatic zones are indicated by a number, and are correlated for the whole of Malawi.

1.2.6 Land units

The Agro-Climate Map was superimposed on the Soils and Physiography Map, and land units were defined as a combination of one particular soil/physiography unit with one particular agro-climatic zone. Some generalizations were made to avoid the creation of very small or irrelevant units. The Land Unit Map was produced at scale 1:250,000, with the boundaries and symbols superimposed on the topographical detail of the 1:250,000 topographical map series. The Land Unit Map is used as a basis for the production of land suitability maps.

1.2.7 Present land-use and vegetation

Information on the distribution of cultivated land and on vegetation cover was derived from field observations, Landsat imagery at scale 1:250,000, and 1:40,000 scale aerial photographs. Pattern recognition on the satellite images was guided by the study of the aerial photographs. Details of photographs and images used are given in Appendix III. Information on crops grown and land husbandry practices was obtained through field observations and interviews. The species composition of the remaining natural vegetation was established through field observation and literature study.

A national legend was drawn up on the basis of extensive literature and own field observations. The Present Land-use and Vegetation Map was produced at scale 1:250,000, with the boundaries and symbols superimposed on the topographical detail of the 1:250,000 topographical map series.

1.2.8 The Land Resources Data Base (LRDB)

Comprehensive information on each of the land units is stored in the computerized Land Resources Data Base (LRDB). The LRDB is a programme developed by the Project from dBASE III PLUS. Apart from functioning as a general data base, from which a wide range of characteristics can be extracted, the programme automatically provides relevant information for the computerized land suitability evaluation (see below) through an interface.

1.2.9 Physical land suitability appraisal

The land units were evaluated for a total of 17 agricultural crops and 14 forestry trees, grouped under different major kinds of land-use: rainfed cultivation at two levels of management, wetland rice cultivation and forestry.

The methodology for land appraisal was developed by LREP and is fully computerized. It is described in detail in the Methodology for Land Resources Survey and Land Suitability Appraisal (Eschweiler et al., 1991). The methodology is in accordance with the FAO Framework for Land Evaluation (FAO, 1976), and the computerized land evaluation is carried out with the help of the Automated Land Evaluation System (ALES), version 2.0 (Rossiter and Van Wambeke, 1989). Additional software for interfacing ALES with the Land Resources Data Base and for manipulating output was created in the project.

1.2.10 Area measurements

Areas on the various maps were measured with a planimeter.

1.2.11 Agro-economic data and research results

Agro-economic data, research results, socio-economic data, and information on policies and existing and future projects were obtained from various institutions and from literature. The most important sources were: Lilongwe ADD, Ministry of Agriculture Head Quarters (Land Husbandry, Planning Unit, Research, Agro-economic Survey) and Central Statistics Office.

1.3 PREVIOUS STUDIES

As for the whole of Malawi, the National Regions and Areas of Lilongwe ADD have been mapped at scale 1:500,000 (Brown and Young, 1965 and Stobbs 1971). Other studies are either detailed surveys of small areas (e.g. research stations) or very general and therefore not very useful for the present study. An annotated bibliography of the most relevant studies is presented in Appendix IV.

CHAPTER 2

LOCATION, POPULATION AND INFRASTRUCTURE

2.1 LOCATION AND BOUNDARIES

Lilongwe ADD is situated in the Central Region of Malawi. It shares a border with Zambia to the south and west, Kasungu ADD to the north, Salima ADD to the east and Liwonde and Blantyre ADDs to the south-east. Lilongwe ADD covers an area of 11,718 km², and is geographically located between latitudes 13°29′ and 15°20′ S, and longitudes 33°14′ and 35°56′ E. See Figure 1.

2.2 POPULATION

2.2.1 Population and population projections

The total population of Lilongwe ADD was approximately 1,757,000 in 1987, or 22.0 percent of the population of Malawi (NSO 1987). Distribution according to sex is 48 percent male against 52 percent female. Nearly half of the population (47 percent) is less than 15 years old.

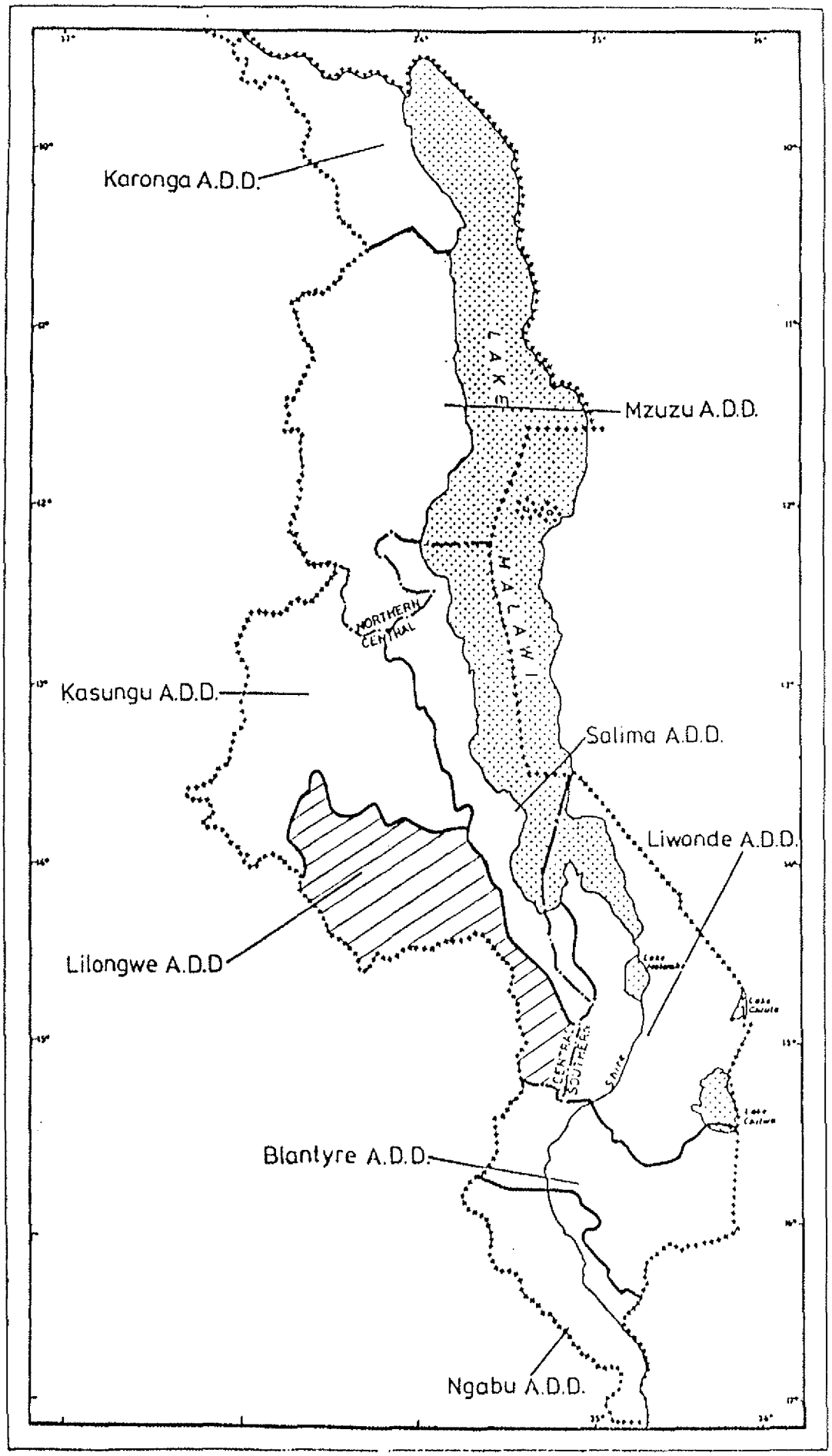
Settlement is of a scattered nature, with most people living near their fields or in small villages. The average population density is 133 persons/km². The population is mainly concentrated in Lilongwe township, on the Lilongwe plains and around Ntcheu. Other areas, such as the Dzalanyama Range and the northern part of the Upper Dedza Escarpment zone have very low population densities.

The annual population growth rate for the period 1977-1987 was 3.4 percent in Lilongwe District, 3.2 percent in Dedza District and 4.7 percent in Ntcheu District. The annual growth rate for the whole country was 3.7 percent over the same period. The discrepancy in growth rate within the ADD is mainly caused by migrations. Assuming a continuing annual growth rate of 3.3 percent, the population of Lilongwe ADD was at 1,937,000 in 1990, and would grow to 2,679,000 in the year 2000 and would double in approximately 22 years.

2.2.2 Employment

As in the rest of the country, most people in Lilongwe ADD make a living as subsistence farmers. During the year 1980 aproximately 88,000 people had paid employment, out of a total population of about 1,375,000 (National Atlas, 1983). Aproximately 36 percent of paid employees were working in agriculture, notably on tobacco estates in Lilongwe and Dedza Districts. Substantial numbers of paid employees are found in the public and social service sector (21 percent) and in construction (20 percent). Lilongwe District has a large commercial sector with 9 percent of paid employees in this sector.

FIGURE 1. LOCATION OF LILONGWE A.D.D.



2.2.3 Food availability and nutrition

The main food in Lilongwe ADD is a thick porridge ("nsima") made from maize and eaten with a relish of green vegetables. The most common fruits are mango, available in December-January in most areas and in February - March in high altitude areas like the Kirk Range. The diet is supplemented with meat from wild animals, wild fruits, etc. throughout the ADD. Few people produce, or can afford to buy, meat, milk, eggs and fruits other than mango and banana.

Food scarcity is widespread during the end of the dry season and the beginning of the rainy season. About 86 percent of ADD households were expected to run out of food before the next harvest during December 1990, while the ability to buy food was not sufficient to compensate completely. The hardest hit RDPs were Lilongwe N.East (91%) and Dedza Hills (88%) (FSNM, 1991).

2.3 ADMINISTRATIVE DIVISIONS

Lilongwe ADD is situated in the Central Region of Malawi, with Lilongwe as headquarters. Lilongwe ADD includes three Administrative Districts: Lilongwe District, Dedza District and Ntcheu District, with offices in Lilongwe, Dedza and Ntcheu respectively. Small parts of Ntcheu and Dedza Districts are in Salima ADD. Each District is headed by a District Commissioner.

Within Lilongwe ADD there is a total of 31 Traditional Authorities, headed by Chiefs and Sub-Chiefs, and with Village Headmen at a lower level.

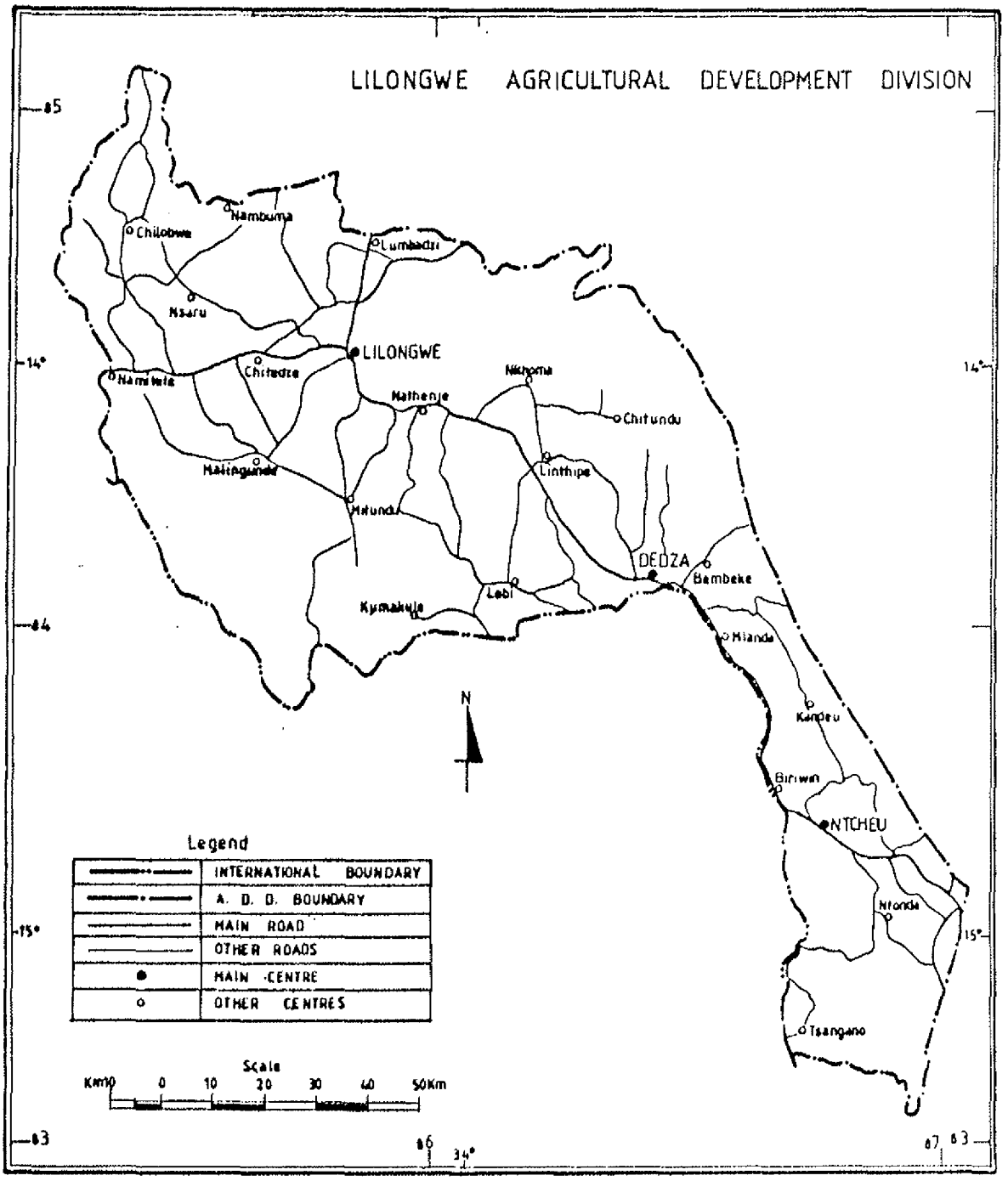
For agricultural administration, Lilongwe ADD with headquarters in Lilongwe contains five Rural Development Projects (RDPs): Lilongwe RDP (3,230 km^2), Lilongwe N.East RDP (2,195 km^2), Thiwi/Lifidzi RDP (1,022 km^2), Dedza Hills RDP (1,832 km^2), and Ntcheu RDP (2,433 km^2), with offices located in Lilongwe, Nkhoma, Dedza (both Thiwi/Lifidzi and Dedza Hills RDPs) and Ntcheu respectively.

2.4 MAIN TOWNS AND COMMUNICATIONS

Of the total population in the Central Region 14.6 percent lived in urban areas in 1987. The major urban centre is Lilongwe City with a population of 234,000 (NSO, 1987). Other major towns/bomas are Dedza (16,700 inhabitants in 1987) and Ntcheu (5,800).

The main north-south road, the M1, connects Lilongwe with Kasungu and the Northern Region to the north, and with Blantyre and the Southern Region to the southeast. The M4 east-west road connects Lilongwe with Zambia to the west and the M5 connects Lilongwe with Salima to the east. In the easternmost part of Ntcheu District the M6 and M17 give access to Blantyre to the south and Salima to the north. A network of upgraded earth roads provides good access in the Lilongwe plains.

FIGURE 2. MAIN TOWNS AND ROADS, LILONGWE A.D.D.



Only a few earth roads exist in the escarpment zones, where accessibility is generally poor, and many roads become impassable at times during the rains. The road system is shown in Figure 2.

A railway connects Lilongwe with Mchinji and the Zambian border in the west and with Blantyre via Salima and Balaka to the south. This same railway also gives access to the Nacala seaport in Mozambique.

Kamuzu international airport, 25 km north of Lilongwe, provides the facilities for both international and national flights.

There are regular bus services operated by private companies between all main towns and local centres. The rivers in Lilongwe ADD are not navigable.

2.5 UTILITIES, HEALTH AND EDUCATION FACILITIES

- Electricity and water

All main towns are connected to the national electricity grid. A 132 KV line connects Lilongwe to Salima and a 66 KV line connects Lilongwe via Dedza and Ntcheu with Blantyre. Another 66 KV line exists between Lilongwe and Mchinji. Along these lines electricity is provided to big trading centres, district headquarters and individual consumers (hospitals, grain mills, EPA centres, etc.) under the Rural Electrification Project.

The Water Supply Branch of the Department of Water Resources is responsible for supply of treated water to all major towns except Lilongwe, which is served by the Lilongwe Water Board. Besides the urban water supply, the Branch provides untreated but protected piped water supply to some rural areas. Water supplies are derived from either rivers or from groundwater (boreholes). Urban water supply centres exist in Kabudula, Chitedze, Likuni and Bunda (Lilongwe District), Dedza and Ntcheu. There are rural piped water projects in Dedza and Chilobwe, Lizulu, Kalitsiro, Dombole, Ntonda, Kasinji and Nanyungu (Ntcheu District). A dam on the Lilongwe river at Malingunde (Kamuzu Dam) with a storage capacity of 11.3 million cubic meters and a recently constructed second dam provide water to Lilongwe Town. In rural areas most of the people draw water from wells, rivers, streams or boreholes.

- Health

Within the ADD health services are provided at the following levels (1983): General Hospitals (2), Central Hospital (1), District and Mission Hospitals (9), Primary Health Centres (7), Health Sub Centres (51), Health Posts (2) and Leprosy Control Centre (1).

About one third of all deaths is caused by malaria and around one fifth is caused by respirative diseases (tubercolosis, pneumonia, etc.). Table 1 gives an indicative statement for Lilongwe District only.

Table 1. Morbidity for Lilongwe District, 1990.

Under 5 years		Over 5 years	
1 - Malaria	36.4%	1 - Malaria	29.7%
2 - Respiration symptoms	21.1%	2 - Respiration symptoms	16.7%
3 - Skin conditions	8.1%	3 - GIT symptoms	9.2%
4 - Inflammation of eye	7.8%	4 - STD	5.6%
5 - Diarrhoea	7.5%	5 - Diarrhoea	4.6%

GIT = Gastro-Intestinal Tract, STD = Sexually Transmitted Diseases.

- Education

In Lilongwe ADD, out of the population aged five years and above, 40 percent have attended primary school and only four percent have attended secondary school. These figures are lowest for Dedza District, 30 percent and two percent respectively, and highest for Lilongwe District with 43 and five percent.

Table 2. Number of schools, teachers and pupils per district, 1990.

	Dedza	Lilongwe (R)	Lilongwe (U)	Ntcheu
Primary schools	126	242	28	114
MCDEs	6	3	4	6
Teachers - qualified	541	1,206	967	654
- unqualified	60	163	9	72
- SDT	74	176	-	104
Enrolment 1990/1991	45,395	97,681	55,071	57,805
Ratio pupils/teacher	67.3	63.2	56.4	69.6
Secondary schools	3	8		2

R = Rural, U = Urban, MCDE = Malawi College of Distance Education Centres, SDT = Special Distance Trainee Teachers.

2.6 AGRICULTURAL SERVICES

2.6.1 Organization of Lilongwe Agricultural Development Division

Malawi is divided into eight Agricultural Development Divisions (ADDs), each headed by a Programme Manager (PM). The Programme Manager is directly responsible to the Principal Secretary of Agriculture through the Controller of Agricultural Services. ADDs are subdivided into Rural Development Projects (RDPs), but land occupied by National Parks and Game Reserves, Forest Reserves, and areas controlled by Smallholder Crop Authorities are excluded from RDP management. RDPs are divided into Extension Planning Areas (EPAs), which in turn are further subdivided into

Sections and Sections into Blocks. An RDP is headed by a Project Officer (PO), an EPA by a Development Officer (DO), and Sections are run by a single Field Assistant (FA) who visits each of the Blocks.

Lilongwe ADD has five RDPs and a total of 31 EPAs:

- Lilongwe RDP has Lilongwe as headquarters and is subdivided into ten EPAs: LL2 (Thiwi), LL3 (Thawale), LL4 (Malingunde), LL5 (Ukwe), LL6 (Mngwangwa), LL7 (Chilaza), LL8 (Ming'ong'o), LL9 (Mwala), LL10 (Kasiya) and LL12 (Mlomba).

- Lilongwe N.East RDP has Nkhoma as headquarters and is subdivided into seven EPAs: LL1 (Chitsime), LL11 (Nakachoka), LL18 (Nyanja), LL19 (Mkuza), LL20 (Chitekwele), LL21 (Chiwamba) and LL22 (Chigonthi).

- Thiwi/Lifidzi RDP has Dedza as headquarters and is subdivided into four EPAs: DE1 (Chafumbwa), DE2 (Kabwazi), DE3 (Linthipe) and DE4 (Lobi).

- Dedza Hills RDP has Dedza as headquarters and is subdivided into four EPAs: DE5 (Kaphuka), DE6 (Mayani), DE7 (Kanyama) and DE8 (Bembeke).

- Ntcheu RDP has Ntcheu as headquarters and is subdivided into six EPAs: NCH1 (Njolomole), NCH2 (Kandeu), NCH4 (Mphepozinai), NCH6 (Tsangano), NCH7 (Nsipe) and NCH8 (Manjawila).

RDP and EPA boundaries are shown on all the 1:250,000 scale thematic maps produced for this study.

The various sections in the ADD, apart from General Management and Administration, are Planning and Evaluation, Agricultural Field Service, Animal Husbandry and Adaptive Research. The Agricultural Field Service is subdivided into Extension, Credit and Marketing, Training, Crops general, Tobacco, Horticulture, Land Husbandry, and Visual Aids.

Subject Matter Specialists are placed in hierarchical order at Ministry Headquarters, ADDs, RDPs and EPAs. Subjects represented at the first three or all four levels are: Planning and Evaluation, General Extension, Credit and Marketing, Land Husbandry and Animal Husbandry.

At present there is no external funding for Lilongwe ADD.

2.6.2 Extension

Day to day agricultural extension to smallholder farmers is carried out by Field Assistants (FAs), each of which is responsible for a Section. Each Section consists of eight Blocks of about 100 farmers each. In Lilongwe ADD there are 368 FAs for a total of about 326,700 farm families (average of one staff member for 888 farm families). Extension messages are conveyed in group meetings and by demonstrations. Because of scattered settlement and transport problems some of the farmers are difficult to reach.

2.6.3 Credit

Credit can be obtained through the Credit Officers in the EPA. Seasonal credit is provided in kind and consists of crop-specific packages of seed, fertilizer and pesticides as recommended by the extension service. Most seasonal credit is taken up by farmers organized in Farmers Clubs or Credit Groups, which totalled 2,592 (with 95,155 members) in the 1990/91 season. Individual farmers can also apply for medium-term credit (2-7 years) to purchase certain farm implements, ox-carts or work oxen. About 29 percent of farming families in the ADD used credit in one form or another in the 1990/91 season, and were using a total loan value of about MK 27,455,000. For comparison, in 1985/86 figures were 23 percent and MK 6,954,000. Repayment of loans was around 94 percent over the years 1985-1990.

2.6.4 Input supply and marketing

Fertilizers, seeds and pesticides are the major external inputs used by farmers. ADMARC and the Smallholder Fertilizer Revolving Fund, through the ADD structure, are the main organizations involved in the supply of these inputs to the smallholder. See Table 3. Fertilizer and pesticides are imported and sold to the farmer at subsidized rates. Improved seeds are obtained from the National Seed Company of Malawi.

Cash crops and excess agricultural produce are sold to ADMARC at fixed prices which are announced at the beginning of the growing season. See Table 4 for an overview of ADMARC produce purchases. Only a small share of total sales by farmers is sold to private traders. Fruits and vegetables, and livestock and animal products are usually sold in local markets.

The main distribution/collection points for agricultural inputs and products are the ADMARC markets. There are 51 permanent markets and 112 seasonal markets in the ADD.

2.6.5 Land Husbandry

The Land Husbandry Branch (LHB) is represented at the ADD level by Land Husbandry Officers at headquarters and by Field Officers and/or Field Assistants at RDP level.

The main activity of the Lilongwe ADD LHB includes catchment conservation, both on a communal and an individual basis, mainly through pegging of contour marker ridges and persuasion of farmers to align their cultivation ridges parallel to these marker ridges. Raising of footpaths and sometimes strip cropping are also part of this conservation programme. A total area of about 3,000 ha of customary land has been conserved in this manner in Lilongwe ADD in 1988/89 and 1989/90.

TABLE 3. INPUT SALES BY ADMARC, LILONGWE ADD 1990/91
(Only main commodities are given)

INPUTS			WEIGHT (m.tons)
SEEDS	Hybrid Maize	MH12	186
		MH15	<1
		MH16	41
		MSCM41	567
		R201	287
		R215	330
	Composite Maize	CCA	4
		UCA	6
	Groundnuts	Chalimbana	890
		Manipintar	2
		Mawanga	10
	Wheat		<1
	Rice		-

INPUTS		WEIGHT (m.tons)
FERTILIZERS	23:21:0 + 4S	8,892
	CAN	8,294
	UREA	9,509
	DAP	5,266
	S/AMONIA	27
	S/MIXTURE	49
	D/MIXTURE	668
PESTICIDES	ACTELIC	102,723
	DIMETHOATE	57,646
	SAFTELEX	348
	HAWKTELEX	1,634
	MALATHION	116
	TRICHLOROFON	10

Source: ADMARC 1991

TABLE 4. ANNUAL CROP PURCHASES BY ADMARC IN LILONGWE ADD, FOR 3 YEARS DURING 1980-1991 (in metric tons)

PRODUCE	1980/81	1985/86	1990/91
Maize	43,031	74,255	56,927
Sorghum	0	2	<1
Wheat	6	10	<1
Beans	260	3,026	971
Soya beans	0	0	1,294
Sunflower	2	2	2
Sesame	0	<1	0
Groundnuts - L	10,792	6,873	899
- S	0	0	<1
Castor seed	<1	<1	0
Cow peas	92	266	12
Ground beans	1	0	<1
Chillies	0	1	2
NDDF Tobacco			
Lower leaf	600	1,398	1,242
Main leaf	5,656	9,666	8,278
Coffee	<1	1	2

L = long cycle variety
S = short cycle variety
Source: ADMARC 1991

The Branch is also active in the promotion of agroforestry principles among farmers, cooperating in seedling distribution schemes and collaborative research with the Agroforestry Commodity Team (Chitedze Research Station). Main species used are: Acacia albida, Leucaena leucocephala, Gliricidia spp, Calliandra spp, Leucaena diversifolia, Sesbania sesban and Cassia glauca; planted either in alleys or in contour marker ridges or dotted all over the farms.

Other LHB activities include training of both staff and farmers in good land husbandry practices, farm planning, leasehold and general surveys, promotion of organic fertilizers, gathering and updating of ADD natural resources data, production of maps and charts, and advising on, siting and construction of graded physical conservation structures and fish ponds.

2.6.6 Animal husbandry

The Animal Husbandry Section is headed by the Divisional Veterinary Officer (DVO) who is responsible for all disease control measures. He is located at the ADD headquarter. The DVO is assisted by a Senior Animal Husbandry Officer who is responsible for all animal husbandry activities. Five Project Veterinary Officers are located in the RDPs, assisted by Veterinary Assistants, Dairy Extension Assistants and Poultry Extension Assistants.

The main animal husbandry programmes are involved with dairy farming extension and beef and poultry extension.

The number of dip tanks in Lilongwe ADD is 87. They serve as centres for livestock extension as well as centres for disease control (tick-born diseases, general treatments, castrations, etc.).

2.6.7 Adaptive research

Trial work forms the core of the Adaptive Research Programme in Lilongwe ADD. There are ten trials spread out in all five RDPs on varieties (composite maize, hybrid maize, sweet potato and cassava), fertilizers (top dressing of maize with urea after basal dressing with DAP and high analysis versus low analysis fertilizers), mixed cropping (maize/bean/potato and maize/bean) and a wheat establishment trial. Some of the trials are carried out in collaboration with Chitedze Research Station. In addition, fertilizer demonstration plots are established in all RDPs by a FAO project.

Apart from the trial work, survey work is executed on an ad hoc basis (assessment of pests and diseases) as well as planned surveys.

2.6.8 Irrigation

There are no irrigation schemes in Lilongwe ADD at present and the Irrigation Department is not represented at the ADD.

2.7 FORESTRY SERVICES

The Department of Forestry of the Ministry of Forestry and Natural Resources has offices at National, Regional, District and ADD levels. The office for the Central Region is located in Lilongwe, and the District offices in the headquarters of the respective Districts. At District level management is the responsibility of the District Forestry Officers who are assisted by TOs, TAs, Forestry Guards, Patrol Men and Nursery Men.

Under the Wood Energy Project, Phase 2 (1986-1992), woodlots have been established, village forest areas have been set aside for domestic use, and bare hills are being reafforested. Activities also include the management of nurseries, distribution of seedlings to clients for transplanting, fuel efficiency initiatives (stoves), indigenous forest management and extension through demonstrations.

2.8 FISHERIES SERVICES

The Fisheries Department Office as well as the Administrative Branch and the Extension Branch for the Central Region are located in Lilongwe. No specific services exist within the ADD.

2.9 NATIONAL PARKS AND GAME RESERVES

The Department of Parks and Wildlife of the Ministry of Forestry and Natural Resources has offices at National, Regional and Park/Reserve levels. The offices for the Central Region and departmental headquarters are located in Lilongwe. Lilongwe has a Nature Sanctuary which provides information to visitors and schools in order to create a greater awareness of the importance of Malawian flora and fauna. Lilongwe ADD does not have National Parks or Game Reserves within its boundaries.

CHAPTER 3

THE PHYSICAL ENVIRONMENT

This chapter describes the agro-climate, soils and physiography of the study area, which together form the resource base for agriculture, and provide the basis of the land component of the land evaluation system. The inventories of agro-climate, soils and physiography are geared to the needs of the land evaluation system, placing emphasis on those aspects of the land which play a role in the definition of land qualities (see Chapter 5).

3.1 GENERAL

3.1.1 Geology

Lilongwe ADD is underlain by Basement Complex rocks of Precambrian and Cambrian age, consisting mainly of gneisses, schists and metamorphosed igneous intrusions. These rock types are masked on the Lilongwe Plain by superficial deposits: colluvium and residual soils. Other rock types of Precambrian and Cambrian age occur locally: granite in the Dzalanyama Range, syenite between Linthipe and Dedza, anorthosite around and north of Linthipe, basic rocks (metagabbro) south west of Balaka. Recent unconsolidated fluvial and colluvial sediments are found in the Lilongwe Plains, but are of relatively limited extent.

The geology of much of the area has been influenced by extensive faulting which took place during the Mesozoic and Tertiary Eras and which has led to the formation of the Great African Rift Valley. Notable structural features in the study area are the N-S to NNW-SSE faults, which have defined the step-like scarps and shelf topography. The main rift faults are the Ntcheu fault which merges with Chirobwe fault northwards and seperates the Kirk Plateau from the Nsipe-Livelezi shelf (also called the Ntcheu Foothills, see Section 3.5). The Bilila fault extends from Mtakataka to Balaka (about 58 km long) and seperates the Nsipe-Livelezi Shelf from Bwanje-Liwawadzi Valley (also called the Salima Lakeshore Plain or Bwanje Valley, see Section 3.5).

3.1.2 Physiography

The macro-relief of the area is largely determined by extensive plains lying at mid-altitude between 1000 and 1400 m asl (the Lilongwe Plains), with isolated inselbergs rising above this level. To the east, the Lilongwe Plains become increasingly dissected and merge with the Dedza Hills and the Dedza Scarp Zone. Dedza Mountain is the highest point in the Central Region at an altitude of 2198 m asl. The Dzanalyama Range south west of the Lilongwe Plains rises to 1713 m asl. The step-like scarp topography of the eastern part of Lilongwe ADD has the following altitudes: Kirk Range 1370-1675 m asl, Nsipe-Livelezi shelf 800-1100 m asl, Bwanje-Liwawadzi Valley 500-775 m asl.

The Lilongwe plains, occupying about half of the total area of Lilongwe ADD and situated in the centre and west of the ADD, have a gently undulating relief, in some places interrupted by inselbergs. These plains are part of the African peneplain of Tertiary age, which occupies large parts of southern Africa.

3.1.3 Climate

Lilongwe ADD experiences a warm tropical climate characterized by one rainy period of approximately five months, lasting from the end of November to the end of April, and dry weather in most areas during the remainder of the year.

From June to August the weather is under the influence of a high pressure system established over southern Africa. South-easterly winds dominate, bringing dry, relatively cool air. From September to November the temperature rapidly increases and winds shift to the east and north-east, sometimes bringing moist air giving rise to occasional thunderstorms over the higher areas. From December to April the weather is under the influence of the passage of the Intertropical Convergence Zone. Moist air is brought in from the north and heavy rains are experienced in all areas. In April/May the high pressure system is gradually re-established and although some showers may still occur, they are becoming less and less frequent.

Annual rainfall varies from lower than 800 mm in the southernmost part of Ntcheu District and a small area north-west of Lilongwe City, to more than 1200 mm on the Kirk Plateau and in the Dzalanyama Range. Most of the Lilongwe Plains experience 800-1000 mm of rainfall per year, while most of the escarpment zone receives 900-1100 mm per year. Rainfall distribution is highly influenced by orographic effects: windward slopes receiving more than the leeside of hills or mountains, and areas with high elevation receiving more than low lying areas.

Mean annual temperature is highest in the Salima Lakeshore Plain, Bwanje Valley and Balaka Region, i.e. 22.5-25.0 °C, and decreases as altitude increases to 15.0°-17.5 °C on Dedza Mountain and near Chimbia in the Kirk Range. Most of the ADD experiences mean annual temperatures of 17.5-22.5 °C. It is relatively cool from May to August, with July being the coolest month with mean minimum temperatures of about 12.5-15.0 °C at the Salima Lakeshore Plain, in Bwanje Valley and Balaka Region, 7.5-12.5 °C in most of the ADD, and 5.0°-7.5 °C on Dedza Mountain and near Chimbia, where night frost may occur. It is relatively hot during the rest of the year, with October and November being the hottest months, with mean maximum temperatures of 32-33 °C in Bwanje Valley, 23-24 °C around Dedza and 29-30 °C in most of the ADD.

Relative humidity varies with the seasons, being 40-60 percent during the dry season and 60-80 percent during the rainy season.

3.1.4 Hydrography

All rivers have a highly variable flow, changing according to the seasons and quickly reacting to rainstorms. Nearly all major rivers maintain a dry season baseflow in most years, due to the large storage capacity of very deep soils in catchment areas. Many smaller streams in the Lilongwe plains, however, dry up during the dry season.

The main catchment area is that of the Linthipe river with an area of about 8,000 km² and an average flow of 33.6 cumecs. The main tributary of the Linthipe river is the Lilongwe river. The second largest catchment in Lilongwe ADD is the Bua catchment, with the Bua river forming the border between Lilongwe ADD and Kasungu ADD. Several minor rivers are to be found flowing down the escarpment zone in the direction of the Lakeshore Plain and Shire Valley: Lifisi, Livulezi and Rivi Rivi rivers, amongst others.

3.1.5 Soils

The soils in Lilongwe ADD generally are very deep, well drained, red to reddish brown and have a coarse to medium topsoil overlying a medium to fine textured subsoil. However, soils of the escarpment zones are often only moderately deep, with rotten rock found in the profile below 50 cm depth, well drained, medium or fine textured and gravelly. Poorly drained, regularly inundated soils occur in a few areas.

Reaction is acid to slightly acid (pH 5.0 to 6.5) for almost all soils. The nutrient status of most soils at present under cultivation is low with widespread deficiencies of nitrogen and phosphorus. The structure of most cultivated topsoils is weak, owing to the cultivation practices of intensive hoeing, and not returning enough organic matter to the soil. Topsoils are therefore highly erodible, and sheet erosion is taking place in most areas.

Soils are most commonly classified (FAO, 1988) as Chromic Luvisols, Eutric Cambisols and Haplic Lixisols with Phaeozems, Gleysols and Fluvisols also being common. Detailed information on the nature and distribution of soils is given in Section 3.3.

3.1.6 Natural vegetation

About 30 percent of Lilongwe ADD remains under natural or derived vegetation. Because of the high population pressure most of this vegetation is found on land which is unsuitable for cultivation or is in reserved areas. The overriding influences on vegetation are climate and soils, particularly soil drainage. Most of the natural vegetation consists of Brachystegia hill or plateau woodland, but there are small areas of low altitude savannas in the southern part of the ADD. A few isolated remnants of evergreen forest can be found at high altitudes. There are significant areas of seasonally wet grassland associated with upland drainage systems (dambos), but not all of these can be shown separately at the scale of mapping used. The following general description of the vegetation is based on the Natural Regions described in Section 3.5.

- Middle Shire Valley, Bwanje Valley (Golomoti footslopes) Balaka Uplands, Ntcheu Foothills

Most of these Regions have a cover of mixed low altitude savanna with Brachystegia hill woodland penetrating in some areas, particularly on the main hills. Common species found throughout the savanna vegetation are Combretum fragrans, Terminalia sericea, Diospyros kirkii, Pseudolachnostylis maprouneifolia, Xeroderris stuhlmannii, Diplorhynchus condylocarpon, Sterculia quinquiloba, Dalbergia melanoxylon, Lonchocarpus capassa and Adansonia digitata. Acacia albida occurs in belts on deep soils associated with drainage lines. The woodland on rocky hills is often dominated by Brachystegia glaucescens and B. bussei; Julbernardia globiflora and Brachystegia boehmii are common species at the transition to Brachystegia hill woodland proper.

- Kasungu Plain, Lilongwe Plain and Upper Bua Plain

Apart from a few small hills and dambo margins, the only significant area of woodland left standing is in the Dzalanyama Forest Reserve, part of which is used as a ranch. In the plateau woodland of the Dzalanyama, and the few other isolated areas, the following species are common: Julbernardia paniculata, J. globiflora, Brachystegia spiciformis, B. floribunda, B. longifolia, B. utilis, Diplorrhyncus condylocarpon, Dichrostachys cinerea, Pseudolachnostylis maprouneifolia, Xeromphis obovata, Diospyros kirkii, Monotes africanus, Parinari curatellifolia and Lonchocarpus capassa. The commonest grasses are Hyparrhenia spp, with Andropogon schirensis and Themeda triandra, but grass cover is sparse. The original cover of much of the most fertile parts of the Lilongwe Plain was Combretum - Acacia - Bauhinia woodland savanna, and one of the only significant, although very small, areas remaining is found in the Lilongwe Nature Sanctuary. Dominant and characteristic species are : Acacia polyacantha, A. karroo, Bauhinia thonningii, Combretum molle, C. zeyheri, C. fragrans, Erythrina abyssinica, Pericopsis angolensis, Pterocarpus angolensis, P. rotundifoliua, Parinari curatellifolia, Strychnos spinosa, Kigelia africana, Terminalia sericea and Lonchocarpus capassa. Grasses found in this savanna include Hyparrhenia spp, Andropogon amplectens, Setaria sphacelata and Panicum maximum.

There are a few isolated rocky hills with some natural vegetation on the Lilongwe and Kasungu Plains, but most of them have been cut over. Stands of Brachystegia bussei remain on some of these hills.

Ten to 15 percent of the Plain zones consists of dambo land (broad, seasonally wet drainage lines), but not all these can be shown on the map due to scale limitations. Where these seasonally wet areas are not overgrazed Hyparrhenia spp dominate, including H. nyassae, H. gazensis and H. filipendula. Other species include Setaria sphacelata, Echinochloa pyramidalis, Eulalia geniculata, Leersia hexandra, Hemarthria altissima, Panicum spp and Eragrostis spp. In overgrazed dambos, which is the common situation, the sward has been converted to an almost pure stand of Sporobolus pyramidalis with an intermediate stage of Urochloa pullulans.

- Dedza Highlands

There are a number of mountains and hills in this Natural Region, most of them Forest Reserves, which retain some of their natural tree cover; otherwise the only natural vegetation remaining is low montane grassland. The mountains and hills are dominated by Brachystegia hill woodland which varies considerably depending on site, elevation and amount of interference, but the following species are common: Julbernardia globiflora, Brachystegia boehmii, B. bussei, B. spiciformis, B. manga, Uapaca kirkiana, Faurea saligna, Pterocarpus angolensis and Diplorrhyncus condylocarpon. At higher altitudes, up to about 1,700 m asl, Brachystegia floribunda and B. longifolia predominate. The sparse grass cover includes Seteria sphacelata, Digitaria spp, Andropogon gayanus, Themeda triandra and Hyparrhenia spp. Near the summit of Chongoni and Dedza mountains there are remnants of evergreen forest and other specialised high altitude vegetation interspersed with montane grassland.

Low montane grassland occurs over extensive areas of these Natural Regions, mixed with rainfed cultivation. Dominant species are Themeda triandra, Exotheca abyssinica and Setaria spp.

- The Dowa Hills and Dedza Escarpment.

Most of the natural vegetation in these Regions consists of Brachystegia escarpment and hill woodland. Again, there is variation in the dominants depending on site and altitude, but the common species are as described for the Dedza Highlands. Near the foot of the escarpment the Brachystegia woodland is generally replaced by low altitude savanna, as along the boundary with Salima ADD, but also flanking the Lithipe and Lilongwe Rivers up to an altitude of about 800 m asl. Where Brachystegia woodland occurs near the foothills, Brachystegia glaucescens is common, especially along rocky ridges, and also B. manga. Mixed with this foothill woodland the following species commonly occur: Pterocarpus angolensis, Albizzia versicolor, Acacia polyacantha, Sterculia quinqueloba, Bauhinia petersiana, Terminalia sericea and Oxytenathera abyssinica (bamboo).

In favourable, moderately sloping sites and near water courses in Tuma Forest Reserve in the northern part of the Natural Region there are areas of exceptionally well grown Combretum-Acacia-Bauhinia woodland such as that which covered much of the Lilongwe/Dowa Plains before settlement took place.

Near the southern end of the Dedza Escarpment, Chirobwe Mountain rises to a height of over 2,000 m asl and has a small area of evergreen forest similar to that found on Dedza Mountain. Low montane grassland mixed with rainfed cropping is found between Chirobwe and the extreme south of the Natural Region.

- Dzalanyama Range

The Dzalanyama Range is covered with Brachystegia woodland almost to the crest. At the highest part (1675 m asl) patches of evergreen forest are found in the valleys of small perennial streams. Away from the streams the crest has dwarf Cryptosepalum maraviense scrub and scattered small trees of Uapaca kirkiana. There is no montane grassland, but below the evergreen forest Hyparrhenia cymbaria, Pteridium aquilinum (bracken), Similax kraussiana, Rubus sp and Veronica sp occur.

- Mwanza Highlands and Ntcheu Highlands

The natural tree cover is Branchystegia woodland as described above. There are small patches of evergreen forest on Mount Mvai and Dzonze Hill. Low montane grassland interspersed with cultivation is found over a large part of these Regions.

Almost all natural woodlands in the ADD are in a degraded state due to annual burning, cutting and grazing. Ground cover is virtually non-existent, particularly at the beginning of the wet season, and the effects of soil erosion are very clear to see. The dambo grasslands are severely overgrazed and trampled and many have a deep gully along the central watercourse. This tends to dry out the dambo and bush encroachment takes place.

Map No.4, Present Land Use and Vegetation, shows the distribution of the remaining natural vegetation throughout the ADD. The classification system is very general as it has to be used on a national basis, and at the scale of mapping there are obviously variations within the categories defined. Hectarages covered by the various types of vegetations are given in Table 8.

3.2 AGRO-CLIMATE

The agro-climatic resources of the Central Region of Malawi were described and mapped by Nanthambwe (1990), using the concept of agro-climatic zonation of FAO. The agro-climatic analysis for Lilongwe ADD is based on data from 82 stations in the Central Region and from a few stations just outside the Central Region. The 82 stations include 30 stations with continuous records of 25-30 years, 10 stations with records of 18-24 years, 24 stations with records of 11-17 years, and 18 stations with records of 5-10 years.

3.2.1 Moisture regime

3.2.1.1 Length of growing period (LGP)

The length of growing period (LGP) is defined as the period of the year when rainfall (P) exceeds half potential evapotranspiration (PET)

plus the period required to evapotranspire an assumed 100 mm of stored soil moisture. The LGP is the period of the year when moisture supply and temperature permit crop growth.

The LGP varies from 120-135 days in the southernmost part of Ntcheu District, to 195-210 days in the Kirk Range near Chimbia. Most of the Lilongwe Plains and the escarpment zone have LGPs of 150-165 days, only small areas around Lilongwe City and south-west of Balaka Township having LGPs of 135-150 days. Some of the high elevated parts in the escarpment zones and the Dzalanyama Range have LGPs of 165-180 days. Parts of the Kirk Range, the Dzalanyama Range and Dedza Mountain have LGPs of 180-195 days.

There may be more than one growing period in a single year. The relative occurrence of years with one or two LGPs is expressed as the "pattern of the growing period". Within the ADD, three patterns occur but the differences between them are of little significance. Virtually the whole ADD has pattern 1 (one growing period per year in all years). Pattern 1-2a (one growing period per year in 90 percent of the years, and two in 10 percent of the years) only occurs in the central and eastern parts of Ntcheu District and parts of the Kirk Range. Pattern 1-2b (one growing period per year in 75 percent of the years, and two in 25 percent of the years) is limited to the southernmost part of Ntcheu District.

3.2.1.2 Average starting dates of the growing period

The average starting dates of the growing period fall within the second half of November in all parts of Lilongwe ADD. Standard deviations for individual stations are in the range of 6-12 days, indicating a fairly reliable estimate of the start of the growing period. Nevertheless, it must be taken into account that computation of the average starting dates is done on a monthly rainfall basis which may not be very accurate for areas with an erratic rainfall in the beginning of the rainy season where decade rainfall figures would be more appropriate.

3.2.1.3 Quality of moisture supply (P/PET)

The quality of moisture supply (P/PET) provides an indication of drought risk during the growing period. Most of Lilongwe ADD has a P/PET value of more than 1.3, indicating that crops are unlikely to suffer from water stress during the growing period and that a maximum soil moisture storage is achieved. P/PET values of 1.0-1.3 occur on the Lilongwe Plains south of Lilongwe City and in the eastern parts of Ntcheu and Dedza Districts, indicating that crops have a chance of suffering from water stress for short periods. P/PET values lower than 1.0 do not occur in the study area.

3.2.1.4 Mean annual precipitation (P-an)

Mean annual precipitation (P-an) is preferred to LGP to describe the climatic aspect of moisture availability for perennial crops and trees, because they have the ability to remain dormant during the dry period

and/or are capable of drawing moisture from the deep subsoil. P-an varies from lower than 800 mm in the southernmost part of Ntcheu District and a small area north-west of Lilongwe City, to more than 1200 mm on the Kirk Plateau and in the Dzalanyama Range. Most of the Lilongwe Plains experience 800-1000 mm of rainfall per year, while most of the escarpment zone receives 900-1100 mm per year.

3.2.1.5 Mean number of dry months per year (DM)

A dry month is defined as a month having less than 50 mm precipitation. The mean number of dry months per year (DM) is of importance for evaluation for perennial crops and trees, because although dormancy during the dry period and deep subsoil water extraction are common features among perennials, there is usually a limit to these abilities. The mean number of dry months in the ADD varies from eight on the Lilongwe Plains east-north-east of Lilongwe City to six or seven everywhere else in Lilongwe ADD.

3.2.2 Temperature regime

Temperature data for Lilongwe ADD are scarce; there are only three meteorological stations in the area: Dedza, Chitedze and Lilongwe Airport. There is however a strong correlation between mean temperatures and altitude, and thermal zones can be defined and mapped fairly accurately with the aid of a contour map.

3.2.2.1 Mean annual temperature (T-an)

Mean annual temperature is highest in the Salima Lakeshore Plain, in Bwanje Valley and Balaka area, i.e. 22.5-25.0 °C, and decreases as altitude increases to 15.0°-17.5 °C on Dedza Mountain and near Chimbia in the Kirk Range. Most of the ADD experiences mean annual temperatures of 17.5-22.5 °C.

3.2.2.2 Mean temperature during the growing period (T-GP)

Most farming in Lilongwe ADD concerns the growth of rainfed annual crops. It is therefore important to know the mean temperatures during the period when there is enough moisture for crop growth (LGP). The LGP varies from one area to another (Section 3.2.1.1), and therefore also the period for which the mean temperature is determined. The mean temperature during the LGP varies from 25.0-27.5 °C in the southernmost part of Ntcheu District to 15.0-17.5 °C on Dedza Mountain. Most of the ADD experiences T-GPs of 20.0-25.0 °C. T-GPs of 17.5-20.0 °C are limited to Dedza Hills, Chongoni and Dzenza Mountains, Dzalanyama Range and Kirk Range.

3.2.2.3 Mean temperature during the end of the growing period (T-EGP)

The mean temperature during the end of the growing period (T-EGP), which is the mean temperature during the last 120 days of the LGP, is of

importance in areas with a relatively long LGP (more than 225 days), where late-season rainfed annual crops can be grown. This value does not apply to Lilongwe ADD because the longest LGP is 210 days.

3.2.2.4 Mean minimum temperature of the coolest month (T-min)

The mean minimum temperature of the coolest month (T-min) is of importance for the growth of perennial crops, trees, and for irrigated agriculture. The coolest month is July when T-min varies from 5.0-7.5 °C on Dedza Mountain and in the Kirk Range near Chimbia to 12.5°-15.0 °C on the footslopes of the escarpment zone and the south-eastern part of Ntcheu District. The other parts of the ADD experience a T-min of 7.5-12.5 °C.

No data is available on the occurrence of night frost. However, the lower the mean minimum temperature the higher the risk of night frost. On Dedza Mountain and in parts of the Kirk Range night frost occurs during the month of July. In general, areas above 1,500 m may experience night frost occasionally.

3.2.3 Agro-climatic zones and the Agro-climatic Zones Map

A total of 31 Agro-climatic zones, defined by seven parameters, have been distinguished and mapped for Lilongwe ADD. They are given in Table 5 and shown on Map 2.

3.3 SOILS

3.3.1 Soil forming factors and processes

The soil forming factors are parent material, climate, topography, age, vegetation and man. In varying degrees, they all play a role in the formation of the soils of Lilongwe ADD. Although the soil forming factors interact, it is possible to link single factors with soil characteristics.

Parent material influences the particle size of soils. The dominant parent material in Lilongwe ADD is gneiss, which weathers into soils of variable texture, which however contain a considerable amount of quartz sand. Quartz veins, if present in the bedrock, usually result in soils having gravel layers or stone lines as they resist weathering. Colluvial and fluvial deposits are mainly restricted to the footslopes of the Dzalanyama Range, the footslopes of the scarp zone and to the dambos in the Lilongwe Plains.

Parent material is also the source of most plant nutrients. Soils derived from gneiss and associated alluvia/colluvia usually have a high potassium content, but are low in phosphorus.

Climate and age together determine to a large extent the degree of weathering and leaching in soils. Weathering is pronounced in the soils of the Dzalanyama Range, the Kirk Range and parts of the Dedza Hills were soils occur with low activity clay (i.e. having a CEC-clay lower than 24

TABLE 5. AGRO-CLIMATIC ZONES OF LILONGWE ADD

Agroclim. zone no.	LGP (days)	P/PET	T-GP (°C)	P-an (mm)	DM (months)	T-an (°C)	T-min (°C)
7	120-135	1-1.3	25.0-27.5	600-800	7-8	22.5-25.0	12.5-15.0
18	135-150	1-1.3	22.5-25.0	800-1200	7-8	22.5-25.0	12.5-15.0
20	"	"	"	"	5-6	"	"
23	"	>1.3	20.0-22.5	"	7-8	20.0-22.5	10.0-12.5
142	"	"	"	"	5-6	"	"
143	"	"	"	"	7-8	17.5-20.0	7.5-10.0
26	150-165	1-1.3	22.5-25.0	800-1200	7-8	22.5-25.0	12.5-15.0
27	"	"	"	"	"	20.0-22.5	"
28	"	"	"	"	5-6	22.5-25.0	"
32	"	"	20.0-22.5	"	7-8	20.0-22.5	10.0-12.5
34	"	"	"	"	5-6	"	"
37	"	>1.3	22.5-25.0	"	7-8	"	"
41	"	"	20.0-22.5	"	"	"	"
42	"	"	"	"	"	17.5-20.0	7.5-10.0
43	"	"	"	"	5-6	20.0-22-5	10.0-12.5
44	"	"	"	"	"	17.5-20.0	7.5-10.0
144	"	"	"	1200-1600	"	"	"
45	"	"	17.5-20.0	800-1200	7-8	"	"
145	"	"	"	"	5-6	"	"
58	165-180	>1.3	20.0-22.5	800-1200	5-6	20.0-22.5	10.0-12.5
59	"	"	"	"	"	17.5-20.0	7.5-10.0
146	"	"	"	1200-1600	"	"	"
61	"	"	17.5-20.0	800-1200	7-8	"	"
62	"	"	"	"	5-6	"	"
147	"	"	"	1200-1600	"	"	"
70	180-195	>1.3	20.0-22.5	800-1200	5-6	20.0-22.5	10.0-12.5
75	"	"	17.5-20.0	"	"	17.5-20.0	7.5-10.0
76	"	"	"	1200-1600	"	"	10.0-12.5
77	"	"	"	"	"	"	7.5-10.0
78	"	"	15.0-17.5	800-1200	"	15.0-17.5	5.0-7.5
96	195-210	>1.3	17.5-20.0	1200-1600	5-6	15.0-17.5	5.0-7.5

LGP = Length of the growing period (in days)
P/PET = Ratio of precipitation and potential evapotranspiration
T-GP = Mean temperature (in °C) during the LGP
P-an = Mean annual precipitation (in mm)
DM = Mean number of dry months per year, i.e., months with <50mm precipitation
T-an = Mean annual temperature (in °C)
T-min = Mean minimum temperature (in °C) of the coolest month (July)

meq/100 g). Weathering is also notable in the soils of the Lilongwe plains and parts of the Escarpment Zone, but the presence of high activity clay (CEC-clay > 24 meq/100 g) indicates a less pronounced weathering. Highly leached soils (Base Saturation < 50 %) do not occur in Lilongwe ADD, at least not on a mapable scale.

Topography determines to a large extent the degree of natural erosion and mass wasting. These processes are pronounced on steep slopes, leading to relatively young soils which are limited in depth and contain a high amount of weatherable minerals and gravel. Soil drainage also strongly relates to topography, causing many of the lowland alluvial soils to have impeded drainage.

With the exception of poorly drained lowlands, soil moisture is not sufficient to support a luxurious vegetation. Because of low biomass production and a high rate of mineralization, organic matter content of the soil is relatively low with not more than a few percent in the top 20 cm under natural vegetation.

The influence of man on soils has been strong throughout the ADD through the removal of the natural vegetation, prolonged and intensive cultivation and man-induced soil erosion. In intensively cultivated areas topsoils have low nitrogen levels, low organic matter content and often weak structure.

Processes mainly responsible for the formation of upland soils are weathering, illuviation of clay and eluviation of bases. The intensities of these processes are mainly a function of rainfall and to a lesser extent temperature. Essentially three different soil formation stages occur, in which the above processes are combined (see Duchaufour (1982) for a detailed description of these processes):

- Fersiallization. Fersiallization is characterized by a limited degree of weathering (dominance of 2:1 clays, i.e., micas and montmorillonite). Fersiallic soils have relatively high CEC, considerable amounts of free iron oxide (brown to reddish colours) and a saturated or nearly saturated exchange complex (high base saturation). A clay illuviation horizon often occurs together with a topsoil with clay eluviation.

  Soils within this stage of formation are found within the escarpment zones, hilly areas, and parts of the Lilongwe Plains. These areas experience medium rainfall and moderately warm temperatures. Rejuvenation of the profile by soil erosion and mass wasting often plays an important role.

- Transitional stage. The transitional stage between fersiallization and ferrallization is characterized by intermediate values for CEC, base saturation and pH. Soils are usually reddish brown or red in colour. Soils in this stage are found on the Lilongwe Plains, in the Escarpment Zone (the high activity clays) but also in wetter areas like the Dzalanyama Range and the Kirk Range (the low activity clays).

- Ferrallization. Ferrallization is characterized by complete weathering of primary minerals (except quartz); kaolinite (and possibly gibbsite) is the dominant clay mineral. This causes low CEC values. Clay illuviation is minimal. Leaching is very advanced causing low percentage base saturation and high acidity. Soils usually have reddish colours. This soil formation stage does not occur as such in Lilongwe ADD.

A soil forming process important in soils developed in unconsolidated material in lowland areas is:

- Gleization. Hydromorphic processes under the influence of permanent or seasonal watertables lead to the degradation of minerals and segregation of iron and manganese. Iron/manganese mottles are the characteristic phenomenon in most soils. The reduction of iron under anaerobic conditions give the soil a grey or black colour. This process occurs in all soils with impeded drainage.

A soil forming process affecting all soils, but varying in intensity depending on factors such as temperature, vegetation type and age, is:

- Littering/humification/melanization. Organic residues from vegetation accumulate in the topsoil (littering), are then transformed into humus (humification), and will give a dark colour to originally light coloured soil (melanization).

3.3.2 Soil moisture and temperature regimes

- Soil Moisture Regime. The ustic soil moisture regime is basically defined as a regime in which the soil is dry in some or all parts for 90 or more cumulative days in most years and moist during another part of the year (Soil Conservation Service, 1975). All soils in Lilongwe ADD have an ustic moisture regime, except for poorly drained soils, which have an aquic soil moisture regime.

- Soil Temperature Regime. The thermic temperature regime has a mean annual soil temperature of 15-22 °C and a difference between mean summer and mean winter soil temperature of more than °5 C at a depth of 50 cm (Soil Conservation Service, 1975). This regime occurs in most of the ADD, except for the areas lying roughly under the 900 m asl contour line: Bwanje Valley, the Balaka Plain and the Middle Shire Valley. In the latter case the soil temperature regime has a hyperthermic regime, having a mean annual soil temperature of over 22 °C.

3.3.3 Soil classification

Soils have been classified in two ways: firstly through a system designed by LREP consisting of soil groups and soil families, and secondly through the FAO-Unesco Revised Legend of the Soil Map of the World (FAO, 1988). The soil classification system previously used in Malawi was first defined by Young and Brown (1962) and is based on the system developed by the Inter African Pedological Service (d'Hoore, 1964). This system is

largely descriptive. The soil groups and subgroups defined are particularly relevant to soils found on undulating uplands, but less so to soils on steep slopes and in lowlands (Venema, 1990).

3.3.3.1 Soil classification: the system used by LREP

The system used by LREP is designed specifically for use in Malawi, and is explained in detail by Venema (1990). Soils are classified at three levels of generalization:

1. soil parent material (Section 3.3.5.1)

2. soil group (Section 3.3.4.1)

3. soil family (Section 3.3.4.2)

For the description and classification of the soils in Malawi quantitative criteria are used similar to those described in the Revised Legend (FAO, 1988). For the purpose of the present soil resources inventory, some of the Soil Units defined in the Revised Legend have been grouped together. The reason for this is that some of the distinctions are thought to be less relevant for land suitability evaluation purposes (e.g. distinction between Luvisols and Nitisols or between Cambisols and Regosols) and also to facilitate the re-interpretation of previous soil surveys.

The differentiating criteria for the soil groups incorporate soil characteristics which are most relevant for land suitability evaluation. Such characteristics are for instance: soil depth, drainage, texture, occurrence of flooding and inherent chemical fertility of the top 50 cm of the soil.

Soil groups consist of a number of soil families. These soil families are defined at a level of detail similar to those of the Soil Series described previously for Northern and Central Malawi by Brown and Young (1962, 1965). Criteria used for the distinction of soil families are mostly a refinement of those used for the soil groups. Soil families are named after a place or river in which vicinity they were first described. The same family, however, may also occur far away from this place.

Soil groups and soil families should not be confused with the units of the Soils and Physiography Map - called Soil Units. These include a land slope classification in addition to purely soil characteristics.

3.3.3.2 The FAO soil classification system

All soil families distinguished in the present survey are also classified according to the FAO Revised Legend (FAO, 1988) so that the soils information can be well understood and for the purpose of soil correlation. The Revised Legend is intended to be used as a soil classification system for surveys at a wide range in level of detail. This system distinguishes 28 major soil groupings, subdivided at second level into 153 Soil Units.

In the Revised Legend, Soil Units are defined on the basis of the occurrence of quantitatively defined soil characteristics which relate to soil formation. In addition, phases are distinguished which refer to additional limiting factors of the land. For a full description of diagnostic horizons and properties, the key to the Soil Units and the definition of phases, the Revised Legend (FAO, 1988) should be referred to.

3.3.4 Description of soil groups and families: Lilongwe ADD

3.3.4.1 Soil groups

A total of 13 soil groups have been distinguished in Malawi. The key to these groups is given in Table 6. Seven soil groups occur within Lilongwe ADD, and are described below in alphabetical order.

a - Arenic soil group. Arenic soils have a sand or loamy sand texture throughout the upper 100 cm (or less if soil depth is less), and lack the diagnostic characteristics of soil groups u, f and g.

e - Eutric-fersialic soil group. Eutric-fersialic soils have a medium to high CEC-clay (>24 me/100 g) in most of the upper 100 cm and a moderate to high base saturation (>50 percent) throughout the upper 50 cm, and lack the diagnostic characteristics of all other soil groups.

f - Fluvic soil group. Fluvic soils are soils which are continuously rejuvenated through the deposition on the surface of sediments transported by water. They are derived from alluvium and are mostly very deep. There may be a considerable variation in particle size, both vertically in the profile (stratification) and horizontally. Gravelly layers can be observed in a minority of the profiles. Fluvic soils lack the diagnostic characteristics of soil group u.

g - Gleyic soil group. Gleyic soils have seriously impeded drainage. They often have a high groundwater table during at least part of the year. Gleyic soils lack the diagnostic characteristics of soil groups u and f.

p - Paralithic soil group. Paralithic soils have highly weathered rock which starts at within a depth of 75 cm from the surface and continues to a depth of at least 150 cm. The soil above the weathered rock is often skeletal (>40 percent coarse mineral fragments). The weathered rock provides a foothold for roots, but only holds limited available moisture and nutrients. Paralithic soils lack the diagnostic characteristics of soil groups u, f, g and a.

u - Lithic soil group. Lithic soils have a depth of 30-50 cm over hard rock or other hard material not penetrable by roots and more than 20 percent fine earth (soil materials with a diameter of 2 mm or less). Characteristics other than depth may vary widely.

x - Eutric-ferralic soil group. Eutric-ferralic soils have a low CEC-clay (<24 me/100 g) in most of the upper 100 cm and a high base saturation (>50 percent) throughout the upper 50 cm. These soils lack the diagnostic characteristics of all other soil groups.

TABLE 6. KEY TO SOIL GROUPS IN MALAWI

SOIL GROUP	DIAGNOSTIC SOIL CHARACTERISTICS	CORRELATION WITH FAO (1988)
u - lithic	effective depth 30-50 cm and <40 percent coarse mineral fragments	lithic phase
v - vertic	clayey topsoil (>30 percent clay) and deep, wide cracks when dry	Vertisols, Vertic Luvisols and Cambisols
f - fluvic	flooding and sedimentation at regular intervals	Fluvisols
s - salic	high salinity (>4 mmho/cm) in most of the upper 100 cm	Solonchaks & salic phase
g - gleyic	seriously impeded drainage, with or without seasonal high groundwater	Gleysols
a - arenic	sand or loamy sand texture throughout upper 100 cm	Arenosols
n - nopanic	within 50 cm from surface a horizon with: - high bulk density - extremely hard consistence - very low permeability	Partly Stagnic, Calcic or Haplic Luvisols, fragipan phase
c - calcaric	calcareous most of upper 100 cm	Calcisols & Calcaric Regosols, Phaeozems and Cambisols & Calcic Luvisols
p - paralithic	weathered rock within 75 cm and >20 percent fine earth in upper 75 cm	Partly Regosols, Phaeozems and Cambisols
r - dystric-ferralic	- low base saturation (<50 percent) in at least part of the upper 50 cm and - low CEC clay (<24me/100 g) in most of the upper 100 cm	Acrisols and partly Ferralsols and Cambisols
x - eutric-ferralic	- high base saturation (>50 percent) throughout the upper 50 cm and - low CEC clay (<24me/100 g) in most of upper 100 cm	Lixisols and partly Phaeozems, Ferralsols and Cambisols
d - dystric-fersialic	- low base saturation (<50 percent) in at least part of the upper 50 cm and - medium to high CEC clay (>24me/100 g) in most of upper 100 cm	Alisols and partly Nitisols & Cambisols
e - eutric-fersialic	- high base saturation (>50 percent) throughout the upper 50 cm and - medium to high CEC clay (>24me/100 g) in most of upper 100 cm	Luvisols and partly Phaeozems, Nitisols and Cambisols

3.3.4.2 Soil families

A total of 23 soil families has been identified within Lilongwe ADD, and they are described in alphabetical sequence in the paragraphs below. A summary of the soil families found in Lilongwe ADD is given in Table 7. The names of the soil families are followed by a code which indicates the soil parent material (first character) and the soil group (second character). Further details can be found in Venema (1991).

- Chalenthuwa family (Bp)

Soils of the Chalenthuwa family are derived from basalt and belong to the paralithic group. They are moderately deep (50-100 cm), well drained, brown and have a sandy loam to sandy clay loam texture with many coarse fragments, particularly in the subsoil. Soil depth is limited by weathered rock. The organic matter content of the upper 30 cm is medium (2-2.5%). The surface of the soil may be gravelly.

Soil reaction in the upper 50 cm is almost neutral (pH 6.5-7.5), total nitrogen medium (0.10-0.12%), available phosphorus very low (< 8 ppm), exchangeable potassium medium (> 0.2 me/100 g) and nutrient retention capacity medium (CEC 10-15 me/100 g).

Soils of the Chalenthuwa family classify as Eutric Cambisols or Haplic Phaeozems, skeletic and partly rudic phase.

- Chambuluka family (Bu)

Soils of the Chambuluka family are derived from basalt and belong to the lithic group. They are shallow (30-50 cm), moderately well to well drained, dark brown and have a sandy loam texture with gravel at the surface and gravel and stones in the profile. Depth is limited by hard rock. The organic matter content of the upper 30 cm is medium (2-3%). Topsoil structure is moderate, fine to medium subangular blocky, and consistence slightly hard to hard when dry and very friable when moist.

Soil reaction is almost neutral (pH 6.0-7.5), total nitrogen medium to very high (> 0.12%), available phosphorus very low (< 6 ppm), exchangeable potassium high (> 0.5 me/100 g) and nutrient retention capacity medium (CEC 10-15 me/100 g).

Soils of the Chambuluka family classify as Eutric Regosols and Calcaric Regosols, lithic and partly rudic phase.

- Chiradzulu family (Af)

Soils of the Chiradzulu family are derived from recent fluvial and colluvial deposits and belong to the fluvic group. They are very deep, well drained, dark brown and have loamy sand to sandy clay loam texture. Locally flash floods occur. The surface and topsoil may be slightly gravelly. Organic matter content of the upper 30 cm is low (0.5-1.5%).

Soil reaction in the upper 50 cm is moderately acid to neutral (pH 5.5-7.0), total nitrogen very low, available phosphorus very low to low and exchangeable potassium medium. Nutrient retention capacity is low (5-10 me/100 g).

TABLE 7. SOIL FAMILIES LILONGWE ADD

PARENT MATERIAL & SOIL GROUP	SOIL FAMILY	SOIL DEPTH (cm)	SOIL DRAINAGE	PARTICLE SIZE topsoil (0-30cm)	PARTICLE SIZE subsoil (>30cm)	pH(H2O) (0-50cm)	CEC-soil (me/100g) (0-50cm)	NPK * (0-50cm)	COLOUR subsoil	SOIL CLASSIFICATION SOIL UNIT (FAO)	SOIL CLASSIFICATION PHASE (FAO) (p.=partly)	LANDFORM	SOIL UNITS
A - FLUVIAL, COLLUVIAL AND/OR LACUSTRINE SEDIMENTS													
Aa - ARENIC													
	Thangadzi	>150	well	coarse	coarse	5.0-6.5	<5	---	brown	Cambic Arenosols		footslopes; outwash plains; alluvial fans	A2a3
Ae - EUTRIC-FERSIALIC													
	Mikaju	>150	mod.well + well	coarse + medium	medium	5.5-6.5	5-10	--v	brown	Haplic Luvisols / Eutric Cambisols		outwash plains; footslopes river terraces	A1e7
	Jombo	>150	well	medium	medium	5.5-7.0	>10	-v+	brown	Haplic Luvisols / Eutric Cambisols		footslopes; outwash plains; valleysides	A3e1
	Kachingwe	100-150	well	coarse	coarse + medium	6.0-7.0	5-10	+-+	reddish brown	Eutric Cambisols / Chromic Cambisols	p. rudic	footslopes; alluvial fans	A2e5
Af - FLUVIC													
	Manitalala	>150	very poor + poor	variable	variable	5.0-6.5	5-10	-v+	variable	Eutric Fluvisols / Mollic Fluvisols	inundic	floodplains; depressions marshes	A1f2
	Gwelweta	>150	imperfect	coarse + medium	variable	5.5-6.5	5-10	-v-	greyish brown	Eutric Fluvisols		footslopes; outwash plains	A2f8
	Lisungwe	>150	mod.well + well	coarse + medium	coarse + medium	5.0-6.5	5-10	--+	brown	Eutric Fluvisols		plains; lake margin plains footslopes	A1f7 A2f7
	Chiradzulu	>150	well	coarse + medium	coarse + medium	5.5-7.0	5-10	-+	dark brown	Eutric Fluvisols	p. rudic	dissected footslopes	A3f2

N (Nitrogen): - = <0.08 % (very low)
- 0.08-0.12 % (low)
+ >0.12 % (medium-very high)
v very variable

P (Phosphorus): - = <6 ppm (very low)
- 6-18 ppm (low)
+ >18 ppm (medium-very high)
v very variable

K (Potassium): - = <0.1 me/100 g (very low)
- 0.1-0.2 me/100 g (low)
+ >0.2 me/100 g (medium-very high)
v very variable

TABLE 7. SOIL FAMILIES LILONGWE ADD (Cont'd)

PARENT MATERIAL & SOIL GROUP	SOIL FAMILY	SOIL DEPTH (cm)	SOIL DRAINAGE	PARTICLE SIZE topsoil (0-30cm)	PARTICLE SIZE subsoil (>30cm)	pH(H2O) (0-50cm)	CEC-soil (me/100g) (0-50cm)	MPE * (0-50cm)	COLOUR subsoil	SOIL CLASSIFICATION SOIL UNIT (FAO)	SOIL CLASSIFICATION PHASE (FAO) (p.=partly)	LANDFORM	SOIL UNITS
Ag - GLEYIC													
	Tenthema	>150	poor -	variable	variable	5.5-6.5	5-10	v=v	grey	Eutric Gleysols	p. fluvic	dambo's	A1g13
	Mpasa	>150	poor + imperfect	medium	medium + fine	5.0-6.0	5-10	-=-	grey	Eutric Gleysols Gleyic Cambisols		alluvial plains; footslopes; lake margin plains	A1g8
Ax - EUTRIC-FERRALIC													
	Liphala	>150	mod.well	medium	medium + fine	5.0-6.0	5-10	--+	dark brown	Haplic Lixisols Ferralic Cambisols		footslopes	A1x1
B - MAFIC IGNEOUS AND METAMORPHIC ROCKS													
Bp - PARALITHIC													
	Chalenthowa	50-100	well	medium	medium skeletal	6.5-7.5	>10	-=+	dark brown	Eutric Cambisols Haplic Phaeozems	skeletic + p. rudic	uplands; dissected ridges	B2p1
Bu - LITHIC													
	Chambuluka	30-50	mod.well + well	medium	medium skeletal	6.0-7.5	>10	+=+	dark brown	Eutric Regosols Calcaric Regosols	lithic + p. rudic	uplands; hillsides	B3u1

N (Nitrogen): = <0.08 % (very low)
- 0.08-0.12 % (low)
+ >0.12 % (medium-very high)
v very variable

P (Phosphorus): = <6 ppm (very low)
- 6-18 ppm (low)
+ >18 ppm (medium-very high)
v very variable

K (Potassium): = <0.1 me/100 g (very low)
- 0.1-0.2 me/100 g (low)
+ >0.2 me/100 g (medium-very high)
v very variable

TABLE 7. SOIL FAMILIES LILONGWE ADD (Cont'd)

PARENT MATERIAL & SOIL GROUP	SOIL FAMILY	SOIL DEPTH (cm)	SOIL DRAINAGE	PARTICLE SIZE topsoil (0-30cm)	PARTICLE SIZE subsoil (>30cm)	pH(H2O) (0-50cm)	CEC-soil (me/100g) (0-50cm)	NPK * (0-50cm)	COLOUR subsoil	SOIL CLASSIFICATION SOIL UNIT (FAO)	SOIL CLASSIFICATION PHASE (FAO) (p.=partly)	LANDFORM	SOIL UNITS
I - FELSIC AND INTERMEDIATE IGNEOUS AND METAMORPHIC ROCKS													
Ie - EUTRIC-FERSIALIC													
	Mpili	>150	well	coarse + medium	medium + fine	5.5-6.5	5-10	--+	brown	Chromic Luvisols Luvic Phaeozems	p. rudic	uplands; footslopes	X1e4 X2e2 X3e1
	Kothini	>150	well	coarse	coarse + medium	5.5-6.5	<5	=vv	brown	Chromic Luvisols		uplands; footslopes;	X1e8 X2e11
	Mzuzu	100-150	well	coarse + medium	medium + fine	5.0-6.5	5-10	==+	(reddish) brown	Chromic Luvisols Luvic Phaeozems	p. rudic	uplands; valleysides	X2e5 X3e9 X3e10 X4e4
	Dzalanyama	100-150	well	coarse	medium skeletal	5.5-6.5	5-10	==+	yellowish brown	Eutric Cambisols	rudic	hills	X4e5
	Katema	50-100	well	medium + coarse	medium + fine	5.5-6.5	5-10	--+	brown	Haplic Luvisols		uplands; dissected footslopes	X2e7
Ip - PARALITHIC													
	Walkers Ferry	50-100	well	medium + coarse	medium skeletal	5.5-6.5	5-10	-=+	brown	Eutric Cambisols Chromic Cambisols	rudic + skeletic	footslopes; uplands; ridges; escarpments	X2p2 X3p2 X3p3 X4p2 X5p5 X5p6
Ix - EUTRIC-FERRALIC													
	Motheriva	>150	well	medium + fine	fine	5.0-6.0	5-10	==+	red	Haplic Lixisols		uplands; hillsides	X3x2
	Mkwepela	>150	well	coarse	medium + fine	5.0-6.0	5-10	=-+	d.reddish brown	Haplic Lixisols		footslopes	X2x2
	Chisope	100-150	well	medium + fine	medium + fine	5.0-6.5	5-10	--+	d.reddish brown	Haplic Lixisols Ferralic Cambisols	p. rudic	uplands; dissected hills; dissected escarpments	X4x5
	Kapalola	100-150	well	coarse + medium	medium	5.0-6.5	<5	-=+	yellowish brown	Xanthic Ferralsols Ferric Luvisols		plains	X3x7

N (Nitrogen): = <0.08 % (very low)
- 0.08-0.12 % (low)
+ >0.12 % (medium-very high)
v very variable

P (Phosphorus): = <6 ppm (very low)
- 6-18 ppm (low)
+ >18 ppm (medium-very high)
v very variable

K (Potassium): = <0.1 me/100 g (very low)
- 0.1-0.2 me/100 g (low)
+ >0.2 me/100 g (medium-very high)
v very variable

Soils of the Chiradzulu family classify as Eutric Fluvisols, partly rudic phase.

- Chisope family (Xx)

Soils of the Chisope family have developed from gneiss, granulite and syenite and their local colluvia and belong to the eutric-ferralic group. They are deep, well drained, dark reddish brown and have a sandy loam to sandy clay over sandy clay to clay texture. Gravel may occur locally at the surface. Organic matter content of the upper 30 cm is low to medium (1-3%).

Soil reaction in the upper 50 cm is acid to slightly acid (pH 5.0-6.5), total nitrogen low (< 0.08-0.12%), available phosphorus very low to low (1-15 ppm), exchangeable potassium medium (0.1-0.4 me/100 g) and nutrient retention capacity low (5-10 me/100 g).

Soils of the Chisope family classify as Haplic Lixisols, partly rudic phase.

- Dzalanyama family (Xe)

Soils of the Dzalanyama family are derived from felsic igneous rocks (granite) and belong to the eutric-fersialic soil group. They are deep, well drained, yellowish brown and have a loamy sand to sandy loam over gravelly sandy loam texture. Soil depth is limited by rock. Organic matter content of the upper 30 cm is low (< 1%).

Soil reaction in the upper 50 cm is moderately to slightly acid (pH 5.5-6.5), total nitrogen is low, available phosphorus very low, exchangeable potassium medium (> 0.2 me/100 g) and nutrient retention capacity low (CEC 5-10 me/100 g).

Soils of the Dzalanyama family classify as Eutric Cambisols, skeletic and partly rudic phase.

- Euthini family (Xe)

Soils of the Euthini family are derived from Basement Complex rocks and local colluvial and alluvial deposits, and belong to the eutric-fersialic group. They are very deep, well drained, brown, and have a loamy sand to sandy loam topsoil texture and a sandy loam to sandy clay loam subsoil texture. Organic matter content of the upper 30 cm is low to medium (0.5-2.5%).

Soil reaction in the upper 50 cm is moderately to slightly acid (pH 5.5-6.5), total nitrogen is very low (< 0.08%), available phosphorus is very low to high (3-30 ppm) and exchangeable potassium low to medium (0.1-0.5 me/100 g). Nutrient retention capacity is very low (CEC < 5 me/100 g).

Soils of the Euthini family classify as Haplic Lixisols or Chromic Luvisols.

- Gweleweta family (Af)

Soils of the Gweleweta family are derived from recent fluvial and lacustrine deposits and belong to the fluvic soil group. They are very deep, imperfectly drained, greyish brown and have a variable texture but topsoils are usually loamy sand to sandy clay loam. Soil structure is moderate, medium subangular blocky or weak, fine subangular blocky. Consistence is firm when dry and very friable when moist. Flooding is exceptional. Organic matter content of the upper 30 cm is low (< 1.5%).

Soil reaction is acid to slightly acid (pH 5.0-6.5), total nitrogen is low to very low (< 0.09%), available phosphorus variable but usually very low to low (< 10 ppm), exchangeable potassium low to medium (0.1-2.5 me/100 g) and nutrient retention capacity low (6-10 me/100 g)

Soils of the Gweleweta family classify as Eutric Fluvisols (sodic phase).

- Jombo family (Ae)

Soils of the Jombo family have developed in sub-recent alluvia and belong to the eutric-fersialic group. They are very deep, well drained, brown and have sandy clay loam texture throughout. Clay content usually increases slightly with depth. The soil is slightly to moderately gravelly throughout. Organic matter content of the upper 30 cm is low to medium (1-2%). Soil structure is weak to moderate, subangular blocky throughout; topsoil consistence is slightly hard to hard when dry and very friable when moist and subsoil consistence is hard when dry and friable when moist.

Soil reaction in the upper 50 cm is moderately acid to almost neutral (pH 5.5-7.0), total nitrogen very low to low (< 0.10%), exchangeable potassium medium (> 0.2 me/100 g), available phosphorus variable (3-30 ppm) and nutrient retention capacity medium (CEC 5-15 me/100 g).

Soils of the Jombo family classify as Haplic Luvisols or Eutric Cambisols.

- Kachingwe family (Ae)

Soils of the Kachingwe family are derived from sub-recent fluvial and colluvial deposits and belong to the eutric-fersialic group. They are deep (100-150 cm), well drained, reddish brown and have loamy sand over sandy loam to sandy clay loam texture. Topsoil and/or subsoil may be slightly gravelly. Organic matter content of the upper 30 cm is low (1.5%). Topsoil structure is moderate, medium subangular blocky, and consistence friable when moist. Subsoil structure is weak (massive) and consistence very hard when dry.

Soil reaction in the upper 50 cm is slightly acid to neutral (pH 6.0-7.0), total nitrogen medium, available phosphorus very low and exchangeable potassium medium. Nutrient retention capacity is low (CEC 5-10 me/100 g).

Soils of the Kachingwe family classify as Eutric or Chromic Cambisols, partly rudic phase.

- Kapalola (Xx)

Soils of the Kapalola family are derived from Basement Complex rocks with inclusions of local colluvial and fluvial deposits, and belong to the eutric-ferralic group. They are deep, well drained, yellowish brown, and have a loamy sand to sandy clay loam topsoil texture and a sandy clay loam to sandy clay subsoil texture, with gravel common in the subsoil. Soil depth is restricted by rotten rock. Organic matter content of the upper 30 cm is low to medium (1.0-2.5%).

Soil reaction in the upper 50 cm is acid to slightly acid (pH 5.0-6.5), total nitrogen is very low to low (0.05-0.14%), available phosphorus is very low to low (3-10 ppm) and exchangeable potassium is medium to high (0.3-0.6 me/100 g). Nutrient retention capacity is very low.

Soils of the Kapalola family classify as Xanthic Ferralsols or Ferric Lixisols.

- Katema family (Xe)

Soils of the Katema family are derived from granulite and gneiss and belong to the eutric-fersialic group. They are moderately deep, well drained, brown and have a loamy sand to sandy loam over sandy clay loam texture. They may be slightly to moderately gravelly. Depth is limited by hard rock. Organic matter content of the upper 30 cm is low (1-1.5%). Topsoil structure is moderate, crumb and consistence slightly hard when dry and very friable when moist. Subsoil structure is moderate, medium subangular blocky and consistence slightly hard to hard when dry and friable when moist.

Soil reaction in the upper 50 cm is moderately to slightly acid (pH 5.5-6.5), total nitrogen low, available phosphorus low, exchangeable potassium medium and nutrient retention capacity low (5-10 me/100 g).

Soils of the Katema family classify as Haplic Luvisols.

- Liphala family (Ax)

Soils of the Liphala family have developed in sub-recent fluvial and colluvial deposits and belong to the eutric-ferralic group. They are very deep, moderately well drained, dark brown and have a sandy clay loam to sandy clay texture. Organic matter content of the upper 30 cm is medium (1.5-2.5%).

Soil reaction in the upper 50 cm is acid to moderately acid (pH 5.0-6.0), total nitrogen very low to low (0.05-0.12%), available phosphorus very low to low (1-10 ppm), exchangeable potassium medium (0.2-0.5 me/100 g) and nutrient retention capacity low (5-10 me/100 g).

Soils of the Liphala family classify as Haplic Lixisols and Ferralic Cambisols.

- Lisungwe family (Af)

Soils of the Lisungwe family are derived from recent fluvial and colluvial deposits and belong to the fluvic group. They are very deep, moderately well to well drained, brown to yellowish brown and have loamy sand to sandy clay loam texture. Organic matter content of the upper 30 cm is low (< 1.5%).

Soil reaction in the upper 50 cm is acid to slightly acid (pH 5.0-6.5), total nitrogen very low (<0.08%), available phosphorus very low to low (1-20 ppm), exchangeable potassium medium (0.16-0.45 me/100 g) and nutrient retention capacity low (CEC 5-10 me/100 g).

Soils of the Lisungwe family classify as Eutric or Mollic Fluvisols and may have a sodic phase in places.

- Mikaju family (Ae)

Soils of the Mikaju family are derived from sub-recent fluvial and colluvial deposits and belong to the eutric-fersialic group. They are very deep, moderately well to well drained, brown and have a loamy sand to sandy loam over sandy clay loam texture. Organic matter content of the upper 30 cm is low (around 1%). Topsoil structure is weak, medium subangular blocky or crumb and consistence is slightly hard when dry and very friable when moist.

Soil reaction in the upper 50 cm is moderately to slightly acid (pH 5.5-6.5), total nitrogen very low (0.02-0.08%), available phosphorus very low to low (2-16 ppm) and exchangeable potassium very low to medium. Nutrient retention capacity is low (CEC 5-10 me/100 g).

Soils of the Mikaju family classify as Haplic Luvisols.

- Motheriwa family (Xx)

Soils of the Motheriwa family have developed from gneiss, granulite and syenite and their local colluvia and belong to the eutric-ferralic group. They are very deep, well drained, reddish brown and have a sandy clay loam over sandy clay to clay texture. They may be slightly to moderately gravelly. Gravel may occur also locally at the surface. Organic matter content of the upper 30 cm is low to medium (1-2.5%). Topsoil structure is moderate crumb and consistence slightly hard when dry and friable when moist. Subsoil structure is moderate to strong, medium to coarse angular blocky, and consistence hard when dry and friable to firm when moist.

Soil reaction in the upper 50 cm is acid to moderately acid (pH 5.0-6.0), total nitrogen very low to low (< 0.12%), available phosphorus very low to low (1-18 ppm), exchangeable potassium medium (0.2-0.4 me/100 g) and nutrient retention capacity low (5-10 me/100 g).

Soils of the Motheriwa family classify as Haplic Lixisols, partly rudic phase.

- Mpasa family (Ag)

Soils of the Mpasa family are derived from recent and sub-recent fluvial, colluvial and lacustrine deposits and belong to the gleyic group. They are very deep, poorly to imperfectly drained, grey and have sandy clay loam to clay texture. They may have a high groundwater table during the rainy season and often have a mottled subsoil. Organic matter content of the upper 30 cm is low (1-1.5%).

Soil reaction in the upper 50 cm is acid to moderately acid (pH 5.0-6.0), total nitrogen low (0.05-0.10%), available phosphorus very low (< 6 ppm), exchangeable potassium low to medium (0.1-0.3 me/100 g) and nutrient retention capacity low to medium (CEC > 5 me/100 g).

Soils of the Mpasa family classify as Gleyic Cambisols or Eutric Gleysols.

- Mpili family (Xe)

Soils of the Mpili family are derived from gneiss and its local colluvia and belong to the eutric-fersialic group. They are very deep, well drained, reddish brown and have loamy sand to sandy loam over sandy clay loam to sandy clay texture. The surface may be gravelly. Organic matter content of the upper 30 cm is low (1-2%). Topsoil structure is weak and consistence slightly hard when dry and friable when moist.

Soil reaction in the upper 50 cm is moderately to slightly acid (pH 5.5-6.5), total nitrogen very low to low (0.03-0.11%), available phosphorus very low to low (1-17 ppm), exchangeable potassium medium (0.2-0.4 me/100 g) and nutrient retention capacity low (CEC 5-10 me/100 g).

Soils of the Mpili family classify as Chromic Luvisols or Luvic Phaeozems, partly rudic phase.

- Namitalala family (Af)

Soils of the Namitalala family are derived from recent fluvial and colluvial deposits and belong to the fluvic group. They are very deep, poorly drained, experiencing floods several times in most years for short periods during the rainy season. They have a wide range in texture and colour. Organic matter content of the upper 30 cm is moderate (1-2.5%). Topsoil structure is moderate, medium subangular blocky, and consistence hard when dry and friable when moist.

Soil reaction in the upper 50 cm is acid to slightly acid (pH 5.0-6.5), total nitrogen low (< 0.15%), available phosphorus very low to medium (2-30 ppm), exchangeable potassium low to high (0.1-0.8 me/100 g) and nutrient retention capacity low to medium.

Soils of the Namitalala family classify as Eutric or Mollic Fluvisols, inundic phase.

- Neno family (Xe)

Soils of the Neno family are derived from various Basement Complex rocks (usually gneiss) and belong to the eutric-fersialic group. They are deep, well drained, reddish brown and have a sandy loam to sandy clay loam topsoil texture over a sandy clay loam to clay subsoil texture. They mostly have gravel at the surface; the profile may be slightly gravelly. Soil depth is limited by weathered rock. Organic matter content of the upper 30 cm is low (1-1.5%). Topsoil structure is moderate, medium subangular blocky or moderate crumb and consistence slightly hard when dry and very friable when moist. Subsoil structure is moderate, medium angular or subangular blocky, and consistence hard when dry and friable when moist.

Soil reaction in the upper 50 cm is acid to slightly acid (pH 5.0-6.5), total nitrogen very low (0.02-0.06%), available phosphorus very low (< 6 ppm), exchangeable potassium medium (0.2-0.4 me/100 g) and nutrient retention capacity low (5-10 me/100 g).

Soils of the Neno family classify as Chromic Luvisols or Cambisols or Luvic Phaeozems, partly rudic phase.

- Nkwepela family (Xx)

Soils of the Nkwepela family have developed from gneiss, granulite and syenite and their local colluvia and belong to the eutric-ferralic group. They are very deep, well drained, dark reddish brown and have a loamy sand over sandy clay loam to sandy clay texture. Organic matter content of the upper 30 cm is low to medium (1-3%).

Soil reaction in the upper 50 cm is assumed to be acid to moderately acid (pH 5.0-6.0), total nitrogen very low, available phosphorus low, exchangeable potassium medium and nutrient retention capacity low (5-10 me/100 g).

Soils of the Nkwepela family classify as Haplic Lixisols.

- Tenthema family (Ag)

Soils of the Tenthema family are derived from colluvial deposits, and belong to the gleyic group. They are very deep, poorly drained and frequently flooded, grey, and have a variable texture. Organic matter content of the upper 30 cm is low to medium (1.2-2.5%).

Soil reaction in the upper 50 cm is moderately to slightly acid (pH 5.5-6.5), total nitrogen is very low to medium, available phosphorus is very low and exchangeable potassium is very low to medium. Nutrient retention capacity is low.

Soils of the Tenthema family classify as Eutric Gleysols, inundic phase.

- Thangadzi family (Aa)

Soils of the Thangadzi family have developed in fluvial and colluvial sediments and belong to the arenic group. They are very deep, well drained, brown and have a sand to loamy sand texture throughout. Structure throughout is very weak (massive) and consistence slightly hard when dry and very friable when moist.

Soil reaction in the upper 50 cm is acid (pH 5.0-5.5), nutrient levels are very low: total nitrogen < 0.08%, available phosphorus < 6 ppm and exchangeable potassium < 0.1 me/100 g. The nutrient retention capacity is also very low (CEC < 5 me/100 g).

Soils of the Thangadzi family classify as Cambic Arenosols.

- Walkers Ferry family (Xp)

Soils of the Walkers Ferry family have developed in material derived from intermediate Basement Complex rocks (gneiss, granulite, syenite) and belong to the paralithic group. They are moderately deep over weathered rock, well drained, brown or reddish brown and have loamy sand to sandy loam over sandy loam to sandy clay loam texture. Gravel and stones are abundant both at the surface and in the profile and subsoils are always skeletal. Organic matter content of the upper 30 cm is low to medium (1-3.5%). Topsoil structure is weak to moderate, crumb or subangular blocky, and consistence slightly hard when dry and very friable when moist. Subsoil structure is weak to moderate, subangular blocky, and consistence friable when moist.

Soil reaction in the upper 50 cm is moderately to slightly acid (pH 5.5-6.5), total nitrogen low (0.06-0.15%), available phosphorus very low to low (1-13 ppm), exchangeable potassium medium (0.2-0.4 me/100 g) and nutrient retention capacity low (5-10 me/100 g).

Soils of the Walkers Ferry family classify as Eutric or Chromic Cambisols, rudic and skeletic phase.

3.3.5 Soils and Physiography Map

The soils and physiography of the ADD are described in terms of "miscellaneous land units" and of "soil units". Miscellaneous land units are types of land defined by one outstanding characteristic which precludes their use for agriculture and forestry. Within the ADD miscellaneous land includes rock outcrops and very steep slopes. Other land is described in terms of soil units, totalling 35 in Lilongwe ADD, which are defined by a large number of characteristics related to soil and physiography. Miscellaneous land units and soil units are shown on the Soils and Physiography Map at scale 1:250,000. This map shows single miscellaneous land units and soil units or a combination (complex) of one miscelleneous land unit with one soil unit or a combination of two soil units. The map is accompanied by a separate legend sheet (located in the back pocket of this report). Some of the most important elements of the inventory of soils and physiography of Lilongwe ADD are explained in the following paragraphs. A full explanation of the methodology used is given by Venema (1990).

3.3.5.1 The legend

Two miscellaneous land units have been distinguished in Lilongwe ADD, each symbolized by one single capital letter. They are:

- R land with predominantly very shallow soils (soils with an effective depth of <30 cm) or with extremely gravelly or stony soils (soils having <20 percent fine earth in the upper 75 cm)

- V land with very steep slopes (>55 percent)

Soil units are defined by characteristics related to both soil and physiography. There are four levels of generalization:

- soil parent material

The first and highest level of generalization is soil parent material. Classes of parent material are symbolysed by a capital letter. Three classes are of importance in Lilongwe ADD:

A fluvial, colluvial and/or lacustrine sediments

B mafic igneous and metamorphic rocks

X felsic and intermediate igneous and metamorphic rocks

- slope class

The second level of generalization is dominant slope inclination. This means that the various parent materials found in the survey area will be sub-divided according to dominant slope. There are five slope classes covering the range of 0 percent to 55 percent slope and are symbolized by the numbers 1 to 5:

1 0 - 2 percent, flat to almost flat land

2 2 - 6 percent, gently sloping land

3 6 -13 percent, sloping land

4 13 -25 percent, moderately steep land

5 25 -55 percent, steep land

Areas with dominant slopes of more than 55 percent are mapped as one of the miscellaneous land units (V).

- soil group

Sub-division at third level is according to soil group. Soil groups are soil types defined at a high level of generalization using some of the most relevant criteria mentioned in the FAO-Unesco Revised Legend (FAO, 1988). The symbol for a soil group is a lower-case letter. Seven soil groups have been distinguished in Lilongwe ADD. They are described in Section 3.3.4.1.

- soil units

At the fourth and lowest level a large number of additional soil characteristics is used to sub-divide units of the third level. Fourth-level units are called soil units. The term "soil unit" is used as an abbreviation for "soil and physiography unit". The symbol for a soil unit consists of four elements, starting with the symbols for the three higher levels of generalization and ending with a serial number, e.g. A1g8. Thirty five soil units have been distinguished in Lilongwe ADD. They are listed on the Legend of the Soils and Physiography Map. Most characteristics shown in the legend are diagnostic for soil units. Mainly descriptive are soil colour, macro-nutrients (N, P and K) and landform. Each soil unit is described in detail in Appendix I.

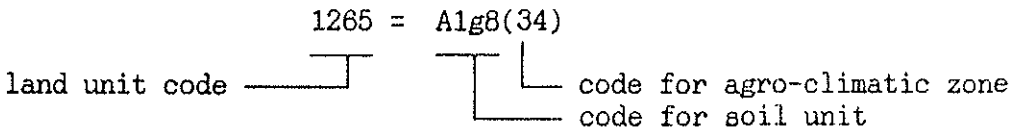
3.3.5.2 Soil mapping units

Soil mapping units are areas on the Soils and Physiography Map defined by one soil unit in the case of a homogeneous soil mapping unit and by two soil units or one soil unit and one miscellaneous land unit in the case of a complex soil mapping unit. The symbol for a soil mapping unit is made up of the symbols of the relevant soil units and miscellaneous land units, e.g. A1g8, X4x5/X2e1 or X5p6/R. In the case of a complex soil mapping unit it is assumed that the first soil unit takes up 70 percent of the area and the second soil unit or miscellaneous land unit 30 percent. A list of soil mapping units in Lilongwe ADD with their coverage in hectares is given in Appendix VII. Seventy one soil mapping units have been distinguished in LADD.

3.4 LAND UNITS

3.4.1 Introduction

For the purpose of land suitability evaluation "land units" are defined in terms of soil, physiography and agro-climate. Land units are a specific combination of a soil unit (Section 3.3.4) and an agro-climatic zone (Section 3.2.2). The symbol for a land unit is a serial number but can also be written as the combined symbols for the relevant soil unit and agro-climatic zone as shown in an example below:



For the two miscellaneous land units (Section 3.3.4) no agro-climatic zone is given.

A total of 163 land units have been identified within Lilongwe ADD, and are described in Appendix I.

3.4.2 The Land Unit Map

Map no. 3 (Land Unit Map), at scale 1:250,000, shows a total of 183 land mapping units (listed in Appendix VIII). Land mapping units are defined by one land unit in the case of a homogeneous land mapping unit and by two land units in the case of a complex land mapping unit. A complex land mapping unit is made up of two soil units or one soil unit and one miscellaneous land unit in combination with one agro-climatic zone. The symbol for a land mapping unit is made up of the symbols for the relevant land units and miscellaneous land units, e.g. 320, 1281/1321 1322/R. In case of complex land mapping units it is assumed that the first land unit takes up 70 percent of the area and the second land unit the remaining 30 percent. Individual land units are described in Appendix I. A list of land mapping units and their area is given in Appendix VIII.

3.5 AGRO-ECOLOGICAL ZONES

3.5.1 Introduction

The general topography, the distribution of soil groups, and two agro-climatic characteristics (LGP and T-GP) are the criteria used to define and map Agro-ecological Zones (AEZs). The Agro-ecological Zones map at scale 1:1,000,000 and legend are presented in Figure 3 and Table 8, and provide a generalized but integrated inventory of the land resources. A total of 21 zones have been distinguished in Lilongwe ADD, grouped into 13 natural regions. The individual AEZs are described in the following sections in the same sequence as they appear in Table 8.

3.5.2 Middle Shire Valley (MS)

This valley is part of the Rift Valley floor and is situated in the south-eastern most part of Ntcheu District. Most of this zone is situated in Blantyre ADD. It is subdivided into an erosional and depositional zone. Two agro-ecological zones have been distinghuished.

- MS1 Middle Shire Valley.

This AEZ is situated in the south eastern part of the ADD and occupies only a small area. It consists of an undulating to rolling erosional surface developed in Basement Complex rocks (gneisses). Main slopes are between 0 and 13 percent and average altitude is about 500 m asl. Soils are mostly deep to moderately deep, brown to reddish brown, well drained and have coarse to medium textured topsoils overlaying medium to fine textured and sometimes skeletic subsoils. They classify as Chromic Luvisols, Luvic Phaeozems, Eutric Cambisols or Chromic Cambisols. The mean annual rainfall is 600-800 mm and the LGP is 120-135 days. The mean monthly temperature during the growing period is 25.0-27.5 °C and the mean minimum temperature in July is 12.5-15.0 °C.

- MS2 Lisungwe valley.

Just the northern part of Lisungwe valley extends into the southern part of LADD where it occupies a very small area. The average altitude of

FIGURE 3. AGRO_ECOLOGICAL ZONES
LILONGWE ADD

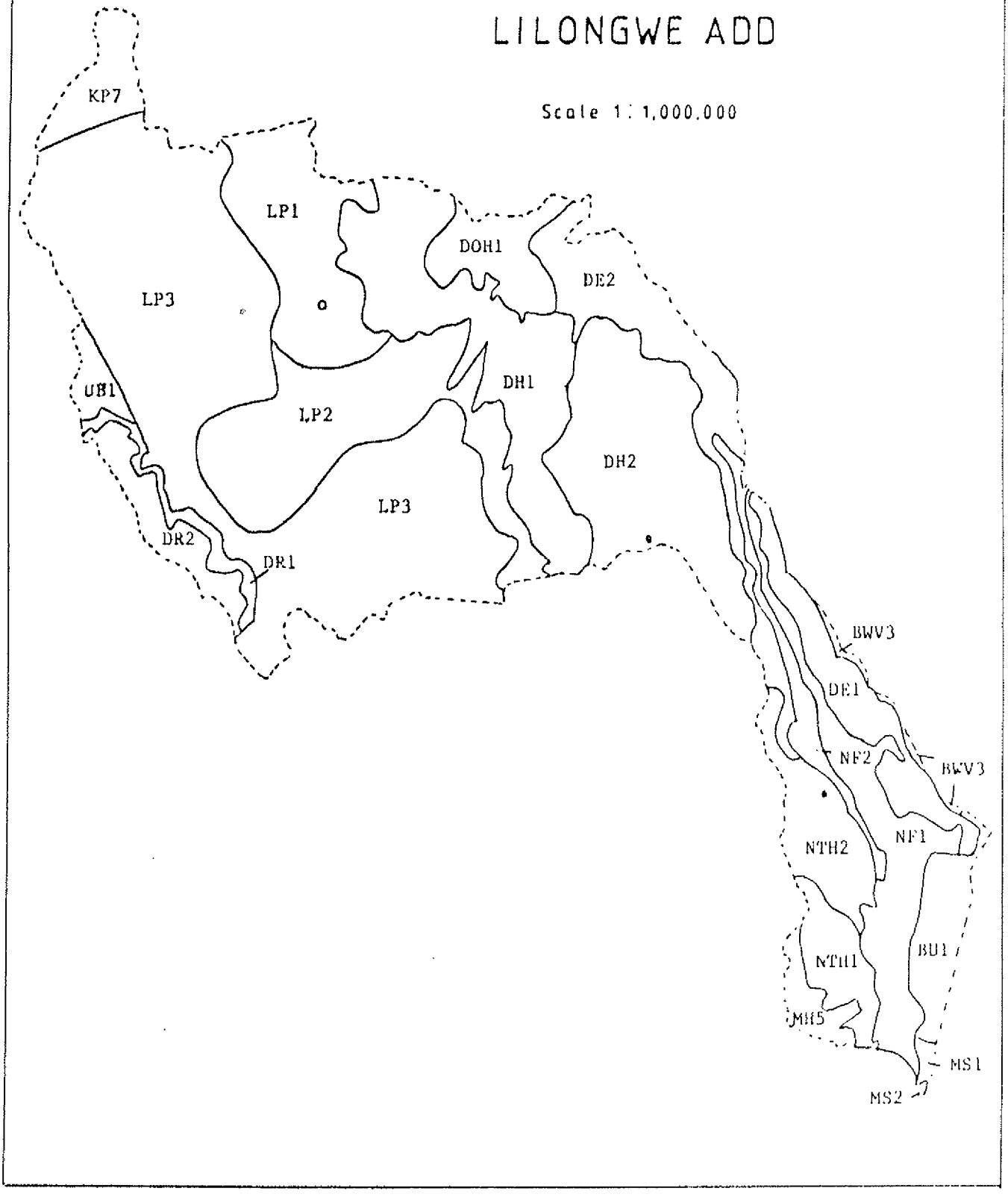


TABLE 8. AGRO-ECOLOGICAL ZONES, LILONGWE ADD

NATURAL REGION	ZONE CODE	ZONE NAME	ALTITUDE (m asl)	SOIL PARENT MATERIAL	DOMINANT SOIL GROUPS(S) AND SOIL FAMILIES	LGP (days)	T-mean Growing Period (°C)
MIDDLE SHIRE VALLEY (MS)	MS1	Middle Shire Valley	500	gneiss	e (Neno) p (Walkers Ferry)	120-135	25.0-27.5
	MS2	Lisungwe Valley	500	fluvial and colluvial deposits	e (Kachingwe) f (Lisungwe)	120-135	25.0-27.5
BWANJE VALLEY (BWV)	BWV3	Golomoti Footslopes	600-700	fluvial and colluvial deposits	f (Lisungwe, Gweleweta)	135-150	22.5-25.0
BALAKA UPLANDS (BU)	BU1	Balaka Plain	500-800	gneiss	e (Mpili, Neno) p (Walkers Ferry)	135-150	22.5-25.0
NTCHEU FOOTHILLS (NF)	NF1	Ntcheu Foothills	600-1000	gneiss	e (Mpili, Neno) p (Walkers Ferry)	150-165	20.0-25.0
	NF2	Ntcheu Footslopes	600-1000	fluvial and colluvial deposits	f (Lisungwe) e (Jumbo)	150-165	20.0-22.5
DOWA HILLS (DOH)	DOH1	South Dowa Hills	700-1200	gneiss	e (Neno) p (Walkers Ferry)	150-165	20.0-22.5
DEDZA ESCARPMENT (DE)	DE1	Lower Dedza Escarpment	600-1200	gneiss	p (Walkers Ferry) e (Neno)	150-165	20.0-22.5
	DE2	Upper Dedza Escarpment	700-1500	gneiss	p (Walkers Ferry) e (Neno)	150-165	20.0-22.5
KASUNGU PLAIN (KP)	KP7	South and West Kasungu Plain	1100	Basement Complex Rocks	e (Mpili) g (Thenthema)	150-165	20.0-22.5
LILONGWE PLAIN (LP)	LP1	North-east Lilongwe Plain	1100-1200	Basement Complex Rocks	e (Mpili)	135-150	20.0-22.5
	LP2	Central Lilongwe Plain	1100-1300	Basement Complex Rocks	e (Mpili)	150-165	20.0-22.5
	LP3	West and South Lilongwe Plain	1100-1300	Basement Complex Rocks	e (Mpili) g (Thenthema)	150-165	20.0-22.5
DEDZA HIGHLANDS (DH)	DH1	Dedza Uplands	1000-1500	various igneous and metamorphic rocks	e (Neno) p (Walkers Ferry)	150-165	20.0-22.5
	DH2	Dedza Hills	1200-2200	ayenite, granite, gneiss	e (Neno) x (Nkwepela)	150-180	17.5-20.0
UPPER BUA PLAIN (UB)	UB1	Upper Bua Plain	1200	Basement Complex Rocks	e (Mpili)	165-180	17.5-22.5
DZALANYAMA RANGE (DR)	DR1	Dzalanyama Footslopes	1200-1400	fluvial and colluvial deposits	a (Thangadzi)	165-180	17.5-20.0
	DR2	Dzalanyama Hills	1300-1600	granite	x (Kapalola) e (Dzalanyama)	165-195	17.5-20.0
MWANZA HIGH-LANDS (MH)	MH5	Kirk Range	1000-1800	gneiss	x (Kapalola, Chisope)	180-195	17.5-20.0
NTCHEU HIGHLANDS (NTH)	NTH1	Ntcheu Uplands	800-1800	gneiss	e (Mpili, Neno)	180-195	17.5-20.0
	NTH2	Ntcheu Escarpment	900-1900	gneiss	p (Walkers Ferry) e (Neno)	165-195	17.5-22.5

this AEZ is about 500 m asl and its topography is flat to gently sloping. The soils are developed in alluvial material, are deep to very deep, brown to reddish brown, moderately well to well drained, coarse to medium textured in both the topsoil and the subsoil. They classify as Eutric and Chromic Cambisols and Eutric Fluvisols. Mean annual rainfall is 600-800 mm and LGP 120-135 days. Mean monthly temperature during the growing period is 25.0-27.5 °C and the mean minimum temperature in July is 12.5-15.0 °C.

3.5.3 Bwanje Valley (BWV3)

A small elongated strip of the Bwanje Valley is situated within Lilongwe ADD on the footslopes of the Ntcheu-Dedza escarpment. One AEZ has been distinguished.

- BWV3 Golomoti Footslopes.

The Golomoti Footslopes have a flat to sloping topography with an average altitude between 600 and 700 m asl. Soils have developped in fluvial and colluvial deposits and are very deep, imperfectly to well drained, coarse to medium over variable textured, greyish brown to brown Eutric Fluvisols. Mean annual rainfall is 800-1200 mm and LGP 135-150 days. Mean monthly temperature during the growing period is 22.5-25.0 °C and the mean minimum temperature in July is 12.5-15.0 °C.

3.5.4 Balaka Uplands (BU)

The Balaka Uplands are situated in the southeastern part of the ADD, east and west of Balaka and they continue for a large extent in Liwonde ADD. One AEZ has been distinguished.

- BU1 Balaka Plain

The plain consists of a flat to undulating erosional surface, developed at an altitude of 500-800 m asl in Basement Complex Rocks (gneisses). Dominant slopes are between 0 and 6 percent. Soils are moderately deep to very deep, well drained, mostly brown and have medium to coarse textured topsoils overlaying medium to fine textured and sometimes skeletal subsoils. They are classified as Chromic Luvisols, Luvic Phaeozems and Chromic and Eutric Cambisols. Mean annual rainfall is 800-1200 mm and LGP 135-150 days. Mean monthly temperature during the growing period is 22.5-25.0 °C and the mean minimum temperature in July is 12.5-15.0 °C.

3.5.5 Ntcheu Foothills (NF)

The Ntcheu Foothills are situated immediately east of the Dedza-Ntcheu escarpment. Subdivision into two AEZs is made.

- NF1 Ntcheu Foothills.

This AEZ is situated at an altitude of 600-1000 m asl and occupies to a large extend the Nsipe-Livelezi shelf (see Section 3.1.1). Slopes vary from 2 to 13 percent. The foothills are underlain by gneiss of the

Basement Complex. Soils are moderately deep to very deep, well drained, brown to reddish brown and coarse to medium over medium textured and are sometimes skeletic in the subsoil. They are classified as Chromic Luvisols, Luvic Phaeozems and Chromic and Eutric Cambisols. The mean annual rainfall is 800-1200 mm and the LGP is 150-165 days. The mean monthly temperature during the growing period is 20.0-25.0 °C and the mean minimum temperature in July is 10.0-15.0 °C.

- NF2 Ntcheu Footslopes.

The Ntcheu Footslopes are situated between AEZ NF1 and the Dedza-Ntcheu escarpment. The average altitude is 600-1000 m asl and the general topography is flat to undulating with average slopes varying from 0 to 6 percent. Soils are developed in colluvial and alluvial material and are usually very deep, moderately well to well drained, brown, and coarse to medium textured in both topsoil and subsoil. Classification: Haplic Luvisols, Eutric Cambisols and Eutric Fluvisols. The mean annual rainfall is 800-1200 mm and the LGP is 150-165 days. The mean monthly temperature during the growing period is 20.0-22.5 °C and the mean minimum temperature in July is 10.0-12.5 °C.

3.5.6 Dowa Hills (DOH)

The Dowa Hills are mainly situated in Kasungu ADD, but a small area extends into the northeastern part of LADD. One AEZ has been distinguished.

- DOH1 South Dowa Hills.

This zone is a rolling to hilly area with steeply dissected valleys and has a range in altitude of 700 to 1200 m asl. Average slopes vary from 6 to 25 percent. Soils have developed in Basement Complex gneisses and are moderately deep to deep, brown to reddish brown, well drained, and coarse to medium over medium to fine textured and can be skeletic in the subsoil (Walkers Ferry soil family). They classify as Eutric and Chromic Cambisols, Chromic Luvisols and Luvic Phaeozems. The mean annual rainfall is 800-1200 mm and the LGP is 150-165 days. The mean monthly temperature during the growing period is 20.0-22.5 °C and the mean minimum temperature in July is 7.5-12.5 °C.

3.5.7 Dedza Escarpment (DE)

The Dedza Escarpment is situated in the eastern and northeastern part of Lilongwe ADD. It is part of the fault system limiting the western side of the Great Rift Valley. Two different AEZs are distinghuished coinciding with the two major fault systems in this region: Chirobwe fault and Bilila fault.

- DE1 Lower Dedza escarpment.

This AEZ is situated in the eastern part of the ADD and is determined by the Bilila fault. Average altitude varies from 600-1200 m asl. It has a

rolling to steeply dissected topography, and is underlain by gneiss. Average slopes range from 6 to 55 percent. The soils are moderately deep to deep, well drained, coarse to medium over medium to fine textured with often a skeletic subsoil, and stony. In less dissected parts soils are deep and do not have a skeletic subsoil. The mean annual rainfall is 800-1200 mm and the LGP is 150-165 days. The mean monthly temperature during the growing period is 20.0-22.5 °C and the mean minimum temperature in July is 10.0-12.5 °C.

- DE2 Upper Dedza Escarpment.

This AEZ is situated in the east and northeast of Lilongwe ADD and is determined by the Chirobwe fault. Average altitude is higher than the Lower Dedza Escarpment and ranges from 700-1500 m asl. It has a hilly to steeply dissected topography with dominant slopes varying from 13 to 55 percent. Parent material also consist of Basement Complex gneisses. Soils have the same general characteristics as the soils of the Lower Dedza Escarpment. The mean annual rainfall is 800-1200 mm and the LGP is 150-165 days. The mean monthly temperature during the growing period is 20.0-22.5 °C and the mean minimum temperature in July is 7.5-12.5 °C.

3.5.8 Kasungu Plain (KP)

The Kasungu Plain extends into Lilongwe ADD in the extreme northwestern part. Only one AEZ has been distinguished.

- KP7 South and West Kasungu Plain.

This AEZ has an altitude of around 1100 m asl. The Plain has a flat to slightly undulating topography and is underlain by several different Basement Complex Rocks (mainly gneiss, granite and syenite). Upland soils are very deep, well drained, brown, coarse to medium over medium to fine textured Chromic Luvisols and Luvic Phaeozems. Dambo soils are very deep, grey, poorly drained Eutric Gleysols with a variable texture. The mean annual rainfall is 800-1200 mm and the LGP is 150-165 days. The mean monthly temperature during the growing period is 20.0-22.5 °C and the mean minimum temperature in July is 10.0-12.5 °C.

3.5.9 Lilongwe Plain (LP)

The Lilongwe Plain is situated in the centre and west of Lilongwe ADD and occupies nearly half of the total area of the ADD. Three AEZs have been distinguished on the basis of LGP and general topography. All three AEZs are underlain by various Basement Complex Rocks and all upland soils are very deep, well drained, brown, coarse to medium over medium to fine textured Chromic Luvisols and Luvic Phaeozems.

- LP1 North-east Lilongwe Plain.

This AEZ is located in the central-northern part of Lilongwe ADD at an altitude of 1100-1200 m asl. General topography is undulating with flat to almost flat parts. The mean annual rainfall is 800-1200 mm and the LGP is 135-150 days. The mean monthly temperature during the growing period is 20.0-22.5 °C and the mean minimum temperature in July is 7.5-12.5 °C.

- LP2 Central Lilongwe Plain.

This AEZ is located in the central part of Lilongwe ADD and is situated at an altitude of 1100-1300 m asl. The topography is undulating with flat to almost flat parts. The mean annual rainfall is 800-1200 mm and the LGP is 150-165 days. The mean monthly temperature during the growing period is 20.0-22.5 °C and the mean minimum temperature in July is 7.5-12.5 °C.

- LP3 West and South Lilongwe Plain.

This AEZ is situated in the south and west of Lilongwe ADD. The altitude is 1100-1300 m asl and topography is flat to almost flat with some undulating parts. Besides the upland soils a large area is occupied by dambo soils which are very deep, grey, poorly drained Eutric Gleysols with a variable texture. The mean annual rainfall is 800-1200 mm and the LGP is 150-165 days. The mean monthly temperature during the growing period is 20.0-22.5 °C and the mean minimum temperature in July is 7.5-12.5 °C.

3.5.10 Dedza Highlands (DH)

The Dedza Highlands occupy the area west of the Dedza escarpment and Dowa Hills. Subdivision into two AEZs is made.

- DH1 Dedza Uplands.

The Dedza Uplands are situated in the central-eastern part of Lilongwe ADD at an altitude varying from 1000-1500 m asl. General topography is undulating to rolling with slopes between 2 and 13 percent. Parent material consists of various igneous and metamorphic rocks. Soils are moderately deep to deep, well drained, brown to reddish brown, coarse to medium over medium to fine textured Chromic Luvisols, Luvic Phaeozems and Eutric or Chromic Cambisols on felsic and intermediate igneous and metamorphic rocks. On mafic igneous and metamorphic rocks (a small area in the central part of the Dedza Uplands) soils are shallow to moderately deep, well drained, medium textured Eutric Regosols and Eutric Cambisols with a skeletic subsoil. Mean annual rainfall is 800-1200 mm and the LGP is 150-165 days. The mean monthly temperature during the growing period is 20.0-22.5 °C and the mean minimum temperature in July is 7.5-12.5 °C.

- DH2 Dedza Hills.

The Dedza Hills are situated around Dedza town at an altitude of 1200-2200 m asl. Topography ranges from undulating to hilly. Soils have developed in syenites, granites and gneisses. They are mainly moderately deep to deep, well drained, brown to dark reddish brown, coarse to medium over medium to fine textured Chromic Luvisols, Luvic Phaeozems and Haplic Lixisols. Lots of rock outcrops occur, especially in the western part of the AEZ. Mean annual rainfall is 800-1200 mm and the LGP is 150-180 days. The mean monthly temperature during the growing period is 17.5-20.0 °C and the mean minimum temperature in July is 7.5-10.0 °C.

3.5.11 Upper Bua Plain (UB)

The Upper Bua Plain forms a small zone northeast of the Dzalanyama Range. One AEZ has been distinghuished.

- UB1 Upper Bua Plain.

The Upper Bua Plain has an altitude of around 1200 m asl. Topography is flat to undulating and it is underlain by various Basement Complex rocks (mainly gneisses, granites and syenites). Soils are in general very deep, brown, well drained, coarse to medium over medium to fine textured, Chromic Luvisols and Luvic Phaeozems. Mean annual rainfall is 800-1200 mm and the LGP is 165-180 days. The mean monthly temperature during the growing period is 17.5-22.5 °C and the mean minimum temperature in July is 7.5-12.5 °C.

3.5.12 Dzalanyama Range (DR)

The Dzalanyama Range forms an elongated strip of hills on the south western border with Mozambique. A subdivision into two agro-ecological zones has been made.

- DR1 Dzalanyama Footslopes

This zone is situated at the foot of the Dzalanyama Hills. It lies at an altitude of 1200-1400 m asl, and is underlain by fluvial and colluvial deposits. The slopes are gently sloping and the soils are very deep, well drained, brown, coarse textured Cambic Arenosols. Mean annual rainfall is 800-1600 mm and the LGP is 165-180 days. The mean monthly temperature during the growing period is 17.5-20.0 °C and the mean minimum temperature in July is 7.5-10.0 °C.

- DR2 Dzalanyama Hills.

The Dzalanyama Hills have an altitude range of 1300-1600 m asl. They are underlain by granite, and the general topography is rolling. Soils are deep, well drained, yellowish brown, coarse to medium over medium textured to skeletic Eutric Cambisols, Xanthic Ferralsols and Ferric Luvisols. Mean annual rainfall is 1200-1600 mm and the LGP is 165-195 days. The mean monthly temperature during the growing period is 17.5-20.0 °C and the mean minimum temperature in July is 7.5-10.0 °C.

3.5.13 Mwanza Highlands (MH)

The Mwanza Highlands are situated in the south eastern part of the ADD and form the western Rift Valley scarp zone. One AEZ has been distinghuished.

- MH5 Kirk Range.

The Kirk Range has an altitude of 1000-1800 m asl and is underlain by gneiss. Topography is rolling to hilly and soils are deep, well drained,

dark reddish brown to yellowish brown and have variable textured topsoils over medium to fine textured subsoils. They classify as Haplic Lixisols, Ferralic Cambisols, Xanthic Ferralsols and Ferric Luvisols. Mean annual rainfall is 1200-1600 mm and the LGP is 180-195 days. The mean monthly temperature during the growing period is 17.5-20.0 °C and the mean minimum temperature in July is 5.0-10.0 °C.

3.5.14 Ntcheu Highlands (NTH)

Together with the Dedza Escarpment and the Kirk Range, this zone forms the western Rift Valley scarp. It is situated in the south of Lilongwe ADD. Two AEZs have been distinghuished.

- NTH1 Ntcheu Uplands.

The Ntcheu Uplands have an average altitude of 800-1600 m asl and are underlain by gneiss. Topography is rolling and soils are deep to very deep, well drained, reddish brown to brown, coarse to medium over medium to fine textured Chromic Luvisols and Luvic Phaeozems. Mean annual rainfall is 800-1200 mm and the LGP is 180-195 days. The mean monthly temperature during the growing period is 17.5-20.0 °C and the mean minimum temperature in July is 7.5-10.0 °C.

- NTH2 Ntcheu Escarpment.

The Ntcheu Escarpment has an altitude which varies from 900 to 1900 m asl, and the underlying rock type is gneiss. Topography is rolling to hilly. Soils are moderately deep to deep, well drained, reddish brown to brown, coarse to medium over medium to fine textured with often a skeletic subsoil. They classify as Eutric and Chromic Cambisols, Chromic Luvisols and Luvic Phaeozems. Mean annual rainfall is 800-1200 mm and the LGP is 165-195 days. The mean monthly temperature during the growing period is 17.5-22.5 °C and the mean minimum temperature in July is 7.5-12.5 °C.

CHAPTER 4

PRESENT LAND-USE

The economy of Lilongwe ADD relies heavily on agriculture. Approximately 91 percent of the population depends on agriculture for a subsistence living or employment.

4.1 LAND TENURE

Three types of land tenure exist: customary land, public land and private land. Data on the area covered by different types of land tenure in Lilongwe ADD is presented on a RDP basis in Table 9. Private land is indicated as leasehold (estate) land and freehold land. Forest Reserves are separately indicated.

Customary land is held in trust by the Traditional Authorities, and is allocated to heads of households for their use and occupation. The right to control and allocate customary land is vested in the local Chief or Village Headman. Residence on customary land includes not only the right to cultivate the land, but also the right to collect fuelwood and timber and the right to graze livestock on the village commons, dambo land and on agricultural land during the dry season. Customary land can not be owned, bought or sold by an individual. Customary land occupies about 53 percent of Lilongwe ADD.

Public land is land used or acquired by Government for public use. It largely consists of Forest Reserves and built-up areas, and occupies about 16 percent of Lilongwe ADD.

Private land is land leased to individuals or corporations for a period of 21-99 years, or owned under freehold title. It is originally taken from either customary or public land. Under the Lilongwe Rural Development Programme all customary land in Lilongwe RDP and part of Lilongwe NE RDP was allocated to family units as freehold land. Nearly all estates in Lilongwe ADD are under leasehold title, and occupy about 3 percent of the ADD. The Control of Land (Agricultural Leases) Order issued in 1990, which prohibits leasing of customary land throughout Malawi except in specified areas, applies in the whole of Lilongwe ADD, except Dedza Hills RDP.

4.2 RAINFED CULTIVATION - SMALLHOLDERS

Rainfed cultivation by smallholders is to be found nearly everywhere in Lilongwe ADD except in the Dzalanyama Range and parts of Dowa Hills, Dedza Escarpment, Balaka Uplands and Ntcheu Foothills, where natural vegetation is predominant. The total area under rainfed and dimba cultivation (including fallow) by smallholders is estimated at 796,300 ha

TABLE 9. BASELINE DATA, LILONGWE ADD.

		LILONGWE RDP		LILONGWE N EAST RDP		THIWI/ LIFIDZI RDP		DEDZA HILLS RDP		NTCHEU RDP		LILONGWE ADD *	
		ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
1	TOTAL LAND	323,050	100	219,500	100	102,200	100	183,200	100	243,250	100	1,071,200	91
2	CUSTOMARY LAND	0	0	141,300	64	99,800	98	118,150	64	212,100	87	571,350	53
3	FREEHOLD LAND	251,750	78	40,300	18	0	0	0	0	0	0	292,050	27
4	ESTATES	21,350	7	350	0	2,000	2	1,350	1	6,700	3	31,750	3
5	PUBLIC LAND	49,200	15	21,050	10	400	0	2,100	1	6,900	3	79,650	7
6	FOREST RESERVES	750	0	16,500	8	0	0	61,600	34	17,550	7	96,400	9
7	NUMBER OF FARM FAMILIES	110,321	34	74,171	23	41,452	13	43,548	13	57,224	17	326,716	100
8	TOTAL FARMING POPULATION	551,605	35	348,604	22	198,969	12	217,740	14	280,397	18	1,597,315	100
9	AVERAGE HOUSEHOLD	5.0		4.7		4.8		5.0		4.9		4.9	
10	AVERAGE HOLDING SIZE (ha)	1.3		1.1		1.2		0.9		0.8		1.1	
11	ESTIMATED AREA CULTIVATED BY SMALLHOLDERS (ha)	140,100	40	79,350	23	47,650	14	39,200	11	44,050	13	350,350	100

Source: Data line 1: Area measurement by planimeter
Data lines 2,3,4,5,7,8,9,10: Lilongwe ADD (1990)
Data line 6: Regional Forestry Office
Data line 11: line 7 multiplied by line 10
* Lilongwe City and Dzalanyama Ranch not included.

or 68 percent of Lilongwe ADD - see Section 4.11. This is 2.3 times as much as the area under cultivation as estimated by multiplication of farm families and average holding size (see Table 9). The difference between the two figures is explained partly by the existence of estates and occurrence of fallow land, but it appears that the ADD figures may be a gross underestimate.

The total number of farm families in Lilongwe ADD was estimated at 326,716 in 1991, and the total farming population at 1,597,315 (see Table 9) or 91 percent of the total population.

Average land holding size is 1,1 ha for the ADD as a whole. A breakdown is presented in Table 10. The smallholder sector can be subdivided into three major groups according to holding size and related socio-economic aspects (OPC, 1987):

- Smallholders with less than 0.7 ha grow subsistence foodcrops but also depend on off-farm income.

- Smallholders with 0.7-1.5 ha grow mainly subsistence foodcrops and are largely able to sustain themselves.

- Smallholders with over 1.5 ha are able to grow cash crops in addition to subsistence foodcrops. Both inputs and yields are higher than for the other groups.

TABLE 10. HOLDING SIZE DISTRIBUTION, LILONGWE ADD (as percentage of total)

	<0.5 ha	0.5-1.0 ha	1.0-2.0 ha	>2.0 ha
Lilongwe	12 %	23 %	44 %	21 %
Lilongwe NE	27 %	33 %	29 %	10 %
Thiwi/Lifidzi	14 %	47 %	33 %	6 %
Dedza Hills	17 %	50 %	24 %	4 %
Ntcheu	42 %	44 %	13 %	1 %
Lilongwe ADD	22 %	37 %	30 %	10 %

Source: Lilongwe ADD 1991.

4.2.1 Crops

A large number of crops are grown in Lilongwe ADD but only the major field crops will be described here. The cropping pattern of each RDP is presented in Table 11. Crops are usually grown in pure stands in Lilongwe RDP and Lilongwe N East RDP, while intercropping of maize with pulses and sometimes maize with groundnuts is very common in Thiwi/Lifidzi RDP, Dedza Hills RDP and to a lesser extent in Ntcheu RDP.

4.2.1.1 Cereals

- Maize. Maize is the main staple food. About 59 percent of the cultivated land is occupied by maize in pure stand and another 22 percent is taken up by a crop mix dominated by maize, with pulses and groundnuts.

Local maize varieties dominate maize production, but the share taken by hybrid varieties is rapidly increasing. Typical yields of non-fertilized local maize varieties average 1.1 ton/ha. Stalkborer is endemic in high altitude areas (Dedza Hills RDP and parts of Ntcheu RDP), but apart from these areas few pests exist in other production areas. Hybrid maize varieties occupy about 14 percent of the land under maize in pure stand. Most of the total ADD production originates from Lilongwe RDP (around 60 percent). Hybrid maize varieties produce superior yields - 2.8 tons/ha average - but are sensitive to drought, incorrect management etc.

TABLE 11. CROPPING PATTERNS IN THE SMALLHOLDER SECTOR, LILONGWE ADD (1989/90) (figures are percentage of cropped area)

	LILONGWE RDP	LILONGWE N. EAST RDP	THIWI/ LIFIDZI RDP	DEDZA HILLS RDP	NTCHEU RDP	LILONGWE ADD
Local maize	71	69	37	28	52	51
Hybrid maize	12	14	2	8	2	8
Composite maize	-	1	-	-	-	0.2
Maize/Groundnuts	1	-	3	2	10	3
Maize/Pulses	-	2.2	46	58	27	19
Maize/Millet/Sorgh	-	-	11	3	1	2
Chalimbana gr.nuts	4	6	-	1	1	3
Other groundnuts	-	1	-	-	1	0.4
Beans pure stand	-	-	1	1	-	0.2
mixed stand	1	2	41	55	26	18
Cassava	-	-	2	-	-	0.2
Sweet potatoes	1	1	1	1	1	1
Tobacco	10	4	2	-	-	4

Source: ASA 1989/1990.
Data may add up to more than 100 percent due to intercropping.

- Wheat. Wheat is grown on a small scale in the high and relatively cool parts of Ntcheu RDP. It is grown as a second crop at the end of the rainy season mostly without fertilizer (around 14 percent of the area is fertilized). Sowing occurs between the end of February and the beginning of March. Typical yields are 600-800 kg/ha.

4.2.1.2 Grain legumes

- Pulses. The main pulse grown is phaseolus bean; others include pigeon pea, cowpea and soya beans. They are grown in pure stands or in mixed stands with maize, or in the case of pigeon pea, as a second crop in relay with maize. Average yield for phaseolus beans is 0.6 ton/ha, and for soya beans 0.6-0.8 tons/ha. They are mainly grown as foodcrops, with the exception of soya beans which are also sold for cash. The production of soya beans is rapidly increasing in the last few years due to a relatively good market and few disease problems.

- Groundnuts. Groundnuts are grown as a food crop in mixed stands with maize mainly in Thiwi/Lifidzi, Dedza Hills and Ntcheu RDPs. Improved varieties (mainly Chalimbana, Manipintar and Chitembana) are grown in pure stands as a cash crop, mainly in the two Lilongwe RDPs. Yields are low: on average 500 kg/ha in the latter RDPs and around 400 kg/ha in the other RDPs.

4.2.1.3 Tuber and root crops

- Cassava. Cassava cultivation is mainly restricted to Thiwi/Lifidzi RDP. For reasons unknown the production is declining. Cassava is grown without fertilizer in pure stands. Typical yields are 2-3 tons/ha. Main pests and diseases are cassava mozaic and, to a lesser extent, spider mite.

- Sweet potato. Local varieties of sweet potato are grown on a small scale throughout the ADD.

- Irish potato. Potatoes are grown in Dedza Hills RDP and the high altitude parts of Ntcheu RDP.

4.2.1.4 Fruits

Fruits include banana, mango, citrus, pawpaw, guava, apples, peaches and plums. Citrus is found throughout the ADD and on a small plantation near Chimutu on the Salima road. Mango is mainly confined to the warmer areas in Ntcheu district, whereas apples, peaches and plums are grown in the higher and cooler areas. Guava is mainly grown throughout Ntcheu District.

4.2.1.5 Cash crops

Most crops described in the sections above are not only grown for subsistence, but are also sold for cash. Other crops exclusively grown for cash are: tobacco, sunflower, coffee and cotton.

- Coffee. Coffee is only grown in Bembeke EPA (DE8) in Dedza Hills RDP.

- Tobacco. Only Northern Division dark fired tobacco is grown by smallholders except for a small proportion of burley which has been grown by smallholder farmers in Ntcheu RDP on a pilot basis in 1990/91. Dark fired was grown by 28,386 farmers on 13,424 hectares in 1990/91. Yields were about 370 kg/ha. Growing of burley (air-cured) tobacco was started by 826 smallholders. Tobacco growers must adhere strictly to a set of cultural and chemical measures including proper rotation, prescribed dates for sowing and transplanting, use of chemicals to control prevalent virus diseases such as bushy top, leaf curl and potato virus 'y'. All tobacco crops are fertilized.

- Sunflower. Sunflower is grown by a number of farmers, but disease problems are a major constraint. Typical yields are 0.4-0.5 ton/ha.

- Cotton. Cotton is grown by smallholders in the warmer parts of Ntcheu RDP. Average yields are 600-700 kg/ha. Weeding during the early growth stages and control of pests (American and red bollworms, red spider mite and aphids) through application of a variety of sprayed pesticides are absolutely essential in improving yields.

4.2.2 Management practices

The onset of the rains in November and the unimodal rainfall pattern throughout the ADD dictate the crop calendar. Annual crops are planted in December in most areas.

Cultivation is mainly done by hoe, but a number of farmers use ox-drawn implements. The number of servicable ox-drawn implements is given in table 12. About 0.3 percent of the farm families in Lilongwe ADD use ox-drawn implements with Lilongwe RDP being the most advanced in this respect: 0.6 percent.
Garden preparation by some farmers starts several months before the onset of the rains by burning of accumulated organic residues and ridging by hoe. Others start just before or even after the first rains and this activity is not completed in time to plant at the optimal period. The practice of ridging is almost universal in the whole of the ADD. Contour alignment of the ridges, however, could be much improved.

TABLE 12. FARM MACHINERY (servicable), LILONGWE ADD

	PLOUGHS	RIDGERS	CULTIVATORS	OX-CARTS
Lilongwe RDP	608	628	30	4171
Lilongwe NE RDP	111	106	10	1259
Thiwi/Lifidzi RDP	64	56	4	1147
Dedza Hills RDP	56	52	4	444
Ntcheu RDP	279	135	15	330
Total Lilongwe ADD	1118	977	63	7351

Source: Lilongwe ADD

Duration of fallow periods varies throughout the ADD mainly in relation to population density. No data are available on fallow practices, but in most cases continuous cultivation is the rule.

Intercropping of maize with pulses or groundnuts is commonly practised, especially on small land holdings. Strip cropping is very uncommon, but systems with natural grass and fruit trees are strongly encouraged by the ADD. Alley cropping with agroforestry trees such as Acacia albida, Sesbania sesban, Leucaena spp., Gliricidia spp., Calliandra spp. and Cassia glauca is also encouraged.

Usually two weedings are carried out: one during the first six weeks after planting, the second at about funnelling stage of the maize.

Similarly fertilization is done twice on most crops. A basal dressing is applied either at planting or when the maize crop has about three leaves (3 weeks after planting). A top dressing is given 3 - 4 weeks after the basal dressing.

Fertilizer use throughout the ADD is quite widespread and averages 53 percent of all farmers (ASA, 1989/90), which is well above the national average of 23 percent. One of the methods of acquisition is through membership of a credit club. A significant percentage (51 %) of the households purchase fertilizer for cash (38 % in the two Lilongwe RDPs and 87 % in Ntcheu RDP). While virtually all the hybrid maize plots get fertilized, only about 40 percent of the area under local maize is fertilized.

Both inorganic and organic fertilizers are applied to crops (maize, tobacco, vegetables, Irish potatoes and wheat mainly). Both basal DAP, 20:20:0, 23:21:0+4S, 23:23:0 and Compounds C and S, and side dressing fertilizers (Urea, Sulphate of Ammonia and Calcium Ammonium Nitrate) are applied to crops. In Lilongwe RDP and Lilongwe N East RDP the use of organic manure is most prevalent on tobacco and hybrid maize.

TABLE 13. FARM FAMILIES APPLYING MANURE, COMPOST AND ALLEY CROPPING.

	Manure		Compost		Alley cropping	
RDP	No.	%	No.	%	No.	%
Lilongwe	2674	2.4	3133	2.8	42	0.2
Lilongwe N.East	5050	6.8	-	-	22	0
Thiwi/Lifidzi	6448	15.6	641	1.5	-	-
Dedza Hills	5126	11.8	900	2.1	182	0.4
Ntcheu	1854	3.2	11	0	22	0

Source: Lilongwe ADD, 1990

Chemical insecticides are used on hybrid maize, but only by a minority of farmers. Cashcrops such as tobacco, coffee and cotton are more commonly sprayed. Local pesticides, which are extracts of parts of indigenous plants in water, are commonly used by farmers, for example to control stalkborer in maize.

Harvesting of most field crops is done in April and May. Pigeon peas are harvested in August. Cassava is harvested whenever a food shortage occurs; but if the need for harvesting does not arise the crop is frequently left in the field till the next year, although pests reduce the reliability of this practice. Post harvest losses due to beetles, weevils and rodents are common.

4.2.3 Yields and output

Present crop yields and annual production figures are presented in Table 14. Yields of unfertilized crops are invariably low and present yields are reported to be considerably lower than some decades ago. This downward trend can be explained by a gradual depletion of soil nutrients and by erosion of topsoil. Smallholder yields may vary by 100-200 percent from year to year or from plot to plot. This is mainly due to variations in management such as planting date, frequency and time of weeding, seed quality, climatic

factors, micro-variability in soils or attack by pests and diseases. Average crop yields for different agro-ecological zones over a number of years show very limited variation. This may be explained by the general low level of crop management which overrides potential differences in crop yield, and to the fact that local cultivars are well adapted to the environment.

4.3 DIMBA CULTIVATION

At certain sites along watercourses, in valley bottoms and at the foot of escarpments crops can be grown in the dry season. Use is made of either high groundwater tables and residual moisture, or water is drawn from a well or stream and carried in buckets to irrigate the crop. Some of the crops grown this way are vegetables (tomato, chinese cabbage, onion, pumpking, rape), beans, banana, sweet potato, maize and sugarcane. Dimba cultivation does not cover much land but provides a very valuable source of fresh produce during the dry season. Crops are grown both for home consumption and for cash. Reported yields of some crops are: cabbage 18t/ha, tomatoes 12t/ha, onions 10t/ha and Irish potatoes 15t/ha.

TABLE 14. AVERAGE ANNUAL YIELDS AND AVERAGE ANNUAL PRODUCTION OF MAJOR CROPS, SMALLHOLDERS (1985/86-1989/90): LILONGWE ADD

	AVERAGE YIELD (t/ha)	PRODUCTION (tons)
Local maize	1.1	393,300
Hybrid maize	2.8	67,200
Composite maize	2.1	-
Millet	0.4	-
Phaseolus beans	0.6	11,000
Groundnuts	0.5	21,200
Cassava (1)	2.2	-
Sweet potato (1)	2.2	-
Cotton (1)	0.8	-
Tobacco (2)	0.7	7,845

Source: Lilongwe ADD, Annual crop estimates.
(1) Estimated data.
(2) Dark Western tobacco only.

4.4 CROPS AND MANAGEMENT IN THE ESTATE SECTOR

About three percent of all land in Lilongwe ADD is taken up by estates, most of which have been established in the last 20 years. The vast majority of these estates are so-called tobacco estates, although very little tobacco growing is found on many of them, probably due to lack of cash and qualified manpower.

Burley tobacco is the main crop grown on estates, covering about 6,775 ha grown by 2,705 growers with an average yield of 1,500 kg/ha in the 1990/91 season. Flue-cured tobacco was only grown on about 120 hectares by 49 growers with an average yield of 700 kg/ha in the 1990/91 season.

Management on tobacco estates is highly variable, and many of the more recent estates are not or only partly developed. Crop management is often well advanced including nursery techniques, spraying against pests and diseases, fertilization, careful curing etc., but improper land management including incorrect ridge alignment often causes serious soil erosion.

Maize is grown as a food crop for labourers on most tobacco estates.

4.5 IRRIGATED AGRICULTURE

There are no irrigation schemes in Lilongwe ADD.

4.6 LIVESTOCK AND GRAZING

In 1989, 185,240 head of cattle, 267,083 goats, 11,491 sheep and 67,956 pigs were counted in the ADD, and poultry numbered 785,652 - see Table 15. Livestock numbers have declined slightly in the last few years. Cattle are kept as a source of protein and manure, but animals are sold if the owner needs cash. They are also kept for status, the size of a herd reflecting the wealth and importance of the owner. Some oxen are used as draught animals (see Section 4.2.2). Cattle graze on natural grasslands in dambos and floodplains and on communal grazing lands. After harvest of crops they are also fed on crop residues. Sheep, goats, pigs and poultry are mainly kept as a source of protein. They browse or scavenge for food in and around the villages.

Some dairy cattle are kept by smallholders or on estates. There are 12 bulking groups, each bulking group consisting of a number of farmers. Table 16 indicates the number of farmers, number of bulking groups, number of Friesian (crossbred) cows and total number of cattle per RDP. Dedza Hills RDP and Ntcheu RDP do not have any dairy cattle.

Any farmer who is recruited to start a dairy enterprise is supposed to establish 1.2 ha of improved pastures per two dairy cows. Pasture species commonly recommended are Napier grass in wet areas and Rhodes grass in drier areas. In addition to grasses, farmers are encouraged to plant leguminous species like Leucaena, stylo, silverleaf and greenleaf. Crop

TABLE 15. LIVESTOCK NUMBERS, LILONGWE ADD, 1989

	CATTLE	GOATS	SHEEP	PIGS	DONKEYS	POULTRY	RABBITS
Lilongwe RDP	68,372	130,915	3,529	25,820	367	500,975	2,681
Lilongwe NE RDP	39,931	45,748	3,445	11,332	181	94,356	0
Thiwi/Lifidzi RDP	28,309	23,099	620	8,061	925	49,348	2,150
Dedza Hills RDP	15,153	31,808	2,961	3,673	29	50,320	0
Ntcheu RDP	33,475	35,513	936	19,070	98	90,653	2,142
Total Lilongwe ADD	185,240	267,083	11,491	67,956	1,600	785,652	6,973

Source: Lilongwe ADD, 1991. Numbers represent totals on customary land, private farms, government farms and foreign (Mozambican) animals.

TABLE 16. SMALLHOLDER DAIRY HERDS, LILONGWE ADD, 1990

	Farmers	Bulking groups	FR crosses	Total cattle
Lilongwe RDP	153	4	369	788
Lilongwe NE RDP	36	5	66	127
Thiwi/Lifidzi RDP	89	3	173	367

Source: Lilongwe ADD

by-products used during the dry season are maize bran, maize stovers, groundnut tops, sweet potato vines and soya bean tops.

Milk farmers are organized in groups who deliver milk to one of the ten centres where milk is cooled and sent to a milk processing plant. Cows are given to farmers on credit repayable in 4 to 5 years time.

There are three dairy estates in Lilongwe ADD: Katete with 168 dairy cows, Capital Hill Dairy Farm with 213 cows and Bwemba with 274 cows.

In the beef production programme cattle are purchased from local markets and loaned to farmers (28.5 percent interest in 1991). After a fattening period of 5 to 6 months they are sold to Cold Storage, Lilongwe.

In the poultry production programme chickens, chicken wire and feeds are loaned to farmers. Eggs are collected in bulk and sold to Lilongwe Egg Marketing.

4.7 FISHERIES

The main fish species caught in rivers and streams are Oreochronis shiranus, Tilapia rendalli, Labeo spp, Barrilius spp, Barbus spp, Haplochronis spp and Clarius spp. The most important fishing areas in Lilongwe ADD are the Kamuzu Dams and Bua river in Lilongwe District and Ntcheu Dam in Ntcheu District. Fish are caught by local fishermen using traditional methods. Fish catch in the Central Region by traps shows a wide range: from 0.2 kg to 1.1 kg/trap/night. The estimated production in reservoirs is about 105 kg/ha/year (caught by beach seines and gill nets).

There are Fish ponds in Dedza District, run by about 400 fish farmers and two fish farmer clubs (of 5 women-farmers each) producing Tilapia shiranus and T. rendalli. Clarius spp are being introduced for growing in fish ponds. The estimated production of a well managed pond of 200 m^2 (standard dimension) equals 15 - 25 kg per half a year, i.e. about 2 ton/ha/year.

4.8 PLANTATION FORESTRY

There are two types of forestry plantations in Lilongwe ADD: large scale commercial plantations and small scale plantations serving the rural population.

Large pine plantations exist in the forest reserves of Dzalanyama - 2,060 ha, Chongoni - 5,210 ha, Dedza Mountain - 1,930ha, and in Dzonze - 3,040 ha. The largest eucalyptus plantation is the Lilongwe Central Government Plantation (Katete) in the Dzalanyama Forest Reserve with 3,200 ha of Eucalyptus. Some smaller plantations, all Eucalyptus, are: Chibvuo - 108 ha, Mbalane - 120 ha, Sani - 85 ha and Area 44 in Lilongwe Town - 90 ha.

Small scale woodlots near homesteads, villages and schools are very common throughout the ADD and are a source of wood for fuel and construction. A few flue-cured tobacco estates have started planting woodlots to meet their future firewood requirements. During the year 1991 over 9 million tree seedlings were grown in nurseries and distributed in Lilongwe ADD. The main tree species found in small scale plantations is Gmelina arborea. Other species include Eucalyptus spp, Toona ciliata and at higher altitudes Pinus patula.

4.9 RESERVED LAND

Reserved land is set aside to maintain biological diversity of both flora and fauna, to protect vulnerable headwater areas from soil erosion and to avoid related problems of flash flooding, increased sedimentation and drying up of rivers downstream.

4.9.1 Forest Reserves

Sixteen gazetted Forest Reserves and Reserves awaiting gazettement are situated in Lilongwe ADD covering a total of about 195,450 ha or 17

percent of the ADD. See Table 17. Nine other areas in the ADD are proposed as Forest Reserves. Except for the plantation forests mentioned in Section 4.8 almost all of the gazetted Forest Reserve areas are taken up by indigenous vegetation, mainly Brachystegia woodlands and some montane grasslands. The vegetation types are described in Chapter 3.1.6 .

TABLE 17. FOREST RESERVES, LILONGWE ADD

FOREST RESERVE	DISTR.	1	2	AREA (ha)
Nalikule	Li	x		104
Mbalame	Li	x		350
Sani	Li	x		260
Chimvuo	Li	x		144
Ngalayapakwamwa	Li		x	?
Dzalanyama	Li+De	x		99,014
Nkhoma	Li		x	?
Chilenje	Li		x	?
Thuma	Li	x		16,407
Dzenza	De	x		849
Chongoni	De	x		12,647
Msitolengwe	De	x		58
Dedza Mountain	De	x		3,266
Dedza/Salima	De	x		32,633
Mua Livulezi	De	x		12,156
Chilobwe	Ne		x	1,348
Bangwe	Ne	x		4,199
RDP proposals *	Ne		x	?
Mvai	Ne	x		4,458
Dzozi/Mvai Ext.	Ne	x		5,076
Dzozi	Ne	x		3,836
Neno Est. Escar	Ne		x	?
		TOTAL 1		195,457

1 = Gazetted reserves (registered and not registered) and reserves awaiting gazettement.
2 = Proposed reserves.
Li = Lilongwe, De = Dedza, Ne = Ntcheu, * comprises 4 different areas.

4.9.2 National Park and Game Reserve

Lilongwe ADD has neither National Parks nor Game Reserves within its boundaries, but there is a Nature Sanctuary covering about 120 ha within the Capital City.

4.10 LAND DEGRADATION

Most of the natural vegetation in the ADD has been cleared for cultivation, including that in some areas that are quite unsuitable for agricultural use. Some clearing of marginal areas is still taking place.

There is a serious shortage of firewood in most areas. About 17 percent of the ADD, including many headwater areas highly susceptible to erosion, is reserved land and is therefore largely protected against degradation, although annual burning causes both degradation of vegetation and soil erosion. Increased floods and sedimentation in downstream areas, rapid drying up of rivers after the rains, and poor water quality do occur and cause problems locally.

Soil erosion is widespread on cultivated land in Lilongwe ADD, particularly on the steep slopes in Dedza and Ntcheu Districts. However, it is also a serious problem on the flatter lands of the Lilongwe Plain where the previously high production potential is now threatened. Sheet and rill erosion are the dominant forms, but gully and streambank erosion also occur. Sheet and rill erosion lead to removal of plant nutrients, decrease in soil depth, deterioration of soil structure and lowered infiltration rates. Susceptibility to erosion is highest during the beginning of the rainy season when little or no ground cover exists on cultivated land and rainfall intensities are high.

Planting of crops on cultivation ridges helps to conserve the land if they are properly contour-aligned. Ridging is a widespread practice, but contour-alignment is not optimal. Ridging at an angle to the slope direction to get rid of excess water is a common practice on tobacco estates and often causes problems of soil erosion.

Land degradation is most serious in parts of the Upper Dedza Escarpment where population densities and therefore cultivation intensities are very high, in part due to the influx of Mozambican refugees.

4.11 THE PRESENT LAND-USE AND VEGETATION MAP

Present land use and vegetation has been mapped at scale 1:250,000 (Map 4). Emphasis is placed on agricultural land-use and occurrence of natural vegetation. Multiple land-uses, such as grazing on cultivated land after the harvest of field crops, and land-uses common in non-reserved wooded areas, such as grazing, cutting of wood, and collection of other forest products, are not indicated on the map.

The various types of land-use and vegetation cover and their hectarage within the ADD are given in Table 18. Land-use is described in more detail in Sections 4.2 - 4.10 and vegetation in Chapter 3.1.6. The mapping units are either pure or complex; pure mapping units are made up of 75 percent or more of one land use type or one vegetation type; complex mapping units are made up by one dominant land use or vegetation type covering 50-75 percent of the area and another land use type or vegetation type covering 25-50 percent of the area.

The area covered by land use types which are of a fragmented nature, such as wetland cultivation and dimba cultivation, are generally underestimated, as they are either too small to be shown on a map at scale 1:250,000 as pure units, or cover less than 25 percent of other units. The areas of the rainfed cultivation units contain some fallow land.

TABLE 18. UNITS OF THE PRESENT LAND-USE AND VEGETATION MAP AND THEIR APPROXIMATE AREAS

		ha	%
A	Rainfed cultivation		
	A1 - maize, pulses, groundnuts, cassava (tobacco).	101,200	8.6
	A2 - maize, pulses, groundnuts, cotton, cassava.	22,100	1.9
	A4 - maize, pulses, finger millet, Irish potato.	25,600	2.2
	A5 - maize, pulses, cotton, groundnuts, millet.	400	0.0
	A14- tobacco, maize.	17,000	1.5
	A17- maize, pulses, tobacco, groundnuts.	548,900	46.8
	A18- maize, pulses, Irish potato, groundnuts.	72.800	6.2
C	Dimba cultivation		
	C1 - vegetables, sw.potato, maize, etc.	8.300	0.7
	Total cultivated	796,300	68.0
E	Grasslands		
	E1 - montane grassland with forest remnants.	26,800	2.3
	E2 - dry grassland.	800	0.1
	E3 - seasonally wet grassland of floodplains.	3,000	0.3
	E4 - seasonally wet grassland of upland drainage systems.	69,500	5.9
F	Plantation forests		
	F1 - Pinus spp.	12,900	1.1
	F2 - Eucalyptus spp.	4,600	0.4
G	Natural forests and woodlands		
	Woodlands		
	G5 - Brachystegia plateau woodland.	56,100	4.8
	G6 - Brachystegia hill woodland.	79,000	6.7
	G7 - Brachystegia escarpment woodland.	69,900	6.0
	Woodland savannas		
	G10- Woodland savanna of fertile plateau areas.	200	0.0
	Tree savannas		
	G13- Mixed low altitude savanna.	29,800	2.5
	Thickets		
	G16- Recent regrowth of undifferentiated woody veg	800	0.1
R	Bare or sparsely vegetated rock outcrops	12,200	1.0
W	Open water	300	0.0
Z	Built-up areas	9,600	0.8
	Total not cultivated	375,500	32.0

CHAPTER 5

LAND SUITABILITY APPRAISAL

5.1 METHODOLOGY

5.1.1 Introduction

The methodology used for land suitability appraisal is based on the Framework for Land Evaluation (FAO, 1976) and a series of subsequent publications of which "Land Evaluation: Guidelines for Rainfed Agriculture" (FAO 1984) is the main one. The concepts and principles of the FAO methodology are summarized in Paris (1988). Based on these publications, land suitability appraisal models for rainfed cropping, wetland rice cropping and forestry have been developed by the project.

The FAO methodology is a system which assesses the suitability of a certain tract of land for a given use, which is called the Land Use Type (LUT). Land Qualities (LQs) are determined through the use of quantified Land Characteristics (LCs) which are then matched with the requirements of a particular LUT.

For a complete land suitability appraisal both physical and socioeconomic aspects will need to be considered. The present study, however, follows a two-stage approach, whereby the physical suitability is assessed first leaving the socioeconomic evaluation to follow at a later stage. Physical suitability is, however, assessed within existing socioeconomic constraints.

Suitability refers to use on a sustainable basis. This means that land is only suitable for a certain use if this use does not result in significant land degradation. Land suitability for crops is expressed in classes which relate to a percentage of the maximum attainable yield.

5.1.2 Land use types

A distinction is made between major kinds of land use and LUTs. A major kind of land use is a major subdivision of rural land use. A major kind of land use has clearly defined levels of technical inputs and an associated socioeconomic setting - see Table 19. Major kinds of land use considered in this study are:

- rainfed cropping under traditional management
- rainfed cropping under improved traditional management
- wetland rice cropping under traditional management
- forestry

A LUT is a specific kind of land use defined in more detail. In this study LUTs are single crops and single tree species grown in pure stands.

TABLE 19. ATTRIBUTES OF THE TWO MANAGEMENT LEVELS CONSIDERED IN LAND SUITABILITY APPRAISAL.

	TRADITIONAL MANAGEMENT	IMPROVED TRADITIONAL MANAGEMENT
PRODUCTION SYSTEM	Rainfed cultivation of crop mixture grown at present	Rainfed cultivation of crops grown in pure or mixed stands
TECHNOLOGY EMPLOYED	Local cultivars. No fertilizers or chemical pest, disease and weed control. Common use of cultivation ridges with sub-optimal spacing and contour-alignment. Sub-optimal plant densities and weeding.	Improved cultivars. Early land preparation and timely planting. Limited use of fertilizers and pesticides. Composting and manuring. Correct plant spacing and adequate weeding. Cultivation on correctly spaced and contour-aligned ridges. Extension advise is followed.
POWER SOURCES	Manual labour with hand tools.	Manual labour with hand tools and/or animal traction with improved implements.
LABOUR INTENSITY	High, including family labour.	High, family labour as well as hired labour.
CAPITAL INTENSITY	Low, no use of credit.	Intermediate, access to credit.
MARKET ORIENTATION	Subsistence production plus commercial sale of surplus.	Subsistence production plus commercial sale of cashcrops.
INFRASTRUCTURE REQUIREMENTS	Limited access to markets and agricultural services.	Free access to market facilities and agricultural services.
LAND TENURE	Customary land with traditional rights.	Customary land with traditional rights.
LAND HOLDINGS	Small and usually fragmented.	Small and sometimes consolidated.
RECURRENT INPUTS REQUIRED	Traditional seed, human labour.	Improved seed, human labour and animal power, fertilizers and pesticides.

The LUTs have been selected on the basis of their agro-climatic suitability, present existence within the ADD and in some cases on the basis of market demand and Government policy. The LUTs considered are given in Table 20. The improved varieties which are included in the improved traditional management model are listed in Table 21.

5.1.2.1 Rainfed agriculture under traditional management

The main characteristics of the traditional management level are: the

TABLE 20. LAND UTILIZATION TYPES.

RAINFED CROPPING, TRADITIONAL MANAGEMENT (1) (tm-model)	RAINFED CROPPING, IMPROVED TRADITIONAL MANAGEMENT (2) (itm-model)	WETLAND CROPPING, TRADITIONAL MANAGEMENT (r-model)	FORESTRY (3) (f-model)	Main use
Bulrush millet	Bulrush millet	Bunded rice	Acacia albida	A
Cassava	Cassava - long cycle		Azadirachta indica	F,P,T
Citrus	Cassava - short cycle		Callitris calcarata	P,T
Cotton	Citrus		Callitris hugellii	P,T
Cowpea	Coffee arabica		Cassia siamea	F,P
Groundnuts	Cotton		Cordyla africana	F,P,T
Irish potato	Cowpea		Eucalyptus camaldulensis	F,P
Maize	Groundnuts - long cycle		Eucalyptus grandis	F,P
Phaseolus beans	Groundnuts - short cycle		Eucalyptus tereticornis	F,P
Pigeon pea	Irish potato		Gmelina arborea	F,P,(T)
Sorghum	Maize - long cycle		Melia azedarach	F,P
Soybeans	Maize - short cycle		Pinus caribaea	T
Sunflower	Phaseolus beans - long cycle		Pinus kesiya	T
Sweet potato	Phaseolus beans - short cycle		Pinus patula	T
Wheat	Pigeon pea			
	Sorghum			
	Soybeans			
	Sunflower			
	Tobacco - air- and fire-cured			
	Tobacco - flue-cured			
	Wheat			

(1) Only varieties available to the traditional farmer.
(2) Improved varieties if available.
(3) Explanation of abbreviations for main use: A = Agro-forestry
F = fuelwood
P = pole wood
T = timber

growing of traditional crops using local seed, manual labour with simple hand tools, no use of fertilizer or pesticides, traditional cultivation practices, and no use of extension and credit facilities. This input level coincides with conditions of subsistence farming with very limited market orientation as is prevalent in most parts of Malawi. Expected yield levels are given in Table 25.

5.1.2.2 Rainfed agriculture under improved traditional management

The improved traditional management level is practised by a relatively small number of more advanced farmers who are in a position to acquire external inputs and who are usually market oriented. The improved traditional management level assumes the availability of improved

TABLE 21. CULTIVARS FOR IMPROVED TRADITIONAL MANAGEMENT

	CROP	CULTIVARS	GROWTH CYCLE (days)
CEREALS	Maize (Zea mays)	Composites: UCA,CCA,CCC,CCD	140-150
		Tuxpeno	100-110
		Hybrids: MH12, MH15	130-150
		NSCM41, MH16	110-130
	Sorghum (Sorghum bicolor)	PN 3	90-110
	Bulrush Millet (Pennisetum typhoides)	Nigerian composite	90-110
	Wheat (Triticum aestivum)	Kenya Nyati	140-150
LEGUMES	Groundnut (Arachis hypogaea)	Chalimbana, Chitembana	140-150
		Manipintar, Mawanga, RG1	130-140
		Malimba	110-120
	Bean (Phaseolus vulgaris)	Nasaka, Bwenzilawana, Kamtsilo, Sapelekedwa, Kanzama, Mamajengo	90-120
	Soybean (Glycine max)	Geduld	90-130
	Cowpea (Vigna unguiculata)	-	90-120
	Pigeon pea (Cajanus cajan)	-	120-150
TUBER AND ROOT CROPS	Cassava (Manihot esculenta)	Gomani	270-360
		Mbundumali/Manyokola	360-450
	Irish potato (Solanum tuberosum)	-	120-150
TREE CROPS	Citrus (Citrus spp.)	Orange (Valencia) and Tangerine varieties	>365
	Coffee (Coffea arabica)	Agaro56, MTR G1 and 11	>365
CASH CROPS	Cotton (Gossypium hirsutum)	Makoka 72, Rasam 17	110-130
		Rzam 6	100-120
	Sunflower (Helianthus annus)	NSCO varieties	100-120
	Tobacco (Nicotiana tabacum)	Air-cured: Barnetts Special, Banket A-1, Burley 37	90-140
		Fire-cured: Malawi western	110-140
		Flue-cured: Kutsaga (K-1, 51E and 110), Coker 347, Speight G-28	100-140

Sources: Extension Aids Branch (1988)
Dept. of Agric. Research (1986)

cultivars, the application of fertilizer and pesticides when required, possible use of hired labour or ox-drawn implements, access to extension and credit, generally better cultivation practices and market orientation as specified below. A more detailed description of this management level is given in Table 19. Only if all the recommendations are carried out or assumptions fulfilled, are crops expected to reach yield levels given in Table 26. In reality there will be various intergrades between traditional management and improved traditional management. Some farmers may adopt some improvements, but not all.

5.1.2.3 Wetland rice under traditional management

The varieties of rice used are improved strains of the traditionally grown Faya variety. Irrigation works other than simple ditches and bunds made by hoe are absent. Water is supplied by natural flooding from a nearby river and/or from adjacent slopes, and is supplemented by rain water. The general management conditions are similar to the conditions assumed for rainfed cropping under traditional management (see Table 19), but planting is done on the flat after an initial nursery stage, and most produce is sold on the market. This major kind of land use does not apply to irrigation schemes.

5.1.2.4 Forestry

The land suitability appraisal model for forestry assesses the suitability of the land for a number of forestry species already known in Malawi and for which suitability is confirmed in at least some part of the country. The forestry model provides valuable information for farmers who plant trees as a source of firewood and timber, and commercial forestry. Trees are grown mainly for the purposes listed in Table 20.

5.1.3 Land characteristics (LCs) and land qualities (LQs)

5.1.3.1 Introduction

LQs are properties of the land and influence land use in a particular manner. They can be matched with a particular requirement of a specific land utilization type. For example, nutrient availability is a LQ which can be compared with the nutrient requirements for the growth of maize. LQs refer to the physiological and/or management requirements of crops, forestry species or animals.

Land qualities are composed of a limited number of land characteristics. The number of land characteristics needed to assess a particular LQ varies. For example, for an assessment of LQ "moisture availability" six land characteristics have been considered relating to climate, soil and physiography; for LQ "oxygen availability" only one land characteristic, i.e. soil drainage class, is required. The LQs and the LCs that define the LQs are presented in Table 22. Table 23 lists all diagnostic land characteristics for the four major kinds of land use.

TABLE 22. LAND QUALITIES AND THEIR COMPOSITION IN TERMS OF LAND CHARACTERISTICS (for explanation of symbols see Table 23).

	LAND QUALITIES		LAND CHARACTERISTICS
RAINFED CROPPING, TRADITIONAL MANAGEMENT (tm-model)	c	Temperature regime	T-an, T-EGP, T-GP, T-min
	e	Erosion hazard	Erod, P-an, Sd, Sl
	f	Flooding hazard	Fl
	k	Soil workability	Mop, Sr, Ver
	m	Moisture regime	DM, LGP, P-an, P/PET, Sd, Sl, Soil-c, Tl
	n	Nutrient availability	K, N, P
	r	Rooting conditions	Mop, Par, Sd, Sr, Ver
	w	Oxygen availability	Dr
	x	Toxicity/acidity	PH, Sal
RAINFED CROPPING, IMPROVED TRADITIONAL MANAGEMENT (itm-model)	c	Temperature regime	T-an, T-EGP, T-GP, T-min
	e	Erosion hazard	Erod, P-an, Sd, Sl
	f	Flooding hazard	Fl
	k	Soil workability	Mop, Sr, Ver
	m	Moisture regime	DM, LGP, P-an, P/PET, Sd, Sl, Soil-c, Tl
	r	Rooting conditions	Mop, Par, Sd, Sr, Ver
	t	Nutrient retention capacity	CEC
	w	Oxygen availability	Dr
	x	Toxicity/acidity	PH, Sal
WETLAND RICE, TRADITIONAL MANAGEMENT (r-model)	c	Temperature regime	T-GP
	m	Moisture regime	Dr, Fl, P-an, Sl, Tl
	n	Nutrient availability	K, N, P
	r	Rooting conditions	Sd
	x	Toxicity/acidity	PH
FORESTRY (f-model)	c	Temperature regime	T-an
	m	Moisture regime	DM, P-an
	r	Rooting conditions	Sd
	s	Soil related factors	Dr, Soil

LQs are usually obtained through an inventory of relevant land characteristics, which are either measured, inferred or sometimes estimated. For example the LQ "nutrient availability" can be assessed through the determination of such land characteristics as: available nitrogen, phosphorus and potassium in the topsoil.

For land suitability appraisal at the traditional management level, nine land qualities are used which are defined by 28 land characteristics. At the improved traditional management level also nine land qualities are used, but here they are defined by 26 land characteristics - see Tables 22 and 23. Six of the land quality definitions are identical at the two management levels, but three important differences occur.

TABLE 23. DIAGNOSTIC LAND CHARACTERISTICS

LAND CHARACTERISTICS			RAINFED CROPPING, TRADITIONAL MANAGEMENT (tm-model)	RAINFED CROPPING, IMPROVED TRADITIONAL MANAGEMENT (itm-model)	WETLAND RICE, TRADITIONAL MANAGEMENT (r-model)	FORESTRY (f-model)
group	symbol	name				
CLIMATE	DM	Mean number of dry months/year	X	X		X
	LGP	Reference length of growing period	X	X		
	P-an	Mean annual precipitation	X	X	X	X
	P/PET	Quality of moisture supply	X	X		
	T-an	Mean annual temperature	X	X		X
	T-EGP	Mean temp. during end growing period	X	X		
	T-GP	Mean temp. during growing period	X	X	X	
	T-min	Mean minimum temp. of coolest month	X	X		
SOIL	CEC	Cation exchange capacity (0-50cm)		X		
	Dr	Median soil drainage class	X	X	X	X
	Krod	Soil erodibility factor (1)(2)	X	X		
	K	Potassium (0-50cm)	X		X	
	Mop	Mopanic soil properties	X	X		
	N	Nitrogen (0-50cm)	X		X	
	P	Phosphorus (0-50cm)	X		X	
	Par	Paralithic soil properties	X	X		
	PH	Median soil reaction (0-50cm)	X	X	X	
	Rmf	Rock and mineral fragments profile	X	X		
	Sal	Salinity (0-50cm)	X	X		
	Sd	Effective soil depth	X	X	X	X
	Soil	Soil group	X	X	X	X
	Soil-c	Soil properties combined (3)	X	X		
	Sr	Surface stoniness and rockiness	X	X		
	Tex-p	Texture profile	X	X		
	Tex-t	Texture topsoil	X	X		
	Ver	Vertic soil properties	X	X		
TOPOGRAPHY and OTHERS	Fl	Frequency of flooding	X	X	X	
	Sl	Dominant slope class	X	X	X	
	Tl	Topolocation (4)	X	X	X	

(1) "Krod" has different values in the itm-model (factor for ridging included) and in the tm-model (no ridging factor included).
(2) "Krod" is derived from "P-an", "Soil" and "Tex-t".
(3) "Soil-c" includes the following soil characteristics: "Mop", "Rmf", "Tex-p", "Tex-t" and "Ver".
(4) "Tl" is derived from "Dr" and "Soil".

The first difference is the use of land quality "nutrient retention capacity (t)" at the improved traditional level instead of "nutrient availability (n)". It is assumed that at the improved traditional management level fertilizers are available in sufficient quantities, and therefore a low quantity of inherent soil nutrients can never be a limiting factor. "Nutrient availability" does not therefore need to be considered at this level. Instead "nutrient retention capacity" is of more importance, since the fertilizers will not be effective if they are not retained by the soil for a sufficiently long period.

The second difference concerns the land quality "soil erosion hazard" (e). One of the characteristics used in the definition of this requirement is the soil erodibility factor (Erod). This factor is assumed to have a more favourable value under improved traditional management, since ridging is assumed to be properly aligned along the contour, than under traditional management where ridging is usually practised but not always properly aligned.

The third difference is in the land quality "moisture regime" (m). For several crops slightly different LGP ratings were used for the two management levels. This is due to different growing cycles and different resistance to moisture-related pests and diseases of traditional varieties versus improved cultivars.

The two other land suitability appraisal models - wetland rice and forestry - are composed of five and four land qualities respectively, and are defined by a limited number of land characteristics - see Tables 22 and 23. In these three models only basic interactions between the LUTs and their environment are described, since detailed information on the data required is generally lacking.

5.1.3.2 Description of land qualities

Below follows a brief description of each land quality used in the various models:

- Temperature regime (c). Temperature regime describes the influence of temperature on crop and tree growth. For annual crops the mean monthly temperature during the growing period is used for the definition of this LQ; for perennial crops the mean annual temperature and the mean minimum temperature of the coolest month is used; for forestry species only the mean annual temperature is used. Each crop has an optimum temperature range and a sub-optimal temperature range. Temperature regime is used as a main criterion in the choice of crops to be analysed for land suitability appraisal.

- Moisture regime (m). The moisture regime is of vital importance to crops in all stages of their growth cycle. Two quite separate limitations to crop growth and production are covered by this one land quality. Firstly, inadequate moisture availability leads to depressed growth or premature death and therefore causes low crop production. Secondly, prolonged moist atmospheric conditions after maturation of the crop can lead to problems with ripening, storing and increased

occurrence of pests and diseases. Moisture regime is a complex LQ and ten LCs were used in its definition for the various models. For crops the definition of this LQ is based on the combined effect of rainfall, physiography and soil moisture storage characteristics; for forestry species it is based only on rainfall characteristics.

- Nutrient availability (n). Nutrient availability is an essential factor in the successful cultivation of crops under traditional management. Land characteristics used in its definition are the status of Nitrogen (N), Phosphorus (P) and Potassium (K).

- Oxygen availability (w). All agricultural crops, with the exception of rice, require the uptake of oxygen through their rooting system. Oxygen is available above the water table. Oxygen availability therefore is determined by the internal drainage of the soil (land characteristic "soil drainage").

- Erosion hazard (e). Erosion hazard refers to the loss of topsoil by water erosion. The model used for the assessment of erosion hazard is a modified version of SLEMSA (see Paris, 1990). Annual rainfall, slope angle, soil depth and a soil erodibility factor are the land characteristics used in the definition of erosion hazard. Slope length is standardized. Ground cover by vegetation, and major management factors are also included in the model.

- Rooting conditions (r). Rooting conditions describe the soil conditions which determine the development of an effective root system. They include foothold for the plant, nutrient and moisture extraction by the plant and the possibility for development of roots and tubers. The main soil characteristics used in the rooting conditions submodel are soil depth and stone content of the soil. Modifiers according to soil type are used in addition.

- Flooding hazard (f). Flooding hazard refers to the risk of damage to crops by running water or by ponding on the surface due to low soil infiltration rates.

- Nutrient retention capacity (t). This land quality refers to the ability of the soil to retain fertilizers. It is defined by the land characteristic "cation exchange capacity". Nutrient retention capacity is only used in the evaluation for crops grown under improved traditional management.

- Soil workability (k). Soil workability refers to the ease of soil cultivation or tillage with simple implements such as hoes and ox-drawn ploughs. It is influenced by the presence of stones and rocks and the stickiness and degree of compaction of the soil. These factors are described by the land characteristics "surface stoniness and rockiness", "vertic" and "sodic" soil properties.

- Toxicity/acidity (x). Most plants, with the notable exception of tea, suffer from Aluminum toxicity at low pH (pH <5). At pH values between 5 and 6, acidity causes sub-optimal yields for most crops, which is probably partially caused by non-availability of a number of micro-nutrients. This LQ is defined through the land characteristics "pH" and "salinity".

- Soil related factors (s). This LQ was introduced to describe all soil related characteristics in a generalized manner, and is made up of LCs "soil group" and "drainage". This LQ applies to forestry only.

5.1.4 Land use requirements

Reliable quantitative information on land use requirements is limited in the literature. Only the influence of a few land characteristics on crop yield is properly verified, for example the influence of pH. Usually only general trends or cut-off points are known for the influence of specific environmental parameters on crop performance. In addition, considerable variation exists in the requirements of different cultivars of a crop. The requirements used in the present study are the best that could be obtained, but can be refined as more information becomes available.

Land-use requirements used in the land suitability appraisal are not published in this report. The requirements of agricultural crops and forestry species are derived from various publications and are published in Eschweiler et al. (1991).

5.1.5 Matching: comparison of crop requirements with land qualities

Matching is the process of comparing land use requirements with the diagnostic land qualities of land units. Matching results in an assessment of land suitability for each LUT/land unit combination. The matching procedure was carried out on microcomputer using commercially available software called ALES, Version 2.0 (Rossiter and Van Wambeke, 1989). ALES does not itself provide any knowledge or data. It only allows the user to record and manipulate data and carry out land evaluation according to the FAO framework. More information on the procedures used is found in Eschweiler et al. (1991).

5.1.6 Land suitability classification

The classification system consists of three levels of generalization:

- Land suitability orders. At the highest level, subdivision is made into tracts of land which are suitable (denoted with "S") or not suitable (denoted with "N").

- Land suitability classes. At the second level a subdivision is made into seven classes which are described in Table 24.

- Land suitability subclasses. At the third level, lower-case letter suffixes are added to the suitability classes. They indicate the type of limitation to the given LUT. If more than three limitations occur, only the three most important ones are indicated. The suffixes used for a particular limitation are explained in Table 22.

The overall land suitability class is determined by the law of the minimum, i.e. the land quality(ies) posing the severest limitation determine(s) the overall land suitability.

TABLE 24. DEFINITIONS OF LAND SUITABILITY CLASSES

SYMBOL	SUITABILITY CLASS	DESCRIPTION	POTENTIAL YIELD as percentage of the maximum attainable yield
S1	Highly suitable	Land having no significant limitations to the sustained application of the given LUT.	100-80 percent
S2	Moderately suitable	Land having limitations which in aggregate are small to substantial to the sustained application of the given LUT; production levels will be reduced and/or costs will be increased when compared with S1.	80-50 percent
S3	Marginally suitable	Land having limitations which in aggregate are severe to the sustained application of the given LUT; production levels will be reduced and/or costs will be increased such that it is often impracticable or uneconomic for the defined use.	50-20 percent
N	Not suitable	Land having limitations which preclude any possibility of successful sustained application of the given LUT. In some cases the land could be made suitable by major changes, e.g. the use of intensive soil conservation measures	<20 percent
S1/2 S2/3 S3/N	intermediate classes	Land having intermediate land suitability, or land of which the suitability is divided among two classes.	

Note: The maximum attainable yield is defined as the maximum yield that can be obtained for a certain crop at a particular management level, - traditional or improved traditional.

It should be noted that the physical land suitability for a certain LUT does not provide information about the socioeconomic suitability. For instance, the socioeconomic situation may be such that it may well be desirable to grow a crop even if only half or less of its potential yield can be obtained. Or alternatively, a crop for which the physical suitability is high, may not be desirable for economic or cultural reasons.

5.1.7 Potential yields

The land suitability classes as presented in Table 24 are expressed in terms of a percentage of the maximum attainable yield. Maximum attainable yields for rainfed crops and wetland rice under improved traditional management and traditional management for Lilongwe ADD are presented in Tables 25 and 26. The maximum attainable yields were estimated on the basis of various sources: yields of comparable regions in Malawi, Annual Surveys of Agriculture, Demonstration Plots, Research Centres and ADD and RDP records.

5.2 LAND SUITABILITY IN LILONGWE ADD

5.2.1 Introduction

The land suitability in Lilongwe ADD for various types of land use is given in three different forms. The most complete form is the land suitability inventory given in Appendix II, in which suitability ratings are given in the form of matrices for all combinations of land use type and land unit. The suitability in Lilongwe ADD for the various land use types is summarized verbally in Sections 5.2.2 to 5.2.6 . The suitability of a few selected land use types has been mapped at scale 1:250,000 as explained in Section 5.2.8. Finally, a summary of the land suitability in each Extension Planning Area (EPA) is given in Chapter 7.

Suitability evaluation for rainfed cropping under traditional management is included, not to encourage this type of land use, but to make a comparison with cropping under improved management possible.

5.2.2 Land suitability for rainfed agriculture under traditional management

The land suitability for crops is discussed below. Land having intermediate suitability, such as S1/2, S2/3 or S3/N, is combined with land having the nearest higher suitability, for example "moderately suitable" includes both S2 and S2/3 class land. The area covered by suitable and not suitable land for the various crops is presented in Table 27. Potential yields of crops grown under traditional management in Lilongwe ADD are given in Table 25.

Erosion hazard on land steeper than six percent and deficiencies in nutrients are major limitations to traditional agriculture on a sustainable basis, and are the major determinants in the land suitability for all crops.

5.2.2.1 Cereals

- Bulrush millet. Only one percent of Lilongwe ADD is moderately suitable for rainfed Bulrush millet under traditional management. All other areas are marginally suitable (50 percent) or not suitable. The main limitations are erosion hazard and, to a lesser extent, temperature regime and oxygen availability. Moderately suitable land only occurs in the Balaka Plain, the Middle Shire Valley and Bwanje Valley.

- Maize. Fifty two percent of Lilongwe ADD is moderately suitable for rainfed maize under traditional management; the remaining part is only marginally suitable or not suitable. Main limitations to the successful cultivation of maize are low nutrient availability (very common all through the ADD), erosion hazard (on slopes of more than six percent), rooting conditions on paralithic soils and locally flooding or lack of moisture. Moderately suitable land occurs extensively on the Lilongwe Plains.

TABLE 25. YIELD LEVELS OF CROPS GROWN UNDER TRADITIONAL MANAGEMENT

		POTENTIAL YIELD (tons/ha)				
		100 %	S1 100-80 %	S2 80-50 %	S3 50-20 %	N <20 %
CEREALS	Maize	1.6	1.6-1.3	1.3-0.8	0.8-0.3	<0.3
	Sorghum	0.8	0.8-0.6	0.6-0.4	0.4-0.2	<0.2
	Finger millet	1.0	1.0-0.8	0.8-0.5	0.5-0.2	<0.2
	Wheat	1.4	1.4-1.1	1.1-0.7	0.7-0.3	<0.3
	Rice	2.2	2.2-1.8	1.8-1.1	1.1-0.4	<0.4
LEGUMES	Groundnuts	0.7	0.7-0.6	0.6-0.4	0.4-0.1	<0.1
	Phaseolus beans	0.8	0.8-0.6	0.6-0.4	0.4-0.2	<0.2
	Soybean	1.0	1.0-0.8	0.8-0.5	0.5-0.2	<0.2
	Cowpea	0.8	0.8-0.6	0.6-0.4	0.4-0.2	<0.2
	Pigeon pea	0.9	0.9-0.7	0.7-0.5	0.5-0.2	<0.2
ROOTS AND TUBERS	Cassava	5.0	5.0-4.0	4.0-2.5	2.5-1.0	<1.0
	Sweet potato	4.0	4.0-3.2	3.2-2.0	2.0-0.8	<0.8
	Irish potato	4.0	4.0-3.2	3.2-2.0	2.0-0.8	<0.8
TREE CROPS	Cashew	0.8	0.8-0.6	0.6-0.4	0.4-0.2	<0.2
	Citrus	5.0	5.0-4.0	4.0-2.5	2.5-1.0	<1.0
CASH CROPS	Cotton	1.1	1.1-0.9	0.9-0.6	0.6-0.2	<0.2
	Sunflower	0.8	0.8-0.6	0.6-0.4	0.4-0.2	<0.2

Note: Cotton is grown at a somewhat higher management level than traditional: improved seeds are used but spraying is suboptimal

- Sorghum. Moderately suitable land for sorghum under traditional management occupies 50 percent of the ADD, the remainder being only marginally or not suitable. The main limitations are low nutrient availability and erosion hazard. Moderately suitable land is mainly found, as for maize, on the Lilongwe Plains, but is slightly less suitable than for maize in the North-east and Central Lilongwe Plain, mainly due to the greater sensitivity of sorghum for erosion hazard in undulating areas.

TABLE 26. YIELD LEVELS OF CROPS GROWN UNDER IMPROVED TRADITIONAL MANAGEMENT (pure stands)

			POTENTIAL YIELD (tons/ha)				
			100 %	S1 100-80 %	S2 80-50 %	S3 50-20 %	N <20 %
CEREALS	Maize	Local varieties	2.5	2.5- 2.0	2.0- 1.3	1.3-0.5	<0.5
		Composites	4.0	4.0- 3.2	3.2- 2.0	2.0-0.8	<0.8
		Hybrids	6.0	6.0- 4.8	4.8- 3.0	3.0-1.2	<1.2
	Sorghum	Local varieties	1.7	1.7- 1.4	1.4- 0.9	0.9-0.3	<0.3
		PN 3	4.0	4.0- 3.2	3.2- 2.0	2.0-0.8	<0.8
	Finger Millet	Local varieties	1.0	1.0- 0.8	0.8- 0.5	0.5-0.2	<0.2
		516, 40, 366, Dobaloba	2.0	2.0- 1.6	1.6- 1.0	1.0-0.4	<0.4
	Wheat	Kenya Nyati	4.0	4.0- 3.2	3.2- 2.0	2.0-0.8	<0.8
LEGUMES	Groundnut	Chalimbana	1.5	1.5- 1.2	1.2- 0.8	0.8-0.3	<0.3
		Manipintar, Mawanga	1.8	1.8- 1.4	1.4- 0.9	0.9-0.4	<0.4
		Malimba	1.2	1.2- 1.0	1.0- 0.6	0.6-0.2	<0.2
	Bean	All varieties	1.2	1.2- 1.0	1.0- 0.6	0.6-0.2	<0.2
	Soybean	-	2.0	2.0- 1.6	1.6- 1.0	1.0-0.4	<0.4
	Cowpea	-	1.3	1.3- 1.0	1.0- 0.6	0.6-0.3	<0.3
	Pigeon pea	-	1.5	1.5- 1.2	1.2- 0.8	0.8-0.3	<0.3
ROOTS and TUBERS	Cassava	Local varieties	10.0	10.0- 8.0	8.0- 5.0	5.0-2.0	<2.0
		Gomani and Mbundumali/Manyokola	15.0	15.0-12.0	12.0- 7.5	7.5-3.0	<3.0
	Irish potato	-	20.0	20.0-16.0	16.0-10.0	10.0-4.0	<4.0
TREE CROPS	Cashew	-	1.5	1.5- 1.2	1.2- 0.8	0.8-0.3	<0.3
	Citrus	Orange (Valencia) and Tangerine varieties	20.0	20.0-16.0	16.0-10.0	10.0-4.0	<4.0
	Coffee arabica	Agaro56, NTK G1 and 11	2.0	2.0- 1.6	1.6- 1.0	1.0-0.4	<0.4
	Tea	SFS and PC varieties	2.5	2.5- 2.0	2.0- 1.3	1.3-0.5	<0.5
CASH CROPS	Cotton	Makoka 72, Rasam 17, Rzam 6	2.3	2.3- 1.8	1.8- 1.1	1.1-0.5	<0.5
	Sunflower	MSCO varieties	2.2	2.2- 1.8	1.8- 1.1	1.1-0.4	<0.4
	Tobacco	Air-cured: Banket A-1, Burley 37	3.0	3.0- 2.4	2.4- 1.5	1.5-0.6	<0.6
		Fire-cured:Malawi western	1.7	1.7- 1.4	1.4- 0.9	0.9-0.3	<0.3
		Flue-cured: KK-1, K51K, K110, Coker 347	3.0	3.0- 2.4	2.4- 1.5	1.5-0.6	<0.6

- Wheat. Around two percent of Lilongwe ADD is moderately suitable for rainfed wheat under traditional management; the remaining part is only marginally suitable or not suitable. Main limitations to the successful cultivation of wheat are high temperatures, erosion hazard (on slopes of more than six percent), and low nutrient availability. Moderately suitable land only occurs in the less dissected parts of the Kirk Range, Dedza Hills and the Dzalanyama Range.

5.2.2.2 Legumes

There are only small differences between the requirements for groundnuts, phaseolus beans, soya beans, cowpea and pigeon pea. Pigeon pea provides a poorer soil cover during the rains, but is more resistant to soil acidity than other legumes. Groundnuts and phaseolus beans have a better performance than other legumes in cool areas. The suitability for soya beans, as compared to other legumes is higher in areas with oxygen deficiencies.

Between 50 and 52 percent of the ADD is moderately suitable for legumes under traditional management. The main limitations are erosion hazard - dissected areas - nutrient availability (particularly phosphorus) - in nearly all areas - moisture deficiency, and cool or warm temperatures. When cultivated in pure stands, pigeon pea has the lowest suitability of the legumes because of erosion hazard, but when interplanted with maize the suitability of pigeon pea will be equal to the other legumes.

5.2.2.3 Roots and tubers

- Cassava. Conditions for the growth of cassava are far from optimal throughout the ADD. No land units are found to be moderately suitable for the cultivation of cassava under traditional management. More than half of the ADD (53 percent) is marginally suitable for cassava; these areas are mainly found on the Lilongwe Plains, with low moisture availability and/or cool temperatures being the main limitations. The remainder of the ADD (48 percent) is unsuitable, with erosion hazard the main limitation precluding most areas with slopes steeper than six percent. The advantage of cassava is however that it is very drought resistant and will seldom completely fail as other crops may do in years of exceptionally low or erratic rainfall.

- Sweet potato. About 44 percent of the ADD is moderately suitable for sweet potato. These areas are found on the Lilongwe Plains, the Dedza Uplands and in the lower, less dissected parts of the escarpment zone. Limitations for its growth in these areas are low temperatures, moisture stress and limited nutrient availability. Twenty six percent of the ADD is marginally suitable with erosion hazard and cool temperatures as the main limitations.

TABLE 27. AREA OF LAND SUITABILITY PER CROP, UNDER TRADITIONAL MANAGEMENT

		LAND SUITABILITY CLASS							
		S1 & S1/2		S2 & S2/3		S3 & S3/N		N	
		ha	%	ha	%	ha	%	ha	%
CEREALS	Bulrush millet	0	0	13,900	1	588,250	50	569,650	48
	Maize	0	0	619,900	52	212,150	18	339,750	28
	Sorghum	0	0	596,750	50	30,200	2	544,850	46
	Wheat	0	0	18,750	2	772,900	66	380,150	32
LEGUMES	Groundnuts	0	0	608,250	51	224,000	19	339,550	28
	Phas. beans	0	0	611,700	52	220,550	18	339,550	28
	Soya beans	0	0	600,300	51	231,950	19	339,550	28
	Cowpea	0	0	592,950	50	239,300	20	339,550	28
	Pigeon pea	0	0	592,850	50	34,100	2	544,850	46
ROOTS and TUBERS	Cassava	0	0	0	0	626,950	53	544,850	46
	Sweet potato	0	0	518,900	44	313,350	26	339,550	28
	Irish potato	0	0	26,400	2	765,250	65	380,150	32
TREE CROPS	Citrus	0	0	8,450	1	776,450	66	386,900	33
CASH CROPS	Cotton	0	0	13,900	1	588,250	50	569,650	48
	Sunflower	0	0	603,450	51	23,500	2	544,850	46

- Irish potato. Around two percent of the ADD is moderately suitable for the cultivation of Irish potatoes under traditional management. These areas are found in the Dedza Hills, the Kirk Range and some parts of the Dzalanyama Range, with high temperature and low nutrient availability as the main limitations. The remainder of the ADD (98 percent) is marginally suitable or not suitable with erosion hazard and high temperatures being the main limitations.

5.2.2.4 Tree crops

- Citrus. Only one percent of Lilongwe ADD is moderately suitable for citrus, the rest being marginally or not suitable. Moderately suitable land is found only in some parts of the Dzalanyama Range and the southern part of the Kirk Range. Nutrient availability is the main limitation in these areas. All other land is marginally suitable or not suitable, with moisture deficit and erosion hazard being the main limitations for the upland soils.

5.2.2.5 Cash crops

- Cotton. Cotton is a crop which is grown at a level of management which is halfway between traditional and improved traditional. Improved seeds are always used, but the application of pesticides is usually far below the recommended rate. Only one percent of the ADD is moderately suitable for cotton, being the warmer Middle Shire Valley and Bwanje Valley. About 50 percent is marginally suitable, with cool temperatures and erosion hazard as the main limitations.

- Sunflower. About half (51 percent) of the ADD is moderately suitable for the cultivation of sunflower, the remainder being mainly not suitable (46 percent). Moderately suitable land is mostly found on the Lilongwe Plains, main limitations being erosion hazard and low nutrient availability. On not suitable land the main limitation is erosion hazard.

5.2.3 Land suitability for wetland rice under traditional management

The technology employed is described in Section 5.1.2.3 and approximates what is usually called 'rainfed rice cultivation' in Malawi. Only the floodplain of the Bua River and the valley bottom of the upper Diamphwe River are moderately suitable for wetland rice cultivation, with low temperature being the limiting factor. Nearly 100 percent of the total area of the ADD is unsuitable for rice cultivation due to moisture stress (Table 28).

TABLE 28. AREA OF LAND SUITABILITY FOR WETLAND RICE, TRADITIONAL MANAGEMENT

	LAND SUITABILITY CLASS							
	S1 & S1/2		S2 & S2/3		S3 & S3/N		N	
	ha	%	ha	%	ha	%	ha	%
RICE	0	0	5,050	0	0	0	1,166,750	100

5.2.4 Land suitability for rainfed agriculture under improved traditional management

Under improved traditional management the suitability of 16 crops has been evaluated. For cassava, groundnuts, maize, phaseolus beans and tobacco, two groups of varieties have been evaluated separately. Thus, a total of 21 LUTs have been distinguished. They are listed in Table 20. The land suitability for these crops is discussed below. Land having intermediate suitability, such as S1/2, S2/3 or S3/N, is combined with land having the nearest higher suitability, for example "moderately suitable" includes both S2 and S2/3 class land. The area covered by suitable and not suitable land for the various crops is presented in Table 29. Potential yields of crops grown under improved traditional management in Lilongwe ADD are given in Table 26. Comparison of Tables 27 and 29 shows that, for all crops, the area covered by suitable land under improved traditional management is larger than under traditional management. Where erosion hazard remains a limiting factor even under improved traditional management, intensive conservation measures can improve the suitability rating and in some cases make unsuitable land suitable.

5.2.4.1 Cereals

- Maize. The suitability assessment has been carried out for long season varieties of maize, such as UCA, CCA and MH15, and for short season varieties, such as Tuxpeno and NSCM41. Sixty three percent of Lilongwe ADD is moderately suitable for rainfed long season varieties of maize under improved traditional management; fifty eight percent of the ADD is moderately suitable and only 0.2 percent is highly suitable for short season maize varieties. The remaining parts are marginally suitable or not suitable. Main limitations to the successful cultivation of maize are low nutrient retention capacity, erosion hazard (on slopes of more than 13 percent), lack of moisture (common limitation for long season varieties), and low temperatures (for short season varieties). Moderately suitable land occurs extensively on the Lilongwe Plains, in the Dedza Uplands and on the less dissected parts of the escarpment zone.

- Sorghum. Highly suitable land for sorghum occupies 49 percent of the ADD, and is mainly found in the Lilongwe Plains, the Dedza Uplands and the less dissected parts of the escarpment zone. The main limitations are low temperature and low nutrient retention capacity. Moderately suitable land for sorghum under improved traditional management occupies 10 percent of the ADD. The main limitations are erosion hazard on steep slopes, poor rooting conditions on shallow soils and oxygen availability in areas with high groundwater.

- Bulrush millet. About three percent of the ADD is moderately suitable. Suitability is lower than for sorghum due to a lower resistance to cool temperatures and oxygen deficiency. Moderately suitable areas are only to be found at low altitude e.g. Balaka Plain, Lakeshore Plain, Middle Shire Valley and the lower parts of the escarpment zone.

TABLE 29. AREA OF LAND SUITABILITY PER CROP, UNDER IMPROVED TRADITIONAL MANAGEMENT

		LAND SUITABILITY CLASS							
		S1 & S1/2		S2 & S2/3		S3 & S3/N		N	
		ha	%	ha	%	ha	%	ha	%
CEREALS	Bulrush millet	0	0	32,700	3	766,500	66	362,600	30
	Maize-L	0	0	744,750	63	215,100	18	211,950	18
	Maize-S	2,500	0	691,050	58	267,550	22	210,700	17
	Sorghum	576,150	49	114,400	10	268,950	22	212,300	18
	Wheat	0	0	121,600	10	795,950	68	254,250	22
LEGUMES	Groundnuts-L	459,150	39	347,950	29	154,000	13	210,700	17
	Groundnuts-S	10,900	1	678,650	57	121,250	10	361,000	30
	Phas. beans-L	45,050	3	688,050	58	223,300	19	215,400	18
	Phas. beans-S	7,100	1	682,450	58	271,550	23	210,700	17
	Soya beans	7,100	1	689,800	58	264,200	22	210,700	17
	Cowpea	7,100	1	682,450	58	271,550	23	210,700	17
	Pigeon pea	11,650	1	671,550	57	276,300	23	212,300	18
ROOTS and TUBERS	Cassava-L	0	0	0	0	959,500	81	212,300	18
	Cassava-S	0	0	0	0	0	0	1,171,800	100
	Irish potato	0	0	129,250	11	788,300	67	254,250	22
TREE CROPS	Citrus	0	0	38,600	3	866,600	74	266,600	23
	Coffee arabica	0	0	0	0	586,900	50	584,900	49
CASH CROPS	Cotton	0	0	32,700	3	776,500	66	362,600	30
	Sunflower	512,400	43	253,100	21	194,600	16	211,700	18
	Tobacco-AFC	0	0	773,700	66	177,400	15	220,700	18
	Tobacco-FC	0	0	773,700	66	178,000	15	220,100	18

NOTE: L = Long season varieties; S = Short season varieties
AFC = air- and fire-cured; FC = flue-cured

- Wheat. About ten percent of Lilongwe ADD is moderately suitable for rainfed wheat under improved traditional management; the remaining part is only marginally suitable or not suitable. Main limitations to the successful cultivation of wheat are high temperature, low nutrient retention capacity, and locally acidity. Moderately suitable land occurs only in the Dedza Hills, the Dzalanayama Range and the high elevation areas of Ntcheu District.

5.2.4.2 Legumes

Around 57 to 58 percent of the ADD is moderately suitable for legumes under improved traditional management except for the long cycle variety groundnuts (29 percent). The latter is highly suitable in 39 percent of the ADD whereas only 1 to 3 percent of the total area is highly suitable for groundnuts short cycle variety, phaseolus beans, soya beans, cowpea and pigeon pea. The main limitations are either low or high temperature (depending on the crop), low nutrient retention capacity, acidity, poor rooting conditions on shallow soils and erosion hazard on steep slopes.

- Pulses: cowpea, pigeon pea, phaseolus beans. The differences in crop requirements are small. The main suitable areas are found on the Lilongwe Plain, in the Dedza Uplands and on the less dissected parts of the escarpment zone.

- Soya beans. Soya beans are a cash crop of which the importance is rapidly increasing in the ADD. The suitability is comparable to that of other legumes. Main limitations are low temperatures, acidity, poor rooting conditions and erosion hazard.

- Groundnuts. Two groups of varieties have been evaluated: short season varieties, such as Malimba with a growth cycle of 110-120 days, and long season varieties, such as Chalimbana with a growth cycle of 140-150 days. Malimba requires somewhat higher temperatures than Chalimbana. Thirty nine percent of the ADD is highly suitable for long season varieties. This land is mainly found on the Lilongwe Plain and some flatter areas in the escarpment zone. A total of 29 percent of the ADD is moderately suitable for the same variety. The short cycle varieties only have a high suitability in low altitude areas like the Balaka Plain and the lower parts of the escarpment zone. The main limitations are low nutrient retention capacity and acidity for all varieties, and, in addition, cool temperatures for the short season varieties.

5.2.4.3 Roots and tubers

- Cassava. Two varieties of cassava have been evaluated: short duration varieties (Gomani) with a cycle of about ten months, and long cycle varieties (such as Mbunumali) with a growth cycle of more than a year. Optimal and sub-optimal conditions for cassava are not found in the ADD. A very large part of the ADD - 81 percent - is marginally suitable for cassava with a long growth cycle. Cassava can be grown virtually anywhere in the ADD except on very steep land and on poorly drained or flooded land, but at relatively low yield levels. The main limitation for both varieties is moisture stress in the dry season.

- Irish potato. About 11 percent of the ADD is moderately suitable for the cultivation of Irish potatoes. These areas are found in the somewhat cooler high altitude places. About 67 percent of the ADD is marginally suitable, with high temperature, poor rooting conditions and erosion hazard as the main limiting factors.

5.2.4.4 Tree crops

- Citrus. Three percent of the ADD is moderately suitable for the cultivation of citrus under improved traditional management; these areas are mainly found in the wetter parts with a short dry period and a relatively low minimum temperature of the coolest month, such as the Dzalanyama Range and the Kirk Range. The remainder of the ADD is only marginally suitable or not suitable, with low moisture availability as the main limitation.

- Coffee. Suitability for coffee is low in the ADD. Fifty percent of the ADD is marginally suitable, with the remainder being not suitable. Main limitation is lack of moisture, even in areas with high rainfall like the Dzalanyama Range.

5.2.4.5 Cash crops

- Cotton. About three percent of the ADD is moderately suitable for cotton, consisting of small areas in the Balaka Plain and Bwanje Valley. Limitations are nutrient retention capacity and acidity. Sixty six percent is marginally suitable, with the remainder being unsuitable. The main limitations for growing cotton in these areas are cool temperature and oxygen availability on poorly drained soils, apart from pests and diseases.

- Sunflower. Sunflower is a cash crop with considerable potential in the ADD. Forty three percent of the ADD is highly suitable for the cultivation of sunflower under improved traditional management. These areas occur on the Lilongwe Plains. Twenty one percent of the ADD is moderately suitable, with erosion hazard, nutrient retention capacity and acidity as the main limitations. These areas occur mainly in the Dedza Uplands.

- Tobacco. Sixty six percent of the ADD is moderately suitable for both flue-cured, oriental, dark fired and burley tobacco. These areas occur mainly on the Lilongwe Plains and Dedza Uplands. Elsewhere it is marginal or not-suitable mainly due to erosion hazard on steep slopes, poor rooting conditions on shallow soils and lack of oxygen in areas with impeded drainage.

5.2.5 Land suitability for extensive grazing

Extensive grazing refers to a land utilization type in which animal feed comes mainly from rangelands or natural, unimproved pastures. This implies that only those areas which are at present under natural vegetation would be considered in the appraisal. In order to determine suitability for extensive grazing in a quantitative way, as has been done

for rainfed agriculture, more detailed information on canopy cover, basal cover and species composition would be needed than has been collected in this study. The availability of surface water supplies would also need to be determined.

Of the land which is not cultivated in Lilongwe ADD, 17 percent is under different types of Brachystegia woodland, and 6 percent consists of seasonally wet grassland of upland drainage systems (dambos). In generral the Brachystegia woodland has a sparse grass cover of species of rather low nutritive value, and browse is also limited. Almost all this woodland is burnt every year further limiting forage availability, and there is no surface water for most of the year. The Brachystegia woodlands are therefore of marginal suitability for extensive grazing. Of the 205,000 ha of Brachystegia woodland in the ADD, 56,000 ha (5 percent of the ADD) are on the plateau and therefore slightly more suitable for development for extensive grazing, due to a large extent to the presence of extensive dambo areas.

The dambos are moderately suitable for extensive grazing for part of the year only, although in practice they are used throughout due to lack of alternative forage during the wet season when there are growing crops in the surrounding arable areas. The residues of these crops provide food during the dry season.

Two and a half percent (30,000 ha) of the ADD is covered in mixed low altitude savanna woodland which would be moderately suitable for extensive grazing by breeds of cattle suited to a hot climate, provided water supplies are available.

5.2.6 Land suitability for forestry

Land suitability was assessed for 14 forestry trees. They are listed in Table 20. The area covered by suitable and not suitable land for the various trees is presented in Table 30.

- Acacia albida. A. albida requires a deep, well drained soil and is able to use soil moisture reserves in the deep subsoil and in soft rock. About 41 percent of the ADD is highly or moderately suitable. The moderately suitable areas are found on alluvial deposits and parts of the Lilongwe Plain, Dedza Uplands and the escarpment zone. Highly suitable areas are only to be found on the Balaka Plain, in the Middle Shire Valley and Bwanje Valley.

- Azadirachta indica. A. indica is a very tolerant species. Most of the ADD is highly to moderately suitable. Marginally suitable or not suitable are areas with poorly or imperfectly drained soils and areas with very shallow soils.

- Callitris calcarata. Moderately suitable land occupies 55 percent of the ADD, and is mainly found in areas with high rainfall, low number of dry months and well drained soils.

- Callitris hugellii. The suitability of C. hugellii is very similar to that of Cassia siamea.

TABLE 30. AREA OF LAND SUITABILITY FOR FORESTRY TREES

	LAND SUITABILITY CLASS							
	S1 & S1/2		S2 & S2/3		S3 & S3/N		N	
	ha	%	ha	%	ha	%	ha	%
ACACIA ALBIDA	1,350	0	485,250	41	529,550	45	155,650	13
AZADIRACHTA INDICA	201,350	17	846,250	72	5,550	0	118,650	10
CALLITRIS CALCARATA	0	0	652,350	55	395,850	34	123,600	10
CALLITRIS HUGELLII	11,700	1	637,550	54	398,350	34	124,200	10
CASSIA SIAMEA	14,850	1	634,400	54	399,950	34	122,600	10
CORDYLA AFRICANA	26,550	2	622,700	53	398,350	34	124,200	10
EUCALYPTUS CAMALDULENSIS	288,900	24	758,700	64	70,700	6	53,500	5
EUCALYPTUS GRANDIS	0	0	663,550	56	391,200	33	117,050	10
EUCALYPTUS TERETICORNIS	288,900	24	758,700	64	7,150	1	117,050	10
GMELINA ARBOREA	297,400	25	709,950	60	109,350	9	55,100	5
MELIA AZEDARACH	286,950	24	760,650	64	600	0	123,600	10
PINUS CARIBAEA	0	0	639,950	54	409,550	34	122,300	10
PINUS KESIYA	11,100	1	1,033,450	88	1,600	0	125,650	10
PINUS PATULA	0	0	40,850	3	1,003,700	85	127,250	10

- Cassia siamea. C. siamea does not tolerate waterlogging, but does not require a very deep soil. One percent of the ADD is highly suitable and fifty four percent is moderately suitable. These areas are found in the drier and hotter parts of the ADD.

- Cordyla africana. The requirements and suitability of C. africana are very similar to those of Cassia siamea and Callitris hugellii.

- Eucalyptus camaldulensis, E. tereticornis. Both Eucalyptus species are tolerant of a wide range of conditions. E. camaldulensis tolerates occasional flooding and ponding; E. tereticornis is drought resistant. About eighty eight percent of the ADD is moderately or highly suitable. Marginal or not suitable land is only found on soils with impeded drainage.

- Eucalyptus grandis. Moderately suitable land occupies about 56 percent and is found throughout the ADD, except in the areas with a prolonged dry season and poorly drained soils.

- Gmelina arborea. About 85 percent of the ADD is moderately or highly suitable. Marginal and not suitable land is found in the hottest parts of the ADD and on soils with impeded drainage.

- Melia azedarach. About 88 percent of the ADD is highly or moderately suitable. Marginal or not suitable land is found in the coolest parts and on soils with impeded drainage.

- Pinus patula. P. patula requires a cool climate with moderate to high rainfall and grows poorly on compacted or shallow soils. Moderately suitable land covers only 3 percent of the ADD, and is found in the cool and relatively wet areas such as the Dzalanyama Range and the Kirk Range.

- Pinus caribea. Land suitable for P. caribaea covers 54 percent of the ADD, and occurs in the same areas as land suitable for P. patula, but also extends into areas with lower rainfall and higher temperatures like parts of the Lilongwe Plains, Dedza Uplands and the escarpment zone.

- Pinus kesiya. P. kesiya tolerates stony soils. Moderately suitable land covers 89 percent of the ADD. Not suitable or marginal land is found in the dambos all over the ADD and in the Middle Shire Valley, Balaka Plain and Bwanje Valley.

5.2.7 Land suitability for wildlife

All the areas of natural vegetation are suitable for the wild animals and birds which are normally found in the particular habitat concerned, but the larger mammals are limited to a few species and populations are very low. Tuma Forest Reserve, part of which is within Lilongwe ADD, has reasonable numbers of elephant, buffalo and a variety of antelope, but recent heavy poaching has reduced their numbers considerably. This Reserve, together with the remainder of the Dedza Escarpment, would be very suitable for preserving as a wilderness area, and being so near Lilongwe would be attractive for walkers and campers if a modest amount of development was undertaken. Dzalanyama Forest Reserve is also an area of considerable potential.

The Lilongwe Nature Sanctuary, although small, contains a large number of bird species and represents one of the few (if not the only) examples left of the Combretum-Acacia-Bauhinia savanna woodland of fertile plateau areas. Dedza and Chirobwe Mountains have small remnant areas of evergreen forest which contain a few very rare species of birds.

Even within the intensively cultivated land throughout the ADD there is a diversity of bird species and small mammals, reptiles and amphibians. However, apart from the areas mentioned above, the potential for the preservation of the larger mammals in the ADD is rather limited due to very high population pressure.

5.2.8 Land suitability maps

Land suitability under improved traditional management is shown in a generalized form on maps at scale 1:250,000 for:

- maize, long season varieties such as CCA, UCA and MH15
- groundnuts, long season varieties such as Chalimbana
- sun flower
- fire cured and burley tobacco
- soya beans

For these maps the land unit map is used as a base. The suitability of each of the land units is derived from the Tables in Appendix II. Four suitability classes are used: Highly Suitable (S1), Moderately Suitable (S2), Marginally Suitable (S3) and Not Suitable (N). Classes S1, S2 and S3 are shown in decreasing intensities of green; not suitable land is not coloured. In cases where the suitability is given as an intermediate class, for example S2/3, it is upgraded by half a class. In the case of complex land mapping units, only the land suitability of the dominant land unit, i.e. the first member of the complex, is shown. The types of limitation are not shown on the map. The land unit numbers and boundaries remain as a background on the suitability map. They can be used to obtain more detailed information on limitations and the occurrence of intermediate classes through the consultation of the suitability tables.

By using Land Unit maps and the Tables in Appendix II users can easily prepare their own suitability maps for any of the crops or other LUTs for which suitability ratings have been prepared.

CHAPTER 6

THE LAND RESOURCES DATA BASE (LRDB)

All relevant information on each of the land units is stored in a computerized data base. The LRDB is a programme developed by the Project from dBase III PLUS software. The programme gives several possibilities for the manipulation of the data. Detailed information is given in the LRDB Manual (Eschweiler et al., 1991). The programme is run on an IBM-XT compatible micro computer with a hard disk. The contents of the database and its most important functions are described below.

(1) information stored in LRDB.

The following information is given for each individual land unit:

- general information:

  area (ha)
  distribution (according to Administrative Districts)
  distribution (according to agro-ecological zones)
  present land use and vegetation
  landform
  dominant slope class
  altitude range (m above sea level)
  present erosion
  frequency of flooding
  frequency of ponding

- information on soils:

  parent material
  description (narrative)
  classification
  effective depth and depth limiting factor
  colour subsoil
  surface stoniness and rockiness
  particle size topsoil (0-30 cm)
  particle size subsoil (30-100 cm)
  rock and mineral fragments in the profile
  drainage class
  reaction (pH) upper 50 cm
  salinity
  cation exchange capacity (0-50 cm)
  total nitrogen (0-50 cm)
  available phosphorus (0-50 cm)
  exchangeable potassium (0-50 cm)

- information on agro-climate

  Length of Growing Period (LGP) in days
  Quality if moisture supply (P/PET ratio during growing period)

Mean annual precipitation (P-an)
Mean number of dry months per year (DM)
Mean annual temperature (T-an)
Mean temperature during growing period (T-GP)
Mean temperature during the last 120 days of the LGP (T-EGP)

(2) LRDB and the Automated Land Evaluation System (ALES)

All information needed for ALES (Rossiter et al, 1988) is stored in LRDB and can be transferred automatically via an interface.

(3) printed descriptions of land units and other reports

LRDB can make printed descriptions of:

- land units; elaborate description such as given in Appendix I.
- land units; brief descriptions only
- agro-climatic zones
- soil units; brief descriptions.
- soil mapping units
- land mapping units
- distribution of soil units
- land use and vegetation of soil units
- land suitability classes and severity level tables
- suitability summaries of each suitability class
- area totals of soil groups, slope classes and agro-climatic zones
- dictionaries which list the definitions used in the coding systems

CHAPTER 7

THE AGRICULTURAL POTENTIAL OF LILONGWE ADD

7.1 GENERAL LAND APPRAISAL FOR RAINFED CULTIVATION

The area of land available for rainfed cultivation is given in Table 31. Four categories of suitability are used and their distribution is shown in Figure 4. The assessment is carried out for a situation in which improved traditional farming practices are applied. Improvements include the use of fertilizer or manure, improved seeds, timely planting and weeding, and the introduction of soil conservation measures (See Chapter 5.1.2).

Approximately 57 percent (671,200 ha) of the total land area of Lilongwe ADD is classified as good quality land. Such land is found on the Lilongwe Plains, in the Dedza Uplands and to a lesser extent in the Ntcheu Foothills and on the Balaka Plain. Almost all good quality land is cultivated except land occupied by the Dzalanyama Ranch and some parts of the Upper Dedza Escarpment and Balaka Plain. Scope for expansion of cultivated land is very limited, leaving improved management and intensification of land use as the main opportunities for increasing production.

Approximately 12 percent (136,200 ha) of the total land area of Lilongwe ADD is classified as moderate quality land. This category of land occurs in the Dzalanyama Range, Dedza Hills, Ntcheu Uplands, Ntcheu Escarpment and the Kirk Range. Limitations to crop performance are low nutrient retention capacity, erosion hazard, temperature (either too high or too low, depending on the crop and the area) and impeded drainage. Most of these areas are cultivated except the Dzalanyama Range (Forest Reserve) and some parts of the Kirk Range (montane grassland).

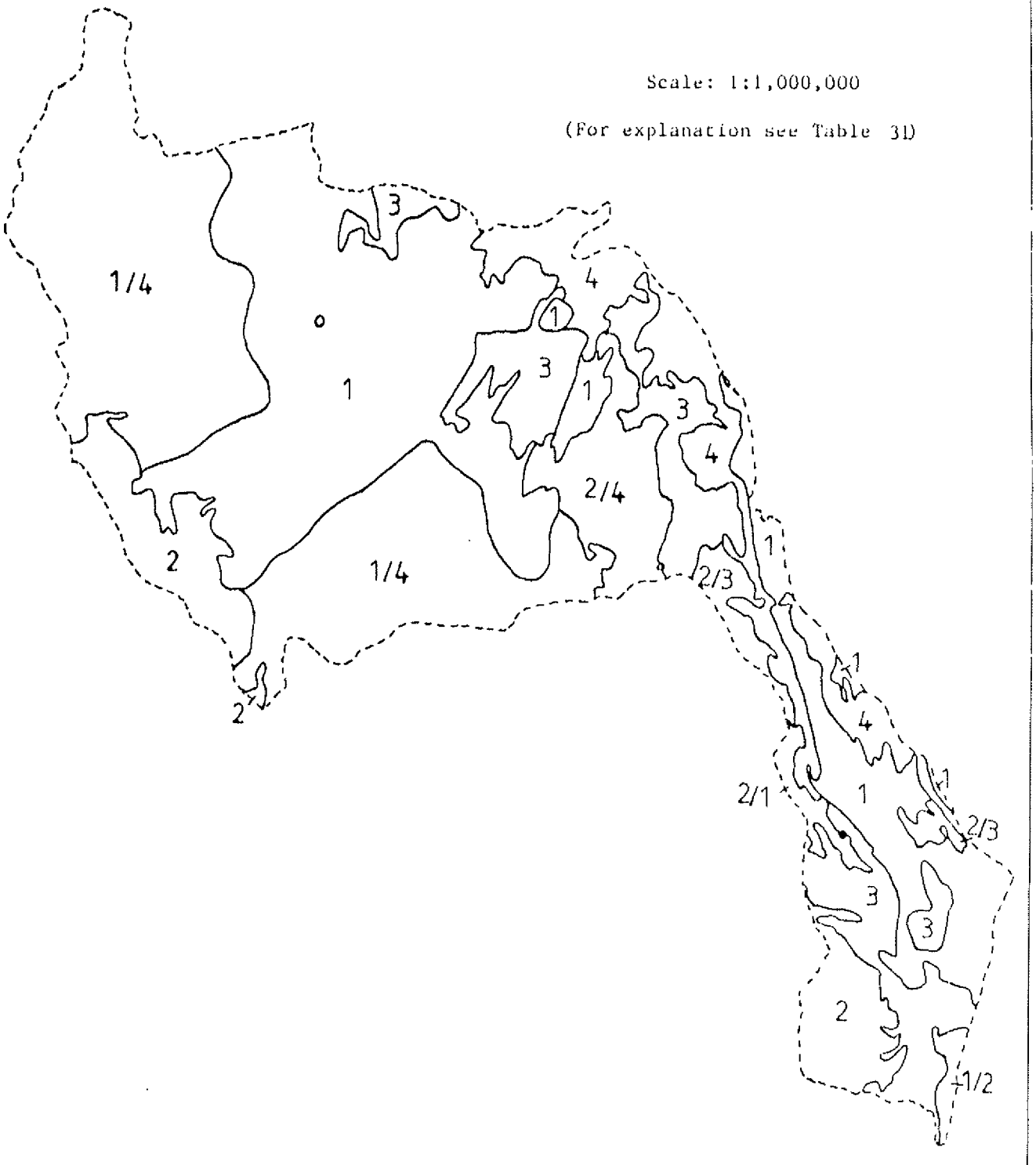
TABLE 31. GENERALIZED LAND APPRAISAL FOR RAINFED AGRICULTURE, LILONGWE ADD

CLASS	DESCRIPTION	DEFINITION IN TERMS OF LAND SUITABILITY FOR RAINFED CROPS UNDER IMPROVED TRADITIONAL MANAGEMENT	AREA	
			ha	%
1	Good quality land	S1, S1/2 or S2 for 8 or more crops	671,200	57
2	Moderate quality land	S1, S1/2 or S2 for 1 to 7 crops	136,200	12
3	Marginal land	S3 or S3/N for 1 or more crops; S1, S1/2 and S2 do not occur	179,300	15
4	Unsuitable land	N for all crops	185,100	16
	Total		1,171,800	100

FIGURE 4. GENERALIZED LAND APPRAISAL FOR RAINFED AGRICULTURE UNDER IMPROVED TRADITIONAL MANAGEMENT, LILONGWE ADD.

Scale: 1:1,000,000

(For explanation see Table 31)



Approximately 15 percent (179,300 ha) of the total land area of Lilongwe ADD is classified as marginal land. Marginal land covers parts of the Dedza Hills, Deza Uplands, Upper Dedza Escarpment, Ntcheu Escarpment and the southern part of the Ntcheu Foothills. Limitations to crop cultivation are severe and include poor rooting conditions, erosion hazard, moisture deficit and high or low temperatures. Quite a lot of the marginal land is cultivated in the Dedza Uplands, Dedza Hills and Ntcheu Escarpment. The other areas are mainly under natural woodland or grassland and/or cultivated at low densities. Marginal land is best used for forestry or extensive grazing.

Approximately 16 percent (185,100 ha) of the total land area of Lilongwe ADD is classified as unsuitable land. Unsuitable land is found extensively in the escarpment zones (both Upper and Lower Dedza Escarpment) and in the South Dowa Hills. To a lesser extent it occurs on the West and South Lilongwe Plain (LP3) where dambos take up a considerable proportion of land which is unsuitable for rainfed cropping. Limitations to crop growth are either erosion hazard and shallow soils or poor drainage and flooding. Cultivation on unsuitable land occurs on a large scale in the Upper Dedza escarpment near Dedza and Ntcheu. Apart from this area, most of the unsuitable land is not being cultivated at present.

Water erosion is widespread in Lilongwe ADD on agricultural land and to a lesser extent on land under natural vegetation. Present erosion is slight to moderate on gentle slopes and moderate to sometimes severe on steep land, depending on soil type, length of slope, etc. On tobacco estates erosion is in general a serious problem at present. Some of the steep land with high erosion hazard is reserved and therefore to some extent protected against degradation (See Chapter 4.9.1). However, annual burning eliminates ground cover and accelerated erosion takes place in most of the indigenous woodland.

7.2 LAND SUITABILITY COMPARED WITH PRESENT LAND USE

7.2.1 Cereals

- Maize. Most land in the ADD (around 66 percent) is used primarily for the cultivation of maize in combination with other crops like pulses, tobacco, groundnuts and sometimes Irish potato and wheat at higher altitudes, and cotton in low lying areas. Cultivation of maize is often done with the use of fertilizer (see Chapter 4.2.2.) but without soil conservation measures. Most farmers grow maize even if their land is marginally suitable or not suitable. Average yields are about 1.1 tons/ha for local maize and are likely to decline even further if no improvements are introduced. About 63 percent of Lilongwe ADD is moderately suitable for maize (see Section 5.2.4.1.), where yields of up to 2 tons/ha (local varieties) or over 3 tons/ha (hybrids) can be obtained under improved management. Increased yields can be achieved by the improvement of cultivation and management practices, including early planting, rationalization of fertilizer use, wider use of improved varieties, better weeding etc. High yields can be sustained if adequate soil conservation measures are taken on sloping land.

- Sorghum. Very little sorghum is grown in the ADD (only farmers in Thiwi/Lifidzi RDP and parts of Dedza Hills and Ntcheu RDPs grow a mixture of maize, millet and sorghum) in spite of the fact that 49 percent of the ADD is highly suitable and 10 percent moderately suitable.

- Finger millet. Finger millet is not widely grown in the ADD. Actual and potential yields are low.

- Rice. Rice is not grown in the ADD, but could be and should be encouraged in the few suitable areas indicated in the suitability matrix.

- Wheat. Wheat is grown to a limited extent at the higher altitudes in Ntcheu RDP at the end of the rainy season and on the Lilongwe Plains as an irrigated crop in the cool, dry season. Ten percent of the ADD is moderately suitable for rainfed wheat under improved management and the unused potential therefore is significant.

7.2.2 Legumes

Legumes are grown both in pure stands and mixed stands with maize. With the increase of cultivation of hybrid maize in pure stands, legumes will also increasingly be grown in pure stands. About 60 percent of the ADD is moderately or highly suitable for legumes, and given the potential for yield increase, their essential contribution to the diet and their generally beneficial effect on soil fertility, the cultivation of legumes should be further encouraged.

7.2.3 Roots and tubers

- Cassava. A significant amount of cassava was grown in Thiwi/Lifidzi RDP, but the production has declined in the last few years for reasons unknown. Cassava is also grown in very small quantities in other parts of the ADD, but nowhere are the physical conditions good enough for cassava to reach its potential. However, even if it reaches only a quarter of its potential, it makes a significant contribution to the local diet in times when other food is scarce.

- Irish potato. Potatoes are grown in Dedza and Ntcheu RDPs. Eleven percent of the ADD is moderately suitable, where crop yields of over 10 tons/ha could be reached under improved traditional management.

7.2.4 Tree crops

- Citrus. Citrus is grown throughout the ADD. Only three percent of the ADD is moderately suitable for citrus growing, with almost three-quarters being marginally suitable.

- Coffee. Coffee is at present grown in Bembeke EPA in Dedza Hills RDP. Yields can be increased considerably by improved management. Fifty percent of the ADD is marginally suitable for coffee and the remainder unsuitable. Cultivation of coffee should therefore only be practised in especially favourable sites.

7.2.5 Cash crops

- Cotton. Cotton is grown in the relatively hot Manjawila EPA. The suitability of the ADD as a whole for this crop is low - 66 percent is marginally suitable and only three percent is moderately suitable.

- Sunflower and soya beans. Of the non-traditional crops assessed, sunflower and soya bean show much promise. Soya beans have the same suitability as other legumes mentioned above. About 43 percent of the land area of the ADD is highly suitable for sunflower and another 21 percent is moderately suitable, making it, together with groundnuts long cycle variety, one of the best suited crops for the ADD.

- Tobacco. Tobacco of different types is grown throughout the ADD both on smallholdings and on estates. Given that about 66 percent of the ADD is moderately suitable for tobacco there is considerable scope for expansion, but at the expense of maize. However, both fire-cured and flue-cured tobacco consume large amounts of firewood for curing and shortage of firewood is already a very serious problem.

7.2.6 Dimba cultivation

Although dimba cultivation only takes up a small part of the land, it produces valuable vegetables and fruits throughout the year. Because of the scale of the survey, areas suitable for dimba cultivation could not be identified, but undoubtedly this type of land use could be expanded.

7.2.7 Grazing

Livestock are concentrated on dambo land throughout most of the year and these areas are generally overgrazed and degraded - often with a gully forming the central watercourse. There is considerable scope for the introduction of controlled grazing schemes, but already livestock numbers exceed the carrying capacity of the land.

7.2.8 Forestry

A small part of the ADD has been designated as Forest Reserves. Most of these areas are not suitable for crop cultivation as they are steep and potentially highly erodible, except for the Dzalanyama Ranch. The natural vegetation in these areas largely protects the land against erosion and forestry is no doubt the best sustainable use. Elsewhere in the ADD, trees are being cut at an alarming rate and planting does not keep pace with tree cutting. Most of the ADD is highly or moderately suitable for a variety of tree species, and the afforestation of hills and important catchments and selective tree planting in cultivated areas is recommended.

7.2.9 National Parks and Game Reserves

Apart from the Lilongwe Nature Sanctuary there are no areas in the ADD specifically set aside for wildlife protection. Dzalanyama, Tuma and Dedza Escarpment Forest Reserves in particular should be given special protection to preserve what wildlife remains and so diversify their potential use.

7.3 SUMMARY OF LAND SUITABILITY IN EXTENSION PLANNING AREAS

Land suitability is described for each EPA individually. The agro-ecological zones as defined in Chapter 3 are used as a basis to summarize the land suitability of the land units. Maps and tables are presented for each EPA to show the correlation between agro-ecological zones and main land units. The land suitability of all land units is presented in full detail in Appendix II.

The terms "highly suitable", "moderately suitable", "marginally suitable" and "not suitable" are used to describe land suitability. Land having intermediate suitability, such as S1/2, S2/3 or S3/N, is combined with land having the nearest higher suitability, for example "moderately suitable" includes both S2 and S2/3 class land.

7.3.1 Lilongwe RDP

Lilongwe RDP (Figure 5) is situated in the western part of the ADD and covers an area of 323,000 ha. The RDP has ten EPAs: LL2 (Thiwi EPA) in the centre, LL3 (Thawale EPA) and LL4 (Malingunde EPA) in the south, LL5 (Ukwe EPA), LL6 (Mngwangwa EPA) and LL7 (Chilaza EPA) in the centre, LL8 (Ming'ongo EPA) in the south-west, LL9 (Mwala EPA) and LL10 (Kasiya EPA) in the north, and LL12 (Mlomba EPA) in the south-east. Project offices are in Lilongwe. Within the RDP five agro-ecological zones are distinguished: North-east Lilongwe Plain (LP1), Central Lilongwe Plain (LP2), West and South Lilongwe Plain (LP3), South and West Kasungu Plain (KP7), and the Upper Bua Plain (UB1).

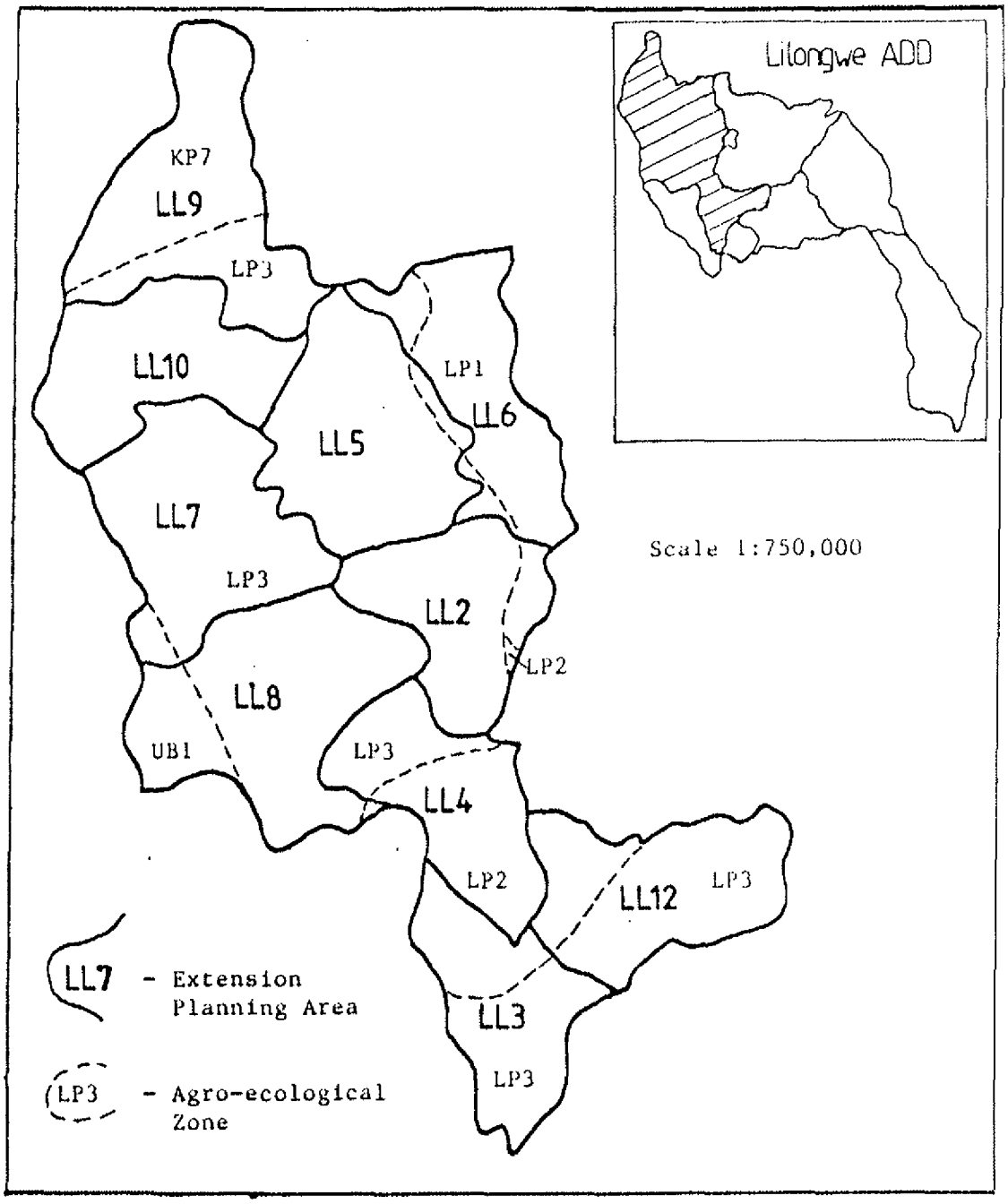
7.3.1.1 LL2 - Thiwi EPA

Thiwi EPA is situated west of Lilongwe City and has a total area of 26,000 ha. The EPA centre is in Thiwi. Three agro-ecological zones can be distinguished: West and South Lilongwe Plain (LP3) which takes up the major part of the EPA, Central Lilongwe Plain (LP1) in the east and a minor part of the Central Lilongwe Plain (LP2) also in the east. Most important soil families are Mpili for upland soils and Tenthema in dambos.

- Suitability for rainfed cultivation under improved traditional management

The West and South Lilongwe Plain (LP3) is highly suitable for groundnuts-L, sorghum and sunflower, moderately suitable for maize, tobacco, cowpea, phaseolus beans, pigeon pea, soya beans and groundnuts-S. The only limiting factors are temperature regime for some crops and low nutrient retention capacity. The overall suitability in the Central Lilongwe Plain (LP2) and in the north of the West and South Lilongwe Plain (LP3) is slightly lower because of a shorter growing period; 135-150 days instead of 150-165 days in the major part of the EPA. Drought resistant sorghum remains highly suitable and all long cycle varieties and perennials become marginally suitable (or not suitable in the case of coffee).

FIGURE 5. EPAs AND AGRO-ECOLOGICAL ZONES, LILONGWE RDP.
The main land units of each agro-ecological zone (AEZ) are presented in tables.



LL2 - THIWI EPA		
AEZ	LP3	LP1
MAIN LAND UNITS	320 1311 1307 1316 1268	1316 1307 1311

LL3 - THANGALE EPA		
AEZ	LP3	LP2
MAIN LAND UNITS	1312 1301 1305 369 1269 1390	369 1301

LL4 - MALINGUNDU EPA		
AEZ	LP2	LP3
MAIN LAND UNITS	369 1301 319	320 1311 369 1268

LL5 - UENE EPA	
AEZ	LP3
MAIN LAND UNITS	320 1309 1299 1268 1311

LL6 - MKUKAMUWA EPA		
AEZ	LP1	LP3
MAIN LAND UNITS	1307 1317 1309 1298 1303	320 1307 1311 1299 1303 1268

Continued on next page

FIGURE 5. EPAs AND AGRO-ECOLOGICAL ZONES, LILONGWE RDP (Cont'd)

LL7 - CHILAZA EPA		
AEZ	LP3	UB1
MAIN LAND UNITS	320 1311 1268	324 371

LL8 - MING'OMGO EPA		
AEZ	LP3	UB1
MAIN LAND UNITS	1311 320 1392 1268 1311 369	371 324 1327 1275 1268

LL9 - MKALA EPA		
AEZ	KP7	LP3
MAIN LAND UNITS	1299 1257 1266 1309 R	1299 1311 320 1268 1266

LL10 - LASIYA EPA	
AEZ	LP3
MAIN LAND UNITS	320 1311 1268 1258 1299

LL12 - MLOMBA EPA		
AEZ	LP3	LP2
MAIN LAND UNITS	1301 369 1312 1269	369 319

- Suitability for forestry

The West and South Lilongwe Plain (LP3) and the North-east Lilongwe Plain (LP1) are almost entirely highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, and moderately suitable for all tree species considered in the evaluation except for Pinus patula. Only the north of the two zones has a different suitability: highly suitable for Azadirachta indica, moderately suitable for Acacia albida, Callitris hugellii, Cassia siamea, Cordyla africana, Eucalyptus camaldulensis, E. tereticornis, Gmelina arborea, Melia azedarach and Pinus kesiya, and marginally suitable for all other trees considered for evaluation.

7.3.1.2 LL3 - Thawale EPA

Thawale EPA is situated in the southern part of the RDP bordering the Dzalanyama Ranch in south, east and west and has a total area of 25,750 ha. The EPA centre is in Thawale. Two agro-ecological zones can be distinguished: West and South Lilongwe Plain (LP3) in the south, and Central Lilongwe Plain (LP2) in the north. Most important soil families are Mpili and Euthini for the upland soils and Tenthema in dambos.

- Suitability for rainfed cultivation under improved traditional management

The whole EPA is highly suitable for the cultivation of groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, pulses (including phaseolus bean and soya beans) and groundnuts-S. The main limitations are temperature regime, low nutrient retention capacity and moisture stress. Only the south-western part of the EPA bordering the Dzalanyama Ranch has a lower overall suitability due to coarser textured soils with very low nutrient retention capacity. The highly suitable crops become moderately suitable in this area. However, citrus becomes moderately suitable in this same area, due to higher rainfall and a lower number of dry months.

- Suitability for forestry

The major parts of the West and South Lilongwe Plain (LP3) are highly suitable for Gmelina arborea, moderately suitable for Azadirachta indica, Callitris calcarata, all three Eucalyptus species, Melia azedarach, Pinus caribaea and P. kesiya. All other species considered are marginally suitable. The western part of the West and South Lilongwe Plain (LP3) near the Dzalanyama Ranch has the same suitability except for Pinus kesiya, which is highly suitable and for Pinus patula, which is moderately suitable. The Central Lilongwe Plain (LP2) is mainly highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, marginally suitable for Pinus patula and moderately suitable for all other trees considered for evaluation.

7.3.1.3 LL4 - Malingunde EPA

Malingunde EPA is also situated in the southern part of the RDP and has a total area of 27,100 ha. The EPA centre is in Malingunde. Two agro-ecological zones can be distinguished: Central Lilongwe Plain (LP2) covering the southern part of the EPA, and West and South Lilongwe Plain (LP3) in the north. Most important soil families are Mpili for upland soils and Tenthema in dambos.

- Suitability for rainfed cultivation under improved traditional management

Both the Central Lilongwe Plain (LP2) and the West and South Lilongwe Plain (LP3) are highly suitable for groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, pulses (including phaseolus beans and soya beans) and groundnuts-S. The main limitations to cultivation are temperature regime, low nutrient retention capacity and moisture deficit.

- Suitability for forestry

The northern part of the Central Lilongwe Plain (LP2) and the whole of the West and South Lilongwe Plain (LP3) are highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, and moderately suitable for all other trees considered in the evaluation except for Pinus patula. The southern part of the Central Lilongwe Plain (LP2) has a different suitability due to cooler temperatures: highly suitable for Gmelina arborea, moderately suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, and marginally suitable for Acacia albida, Callitris hugellii, Cassia siamea and Cordyla africana. All other suitabilities are the same as in other parts of the EPA.

7.3.1.4 LL5 - Ukwe EPA

Ukwe EPA is situated in the central-northern part of Lilongwe RDP and covers an area of 36,650 ha. The EPA centre is in Ukwe. Two agro-ecological zones are distinguished: West and South Lilongwe Plain (LP3), which occupies about 98 percent of the EPA, and North-east Lilongwe

Plain (LP1) in the east. Most important soil families are Mpili for upland soils and Tenthema in dambos.

- Suitability for rainfed cultivation under improved traditional management

The West and South Lilongwe Plain (LP3), and therefore virtually the whole EPA, is highly suitable for Groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, pulses and groundnuts-S.

- Suitability for forestry

The West and South Lilongwe Plain (LP3) is highly suitable for Azadirachta indica, marginally suitable for Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula. All other tree species considered are moderately suitable. The northern part of the EPA, with a slightly lower number of dry months per year, is highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, moderately suitable for Azadirachta indica, Callitris calcarata, Eucalyptus grandis and Pinus caribaea. All other suitabilities are the same as for the southern part.

7.3.1.5 LL6 - Mngwangwa EPA

Mngwangwa EPA is situated in the north eastern part of the RDP and covers an area of 27,700 ha. Two agro-ecological zones are distinguished: North-east Lilongwe Plain (LP1) covering the whole of the EPA except for the north-western and south-western part where AEZ West and South Lilongwe Plain (LP3) can be found. The most important soil family is Mpili.

- Suitability for rainfed cultivation under improved traditional management

The North-east Lilongwe Plain (LP1) is highly suitable for sorghum and sunflower and moderately suitable for maize-S, tobacco, groundnuts, cowpea, pigeon pea, phaseolus bean-S and soya beans. The West and South Lilongwe Plain (LP3) has a longer growing period and is therefore more suitable for long cycle varieties: highly suitable for groundnuts-L and moderately suitable for maize-L and phaseolus beans-L. Other suitabilities are as described for the North-east Lilongwe Plain.

- Suitability for forestry

The North-east Lilongwe Plain (LP1) is highly suitable for Azadirachta indica, marginally suitable for Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for all other species considered for evaluation. The north-eastern part of the EPA has a slightly lower suitability due to lower temperatures: moderately suitable for Azadirachta indica and marginally suitable for Acacia albida, Callitris hugellii, Cassia siamea and Cordyla africana. All other suitabilities are as described above.

7.3.1.6 LL7 - Chilaza EPA

Chilaza EPA is situated in the west of the RDP and has a total area of 38,600 ha. The EPA centre is in Chilaza. Two agro-ecological zones can be distinguished: West and South Lilongwe Plain (LP3) which takes up the major part of the EPA, and a minor part of the Upper Bua Plain (UB1) in the south. Most important soil families are Mpili for upland soils and Tenthema in dambos.

- Suitability for rainfed cultivation under improved traditional management

The whole EPA is highly suitable for groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, groundnuts-S and pulses. The UB1 zone has a longer growing period, which results in land being highly suitable for phaseolus beans-L. All other suitabilities are the same as above. The main limitations are temperature regime, low nutrient retention capacity and moisture deficit.

- Suitability for forestry

Both the West and South Lilongwe Plain (LP3) and the Upper Bua Plain (UB1) are highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, marginally suitable for Pinus patula, and moderately suitable for all other trees considered.

7.3.1.7 LL8 - Ming'ongo EPA

Ming'ongo EPA is situated in the central western part of the RDP bordering the Dzalanyama Ranch in the south, and has a total area of 43,200 ha. The EPA centre is in Ming'ongo. Three agro-ecological zones can be distinguished: West and South Lilongwe Plain (LP3) in the major part of the EPA, Upper Bua Plain (UB1) in the west and a very small part of Central Lilongwe Plain (LP2) in the south-east. Most important soil families are Mpili and Euthini for the upland soils and Tenthema in dambos.

- Suitability for rainfed cultivation under improved traditional management

The West and South Lilongwe Plain (LP3) is highly suitable for groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, groundnuts-S and pulses. Only a small part in the south near the Dzalanyama Range has soils with a very low nutrient retention capacity and is therefore not highly suitable but moderately suitable for groundnuts-L, sorghum and sunflower. The Upper Bua Plain (UB1) has to a large extent the same suitabilities as the major part of the West and South Lilongwe Plain (LP3) except for phaseolus beans-L, for which it is highly suitable due to a longer growing period. The south-eastern part of the Upper Bua Plain (UB1) has different agro-climatic features (lower temperature and shorter dry period) and is moderately suitable for maize-L, tobacco, groundnuts-L, phaseolus bean-L, sunflower, Irish potato and wheat.

- Suitability for forestry

Except for the southern part of the Upper Bua Plain (UB1), both the West and South Lilongwe Plain (LP3) and the Upper Bua Plain (UB1) are highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, marginally suitable for Pinus patula, and moderately suitable for all other tree species considered. The southern part of the Upper Bua Plain (UB1), bordering the Dzalanyama Range, has lower temperatures. It is highly suitable for Gmelina arborea, marginally suitable for Acacia albida, Callitris hugellii, Cassia siamea, Cordyla africana and Pinus patula, and moderately suitable for all other trees considered.

7.3.1.8 LL9 - Mwala EPA

Mwala EPA is situated in the northern part of the RDP and has a total area of 37,150 ha. The EPA centre is in Mwala. Two agro-ecological zones can be distinguished: South and West Kasungu Plain (KP7) covering the northern part of the EPA, and West and South Lilongwe Plain (LP3) in the south. Most important soil families are Mpili for upland soils, Tenthema in dambos and Namitalala in the Bua floodplain.

- Suitability for rainfed cultivation under improved traditional management

The South and West Kasungu Plain (KP7) and the West and South Lilongwe Plain (LP3) have almost the same suitability: highly suitable for groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, groundnuts-S and pulses.

- Suitability for forestry

As for rainfed crops, the South and West Kasungu Plain (KP7) and the West and South Lilongwe Plain (LP3) have almost the same suitability for forestry species: highly suitable for Azadirachta indica, marginally suitable for Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and not suitable for the other species considered for evaluation. The south-eastern part of the West and South Lilongwe Plain (LP3) is highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, marginally suitable for Pinus patula, and moderately suitable for all other species considered.

7.3.1.9 LL10 - Kasiya EPA

Kasiya EPA is situated in the northern part of Lilongwe RDP and covers an area of 29,600 ha. The EPA centre is in Kasiya. Only one agro-ecological zone is distinguished: West and South Lilongwe Plain (LP3). Most important soil families are Mpili for upland soils, Tenthema in dambos and Namitalala in the Bua floodplain.

- Suitability for rainfed cultivation under improved traditional management

The whole EPA is highly suitable for groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, groundnuts-S and pulses. The main limitations are temperature regime, low nutrient retention capacity and moisture stress.

- Suitability for forestry

The West and South Lilongwe Plain (LP3) is highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, marginally suitable for Pinus patula, and moderately suitable for all other trees considered.

7.3.1.10 LL12 - Mlomba EPA

Mlomba EPA is situated in the south eastern part of the RDP and covers an area of 31,300 ha. Two agro-ecological zones are distinguished: West and South Lilongwe Plain (LP3) in the central and eastern part of the EPA and Central Lilongwe Plain (LP2) in the west. Most important soil families are Mpili for upland soils and Tenthema in dambos.

- Suitability for rainfed cultivation under improved traditional management

The whole EPA is highly suitable for the cultivation of groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, pulses (including phaseolus bean and soya beans) and groundnuts-S. The main limitations are temperature regime, low nutrient retention capacity and moisture stress.

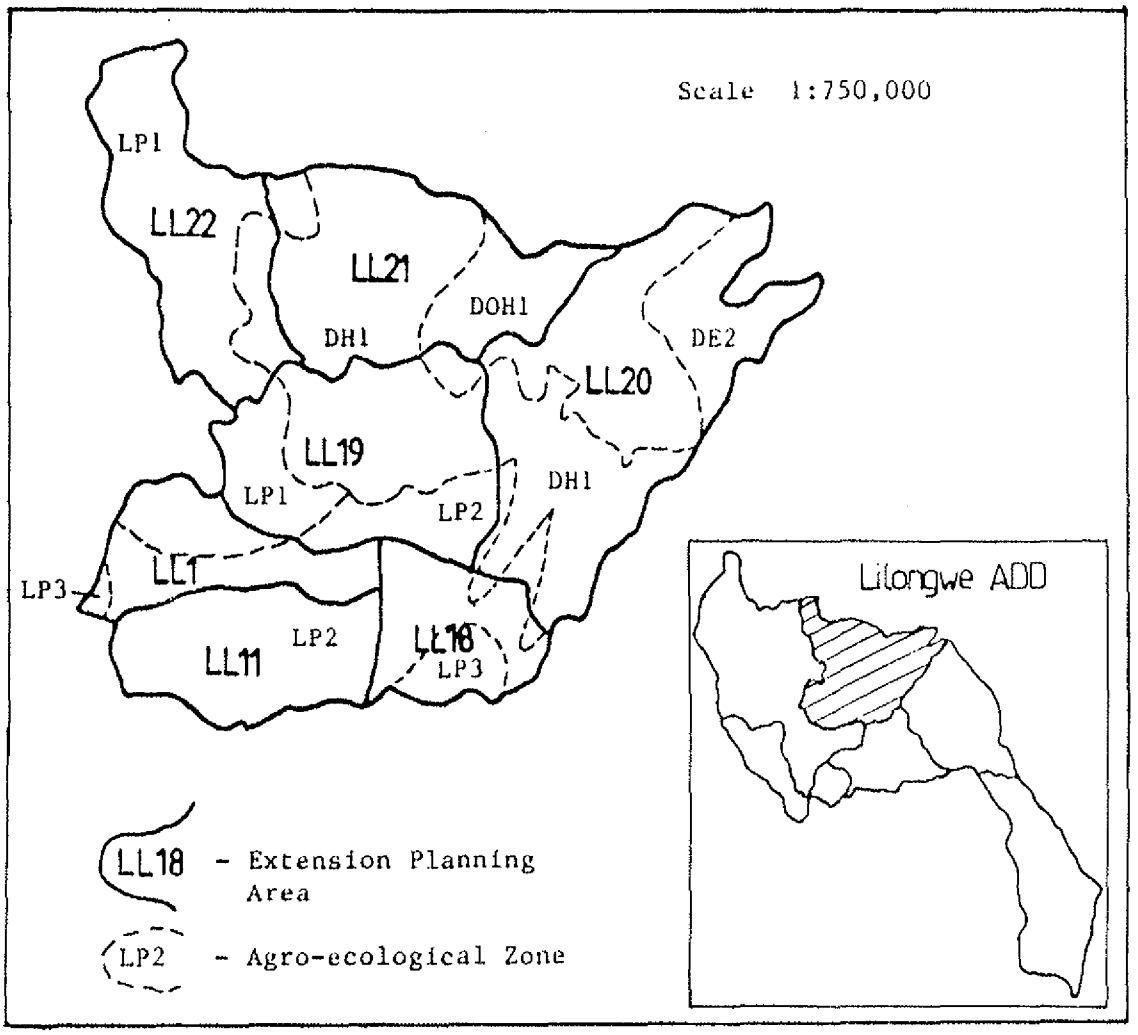
- Suitability for forestry

The West and South Lilongwe Plain (LP3) is highly suitable for Gmelina arborea and moderately suitable for Azadirachta indica, Callitris calcarata, all three Eucalyptus species, Melia azedarach, Pinus caribaea and P. kesiya. All other species considered are marginally suitable. The Central Lilongwe Plain (LP2) is highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, marginally suitable for Pinus patula and moderately suitable for all other trees considered for evaluation.

7.3.2 Lilongwe North East RDP

Lilongwe N East RDP (Figure 6) is situated in the central northern part of the ADD and covers an area of 219,500 ha. The RDP has seven EPAs: LL1 (Chitsime EPA) in the south west, LL11 (Nakachoka EPA) in the south, LL18 (Nyanja EPA) in the south-east, LL19 (Mkuza EPA) in the center, LL20 (Chitekwele EPA) in the east, LL21 (Chiwamba EPA) in the north, and LL22 (Chigonthi EPA) in the north-west. Project offices are in Nkhoma. Within the RDP six agro-ecological zones are distinguished: North-east Lilongwe

FIGURE 6. EPAs AND AGRO-ECOLOGICAL ZONES, LILONGWE N.EAST RDP.
The main land units of each agro-ecological zone (AEZ) are presented in tables.



LL1 - CHITSIME EPA			
AEZ	LP1	LP2	LP3
MAIN LAND UNITS	1316 1302 1311	369 1311 1332	320

LL11 - MAKACHOKA EPA		
AEZ	LP2	
MAIN LAND UNITS	369 1311 319 1265	

LL18 - NYANJA EPA			
AEZ	LP2	LP3	DH1
MAIN LAND UNITS	1311 1310 1312 1269	1301 1312 1269	1331 1322

LL19 - MKUZA EPA				
AEZ	DH1	LP1	LP2	DOH1
MAIN LAND UNITS	1321 1337 1281 1288	1311 1307 1316	1311 1310	1347 1321

LL20 - CHITEMELE EPA				
AEZ	DOH1	DH1	DE2	LP2
MAIN LAND UNITS	1347 1374 1348 1346 1365 1288	1331 1321 1347 1322 R 1348	1377 1373 1374 1346	1310

LL21 - CHIWAMBA EPA			
AEZ	DH1	DOH1	LP1
MAIN LAND UNITS	1321 1358 1357 1347	1347 1321 1365 1374	1310 1300

LL22 - CHIGONTHI EPA		
AEZ	LP1	DH1
MAIN LAND UNITS	1307 1317 1303 1310 1271	1321 1358

Plain (LP1), Central Lilongwe Plain (LP2), West and South Lilongwe Plain (LP3), Dedza Uplands (DH1), South Dowa Hills (DOH1), and Upper Dedza Escarpment (DE2).

7.3.2.1 LL1 - Chitsime EPA

Chitsime EPA is situated in the south-western part of the RDP and has a total area of 18,300 ha. Three agro-ecological zones can be distinguished: North-east Lilongwe Plain (LP1) in the north, Central Lilongwe Plain (LP2) in the south, and a small part of the West and South Lilongwe Plain (LP3) in the south-west. The most important soil family is Mpili.

- Suitability for rainfed cultivation under improved traditional management

The Central Lilongwe Plain (LP2) is mainly highly suitable for the cultivation of groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, pulses (including phaseolus bean and soya beans) and groundnuts-S. The main limitations are temperature regime, low nutrient retention capacity and moisture deficit. The North-east Lilongwe Plain (LP1) has a shorter growing period (135-150 days) and is therefore less suitable for long cycle varieties: moderately suitable for groundnuts-L and marginally suitable for maize-L and phaseolus bean-L.

- Suitability for forestry

Both the North-east Lilongwe Plain (LP1) and the Central Lilongwe Plain (LP2) are highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, marginally suitable for Pinus patula, and moderately suitable for all other tree species considered.

7.3.2.2 LL11 - Nakachoka EPA

Nakachoka EPA is situated in the southern part of the RDP and has a total area of 22,350 ha. The EPA centre is in Nakachoka. Only one agro-ecological zone is distinguished: Central Lilongwe Plain (LP2). The most important soil family is Mpili.

- Suitability for rainfed cultivation under improved traditional management

The Central Lilongwe Plain (LP2), and therefore the whole EPA, is highly suitable for the cultivation of groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, pulses (including phaseolus bean and soya beans) and groundnuts-S. The main limitations are temperature regime, low nutrient retention capacity and moisture stress.

- Suitability for forestry

The Central Lilongwe Plain (LP2) is highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, marginally suitable for Pinus patula, and moderately suitable for all other tree species considered.

7.3.2.3 LL18 - Nyanja EPA

Nyanja EPA is situated in the south-eastern part of the RDP and has a total area of 16,050 ha. The EPA centre is in Nyanja. Three agro-ecological zones are distinguished: Central Lilongwe Plain (LP2) in the major part of the EPA, West and South Lilongwe Plain (LP3) in the south, and small parts of the Dedza Uplands (DH1) in the north-west. The most important soil family is Mpili.

- Suitability for rainfed cultivation under improved traditional management

The western and central part of the Central Lilongwe Plain (LP2) and the whole of West and South Lilongwe Plain (LP3) are highly suitable for groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, groundnuts-S and pulses. The Dedza Uplands (DH1) are either marginally suitable for all crops except cassava-S, citrus and coffee for which they are not suitable, due to poor rooting conditions on shallow soils, or have the same suitabilities as the eastern part of the Central Lilongwe Plain (LP2), except for groundnuts-L and sunflower, for which they are moderately suitable due to a low pH.

- Suitability for forestry

The western part of the Central Lilongwe Plain (LP2) is highly suitable for Eucalyptus camaldulensis, E. tereticornis, and Melia azedarach, marginally suitable for Pinus patula, and moderately suitable for all other trees considered. The eastern part is, due to a longer dry period and lower temperatures, highly suitable for none of the species, moderately suitable for Azadirachta indica, Eucalyptus camaldulensis, E. tereticornis, Gmelina arborea, Melia azedarach and Pinus kesiya, and marginally suitable for the other species considered. The central part has intermediate suitabilities: highly suitable for Gmelina arborea, marginally suitable for Acacia albida, Callitris hugellii, Cassia siamea, Cordyla africana and Pinus patula, and moderately suitable for the other species. The West and South Lilongwe Plain (LP3) has the same suitability as the central part of the Central Lilongwe Plain (LP2). The Dedza Uplands (DH1) are moderately suitable for Azadirachta indica, Eucalyptus camaldulensis, E. tereticornis, Gmelina arborea, Melia azedarach and Pinus kesiya, and marginally suitable for the other trees considered (e.g. the same suitability as the eastern part of the Central Lilongwe Plain).

7.3.2.4 LL19 - Mkuza EPA

Mkuza EPA is situated in the central part of the RDP, east of Lilongwe City and has a total area of 35,850 ha. The EPA centre is in Mkuza. Four agro-ecological zones are distinguished: Dedza Uplands (DH1) in the center and north, Central Lilongwe Plain (LP2) in the south-east, North-east Lilongwe Plain (LP1) in the south-west, and South Dowa Hills (DOH1) in the extreme north-east. Most important soil families are Neno and Mpili.

- Suitability for rainfed cultivation under improved traditional management

The Dedza Uplands (DH1) are highly suitable for sorghum and moderately suitable for maize, tobacco, groundnuts, pulses and sunflower. The south-eastern part of Dedza Uplands (DH1), which has soils with a higher pH but is more sensitive to erosion due to steeper slopes, has a higher suitability for groundnuts-L (highly suitable) and a lower suitability for sorghum (moderately suitable). The colluvial soils of the depressions in this area are moderately suitable for sorghum and soya beans. The eastern part of the North-east Lilongwe Plain (LP1) is highly suitable for groundnuts-L, sorghum and soya beans and moderately suitable for maize, tobacco, groundnuts-S and pulses. The north-western part has a shorter growing period and a longer dry period and is therefore less suitable for groundnuts-L and tobacco (moderately suitable), maize-L, phaseolus bean-L and citrus (marginally suitable). The south-western part of the North-east Lilongwe Plain (LP1) has the same agro-climatic characteristics as the north-western part except for the dry period which is shorter. The Central Lilongwe Plain (LP2) has the same suitabilities as the eastern part of the North-east Lilongwe Plain (LP1) except for the south-eastern part which has a longer dry period. Suitabilities for perennials are lower here. The South Dowa Hills (DOH1) are moderately suitable for maize, groundnuts, pulses, tobacco, sorghum and sunflower. Limitations are numerous: temperature regime, moisture deficit, low pH, high erosion hazard and low nutrient retention capacity for the different crops.

- Suitability for forestry

The Dedza Uplands (DH1) are highly suitable for Azadirachta indica, marginally suitable for Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for all other tree species considered. The North-east Lilongwe Plain (LP1) is highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, marginally suitable for Pinus patula, and moderately suitable for the other species. Only the noth-western part has a lower overall suitability due to both a shorter growing period and a longer dry period: highly suitable for Azadirachta indica, marginally suitable for Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for the other species. The Central Lilongwe Plain (LP2) has the same suitabilities as the major part of the North-east Lilongwe Plain (LP1) except for the south-eastern part which has a longer dry period and lower temperatures: moderately suitable for Azadirachta indica, Eucalyptus camaldulensis, E. tereticornis, Gmelina arborea, Melia azedarach and Pinus kesiya, and marginally suitable for the other species. The South Dowa Hills (DOH1) have the same suitability as the nort-western part of the North-east Lilongwe Plain (LP1).

7.3.2.5 LL20 - Chitekwele EPA

Chitekwele EPA is situated in the eastern part of the RDP and has a total area of 56,400 ha, about 29 percent of which is taken up by Thuma Forest Reserve. The EPA centre is in Chitekwele. Four agro-ecological zones are distinguished: South Dowa Hills (DOH1) in the north-west, Dedza Uplands (DH1) in the south, Upper Dedza Escarpment (DE2) in the north-east, and Central Lilongwe Plain (LP2) in the south-west. Most important soil families are Neno in the Dedza Uplands (DH1) and Walkers Ferry in the South Dowa Hills (DOH1) and the Upper Dedza Escarpment (DE2).

- Suitability for rainfed cultivation under improved traditional management

The major part of the South Dowa Hills (DOH1) is moderately suitable for maize, tobacco, groundnuts, pulses, sorghum and sunflower. The sloping areas (with slopes 6-13 percent) have lower suitabilities for tobacco, pigeon pea, sorghum and sunflower (marginally suitable). Moderately steep land is not suitable for any crop, mainly due to high erosion hazard. The central and southern parts of the Dedza Uplands (DH1) are marginally or not suitable for any crops due to shallow to moderately deep soils. The northern part has similar suitabilities as the major part of the South Dowa Hills (DOH1), except for sorghum which is highly suitable because of the less severe erosion hazard. The Upper Dedza Escarpment (DE2) is generaly not suitable for any crops because of high erosion hazard. The Central Lilongwe Plain (LP2) is highly suitable for groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, groundnuts-S and pulses.

- Suitability for forestry

The South Dowa Hills (DOH1) and the Dedza Uplands (DH1) are highly suitable for Azadirachta indica, marginally suitable for Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for the other species considered for evaluation. The higher zones with lower temperatures have a lower suitability for Azadirachta indica (moderately suitable) and Acacia albida, Callitris hugellii, Cassia siamea and Cordyla africana (marginally suitable). Shallow or moderately deep soils are marginally suitable for Acacia albida, Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for other trees considered. The Upper Dedza Escarpment (DE2) is moderately suitable for Azadirachta indica, Callitris hugellii, Cassia siamea, Cordyla africana, Eucalyptus camaldulensis, E. tereticornis, Gmelina arborea, Melia azedarach and Pinus kesiya, and marginally suitable for the other species. The Central Lilongwe Plain (LP2) has the same suitability as the higher zones in the Dedza Uplands (DH1).

7.3.2.6 LL21 - Chiwamba EPA

Chiwamba EPA is situated in the northern part of the RDP and has a total area of 38,800 ha. The EPA centre is in Chiwamba. Three agro-ecological zones are distinguished: Dedza Uplands (DH1) in the centre and west, South Dowa Hills (DOH1) in the east, and the North-east Lilongwe

Plain (LP1) in the north-west. Most important soil families are Neno in the Dedza Uplands (DH1), Walkers Ferry in the South Dowa Hills (DOH1), and Mpili in the North-east Lilongwe Plain (LP1).

- Suitability for rainfed cultivation under improved traditional management

The central and southern part of the Dedza Uplands (DH1) are highly suitable for sorghum and moderately suitable for maize, tobacco, groundnuts, pulses and sunflower. The northern part is, due to poor rooting conditions on mostly shallow and moderately deep soils and erosion hazard, marginally suitable for all crops except cassava-S, citrus and coffee, which are not suitable. The major part of the South Dowa Hills (DOH1) has moderately steep land and is moderately suitable for maize, groundnuts and pulses (except pigeon pea) only. The main limitation is erosion hazard. The less steep land is moderately suitable for sorghum, sunflower and tobacco. The very steep land is not suitable for any crops. The North-east Lilongwe Plain (LP1) is highly suitable for groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, groundnuts-S and pulses.

- Suitability for forestry

The central and southern part of the Dedza Uplands (DH1) are highly suitable for Azadirachta indica, marginally suitable for Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for all other species considered. The lower areas of the northern part are marginally suitable for Acacia albida, Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for all other trees considered. The higher areas are marginally suitable for Acacia albida, Callitris calcarata, Callitris hugellii, Cassia siamea, Cordyla africana, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for the other species. The South Dowa Hills (DOH1) have the same suitability as the central and southern part of the Dedza Uplands (DH1) except the eastern area where, due to less deep soils, land is moderately suitable for Azadirachta indica and marginally suitable for Acacia albida. The North-east Lilongwe Plain (LP1) has similar suitabilities to the adjacent higher zones of the northern part of the Dedza Uplands (DH1).

7.3.2.7 LL22 - Chigonthi EPA

Chigonthi EPA is situated in the north-western part of the RDP and has a total area of 31,750 ha. The EPA centre is in Chigonthi. Two agro-ecological zones are distinguished: North-east Lilongwe Plain (LP1) in the major part of the EPA, and Dedza Uplands (DH1) in the east. Most important soil families are Mpili for upland soils and Tenthema in dambos.

- Suitability for rainfed cultivation under improved traditional management

The North-east Lilongwe Plain (LP1) is highly suitable for sorghum and sunflower and moderately suitable for maize-S, tobacco, groundnuts, cowpea, pigeon pea, phaseolus bean-S and soya beans. The major part of the

Dedza Uplands (DH1) has a longer growing period and is therefore more suitable for long cycle varieties: moderately suitable for maize-L and phaseolus beans-L, but soils generaly have a lower pH which makes it only moderately suitable for sunflower. Other suitabilities are as described for the North-east Lilongwe Plain. The northern part of the Dedza Uplands (DH1) is marginally suitable for all crops except cassava-S, citrus and coffee arabica which are not suitable, because of shallow to moderately deep soils

- Suitability for forestry

The southern part of the North-east Lilongwe Plain (LP1) and the whole of the Dedza Uplands (DH1) are highly suitable for Azadirachta indica, marginally suitable for Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and marginally suitable for all other species considered for evaluation. The north-western part of the North-east Lilongwe Plain (LP1) has a slightly lower suitability due to lower temperatures: moderately suitable for Azadirachta indica and marginally suitable for Acacia albida, Callitris hugellii, Cassia siamea and Cordyla africana. All other suitabilities are the same as for the Dedza Uplands.

7.3.3 Thiwi/Lifidzi RDP

Thiwi/Lifidzi RDP (Figure 7) is situated in the central-southern part of the ADD and covers an area of 102,200 ha. The RDP has four EPAs: DE1 (Chafumbwa EPA) in the east, DE2 (Kabwazi EPA) in the centre, DE3 (Linthipe EPA) in the north-east, and DE4 (Lobi) in the south. Project offices are in Dedza. Within the RDP four agro-ecological zones are distinguished: West and South Lilongwe Plain (LP3), Central Lilongwe Plain (LP2), Dedza Uplands (DH1), and the Dedza Hills (DH2).

7.3.3.1 DE1 - Chafumbwa EPA

Chafumbwa EPA is situated in the western part of the RDP and has a total area of 21,850 ha. The EPA centre is in Chafumbwa. The West and South Lilongwe Plain (LP3) is the only agro-ecological zone. Most important soil families are Mpili for upland soils and Tenthema in dambos.

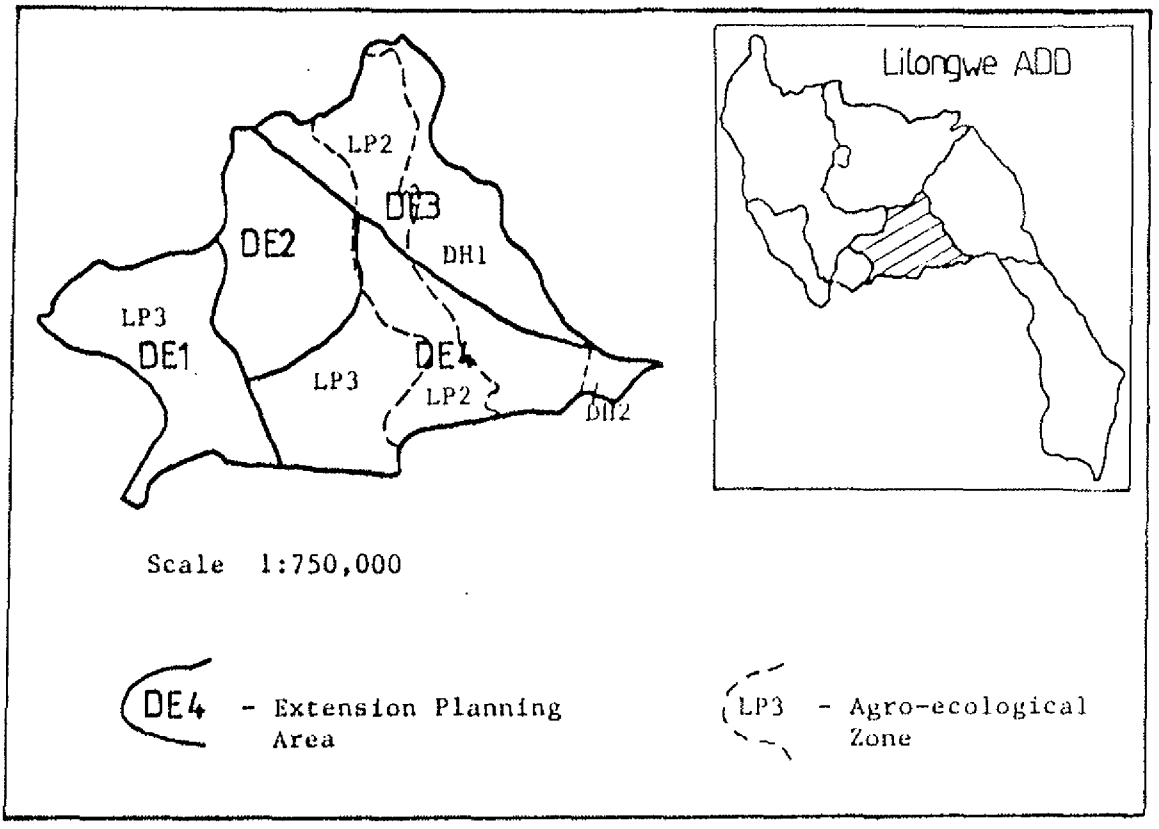
- Suitability for rainfed cultivation under improved traditional management

The whole EPA is highly suitable for the cultivation of groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, pulses (including phaseolus bean and soya beans) and groundnuts-S. The main limitations are temperature regime, low nutrient retention capacity and moisture deficit.

- Suitability for forestry

The West and South Lilongwe Plain (LP3) is highly suitable for Gmelina arborea, moderately suitable for Azadirachta indica, Callitris calcarata, all three Eucalyptus species considered, Melia azedarach, Pinus caribaea and P. kesiya. All other species considered are marginally suitable.

FIGURE 7. EPAs AND AGRO-ECOLOGICAL ZONES, THIWI/LIFIDZI RDP.
The main land units of each agro-ecological zone (AEZ) are presented in tables.



DE1 - CHAFUMBWA EPA	
AEZ	LP3
MAIN LAND UNITS	1301 1312 1269

DE2 - KABWAZI EPA	
AEZ	LP3
MAIN LAND UNITS	1301 1312 1269 1310

DE3 - LIMTHIPE EPA			
AEZ	DH1	LP2	LP3
MAIN LAND UNITS	1324 1295 1339 1322 1263 R	1310 1300 1267	1301 1312 1310

DE4 - LOBI EPA				
AEZ	LP3	LP2	DH1	DH2
MAIN LAND UNITS	1301 1312 1269	1310 1312 1269 1300	1339 1324 R	1334 R

7.3.3.2 DE2 - Kabwazi EPA

Kabwazi EPA is situated in the central part of the RDP and has a total area of 20,000 ha. The EPA centre is in Kabwazi. The West and South Lilongwe Plain (LP3) is the only agro-ecological zone. Most important soil families are Mpili for upland soils and Tenthema in dambos.

- Suitability for rainfed cultivation under improved traditional management

The whole EPA is highly suitable for the cultivation of groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, pulses and groundnuts-S. The main limitations are temperature regime, low nutrient retention capacity and moisture stress.

- Suitability for forestry

The West and South Lilongwe Plain (LP3) is highly suitable for Gmelina arborea, moderately suitable for Azadirachta indica, Callitris calcarata, all three Eucalyptus species, Melia azedarach, Pinus caribaea and P. kesiya. All other species considered are marginally suitable.

7.3.3.3 DE3 - Linthipe EPA

Linthipe EPA is situated in the north-eastern part of the RDP and has a total area of 26,050 ha. The EPA centre is in Linthipe. Three agro-ecological zones are distinguished: Dedza Uplands (DH1) in the east, Central Lilongwe Plain (LP2) in the centre, and the West and South Lilongwe Plain (LP3) in the west. Most important soil families are Neno and Chalenthuwa for shallow soils in the Dedza Uplands (DH1), and Mpili in the west of the EPA.

- Suitability for rainfed cultivation under improved traditional management

The major part of the Dedza Uplands (DH1) is highly suitable for sorghum and moderately suitable for maize, tobacco, groundnuts, pulses, sunflower. The south-eastern part has soils with a higher pH and is therefore highly suitable for groundnuts-L, but also has steeper land and thus only moderately suitable for sorghum. The northern part has moderately deep to shallow soils which makes it marginally suitable for all crops except cassava-S, citrus and coffee arabica, which are not suitable. The Central Lilongwe Plain (LP2) is highly suitable for groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, groundnuts-S and pulses.

- Suitability for forestry

The Dedza Uplands (DH1) and the West and South Lilongwe Plain (LP3) are highly suitable for Gmelina arborea, marginally suitable for Acacia albida, Callitris hugellii, Cassia siamea, Cordyla africana and Pinus patula, and moderately suitable for the other species considered in the evaluation. Only the northern part of the Dedza Uplands (DH1), with a longer dry period, has a different suitability for Gmelina arborea

(moderately suitable) and Callitris calcarata, Eucalyptus grandis and Pinus caribaea (marginally suitable). The Central Lilongwe Plain (LP2) is marginally suitable for Acacia albida, Callitris calcarata, Callitris hugellii, Cassia siamea, Cordyla africana, Eucalyptus grandis, Pinus caribaea and P. patula, while all other trees are moderately suitable.

7.3.3.4 DE4 - Lobi EPA

Lobi EPA is situated in the southern part of the RDP and has a total area of 34,300 ha. The EPA centre is in Lobi. Four agro-ecological zones are distinguished: West and South Lilongwe Plain (LP3) in the west, Central Lilongwe Plain (LP2) in the centre, Dedza Uplands (DH1) in the east, and Dedza Hills (DH2) in the extreme east. Most important soil families are Mpili for upland soil and Tenthema in dambos in the centre and west, Neno in the Dedza Uplands (DH1) and the Dedza Hills (DH2), and Nkwepela in the southern part of the Dedza Uplands (DH1).

- Suitability for rainfed cultivation under improved traditional management

The Dedza Uplands (DH1) are highly suitable for groundnuts-L and moderately suitable for maize, tobacco, groundnuts-S, pulses, sorghum and sunflower. The north-east is highly suitable for sorghum and moderately suitable for groundnuts-L due to a lower pH of the soil. The Dedza Hills (DH2) are moderately suitable for maize, tobacco, pigeon pea and sorghum. The Central Lilongwe Plain (LP2) is highly suitable for groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, groundnuts-S and pulses.

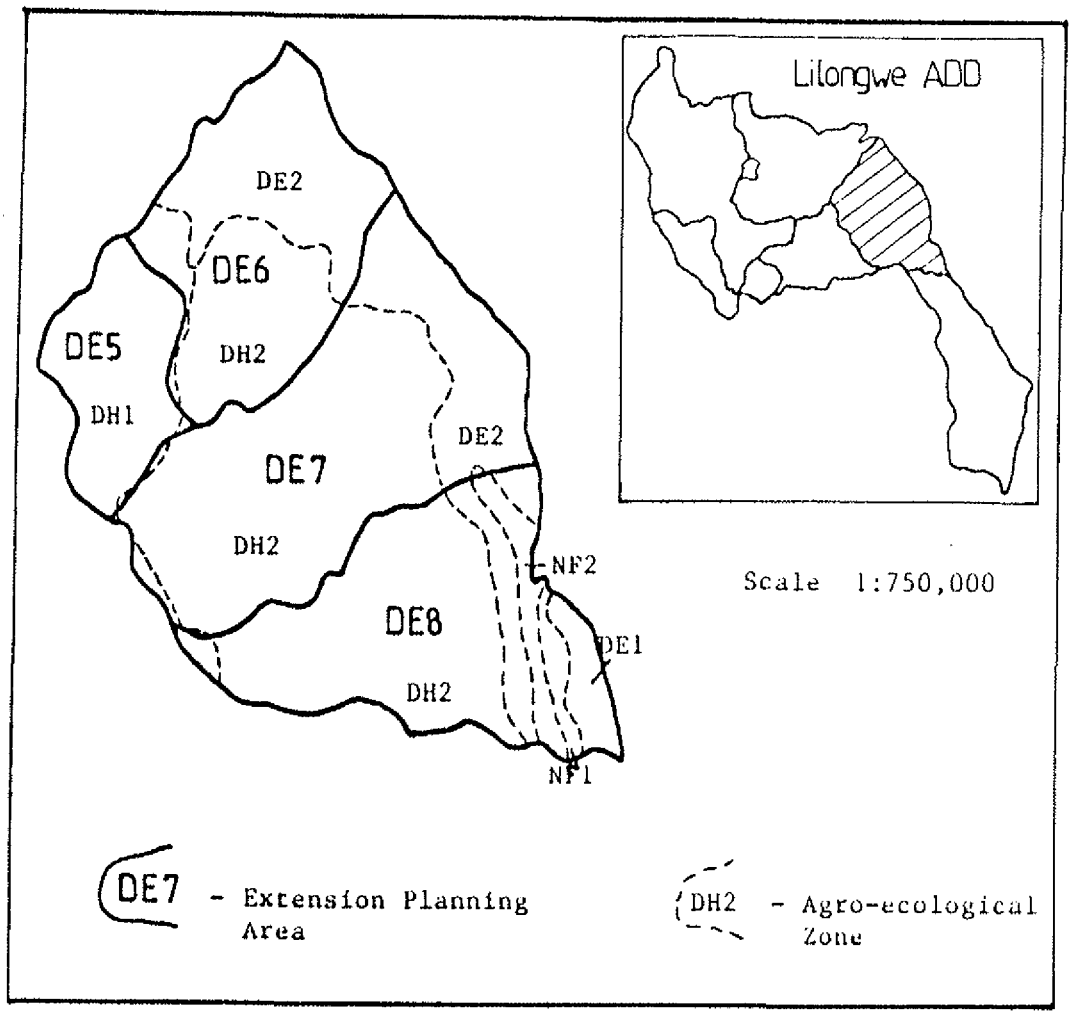
- Suitability for forestry

The West and South Lilongwe Plain (LP3) is highly suitable for Gmelina arborea, moderately suitable for Azadirachta indica, Callitris calcarata, all three Eucalyptus species considered, Melia azedarach, Pinus caribaea and P. kesiya. All other species considered are marginally suitable. The Central Lilongwe Plain (LP2) is marginally suitable for Acacia albida, Callitris calcarata, Callitris hugellii, Cassia siamea, Cordyla africana, Eucalyptus grandis, Pinus caribaea and P. patula, while all other trees are moderately suitable, due to a longer dry period. The Dedza Uplands (DH1) are highly suitable for Gmelina arborea, marginally suitable for Acacia albida, Callitris hugellii, Cassia siamea, Cordyla africana and Pinus patula, and moderately suitable for all other species. The Dedza Hills (DH2) have an identical suitability to the Dedza Uplands (DH1), except for Acacia albida which is not suitable because of soils with low CEC.

7.3.4 Dedza Hills RDP

Dedza Hills RDP (Figure 8) is situated in the eastern part of the ADD and covers an area of 183,200 ha. The RDP has four EPAs: DE5 (Kaphuka EPA) in the west, DE6 (Mayani EPA) in the north, DE7 (Kanyama EPA) in the centre and east, and DE8 (Bembeke EPA) in the south. Project offices are in Dedza. Within the RDP six agro- ecological zones are distinguished:

FIGURE 8. EPAs AND AGRO-ECOLOGICAL ZONES, DEDZA HILLS RDP.
The main land units of each agro-ecological zone (AEZ) are presented in tables.



DE5 - KAPHUKA EPA	
AEZ	DH1
MAIN LAND UNITS	1295 1310 1263 1294 1282 R

DE6 - MAYANI EPA			
AEZ	DE2	DH2	DH1
MAIN LAND UNITS	1365 1377 1374 1378 V 1346	1388 1310 1348 1369 R 1322	1294 1348

DE7 - KANYAMA EPA		
AEZ	DH2	DE2
MAIN LAND UNITS	1352 1326 1369 1314 R 1379	1379 1343 1378 1357 1366 1347

DE8 - BEMBEKE EPA					
AEZ	DH2	DE2	DE1	NF2	NF1
MAIN LAND UNITS	1369 1367 1334 1335 1340 R	1379 1387 1343	1341	1285 1344	1344

Dedza Hills (DH2), Upper Dedza Escarpment (DE2), Dedza Uplands (DH1), Lower Dedza Escarpment (DE1), Ntcheu Footslopes (NF2), and the Ntcheu Foothills (NF1).

7.3.4.1 DE5 - Kaphuka EPA

Kaphuka EPA is situated in the western part of the RDP and has a total area of 19,300 ha, four percent of which is taken up by Dzenza Forest Reserve. The EPA centre is in Kaphuka. The Dedza Uplands (DH1) is the only agro-ecological zone included. Most important soil families are Chalenthuwa for shallow soils, Mpili for upland soils, Mpasa in dambos and Gweleweta on footslopes of hills. Rock outcrops are also very common.

- Suitability for rainfed cultivation under improved traditional management

The central, western and northern part of the Dedza Uplands (DH1) are, due to shallow soils, marginally suitable for all crops except cassava-S, citrus and coffee arabica, which are not suitable. The eastern part is highly suitable for the cultivation of groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, pulses (including phaseolus bean and soya beans) and groundnuts-S. The main limitations are temperature regime, low nutrient retention capacity and moisture stress. The gleyic soils in the south-west and the colluvial soils in the south-east are moderately suitable for sorghum and soya beans.

Suitability for forestry

The major part of the Dedza Uplands (DH1) is moderately suitable for Azadirachta indica, Eucalyptus camaldulensis, E. tereticornis, Gmelina arborea, Melia azedarach and Pinus kesiya, and marginally suitable for the other tree species considered for evaluation. The northern part has a slightly higher suitability for Callitris hugellii, Cassia siamea and Cordyla africana (moderately suitable) due to higher temperatures. The colluvial/alluvial soils in the south are less suitable: in the south-west marginally suitable for Eucalyptus camaldulensis and Gmelina arborea, and not suitable for the other species; in the south-east marginally suitable for Acacia albida, Azadirachta indica, Eucalyptus camaldulensis, E. grandis, E. tereticornis, Gmelina arborea and Pinus caribaea, and not suitable for the other species.

7.3.4.2 DE6 - Mayani EPA

Mayani EPA is situated in the northern part of the RDP and has a total area of 45,150 ha, of which about one fifth is taken up by Dedza-Salima Escarpment Forest Reserve. The EPA centre is in Mayani. Three agro-ecological zones are distinguished: Upper Dedza Escarpment (DE2) in the north, Dedza Hills (DH2) in the south, and Dedza Uplands (DH1) in the west. Most important soil families are Walkers Ferry and Chalenthuwa for shallow soils, and Neno and Mpili for upland soils. Rock outcrops are common in the Dedza Hills.

- Suitability for rainfed cultivation under improved traditional management

Only the central, southern and northern part of the Upper Dedza Escarpment (DE2) are of importance for rainfed cultivation. The central and southern part are moderately suitable for maize, groundnuts and pulses (except pigeon pea). The main limitations are erosion hazard and moisture stress. The northern part is moderately suitable for maize, tobacco, groundnuts, pulses, cotton, sorghum, soya beans and sunflower. All other parts of the Upper Dedza Escarpment (DE2) are steep to very steep and therefore not suitable due to erosion hazard. The central part of the Dedza Hills (DH2) is moderately suitable for maize-L, tobacco, groundnuts-L, phaseolus bean-L, Irish potato, wheat and sunflower. The southern part is highly suitable for the cultivation of groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, pulses and groundnuts-S. The western part is partly not suitable due to erosion hazard on steep land but otherwise has the same suitability as the southern part except for the highly suitable crops which become moderately suitable because of soils with a lower pH or because of erosion hazard. The eastern part of the Dedza Hills (DH2) is moderately suitable for all long cycle varieties considered plus Irish potato and wheat. Due to moderately deep and shallow soils the Dedza Uplands (DH1) are mainly marginally suitable for all crops except cassava-S, citrus and coffee, which are not suitable.

- Suitability for forestry

The Upper Dedza Escarpment (DE2) is moderately suitable for Azadirachta indica, Callitris hugellii, Cassia siamea, Cordyla africana, Eucalyptus camaldulensis, E. tereticornis, Gmelina arborea, Melia azedarach and Pinus kesiya, and marginally suitable for the other species, except in the central southern and the northern part. These areas are highly suitable for Azadirachta indica, marginally suitable for Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for the other trees because of more favorable edaphic conditions. The Dedza Hills (DH2) are, except for the eastern zone, moderately suitable for Azadirachta indica, Eucalyptus camaldulensis, E. tereticornis, Gmelina arborea, Melia azedarach and Pinus kesiya, and marginally suitable for the other species considered. The eastern zone has a slightly higher suitability because of a shorter dry period: highly suitable for Gmelina arborea, and moderately suitable for Callitris calcarata, Eucalyptus grandis and Pinus caribaea. The other suitability ratings are the same as in the other parts of the Dedza Hills (DH2).
The Dedza Uplands (DH1) is manily marginally suitable for Acacia albida, Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for all other tree species.

7.3.4.3 DE7 - Kanyama EPA

Kanyama EPA is situated in the central and eastern part of the RDP and has a total area of 66,550 ha, of which more than one third is taken up by forest reserves (Chongoni and Dedza-Salima Escarpment). The EPA centre is in Kanyama. Three agro-ecological zones are distinguished: Dedza Hills (DH2) in the centre and west, Upper Dedza Escarpment (DE2) in the east,

and Dedza Uplands (DH1) in the extreme west. Most important soil families are Neno, Mpili and Walkers Ferry for shallow soils in the Dedza Hills (DH2) where rock outcrops are also common, and Neno and Walkers Ferry in the Upper Dedza Escarpment (DE2).

- Suitability for rainfed cultivation under improved traditional management

The central and western parts of the Dedza Hills (DH2) is are moderately suitable for maize-L, tobacco, groundnuts-L, phaseolus bean-L, sunflower, Irish potato and wheat. Apart from cool temperatures, limitations are various. The central and eastern part are marginally suitable for sunflower and tobacco due to high erosion hazard. Other suitabilities are the same as mentioned above. The center-south is highly suitable for phaseolus bean-L due to the long growing period. Other suitabilities are as for the central and western part of the Dedza Hills (DH2). The very steep land in the east is not suitable for any crops because of high erosion hazard. The most suitable zone in the Upper Dedza Escarpment (DE2) is the south-east: moderately suitable for all crops except cassava-L, citrus and coffee arabica (marginally suitable) and cassava-S, Irish potato and wheat (not suitable). Other parts are too steep for crop cultivation, except for small areas of flatter land within this zone, which are marginally suitable for nearly all crops.

- Suitability for forestry

The major part of the Dedza Hills (DH2) is highly suitable for Gmelina arborea, marginally suitable for Acacia albida, Callitris hugellii, Cassia siamea, Cordyla africana and Pinus patula, and moderately suitable for the other trees considered. Many rockoutcrops occur, especialy in the east and west. The eastern part is moderately suitable for Callitris hugellii, Cassia siamea, Cordyla africana and Gmelina arborea but other suitabilities are the same as for the major part of the Dedza Hills (DH2). The central and south-western part of the Upper Dedza Escarpment (DE2) is marginally suitable for Acacia albida and Pinus patula, and moderately suitable for the other tree species. The south-eastern part has a higher overall suitability due to better soils and a higher temperature: highly suitable for Cassia siamea, Cordyla africana, Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, marginally suitable for Gmelina arborea, Pinus caribaea and P. patula, and moderately suitable for the other species. The northern part of the Upper Dedza Escarpment (DE2) is marginally suitable for Acacia albida, Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for all other species due to less deep soils and a long dry period.

7.3.4.4 DE8 - Bembeke EPA

Bembeke EPA is situated in the southern part of the RDP and has a total area of 52,200 ha, of which more than one third is taken up by forest reserves (Mua Livulezi, Dedza Mountain and Dedza-Salima Escarpment). The EPA centre is in Bembeke. Six agro-ecological zones are distinguished: Dedza Hills (DH2), Upper Dedza Escarpment (DE2), Lower Dedza Escarpment (DE1), Ntcheu Footslopes (NF2), Ntcheu Foothills (NF1)

and Dedza Uplands (DH1). Most important soil families are Neno and Nkwepela in the Dedza Hills (DH2) where rock outcrops are also common, Walkers Ferry in the Upper Dedza Escarpment (DE2), Neno in the Lower Dedza Escarpment (DE1) and the Ntcheu Foothills (NF1), and Jombo on the escarpment footslopes of the Ntcheu Footslopes (NF2).

- Suitability for rainfed cultivation under improved traditional management

The major part of the Dedza Hills (DH2) is, apart from the numerous rock outcrops, moderately suitable for maize-L, groundnuts-L, Irish potato, wheat and phaseolus bean-L. The western part has a slightly higher suitability for phaseolus bean-L (highly suitable) and sunflower and tobacco (moderately suitable) due to less steep land. The extreme south-west is moderately suitable for maize, tobacco, pigeon pea and sorghum. The south-central part has a longer growing period and lower temperatures and is moderately suitable for maize-L, Irish potato, wheat and tobacco. The Upper Dedza Escarpment (DE2) is not suitable for any crops due to high erosion hazard. Only the north-eastern part, which is moderately to marginally suitable for most crops except cassava-S, Irish potato and wheat (not suitable) has some agricultural value. The Lower Dedza Escarpment (DE1) is moderately suitable for maize, tobacco, groundnuts, pulses, sorghum, sunflower and cotton. Main limitations are low pH, high erosion hazard, moisture deficit, low nutrient retention capacity and temperature regime. The Ntcheu Footslopes (NF2) are highly suitable for maize-S, groundnuts and pulses (except phaseolus bean-L and pigeon pea which are moderately suitable) and moderately suitable for maize-L, tobacco, sunflower, sorghum and cotton. The Ntcheu Foothills (NF1) are moderately suitable for all crops except cassava-L, Irish potato, wheat, citrus and cotton (marginally suitable) and cassava-S and coffee arabica (not suitable).

- Suitability for forestry

Apart from the rockoutcrops, nearly the whole of the Dedza Hills (DH2) is highly suitable for Gmelina arborea, marginally suitable for Acacia albida, Callitris hugellii, Cassia siamea, Cordyla africana and Pinus patula, and moderately suitable for all other tree species considered. Only the south-west and center-south are not suitable for Acacia albida. The Upper Dedza Escarpment (DE2) is marginally suitable for Acacia albida but moderately suitable for Callitris hugellii, Cassia siamea and Cordyla africana. The Lower Dedza Escarpment (DE1) is highly suitable for Azadirachta indica, Callitris hugellii and Cordyla africana, marginally suitable for Callitris calcarata, Eucalyptus grandis, Gmelina arborea, Pinus caribaea and P. patula, and moderately suitable for all other trees considered. The Ntcheu Footslopes (NF2) are highly suitable for Cassia siamea, Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, marginally suitable for Gmelina arborea, Pinus caribaea and P. patula, and moderately suitable for the other species considered. The Ntcheu Foothills (NF1) are highly suitable for Azadirachta indica, marginally suitable for Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for the other trees.

7.3.5 Ntcheu RDP

Ntcheu RDP (Figure 9) is situated in the southern part of the ADD and covers an area of 243,250 ha. The RDP has six EPAs: NCH1 (Njolomole EPA) in the north-west, NCH2 (Kandeu EPA) in the north-east, NCH4 (Mphepozinai EPA) in the north-central and east, NCH6 (Tsangano EPA) in the south-west, NCH7 (Nsipe EPA) in the centre, and NCH7 (Manjawila EPA) in the south-east. Project offices are in Ntcheu. Within the RDP twelve agro-ecological zones are distinguished: Ntcheu Foothills (NF1), Ntcheu Footslopes (NF2), Lower Dedza Escarpment (DE1), Upper Dedza Escarpment (DE2), Ntcheu Uplands (NTH1), Ntcheu Escarpment (NTH2), Balaka Plain (BU1), Kirk Range (MH5), Dedza Hills (DH2), Golomoti Footslopes (BWV3), Middle Shire Valley (MS1) and Lisungwe Valley (MS2).

7.3.5.1 NCH1 - Njolomole EPA

Njolomole EPA is situated in the north-western part of the RDP and has a total area of 33,350 ha, 16 percent of which is taken up by Mvai and Chirobwe Forest Reserves. The EPA centre is in Njolomole. Three agro-ecological zone are distinguished: Dedza Hills (DH2), Ntcheu Escarpment (NTH2) and Upper Dedza Escarpment (DE2). Most important soil families are Neno, Nkwepela, and Walkers Ferry on shallow soils in the Dedza Hills (DH2), Neno in the Ntcheu Escarpment (NTH2) where rock outcrops are also common, and Walkers Ferry and Neno in the Upper Dedza Escarpment (DE2).

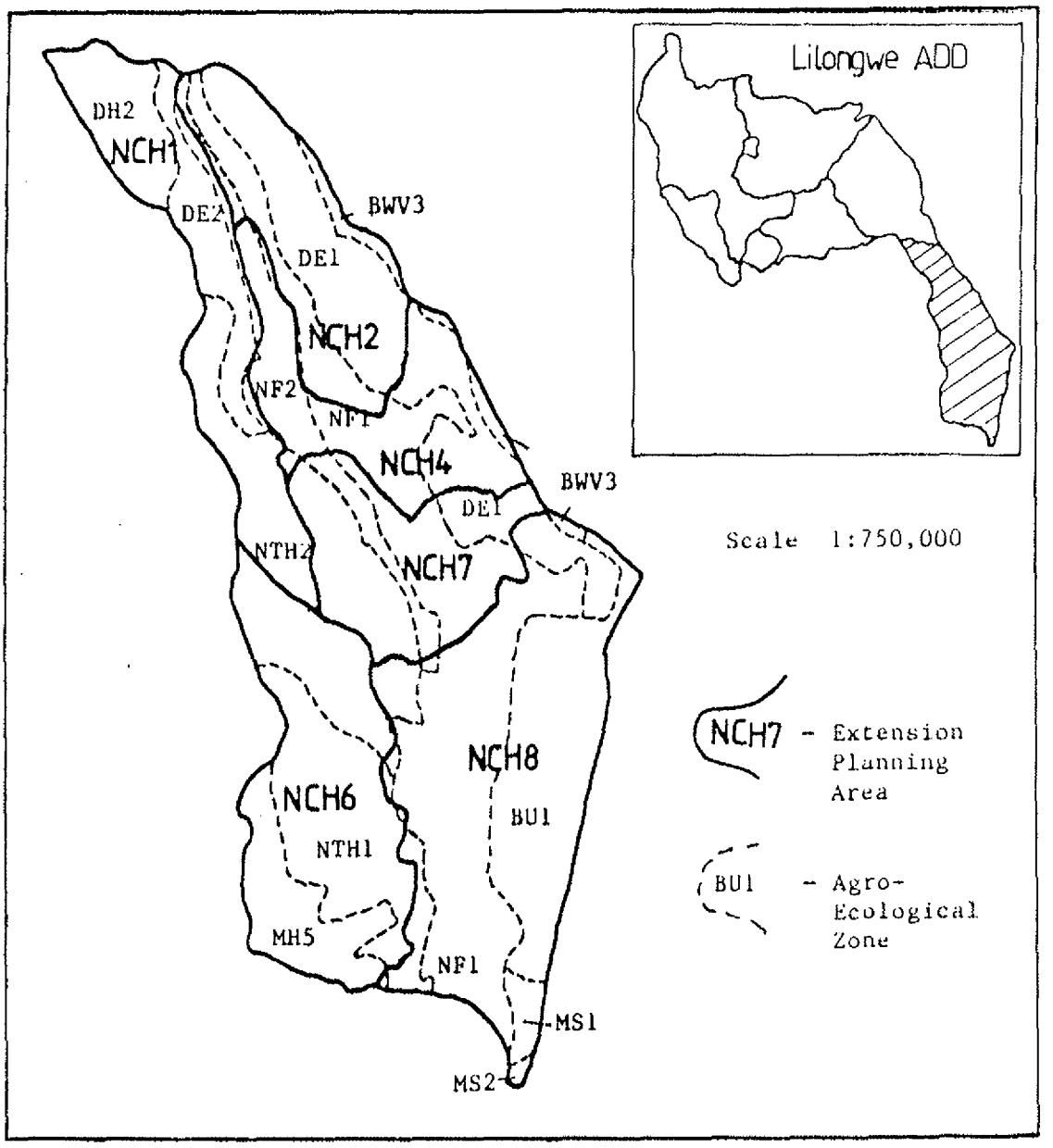
- Suitability for rainfed cultivation under improved traditional management

The major part of the Dedza Hills (DH2) is moderately suitable for maize-L, Irish potato, wheat, tobacco, phaseolus bean-L, groundnuts-L and sunflower. The north-eastern part has a lower suitability for sunflower and tobacco due to high erosion hazard. The north-west is moderately suitable for maize-L, Irish potato and tobacco. The eastern part is not suitable for any crops because of high erosion hazard. The central part of the Ntcheu Escarpment (NTH2) has the same suitability as the major part of the Dedza Hills (DH2). The northern area is moderately suitable for all crops except cassava-L, Irish potato, wheat, citrus, cotton, cassava-S and coffee arabica. The southern zone is not suitable for any crops because of high erosion hazard and the occurence of rock outcrops. The Upper Dedza Escarpment (DE2) is mainly not suitable for any crops due to steep slopes. Only the west-central zone is moderately suitable for maize-L, Irish potato, wheat, groundnuts-L and phaseolus bean-L.

- Suitability for forestry

The western and northern part of the Dedza Hills (DH2) is highly suitable for Gmelina arborea, marginally suitable for Acacia albida, Callitris hugellii, Cassia siamea, Cordyla africana and Pinus patula, and moderately suitable for the other tree species considered for evaluation. Only the north-western part is not suitable for Acacia albida. The eastern part of the Dedza Hills (DH2) is marginally suitable for Acacia albida, Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for all other species. The Ntcheu Escarpment (NTH2)

FIGURE 9. EPAs AND AGRO-ECOLOGICAL ZONES, NTCHEU RDP.
The main land units of each agro-ecological zone (AEZ) are presented in tables.



NCH1 - NJOLOMOLE EPA			
AEZ	DH2	NTH2	DE2
MAIN LAND UNITS	1352 1384 1335 1369 1376	1351 1348 R 1375 1359 1291	1374 1369 1382 1384

NCH2 - KAMDEU EPA				
AEZ	DE1	NF1	NF2	BWV3
MAIN LAND UNITS	1372 550 1344 1124 1308	1308 1344	1279 1386	1277 1286

NCH4 - MPHEPOZIMAI EPA				
AEZ	DE1	NF1	NF2	BWV3
MAIN LAND UNITS	1344 1124 1383 1356 1293 550	1308 1329 323	1274 1279 1261 1260 1288 1330	1280

NCH6 - TSANGANO EPA			
AEZ	NTH1	MH5	NTH2
MAIN LAND UNITS	1338 1351 1315 1349 657	1362 1202 574 R 1381 1380	1375 1338 R 1296 1359 1351

Continued on next page

FIGURE 9. EPAs AND AGRO-ECOLOGICAL ZONES, NTCHEU RDP (Cont'd)

NCH7 - MSIPE EPA				
AEZ	MTH2	MF1	DE1	MF2
MAIN LAND UNITS	1359	1308	1344	1261
	657	1329	1356	1256
	1349	1385	1293	1278
	1291	369	369	1308
				323

NCH8 - MANJAMILA EPA										
AEZ	MF1	BU1	DE1	MTH2	MS1	MTH1	SL3	MS2	MF2	MH5
MAIN LAND UNITS	1385	319	1344	1359	1319	1380	1259	210	1256	1380
	1354	1328	1308	1375	1353	1349		96		
	549	318	1356			657				
	552	369								
	369	1320								
	1345	317								

is, besides the several rockoutcrops in the south, highly suitable for Gmelina arborea, moderately suitable for Azadirachta indica, Callitris calcarata, Eucalyptus camaldulensis, E. grandis, E. tereticornis, Melia azedarach, Pinus caribaea and P. kesiya, and marginally suitable for the other species. The northern zone is moderately suitable for Gmelina arborea and marginally suitable for Callitris calcarata, Eucalyptus grandis and Pinus caribaea due to a shorter growing period and a longer dry period. The major part of the Upper Dedza Escarpment (DE2) is marginally suitable for Acacia albida, Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for the other tree species. A minor area in the west-central part is highly suitable or moderately suitable for Gmelina arborea, moderately suitable for Azadirachta indica, Callitris calcarata, Eucalyptus camaldulensis, E. grandis, E. tereticornis, Melia azedarach, Pinus caribaea and P. kesiya, and marginally suitable for the other species.

7.3.5.2 NCH2 - Kandeu EPA

Kandeu EPA is situated in the north-eastern part of the RDP and has a total area of 33,400 ha, of which 13 percent is taken up by Bangwe Forest Reserve. The EPA centre is in Kandeu. Four agro-ecological zones are distinguished: Lower Dedza Escarpment (DE1) in the east, Ntcheu Foothills (NF1) in the centre, Ntcheu Footslopes (NF2) in the north-west and Golomoti Footslopes (BWV3) in the east. Most important soil families are Neno, Mpili and Walkers Ferry in the Lower Dedza Escarpment (DE1), Mpili in the Ntcheu Foothills (NF1), Liphala and Lisungwe in the Ntcheu Footslopes (NF2), and Lisungwe in the Golomoti Footslopes (BWV3).

- Suitability for rainfed cultivation under improved traditional management

The Lower Dedza Escarpment (DE1) is to a large extent not suitable for any crops mainly due to high erosion hazard. The north-eastern and southern fringe are highly suitable to moderately suitable for groundnuts-L and moderately suitable for all crops except cassava-L, Irish potato, wheat, citrus and cotton for which they are marginally suitable, and cassava-S and coffee arabica for which they are not suitable. Some

areas in the south have shallow to moderately deep soils which are only marginally suitable for all crops except cassava-S, citrus and coffee arabica. The Ntcheu Foothills (NF1) are highly suitable for groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, groundnuts and pulses. Only the northern part is less suitable for groundnuts-L, sorghum and sunflower due to soils with low pH and due to high erosion hazard. The Ntcheu Footslopes (NF2) and the Golomoti Footslopes (BWV3) are moderately suitable for all crops except sorghum (highly suitable), cassava-L, Irish potato, wheat, citrus and cotton (marginally suitable), and cassava-S and coffee arabica (not suitable).

- Suitability for forestry

The major part of the Lower Dedza Escarpment (DE1) is marginally suitable for Acacia albida, Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for all other trees considered. The north-eastern and southern fringes are more suitable due to deeper soils. They are highly suitable for Azadirachta indica, marginally suitable for Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for the other species. The Ntcheu Foothills (NF1), the Ntcheu Footslopes (NF2) and the Golomoti Footslopes (BWV3) have the same suitability for trees as the deeper soils of the Lower Dedza Escarpment (DE1).

7.3.5.3 NCH4 - Mphepozinai EPA

Mphepozinai EPA is situated in the north-central and eastern parts of the RDP and has a total area of 27,600 ha, of which no land is taken up by forest reserves. The EPA centre is in Mphepozinai. Four agro-ecological zones are distinguished: Lower Dedza Escarpment (DE1) in the east, Ntcheu Foothills (NF1) in the centre, Ntcheu Footslopes (NF2) in the west, and Golomoti Footslopes (BWV3) in the extreme east. Most important soil families are Neno, Walkers Ferry and Chalenthuwa for shallow to moderately deep soils in the Lower Dedza Escarpment (DE1), Mpili in the Ntcheu Foothills (NF1), Liphala and Lisungwe in the Ntcheu Footslopes (NF2), and Gweleweta in the Golomoti Footslopes (BWV3).

- Suitability for rainfed cultivation under improved traditional management

The areas near the Ntcheu Foothills (NF1) in the Lower Dedza Escarpment (DE1) are highly suitable to moderately suitable for groundnuts-L and moderately suitable for maize, tobacco, groundnuts-S, pulses, sunflower and sorghum. The escarpment slopes are not suitable for any crops due to high erosion hazard, and other areas are mainly marginally suitable to not suitable because of shallow soils and also high erosion hazard. The Ntcheu Foothills (NF1) are highly suitable for groundnuts-L, sorghum and sunflower and moderately suitable for most other crops. The major part of the Ntcheu Footslopes (NF2) has the same suitability as the Ntcheu Foothills (NF1) except for groundnuts-L and sunflower, which are moderately suitable. The Golomoti Footslopes (BWV3) are marginally suitable or not suitable for all crops due to impeded drainage.

- Suitability for forestry

The major part of the Lower Dedza Escarpment (DE1) is marginally suitable for Acacia albida, Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for the other tree species considered for evaluation. The areas bordering the Ntcheu Foothills (NF1) have a suitability similar to that of the Ntcheu Foothills (NF1). The Ntcheu Foothills (NF1) and the Ntcheu Footslopes (NF2) are highly suitable for Azadirachta indica, marginally suitable for Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for the other trees, with the exception of Acacia albida which is moderately suitable in the northern part of the Ntcheu Footslopes (NF2) due to soils with a high CEC (fluvic soil group). The Golomoti Footslopes (BWV3) are marginally suitable or not suitable for all crops because of impeded drainage.

7.3.5.4 NCH6 - Tsangano EPA

Tsangano EPA is situated in the south-western part of the RDP and has a total area of 45,800 ha, of which eight percent is taken up by Dzonzi Forest Reserve. The EPA centre is in Tsangano. Four agro-ecological zones are distinguished: Ntcheu Uplands (NTH1) in the centre, Kirk Range (MH5) in the south-west, Ntcheu Escarpment (NTH2) in the north and the Ntcheu Foothills (NF1) to a limited extent in the east. Most important soil families are Mpili and Neno the Ntcheu Uplands (NTH1), Kapalolo, Chisope and Motheriwa in the Kirk Range (MH5) where rock outcrops are common as well, and Walkers Ferry in the Ntcheu Escarpment (NTH2).

- Suitability for rainfed cultivation under improved traditional management

Virtually the whole of the Ntcheu Uplands (NTH1) is highly suitable for phaseolus bean-L and moderately suitable for maize-L, Irish potato, wheat, tobacco, groundnuts-L and sunflower. The western part of the Kirk Range (MH5) is marginally suitable to not suitable for all crops due to high erosion hazard and cool temperatures, except for citrus which is moderately suitable. The eastern part is more suitable for crop cultivation: moderately suitable for maize-L, Irish potato, wheat, tobacco, groundnuts-L, phaseolus bean-L, sunflower and citrus (in part). The major part of the Ntcheu Escarpment (NTH2) is not suitable for almost all crops due to high erosion hazard. A minor part in the centre of the Ntcheu Escarpment (NTH2) has the same suitability as the Ntcheu Uplands (NTH1).

- Suitability for forestry

As for rainfed cultivation virtually the whole of the Ntcheu Uplands (NTH1) has the same suitability for forestry species: highly suitable for Gmelina arborea, marginally suitable for Acacia albida, Callitris hugellii, Cassia siamea, Cordyla africana and Pinus patula, and moderately suitable for the other species considered for evaluation. The Kirk Range (MH5) has the same suitability as the the Ntcheu Uplands (NTH1), except for Acacia albida which is not suitable due to soils with low CEC. The major part of the Ntcheu Escarpment (NTH2) also has the same suitability

as the Ntcheu Uplands (NTH1), except for Gmelina arborea which is moderately suitable due to shallow soils. A minor part in the centre is highly suitable for Gmelina arborea.

7.3.5.5 NCH7 - Nsipe EPA

Nsipe EPA is situated in the central part of the RDP and has a total area of 27,750 ha, of which no land is taken up by forest reserves. The EPA centre is in Nsipe. Four agro-ecological zones are distinguished: Ntcheu Escarpment (NTH2) in the west, Ntcheu Foothills (NF1) in the centre, Lower Dedza Escarpment (DE1) in the east, and the Ntcheu Footslopes (NF2) in the north-central part. Most important soil families are Walkers Ferry representing shallow to moderately deep soils in the Ntcheu Escarpment (NTH2), Mpili in the Ntcheu Foothills (NF1), Neno, Walkers Ferry and Chalenthuwa in the Lower Dedza Escarpment (DE1), and Lisungwe and Mikaju in the Ntcheu Footslopes (NF2).

- Suitability for rainfed cultivation under improved traditional management

The major part of the Ntcheu Escarpment (NTH2) is marginally suitable or not suitable for all crops due to high erosion hazard and shallow soils. A small area in the centre-west has a higher suitability due to deeper soils, being moderately suitable for maize, groundnuts, pulses, tobacco, sorghum and sunflower. The Ntcheu Foothills (NF1) are highly suitable for groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, groundnuts-S and pulses. A minor part in the south-south-east is marginally suitable to not suitable for all crops due to high erosion hazard and poor rooting conditions. The major part of the Lower Dedza Escarpment (DE1) is moderately suitable for all crops with the exception of cassava-L, Irish potato, wheat, citrus and cotton (marginally suitable) and cassava-S and coffee arabica (not suitable). The north and north-east are less suitable: marginally suitable to not suitable for all crops, mainly because of poor rooting conditions on shallow soils. The colluvial soils of the Ntcheu Footslopes (NF2) are highly suitable for sorghum and moderately suitable for maize, groundnuts, pulses, tobacco and sunflower. Other soils have the same suitability as the Ntcheu Foothills (NF1)

- Suitability for forestry

Almost the whole of the Ntcheu Escarpment (NTH2) is moderately suitable for all trees considered for evaluation, except Acacia albida and Pinus patula, which are marginally suitable. A small area in the west-central part is highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, marginally suitable for Pinus patula, and moderately suitable for all other species, due to deeper soils. The major part of the Ntcheu Foothills (NF1) is highly suitable for Azadirachta indica, marginally suitable for Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for the other trees. A minor part in the south-east has a different suitability due to shallower soils and/or a longer dry period. The Lower Dedza Escarpment (DE1) has the same suitability as the major part of the Ntcheu Foothills (NF1), except for the north and north-east which are

moderately suitable for all trees except Acacia albida, Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, which are marginally suitable. The colluvial soils of the Ntcheu Footslopes (NF2) are highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, marginally suitable for Pinus patula, and moderately suitable for the other species. Other soils have the same suitability as the Ntcheu Foothills (NF1).

7.3.5.6 NCH8 - Manjawila EPA

Manjawila EPA is situated in the south-eastern part of the RDP and has a total area of 73,350 ha, of which no land is taken up by forest reserves. The EPA centre is in Manjawila. Ten agro-ecological zones are distinguished: Ntcheu Foothills (NF1) in the centre and west, Balaka Plain (BU1) in the east, Lower Dedza Escarpment (DE1) in the north, Ntcheu Escarpment (NTH2) in the west, Middle Shire Valley (MS1) in the south-east, Ntcheu Uplands (NTH1) in the south-west, Golomoti Footslopes (BWV3) in the north, Lisungwe Valley (MS2) in the extreme south, the Ntcheu Footslopes (NF2) in the north-west and the Kirk Range (MH5) in the south-west. Most important soil families are Walkers Ferry, Neno and Mpili in the Ntcheu Foothills (NF1) and the Balaka Plain (BU1), Neno in the Lower Dedza Escarpment (DE1) and the Middle Shire Valley (MS1), and Walkers Ferry in the Ntcheu Escarpment (NTH2).

- Suitability for rainfed cultivation under improved traditional management

The major part of the Ntcheu Foothills (NF1) is marginally suitable or not suitable for all crops due to poor rooting conditions in shallow and moderately deep soils. Some parts scattered around the zone are more suitable for crop cultivation: highly suitable or moderately suitable for groundnuts-L, sorghum and sunflower and moderately suitable for maize, tobacco, groundnuts-S and pulses. The Balaka Plain (BU1) has a wide variety of land units, suitabilities and limiting factors as can be found in Appendix II. The Lower Dedza Escarpment (DE1) is in general moderately suitable for most crops. The Ntcheu Uplands (NTH1) are marginally suitable to not suitable for all crops due to shallow soils. The Middle Shire Valley (MS1) is mainly moderately suitable for maize-S, groundnuts-S, pulses (except phaseolus bean-L, which is not suitable), sorghum, sunflower and cotton. The northern part of the Ntcheu Uplands (NTH1) is moderately suitable for maize, groundnuts, pulses, tobacco, sorghum and sunflower. The southern part is not suitable for any crops because of high erosion hazard. The Golomoti Footslopes (BWV3), the Lisungwe Valley (MS2), the Ntcheu Footslopes (NF2) and the Kirk Range (MH5) occupy only very small areas and are therefore not described here.

- Suitability for forestry

The majority of the Ntcheu Foothills (NF1) is moderately suitable for all tree species considered for evaluation, except for Acacia albida and Pinus patula. Small units scattered all over the zone are highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, and moderately suitable for Acacia albida. The Balaka Plain (BU1) has a wide variety of suitabilities over the whole zone. Please see Appendix II. The

Lower Dedza Escarpment (DE1) is to a large extent highly suitable for Azadirachta indica, marginally suitable for Callitris calcarata, Eucalyptus grandis, Pinus caribaea and P. patula, and moderately suitable for the other species. The Ntcheu Escarpment (NTH2) is moderately suitable for almost all trees, except for Acacia albida and Pinus patula (marginally suitable). The Middle Shire Valley (MS1) is highly suitable for Azadirachta indica, Callitris hugellii and Cordyla africana, moderately suitable for Acacia albida, Cassia siamea, Eucalyptus camaldulensis, E. tereticornis and Melia azedarach. The northern part of the Ntcheu Uplands (NTH1) is highly suitable for Eucalyptus camaldulensis, E. tereticornis and Melia azedarach, marginally suitable for Pinus patula, and moderately suitable for the other tree species. The southern part is moderately suitable for all species except Acacia albida and Pinus patula for which it is marginally suitable.

APPENDIX I

LAND UNIT DESCRIPTIONS

This Appendix contains a tabular description of the land units of Lilongwe ADD and can be considered as the legend for the Land Unit Map (Map 3). The soil unit is described in detail in this Appendix; the agro-climatic zones are defined in Table 5 (Section 3.2.3). Land units that have a soil unit in common are grouped together on one page for the sake of brevity.

Soil and agro-climate are not given for the following two miscellaneous land units (see also Chapter 3.4.1):

R	land with predominantly very shallow soils	(38,000 ha)
V	land with very steep slopes (> 55%)	(10,450 ha)

Brief explanation of land unit data sheet

1. Land unit code: This code consists of a single number (e.g. 1283) or a capital letter (for miscellaneous land units).

2. Soil unit code: See Chapter 3.4.1 .

3. Agro-climatic zone code: This code consists of a single number (e.g. 58) and is put between brackets to clearly distinguish it from the land unit code. Each code stands for a combination of classes of agro-climatic characteristics. See also Chapter 3.4.1 .

4. Area: Area of land unit in hectares.

5. Distribution: Descriptive.

6. Dominant present land-use and vegetation: Descriptive.

7. Landform: Descriptive.

8. Dominant slope class: Six classes used (See Chapter 3.3.5.1).

9. Altitude range: Range in meters asl.

10. Present erosion: Four erosion classes used: none, slight, moderate and severe.

11. Parent material: Descriptive (See Chapter 3.3.5.1).

12. Soil description: Brief characterization of soil.

13. Soil classification: Classified in terms of soil group, soil family and FAO-soil unit.

14. Effective soil depth: Five classes used; 0-30 cm (very shallow), 30-50 cm (shallow), 50-100 cm (moderately deep), 100-150 cm (deep) and >150 cm (very deep).

16. Depth limiting factor: Descriptive; only mentioned when applicable.

17. Colour subsoil: Descriptive. The Munsell Scale colours have been followed as closely as possible.

18. Surface stoniness and rockiness (%): Three classes used: <1 % (non-stony and non-rocky), 1-15 % (stony and/or fairly rocky) and >15 % (very stony and/or rocky).

19. Particle size, topsoil: Twelve classes are used according to the 'texture triangle'. Soil horizons with more than 40 percent coarse fragments are indicated as 'skeletal'.

20. Particle size, subsoil: Twelve classes are used according to the 'texture triangle'. Soil horizons with more than 40 percent coarse fragments are indicated as 'skeletal'.

21. Soil drainage class: Seven classes used: very poor, poor, imperfect, moderately well, well, somewhat excessive and excessive.

22. Frequency of flooding: Four classes used: none, none to exceptional, exceptional and frequent.

23. Ponding: Descriptive; only mentioned when applicable.

24. Soil reaction (pH): Eleven classes are used: 3.5-4.0, 4.0-4.5, 4.5-5.0, 5.0-5.5, 5.5-6.0, 6.0-6.5, 6.5-7.0, 7.0-7.5, 7.5-8.0, 8.0-8.5 and 8.5-9.9 .

25. Cation exchange capacity (CEC), soil: Three classes are used: very low = <5 me/100 g; low = 5-10 me/100 g; medium to very high = >10 me/100 g.

26. Nitrogen (N): Three classes are used: very low = <0.08 %; low = 0.08-0.12 %; medium to very high = >0.12 %.

27. Phosphorus (P): Three classes are used: very low = <6 ppm; low = 6-18 ppm; medium to very high = >18 ppm.

28. Potassium (K): Three classes are used: very low = <0.1 me/100 g; low = 0.1-0.2 me/100 g; medium to very high = >0.2 me/100 g.

LIST OF LAND UNITS, LILONGWE ADD

Land Unit	Area (ha)	Land Unit	Area (ha)	Land Unit	Area (ha)	Land Unit	Area (ha)
96	300	1274	3650	1316	12600	1358	5050
210	300	1275	3950	1317	14100	1359	10450
316	950	1276	7250	1318	2900	1360	1750
317	1650	1277	1150	1319	2850	1361	2350
318	3350	1278	500	1320	2300	1362	14650
319	9200	1279	4250	1321	27700	1363	1200
320	99000	1280	900	1322	5800	1364	3800
323	2050	1281	950	1323	6400	1365	10000
324	4500	1282	2250	1324	8300	1366	350
367	1150	1283	500	1325	250	1367	6650
369	60600	1284	350	1326	4550	1368	600
371	4550	1285	2500	1327	1900	1369	27450
411	1200	1286	350	1328	6050	1370	600
434	1650	1287	100	1329	7250	1371	3250
549	2500	1288	2350	1330	1650	1372	8400
550	4300	1289	200	1331	9250	1373	4150
552	3500	1290	1650	1332	1000	1374	17850
574	600	1291	1000	1333	3550	1375	10200
650	1150	1292	450	1334	4000	1376	1850
651	500	1293	1450	1335	5400	1377	9750
652	1650	1294	3750	1336	2250	1378	10000
657	6600	1295	10500	1337	3550	1379	9850
1124	4700	1296	600	1338	14950	1380	1900
1202	3550	1297	1600	1339	6550	1381	250
1256	1950	1298	3250	1340	6900	1382	1700
1257	2850	1299	24300	1341	7600	1383	2800
1258	1300	1300	2600	1342	1050	1384	3000
1259	1050	1301	77600	1343	3900	1385	7450
1260	700	1302	750	1344	17000	1386	500
1261	1950	1303	7800	1345	3450	1387	1450
1262	300	1304	4550	1346	2450	1388	4850
1263	2450	1305	3400	1347	14500	1389	2050
1264	200	1306	1550	1348	8900	1390	900
1265	1350	1307	31250	1349	3950	1391	1200
1266	5700	1308	17350	1350	1500	1392	5800
1267	1500	1309	16600	1351	11450	R	38000
1268	22600	1310	9950	1352	11250	V	10450
1269	24300	1311	53950	1353	200		
1270	1050	1312	44500	1354	5800	TOT.	1171800
1271	1150	1313	2750	1355	1050		
1272	1800	1314	4600	1356	3250		
1273	650	1315	1250	1357	17450		

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1256	A1e7	(34)	1,950

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Ntcheu (C)
AGRO-ECOLOGICAL ZONE(S): Ntcheu Footslopes

DOMINANT PRESENT LAND-USE AND VEGETATION:
Rainfed cultivation: maize, pulses, groundnuts, cassava

SOILS AND PHYSIOGRAPHY:

LANDFORM: footslopes river terraces
outwash plains
DOMINANT SLOPE CLASS (%): 0-2 (flat to almost flat)
ALTITUDE RANGE (m asl): 800-1000 PRESENT EROSION: slight

PARENT MATERIAL: fluvial and colluvial deposits
SOIL DESCRIPTION: Very deep, well drained, coarse and medium textured brown soils of low chemical fertility; pH(0-50 cm) 5.5-6.5
SOIL CLASSIFICATION, SOIL GROUP: eutric-fersialic
SOIL FAMILY: Mikaju
FAO, 1988: Haplic Luvisols
Chromic Cambisols

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): <1 (non-stony and non-rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy clay loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy loam to sandy clay loam

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	<0.08 (very low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	0.1-0.2 (low)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1257	A1f2	(41)	2,850
1258		(43)	1,300
1390		(44)	900

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Lilongwe (W+S)
AGRO-ECOLOGICAL ZONE(S): South and West Kasungu Plain
West and South Lilongwe Plain

DOMINANT PRESENT LAND-USE AND VEGETATION:
Seasonally wet grassland of floodplains

SOILS AND PHYSIOGRAPHY:

LANDFORM: floodplains depressions

DOMINANT SLOPE CLASS (%): 0-2 (flat to almost flat)
ALTITUDE RANGE (m asl): 1000-1300 PRESENT EROSION: slight

PARENT MATERIAL: fluvial and colluvial deposits
SOIL DESCRIPTION: Very deep, poorly drained soils with a wide range in texture and colour. Moderate chemical fertility; pH upper 50 cm 5.0-6.5
SOIL CLASSIFICATION, SOIL GROUP: fluvic
SOIL FAMILY: Namitalala
FAO, 1988: Eutric Fluvisols, inundic phase
Mollic Fluvisols, inundic phase

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: variable
SURFACE STONINESS AND ROCKINESS (%): <1 (non-stony and non-rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): variable
PARTICLE SIZE, SUBSOIL (>30 cm): variable

SOIL DRAINAGE CLASS: poor
FREQUENCY OF FLOODING: frequent PONDING: moderate to severe

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	6-18 (low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
96	A1f7	(7)	300
1259		(18)	1,050
1260		(32)	700
1261		(58)	1,950

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Ntcheu (C+E)
AGRO-ECOLOGICAL ZONE(S): Ntcheu Footslopes
Golomoti Footslopes

DOMINANT PRESENT LAND-USE AND VEGETATION:
Rainfed cultivation: maize, pulses, groundnuts, cassava

SOILS AND PHYSIOGRAPHY:

LANDFORM: plains footslopes

DOMINANT SLOPE CLASS (%): 0-2 (flat to almost flat)
ALTITUDE RANGE (m asl): 600-1000 PRESENT EROSION: none

PARENT MATERIAL: fluvial and colluvial deposits
SOIL DESCRIPTION: very deep, moderately well drained, brown, coarse to medium textured soils with low chemical fertility; pH(0-50cm) 5.0-6.5
SOIL CLASSIFICATION, SOIL GROUP: fluvic
SOIL FAMILY: Lisungwe
FAO, 1988: Eutric Fluvisols

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): <1 (non-stony and non-rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy clay loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy loam to sandy clay loam

SOIL DRAINAGE CLASS: moderately well
FREQUENCY OF FLOODING: exceptional PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	<0.08 (very low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1262	A1g8	(34)	300
1386		(41)	500
1263		(42)	2,450

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Dedza (W) Ntcheu (N)
AGRO-ECOLOGICAL ZONE(S): Dedza Uplands
Ntcheu Footslopes

DOMINANT PRESENT LAND-USE AND VEGETATION:
maize, pulses, tobacco, groundnuts (cassava, etc.)

SOILS AND PHYSIOGRAPHY:

LANDFORM: footslopes depressions
lake margin plains
DOMINANT SLOPE CLASS (%): 0-2 (flat to almost flat)
ALTITUDE RANGE (m asl): 800-1400 PRESENT EROSION: slight

PARENT MATERIAL: fluvial and lacustrine deposits
SOIL DESCRIPTION: very deep, poor to imperfectly drained, light grey soils with medium over medium and fine texture, and with low chemical fertility; pH(0-50cm) 5.0-6.0
SOIL CLASSIFICATION, SOIL GROUP: gleyic
SOIL FAMILY: Mpasa
FAO, 1988: Gleyic Cambisols
Eutric Gleysols

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: light grey
SURFACE STONINESS AND ROCKINESS (%): <1 (non-stony and non-rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): sandy loam to sandy clay loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy clay loam to clay

SOIL DRAINAGE CLASS: poor to imperfect
FREQUENCY OF FLOODING: none to exceptional PONDING: moderate

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.0
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	0.1-0.2 (low)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1264	A1g13	(23)	200
1265		(34)	1,350
1266		(41)	5,700
1267		(42)	1,500
1268		(43)	22,600
1269		(44)	24,300
1270		(62)	1,050
1271		(143)	1,150
1272		(144)	1,800
1273		(146)	650

DISTRIBUTION.
DISTRICT(S): Lilongwe (W+S) Dedza (W)
AGRO-ECOLOGICAL ZONE(S): West and South Lilongwe Plain
Central Lilongwe Plain
North-east Lilongwe Plain

DOMINANT PRESENT LAND-USE AND VEGETATION:
Seasonally wet grassland in upland drainage systems

SOILS AND PHYSIOGRAPHY:

LANDFORM: dambos

DOMINANT SLOPE CLASS (%): 0-2 (flat to almost flat)
ALTITUDE RANGE (m asl): 1100-1400 PRESENT EROSION: moderate

PARENT MATERIAL: fluvial and colluvial deposits
SOIL DESCRIPTION: Very deep, poorly to imperfectly drained, grey soils with variable texture and low chemical fertility; pH upper 50 cm 5.5-6.5
SOIL CLASSIFICATION, SOIL GROUP: gleyic
SOIL FAMILY: Tenthema
FAO, 1988: Eutric Gleysols
Eutric Gleysols, inundic phase

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: grey
SURFACE STONINESS AND ROCKINESS (%): <1 (non-stony and non-rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): sand to clay
PARTICLE SIZE, SUBSOIL (>30 cm): sand to clay

SOIL DRAINAGE CLASS: poor to imperfect
FREQUENCY OF FLOODING: none to exceptional PONDING: moderate to severe

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	0.1-0.2 (low)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1274	A1x1	(32)	3,650

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Ntcheu (C)
AGRO-ECOLOGICAL ZONE(S): Ntcheu Footslopes

DOMINANT PRESENT LAND-USE AND VEGETATION:
Rainfed cultivation: maize, pulses, groundnuts, cassava

SOILS AND PHYSIOGRAPHY:

LANDFORM: footslopes

DOMINANT SLOPE CLASS (%): 0-2 (flat to almost flat)
ALTITUDE RANGE (m asl): 900-1200 PRESENT EROSION: slight

PARENT MATERIAL: fluvial deposits
SOIL DESCRIPTION: very deep, moderately well drained, dark brown soils with medium over medium and fine texture, and with moderate chemical fertility; pH(0-50cm) 5.0-6.0
SOIL CLASSIFICATION, SOIL GROUP: eutric-ferralic
SOIL FAMILY: Liphala
FAO, 1988: Haplic Lixisols

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: dark brown
SURFACE STONINESS AND ROCKINESS (%): <1 (non-stony and non-rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): sandy loam to sandy clay loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy clay loam to sandy clay

SOIL DRAINAGE CLASS: moderately well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.0
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	6-18 (low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1275	A2a3	(62)	3,950
1276		(147)	7,250

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Lilongwe (S)
AGRO-ECOLOGICAL ZONE(S): Dzalanyama Footslopes

DOMINANT PRESENT LAND-USE AND VEGETATION:
Brachystegia plateau woodland

SOILS AND PHYSIOGRAPHY:

LANDFORM: footslopes

DOMINANT SLOPE CLASS (%): 2-6 (gently sloping)
ALTITUDE RANGE (m asl): 1200-1300 PRESENT EROSION: slight

PARENT MATERIAL: fluvial and colluvial deposits
SOIL DESCRIPTION: Very deep, well drained, brown, coarse textured soils of very low chemical fertility; pH (0-50 cm) 5.0-6.5

SOIL CLASSIFICATION, SOIL GROUP: arenic
SOIL FAMILY: Thangadzi
FAO, 1988: Cambic Arenosols

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): <1 (non-stony and non-rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): sand to loamy sand
PARTICLE SIZE, SUBSOIL (>30 cm): sand to loamy sand

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	<5 (very low)
NITROGEN (N in %):	<0.08 (very low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	<0.1 (very low)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
210	A2e5	(7)	300

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Ntcheu (S)
AGRO-ECOLOGICAL ZONE(S): Lisungwe Valley

DOMINANT PRESENT LAND-USE AND VEGETATION:
Mixed low altitude savanna with
Rainfed cultivation: maize, pulses, cotton, groundnuts,etc

SOILS AND PHYSIOGRAPHY:

LANDFORM: footslopes alluvial fans

DOMINANT SLOPE CLASS (%): 2-6 (gently sloping)
ALTITUDE RANGE (m asl): 400-600 PRESENT EROSION: slight

PARENT MATERIAL: fluvial and colluvial deposits
SOIL DESCRIPTION: deep, well drained, reddish brown soils with coarse over coarse and medium texture and with moderate fertility; pH(0-50cm) 6.0-7.0
SOIL CLASSIFICATION, SOIL GROUP: eutric-fersialic
SOIL FAMILY: Kachingwe
FAO, 1988: Eutric Cambisols
Chromic Cambisols

EFFECTIVE SOIL DEPTH (cm): 100-150 (deep)
DEPTH LIMITING FACTOR: >70 % stones COLOUR SUBSOIL: reddish brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy loam to sandy clay loam

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	6.0-7.0
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	>0.12 (medium to very high
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1277	A2f7	(32)	1,150
1278		(34)	500
1279		(41)	4,250

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Ntcheu (C+E)
AGRO-ECOLOGICAL ZONE(S): Ntcheu Footslopes
Golomoti Footslopes

DOMINANT PRESENT LAND-USE AND VEGETATION:
Rainfed cultivation: maize, pulses, groundnuts, cassava

SOILS AND PHYSIOGRAPHY:

LANDFORM: footslopes

DOMINANT SLOPE CLASS (%): 2-6 (gently sloping)
ALTITUDE RANGE (m asl): 800-1200 PRESENT EROSION: slight

PARENT MATERIAL: fluvial and colluvial deposits
SOIL DESCRIPTION: Very deep, moderately well to well drained, medium textured brown soils of low chemical fertility; pH(0-50 cm) 5.0-6.5
SOIL CLASSIFICATION, SOIL GROUP: fluvic
SOIL FAMILY: Lisungwe
FAO, 1988: Eutric Fluvisols

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): <1 (non-stony and non-rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy clay loam

SOIL DRAINAGE CLASS: moderately well to well
FREQUENCY OF FLOODING: none to exceptional PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	<0.08 (very low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1280	A2f8	(32)	900
1281		(41)	950
1282		(42)	2,250
1283		(62)	500
1284		(145)	350

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Lilongwe (E) Dedza (C) Ntcheu (E)
AGRO-ECOLOGICAL ZONE(S): Dedza Uplands
Dedza Hills
Golomoti Footslopes

DOMINANT PRESENT LAND-USE AND VEGETATION:
maize, pulses, tobacco, groundnuts (cassava, etc.)

SOILS AND PHYSIOGRAPHY:

LANDFORM: footslopes outwash plains

DOMINANT SLOPE CLASS (%): 2-6 (gently sloping)
ALTITUDE RANGE (m asl): 600-800 PRESENT EROSION: slight

PARENT MATERIAL: fluvial and colluvial deposits
SOIL DESCRIPTION: Very deep, imperfectly drained, greyish brown soils of variable texture, with low chemical fertility; pH (0-50 cm) 5.0-6.5
SOIL CLASSIFICATION, SOIL GROUP: fluvic
SOIL FAMILY: Gweleweta
FAO, 1988: Eutric Fluvisols
Eutric Fluvisols, inundic phase

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: greyish brown
SURFACE STONINESS AND ROCKINESS (%): <1 (non-stony and non-rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy clay loam
PARTICLE SIZE, SUBSOIL (>30 cm): variable

SOIL DRAINAGE CLASS: imperfect
FREQUENCY OF FLOODING: none to exceptional PONDING: slight to moderate

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	6-18 (low)
POTASSIUM (K in me/100g soil):	0.1-0.2 (low)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1285	A3e1	(28)	2,500

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Dedza (E)
AGRO-ECOLOGICAL ZONE(S): Ntcheu Footslopes

DOMINANT PRESENT LAND-USE AND VEGETATION:
Brachystegia hill woodland

SOILS AND PHYSIOGRAPHY:

LANDFORM: footslopes

DOMINANT SLOPE CLASS (%): 6-13 (sloping)
ALTITUDE RANGE (m asl): 500-800 PRESENT EROSION: moderate

PARENT MATERIAL: colluvial deposits
SOIL DESCRIPTION: Very deep, moderately well to well drained, dark brown, medium textured soils of medium chemical fertility; pH (0-50 cm) 5.5-7.0
SOIL CLASSIFICATION, SOIL GROUP: eutric-fersialic
SOIL FAMILY: Jombo
FAO, 1988: Haplic Luvisols, rudic phase
Eutric Cambisols, rudic phase

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: dark brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): sandy clay loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy clay loam

SOIL DRAINAGE CLASS: moderately well to well
FREQUENCY OF FLOODING: none to exceptional PONDING: slight

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-7.0
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	>10 (medium to very high)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	6-18 (low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1286	A3f2	(32)	350
1287		(37)	100
1288		(41)	2,350
1289		(42)	200
1290		(62)	1,650
1291		(75)	1,000
1292		(145)	450

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Ntcheu (C+E) Dedza (C+N)
AGRO-ECOLOGICAL ZONE(S): Ntcheu Footslopes
Ntcheu Escarpment
Dedza Uplands

DOMINANT PRESENT LAND-USE AND VEGETATION:
Rainfed cultivation: maize, pulses, groundnuts, cassava

SOILS AND PHYSIOGRAPHY:

LANDFORM: footslopes

DOMINANT SLOPE CLASS (%): 6-13 (sloping)
ALTITUDE RANGE (m asl): 600-1200 PRESENT EROSION: moderate

PARENT MATERIAL: colluvial deposits
SOIL DESCRIPTION: very deep, well drained, medium textured, dark brown soils with low chemical fertility; pH(0-50cm) 5.5-7.0

SOIL CLASSIFICATION, SOIL GROUP: fluvic
SOIL FAMILY: Chiradzulu
FAO, 1988: Eutric Fluvisols

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: dark brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): sandy loam to sandy clay loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy loam to sandy clay loam

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none to exceptional PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-7.0
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	<0.08 (very low)
PHOSPHORUS (P in ppm):	6-18 (low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE.	AREA (ha)
1293	B2p1	(32)	1,450
1294		(41)	3,750
1295		(42)	10,500
1296		(75)	600

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Dedza (C+N) Ntcheu (C)
AGRO-ECOLOGICAL ZONE(S): Dedza Uplands
Lower Dedza Escarpment
Ntcheu Escarpment

DOMINANT PRESENT LAND-USE AND VEGETATION:
maize, pulses, tobacco, groundnuts (cassava, etc.)

SOILS AND PHYSIOGRAPHY:

LANDFORM: uplands

DOMINANT SLOPE CLASS (%): 2-6 (gently sloping)
ALTITUDE RANGE (m asl): 1000-1300 PRESENT EROSION: slight

PARENT MATERIAL: mafic igneous rocks (basalt)
SOIL DESCRIPTION: Moderately deep, well drained, dark brown, medium textured gravelly soil of moderate chemical fertility; pH upper 50 cm 6.5-7.5
SOIL CLASSIFICATION, SOIL GROUP: paralithic
SOIL FAMILY: Chalenthuwa
FAO, 1988: Eutric Cambisols, skeletic phase
Haplic Phaeozems, skeletic phase

EFFECTIVE SOIL DEPTH (cm): 50-100 (moderately deep)
DEPTH LIMITING FACTOR: rotten rock COLOUR SUBSOIL: dark brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): sandy loam to loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy loam to sandy clay loam, skeletal

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	6.5-7.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	>10 (medium to very high)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1297	B3u1	(41)	1,600

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Dedza (N)
AGRO-ECOLOGICAL ZONE(S): Dedza Uplands

DOMINANT PRESENT LAND-USE AND VEGETATION:
maize, pulses, tobacco, groundnuts (cassava, etc.) with
Brachystegia hill woodland

SOILS AND PHYSIOGRAPHY:

LANDFORM: uplands hillsides

DOMINANT SLOPE CLASS (%): 6-13 (sloping)
ALTITUDE RANGE (m asl): 1000-1200 PRESENT EROSION: slight

PARENT MATERIAL: mafic igneous rocks (basalt)
SOIL DESCRIPTION: Shallow, well drained, dark brown, medium textured soil of moderate chemical fertility; pH upper 50 cm 6.0-7.5

SOIL CLASSIFICATION, SOIL GROUP: lithic
SOIL FAMILY: Chambuluka
FAO, 1988: Eutric Regosols, lithic phase
Calcaric Regosols, lithic phase

EFFECTIVE SOIL DEPTH (cm): 30-50 (shallow)
DEPTH LIMITING FACTOR: hard rock COLOUR SUBSOIL: dark brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy loam, skeletal

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	6.0-7.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	>10 (medium to very high)
NITROGEN (N in %):	>0.12 (medium to very high
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
316	X1e4	(18)	950
1298		(23)	3,250
323		(32)	2,050
1299		(41)	24,300
320		(43)	99,000
324		(58)	4,500
1303		(143)	7,800
317		(20)	1,650
318		(28)	3,350
319		(34)	9,200
1300		(42)	2,600
1301		(44)	77,600
1302		(142)	750

DISTRIBUTION.
DISTRICT(S): Lilongwe (W+S) Dedza (W)
AGRO-ECOLOGICAL ZONE(S): West and South Lilongwe Plain
Central Lilongwe Plain
North-east Lilongwe Plain

DOMINANT PRESENT LAND-USE AND VEGETATION:
maize, pulses, tobacco, groundnuts (cassava, etc.)

SOILS AND PHYSIOGRAPHY:

LANDFORM: footslopes

DOMINANT SLOPE CLASS (%): 0-2 (flat to almost flat)
ALTITUDE RANGE (m asl): 1100-1300 PRESENT EROSION: slight

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: Very deep, well drained, brown, coarse to medium over fine textured soils of moderate chemical fertility; pH upper 50 cm 5.5-6.5
SOIL CLASSIFICATION, SOIL GROUP: eutric-fersialic
SOIL FAMILY: Mpili
FAO, 1988: Chromic Luvisols
Luvic Phaeozems

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): <1 (non-stony and non-rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy clay loam to sandy clay

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	6-18 (low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1304	X1e8	(34)	4,550
1392		(43)	5,800
1305		(144)	3,400
1306		(146)	1,550

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Lilongwe (S+W)
AGRO-ECOLOGICAL ZONE(S): West and South Lilongwe Plain

DOMINANT PRESENT LAND-USE AND VEGETATION:
Brachystegia plateau woodland

SOILS AND PHYSIOGRAPHY:

LANDFORM: uplands plains

DOMINANT SLOPE CLASS (%): 0-2 (flat to almost flat)
ALTITUDE RANGE (m asl): 1100-1300 PRESENT EROSION: slight

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: Very deep, well drained, coarse over coarse to medium textured brown soils of very low chemical fertility; pH(0-50 cm) 5.5-6.5
SOIL CLASSIFICATION, SOIL GROUP: eutric-fersialic
SOIL FAMILY: Euthini
FAO, 1988: Haplic Lixisols

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): <1 (non-stony and non-rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy loam to sandy clay loam

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	<5 (very low)
NITROGEN (N in %):	<0.08 (very low)
PHOSPHORUS (P in ppm):	6-18 (low)
POTASSIUM (K in me/100g soil):	0.1-0.2 (low)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1307	X2e2	(23)	31,250
1308		(32)	17,350
1309		(41)	16,600
1311		(43)	53,950
1389		(45)	2,050
1313		(59)	2,750
1315		(75)	1,250
1317		(143)	14,100

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
367	(28)	1,150
369	(34)	60,600
1310	(42)	9,950
1312	(44)	44,500
371	(58)	4,550
1314	(62)	4,600
1316	(142)	12,600
1318	(146)	2,900

DISTRIBUTION.
DISTRICT(S): Lilongwe (C+E) Dedza (W) Ntcheu (C)
AGRO-ECOLOGICAL ZONE(S): North-east Lilongwe Plain
Central Lilongwe Plain
Ntcheu Foothills

DOMINANT PRESENT LAND-USE AND VEGETATION:
maize, pulses, tobacco, groundnuts (cassava, etc.)

SOILS AND PHYSIOGRAPHY:

LANDFORM: uplands footslopes

DOMINANT SLOPE CLASS (%): 2-6 (gently sloping)
ALTITUDE RANGE (m asl): 600-1400 PRESENT EROSION: slight

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: very deep, well drained, reddish brown, coarse to medium over medium to fine textured soils of moderate chemical fertility; pH(0-50cm) 5.5-6.5
SOIL CLASSIFICATION, SOIL GROUP: eutric-fersialic
SOIL FAMILY: Mpili
FAO, 1988: Chromic Luvisols
Luvic Phaeozems

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: reddish brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy clay loam to sandy clay

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	6-18 (low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1319	X2e5	(7)	2,850
1320		(28)	2,300
1321		(41)	27,700
1322		(42)	5,800

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1323	(43)	6,400
1324	(44)	8,300
1325	(62)	250
1326	(145)	4,550

DISTRIBUTION.
DISTRICT(S): Lilongwe (N+E) Dedza (C) Ntcheu (S)
AGRO-ECOLOGICAL ZONE(S): Dedza Uplands
Balaka Plains

DOMINANT PRESENT LAND-USE AND VEGETATION:
maize, pulses, tobacco, groundnuts (cassava, etc.)

SOILS AND PHYSIOGRAPHY:

LANDFORM: uplands valley sides

DOMINANT SLOPE CLASS (%): 2-6 (gently sloping)
ALTITUDE RANGE (m asl): 500-1400 PRESENT EROSION: slight

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: Deep, well drained, reddish brown to brown, coarse to medium over medium to fine textured soils of low chemical fertilty; pH upper 50 cm 5.0-6.5
SOIL CLASSIFICATION, SOIL GROUP: eutric-fersialic
SOIL FAMILY: Neno (or Zimphonje)
FAO, 1988: Chromic Luvisols
Luvic Phaeozems

EFFECTIVE SOIL DEPTH (cm): 100-150 (deep)
DEPTH LIMITING FACTOR: rotten rock COLOUR SUBSOIL: reddish brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy clay loam to sandy clay

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	<0.08 (very low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
411	X2e7	(18)	1,200

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Ntcheu (S)
AGRO-ECOLOGICAL ZONE(S): Balaka Plains

DOMINANT PRESENT LAND-USE AND VEGETATION:
Mixed low altitude savanna

SOILS AND PHYSIOGRAPHY:

LANDFORM: dissected footslopes

DOMINANT SLOPE CLASS (%): 2-6 (gently sloping)
ALTITUDE RANGE (m asl): 500-600 PRESENT EROSION: moderate

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: Moderately deep, well drained, brown, coarse to medium over medium textured soils of moderate chemical fertility pH upper 50 cm 5.5-6.5
SOIL CLASSIFICATION, SOIL GROUP: eutric-fersialic
SOIL FAMILY: Katema
FAO, 1988: Haplic Luvisols

EFFECTIVE SOIL DEPTH (cm): 50-100 (moderately deep)
DEPTH LIMITING FACTOR: hard rock COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy loam to sandy clay

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	6-18 (low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1327	X2e11	(62)	1,900

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Lilongwe (W)
AGRO-ECOLOGICAL ZONE(S): Upper Bua Plain
West and South Lilongwe Plain

DOMINANT PRESENT LAND-USE AND VEGETATION:
maize, pulses, tobacco, groundnuts (cassava, etc.)

SOILS AND PHYSIOGRAPHY:

LANDFORM: uplands plains

DOMINANT SLOPE CLASS (%): 2-6 (gently sloping)
ALTITUDE RANGE (m asl): 1200-1400 PRESENT EROSION: slight

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: Very deep, well drained, coarse over coarse to medium textured, brown soils of very low chemical fertility; pH(0-50 cm) 5.0-6.5
SOIL CLASSIFICATION, SOIL GROUP: eutric-fersialic
SOIL FAMILY: Euthini
FAO, 1988: Haplic Lixisols
Chromic Luvisols

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): <1 (non-stony and non-rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy loam to sandy clay loam

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	<5 (very low)
NITROGEN (N in %):	<0.08 (very low)
PHOSPHORUS (P in ppm):	6-18 (low)
POTASSIUM (K in me/100g soil):	0.1-0.2 (low)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
434	X2p2	(18)	1,650
1328		(28)	6,050
1329		(32)	7,250
1330		(41)	1,650
1331		(42)	9,250

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1332	(43)	1,000
1333	(44)	3,550

DISTRIBUTION.
DISTRICT(S): Dedza (C) Ntcheu (S) Lilongwe (E)
AGRO-ECOLOGICAL ZONE(S): Dedza Uplands
Balaka Plains
Ntcheu Foothills

DOMINANT PRESENT LAND-USE AND VEGETATION:
Mixed low altitude savanna with
Rainfed cultivation: maize, pulses, groundnuts, cassava

SOILS AND PHYSIOGRAPHY:

LANDFORM: uplands

DOMINANT SLOPE CLASS (%): 2-6 (gently sloping)
ALTITUDE RANGE (m asl): 600-1400 PRESENT EROSION: slight

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: moderately deep, well drained, brown soils with coarse and medium over medium texture, skeletal subsoil, and low chemical fertility; pH(0-50cm) 5.5-6.5
SOIL CLASSIFICATION, SOIL GROUP: paralithic
SOIL FAMILY: Walkers Ferry
FAO, 1988: Eutric Cambisols, rudic phase
Chromic Cambisols, rudic phase

EFFECTIVE SOIL DEPTH (cm): 50-100 (moderately deep)
DEPTH LIMITING FACTOR: rotten rock COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy loam to sandy clay loam, skeletal

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1334	X2x2	(44)	4,000
1335		(62)	5,400
1336		(77)	2,250

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Dedza (S) Lilongwe (S+W)
AGRO-ECOLOGICAL ZONE(S): Dedza Hills
Dzalanyama Hills

DOMINANT PRESENT LAND-USE AND VEGETATION:
maize, pulses, Irish potato, groundnuts

SOILS AND PHYSIOGRAPHY:

LANDFORM: footslopes

DOMINANT SLOPE CLASS (%): 2-6 (gently sloping)
ALTITUDE RANGE (m asl): 1200-1600 PRESENT EROSION: slight

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: Very deep, well drained, dark reddish brown, coarse over medium to fine textured soil of low chemical fertility; pH upper 50 cm 5.0-6.0
SOIL CLASSIFICATION, SOIL GROUP: eutric-ferralic
SOIL FAMILY: Nkwepela
FAO, 1988: Haplic Lixisols

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: dark reddish brown
SURFACE STONINESS AND ROCKINESS (%): <1 (non-stony and non-rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand
PARTICLE SIZE, SUBSOIL (>30 cm): sandy clay loam to sandy clay

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.0
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	<0.08 (very low)
PHOSPHORUS (P in ppm):	6-18 (low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1337	X3e1	(41)	3,550
1338		(75)	14,950

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Ntcheu (S) Lilongwe (E)
AGRO-ECOLOGICAL ZONE(S): Ntcheu Uplands
Dedza Uplands
Ntcheu Escarpment

DOMINANT PRESENT LAND-USE AND VEGETATION:
Rainfed cultivation: maize,pulses,finger millet,wheat,etc.with
Montane grassland with forest remnants

SOILS AND PHYSIOGRAPHY:

LANDFORM: uplands footslopes

DOMINANT SLOPE CLASS (%): 6-13 (sloping)
ALTITUDE RANGE (m asl): 1000-1600 PRESENT EROSION: slight

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: very deep, well drained, brown, coarse to medium over medium to fine textured soils with moderate chemical fertility; pH(0-50cm) 5.5-6.5
SOIL CLASSIFICATION, SOIL GROUP: eutric-fersialic
SOIL FAMILY: Mpili
FAO, 1988: Chromic Luvisols
Luvic Phaeozems

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: reddish brown
SURFACE STONINESS AND ROCKINESS (%): <1 (non-stony and non-rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy clay loam to sandy clay

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	6-18 (low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1124	X3e9	(32)	4,700
1339		(44)	6,550
1340		(62)	6,900

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Dedza (S) Ntcheu (E)
AGRO-ECOLOGICAL ZONE(S): Dedza Uplands
Dedza Hills
Lower Dedza Escarpment

DOMINANT PRESENT LAND-USE AND VEGETATION:
maize, pulses, tobacco, groundnuts (cassava, etc.)

SOILS AND PHYSIOGRAPHY:

LANDFORM: valleys in uplands

DOMINANT SLOPE CLASS (%): 6-13 (sloping)
ALTITUDE RANGE (m asl): 1000-1600 PRESENT EROSION: slight to moderate

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: Deep, well drained, medium textured, brown soils, of low chemical fertility; pH(0-50 cm) 5.0-6.5

SOIL CLASSIFICATION, SOIL GROUP: eutric-fersialic
SOIL FAMILY: Neno (or Zimphonje)
FAO, 1988: Chromic Luvisols
Chromic Cambisols

EFFECTIVE SOIL DEPTH (cm): 100-150 (deep)
DEPTH LIMITING FACTOR: rotten rock COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): <1 (non-stony and non-rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy clay loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy clay loam

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	<0.08 (very low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1341	X3e10	(26)	7,600
1343		(28)	3,900
1345		(34)	3,450
1347		(41)	14,500
1388		(45)	4,850
1391		(59)	1,200
1351		(75)	11,450

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1342	(27)	1,050
1344	(32)	17,000
1346	(37)	2,450
1348	(42)	8,900
1349	(58)	3,950
1350	(62)	1,500
1352	(145)	11,250

DISTRIBUTION.
DISTRICT(S): Lilongwe (E) Dedza (C+E) Ntcheu
AGRO-ECOLOGICAL ZONE(S): Dedza Uplands
Upper Dedza Escarpment
Lower Dedza Escarpment

DOMINANT PRESENT LAND-USE AND VEGETATION:
maize, pulses, tobacco, groundnuts (cassava, etc.)

SOILS AND PHYSIOGRAPHY:

LANDFORM: uplands low hills

DOMINANT SLOPE CLASS (%): 6-13 (sloping)
ALTITUDE RANGE (m asl): 600-1400 PRESENT EROSION: slight to moderate

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: Deep, well drained, brown, coarse to medium over medium to fine textured soils of low chemical fertility; pH upper 50 cm 5.0-6.5
SOIL CLASSIFICATION, SOIL GROUP: eutric-fersialic
SOIL FAMILY: Neno
FAO, 1988: Chromic Luvisols, rudic phase
Chromic Cambisols, rudic phase

EFFECTIVE SOIL DEPTH (cm): 100-150 (deep)
DEPTH LIMITING FACTOR: rotten rock COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): sandy loam to sandy clay loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy clay loam to clay

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	<0.08 (very low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1353	X3p2	(7)	200
549		(27)	2,500
550		(32)	4,300
1354		(34)	5,800
552		(58)	3,500

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Ntcheu (S+E) Lilongwe (N)
AGRO-ECOLOGICAL ZONE(S): Ntcheu Foothills
Lower Dedza Escarpment
Dedza Uplands

DOMINANT PRESENT LAND-USE AND VEGETATION:
Rainfed cultivation: maize, pulses, groundnuts, cassava

SOILS AND PHYSIOGRAPHY:

LANDFORM: dissected uplands ridges
escarpments
DOMINANT SLOPE CLASS (%): 6-13 (sloping)
ALTITUDE RANGE (m asl): 600-1100 PRESENT EROSION: slight to moderate

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: moderately deep, well drained, brown soils with coarse and medium over medium texture, skeletal subsoil, and low chemical fertility; pH(0-50cm) 5.5-6.5
SOIL CLASSIFICATION, SOIL GROUP: paralithic
SOIL FAMILY: Walkers Ferry
FAO, 1988: Eutric Cambisols, rudic phase
Chromic Cambisols, rudic phase

EFFECTIVE SOIL DEPTH (cm): 50-100 (moderately deep)
DEPTH LIMITING FACTOR: rotten rock COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): >15 (very stony and/or rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy clay loam, skeletal

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1355	X3p3	(28)	1,050
1356		(32)	3,250
1385		(34)	7,450
1357		(41)	17,450
1358		(42)	5,050
1359		(58)	10,450
1360		(145)	1,750

DISTRIBUTION.
DISTRICT(S): Ntcheu (C) Lilongwe (E)
AGRO-ECOLOGICAL ZONE(S): Ntcheu Foothills
Ntcheu Escarpment
Dedza Uplands

DOMINANT PRESENT LAND-USE AND VEGETATION:
maize, pulses, tobacco, groundnuts (cassava, etc.)

SOILS AND PHYSIOGRAPHY:

LANDFORM: uplands escarpments

DOMINANT SLOPE CLASS (%): 6-13 (sloping)
ALTITUDE RANGE (m asl): 800-1400 PRESENT EROSION: slight to moderate

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: Moderately deep, well drained, brown, coarse to medium over medium textured soil, with gravelly subsoil, of low chemical fertility; pH upper 50 cm 5.5-6.5
SOIL CLASSIFICATION, SOIL GROUP: paralithic
SOIL FAMILY: Walkers Ferry
FAO, 1988: Eutric Cambisols, skeletic phase
Chromic Cambisols, skeletic phase

EFFECTIVE SOIL DEPTH (cm): 50-100 (moderately deep)
DEPTH LIMITING FACTOR: rotten rock COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy loam to sandy clay loam, skeletal

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
574	X3x2	(77)	600

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Ntcheu (S)
AGRO-ECOLOGICAL ZONE(S): Kirk Range

DOMINANT PRESENT LAND-USE AND VEGETATION:
Montane grassland with forest remnants with
Rainfed cultivation: maize,pulses,finger millet,wheat,etc.

SOILS AND PHYSIOGRAPHY:

LANDFORM: uplands

DOMINANT SLOPE CLASS (%): 6-13 (sloping)
ALTITUDE RANGE (m asl): 1400-1600 PRESENT EROSION: slight

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: very deep, well drained, reddish brown soils with medium over fine texture, and with moderate chemical fertility; pH(0-50cm) 5.0-6.0
SOIL CLASSIFICATION, SOIL GROUP: eutric-ferralic
SOIL FAMILY: Motheriwa
FAO, 1988: Haplic Lixisols

EFFECTIVE SOIL DEPTH (cm): >150 (very deep)
DEPTH LIMITING FACTOR: none COLOUR SUBSOIL: reddish brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): sandy clay loam
PARTICLE SIZE, SUBSOIL (>30 cm): clay

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.0
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	<0.08 (very low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1361	X3x7	(62)	2,350
1362		(77)	14,650
1363		(146)	1,200
1364		(147)	3,800

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Lilongwe (S+W) Ntcheu (S)
AGRO-ECOLOGICAL ZONE(S): Dzalanyama Hills
Kirk Range

DOMINANT PRESENT LAND-USE AND VEGETATION:
Rainfed cultivation: maize,pulses,finger millet,wheat,etc.

SOILS AND PHYSIOGRAPHY:

LANDFORM: hillsides

DOMINANT SLOPE CLASS (%): 6-13 (sloping)
ALTITUDE RANGE (m asl): 1200-1800 PRESENT EROSION: slight

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: Deep, well drained, yellowish brown, medium textured soils of very low chemical fertility; pH upper 50 cm 5.0-6.5
SOIL CLASSIFICATION, SOIL GROUP: eutric-ferralic
SOIL FAMILY: Kapalola
FAO, 1988: Xanthic Ferralsols, rudic phase
Ferric Luvisols, rudic phase

EFFECTIVE SOIL DEPTH (cm): 100-150 (deep)
DEPTH LIMITING FACTOR: rotten rock COLOUR SUBSOIL: yellowish brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy clay loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy clay loam to sandy clay

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	<5 (very low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1365	X4e4	(41)	10,000
1366		(43)	350
1367		(62)	6,650
1368		(78)	600
1369		(145)	27,450

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Dedza (E+N) Lilongwe (E)
AGRO-ECOLOGICAL ZONE(S): Upper Dedza Escarpment
Dedza Hills
South Dowa Hills

DOMINANT PRESENT LAND-USE AND VEGETATION:
maize, pulses, Irish potato, groundnuts

SOILS AND PHYSIOGRAPHY:

LANDFORM: hillsides

DOMINANT SLOPE CLASS (%): 13-25 (moderately steep)
ALTITUDE RANGE (m asl): 900-2000 PRESENT EROSION: slight to moderate

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: Deep, well drained, reddish brown, coarse to medium over medium to fine textured soils of low chemical fertility; pH upper 50 cm 5.0-6.5
SOIL CLASSIFICATION, SOIL GROUP: eutric-fersialic
SOIL FAMILY: Neno
FAO, 1988: Chromic Luvisols, rudic phase
Chromic Cambisols, rudic phase

EFFECTIVE SOIL DEPTH (cm): 100-150 (deep)
DEPTH LIMITING FACTOR: rotten rock COLOUR SUBSOIL: reddish brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): sandy loam to sandy clay loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy clay loam to clay

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	<0.08 (very low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1370	X4e5	(62)	600
1371		(77)	3,250

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Lilongwe (S)
AGRO-ECOLOGICAL ZONE(S): Dzalanyama Hills

DOMINANT PRESENT LAND-USE AND VEGETATION:
Brachystegia hill woodland

SOILS AND PHYSIOGRAPHY:

LANDFORM: hillsides

DOMINANT SLOPE CLASS (%): 13-25 (moderately steep)
ALTITUDE RANGE (m asl): 1300-1650 PRESENT EROSION: slight

PARENT MATERIAL: felsic igneous rocks (granite)
SOIL DESCRIPTION: Deep, well drained, yellowish brown, coarse over medium skeletal textured soils of low chemical fertility; pH upper 50 cm 5.5-6.5
SOIL CLASSIFICATION, SOIL GROUP: eutric-fersialic
SOIL FAMILY: Dzalanyama
FAO, 1988: Eutric Cambisols, rudic phase

EFFECTIVE SOIL DEPTH (cm): 100-150 (deep)
DEPTH LIMITING FACTOR: rotten rock COLOUR SUBSOIL: yellowish brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy loam, skeletal

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	<0.08 (very low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
650	X4p2	(26)	1,150
651		(27)	500
652		(28)	1,650
1372		(32)	8,400
1373		(37)	4,150
1374		(41)	17,850
1387		(43)	1,450
657		(58)	6,600
1375		(75)	10,200
1376		(145)	1,850

DISTRIBUTION.
DISTRICT(S): Ntcheu Dedza (E) Lilongwe (E)
AGRO-ECOLOGICAL ZONE(S): Lower Dedza Escarpment
Upper Dedza Escarpment
Ntcheu Escarpment

DOMINANT PRESENT LAND-USE AND VEGETATION:
Brachystegia hill woodland

SOILS AND PHYSIOGRAPHY:

LANDFORM: hillsides dissected escarpments

DOMINANT SLOPE CLASS (%): 13-25 (moderately steep)
ALTITUDE RANGE (m asl): 600-1500 PRESENT EROSION: moderate

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: moderately deep, well drained, brown soils with coarse over medium texture, skeletal subsoil, and low chemical fertility; pH(0-50cm)= 5.5-6.5
SOIL CLASSIFICATION, SOIL GROUP: paralithic
SOIL FAMILY: Walkers Ferry
FAO, 1988: Eutric Cambisols, rudic phase
Chromic Cambisols, rudic phase

EFFECTIVE SOIL DEPTH (cm): 50-100 (moderately deep)
DEPTH LIMITING FACTOR: rotten rock COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): >15 (very stony and/or rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy loam, skeletal

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1202	X4x5	(75)	3,550

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Ntcheu (S)
AGRO-ECOLOGICAL ZONE(S): Kirk Range

DOMINANT PRESENT LAND-USE AND VEGETATION:
Montane grassland with forest remnants with
Rainfed cultivation: maize,pulses,finger millet,wheat,etc.

SOILS AND PHYSIOGRAPHY:

LANDFORM: dissected plateaux

DOMINANT SLOPE CLASS (%): 13-25 (moderately steep)
ALTITUDE RANGE (m asl): 1200-1600 PRESENT EROSION: moderate

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: Deep, well drained, medium to fine textured, reddish brown soils, of low chemical fertility; pH(0-50 cm)= 5.0-6.5
SOIL CLASSIFICATION, SOIL GROUP: eutric-ferralic
SOIL FAMILY: Chisope
FAO, 1988: Haplic Lixisols
Haplic Ferralsols

EFFECTIVE SOIL DEPTH (cm): 100-150 (deep)
DEPTH LIMITING FACTOR: rotten rock COLOUR SUBSOIL: reddish brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): sandy clay loam to sandy clay
PARTICLE SIZE, SUBSOIL (>30 cm): sandy clay loam to sandy clay

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.0-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	6-18 (low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1377	X5p5	(37)	9,750
1378		(41)	10,000
1379		(43)	9,850
1380		(70)	1,900
1381		(77)	250
1382		(145)	1,700

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Dedza (E) Ntcheu (N)
AGRO-ECOLOGICAL ZONE(S): Upper Dedza Escarpment

DOMINANT PRESENT LAND-USE AND VEGETATION:
Brachystegia escarpment woodland

SOILS AND PHYSIOGRAPHY:

LANDFORM: hillsides escarpments

DOMINANT SLOPE CLASS (%): 25-55 (steep)
ALTITUDE RANGE (m asl): 700-1500 PRESENT EROSION: slight to moderate

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: Moderately deep, well drained, brown, coarse to medium over medium skeletal soils of low chemical fertility; pH upper 50 cm 5.5-6.5
SOIL CLASSIFICATION, SOIL GROUP: paralithic
SOIL FAMILY: Walkers Ferry
FAO, 1988: Eutric Cambisols, rudic phase
Chromic Cambisols, rudic phase

EFFECTIVE SOIL DEPTH (cm): 50-100 (moderately deep)
DEPTH LIMITING FACTOR: rotten rock COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy loam to sandy clay loam, skeletal

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

STUDY AREA: LADD

LAND UNIT	SOIL UNIT	AGRO-CLIMATIC ZONE	AREA (ha)
1383	X5p6	(32)	2,800
1384		(41)	3,000

LAND UNIT	AGRO-CLIMATIC ZONE	AREA (ha)

DISTRIBUTION.
DISTRICT(S): Ntcheu (N)
AGRO-ECOLOGICAL ZONE(S): Upper Dedza Escarpment
Lower Dedza Escarpment

DOMINANT PRESENT LAND-USE AND VEGETATION:
maize, pulses, Irish potato, groundnuts with
Montane grassland with forest remnants

SOILS AND PHYSIOGRAPHY:

LANDFORM: hillsides escarpments

DOMINANT SLOPE CLASS (%): 25-55 (steep)
ALTITUDE RANGE (m asl): 600-1500 PRESENT EROSION: moderate to severe

PARENT MATERIAL: intermediate metamorphic rocks (gneiss or granulite)
SOIL DESCRIPTION: Moderately deep, well drained, brown, coarse to medium over medium skeletal soils of low chemical fertility; pH upper 50 cm 5.5-6.5
SOIL CLASSIFICATION, SOIL GROUP: paralithic
SOIL FAMILY: Walkers Ferry
FAO, 1988: Eutric Cambisols, rudic phase
Chromic Cambisols, rudic phase

EFFECTIVE SOIL DEPTH (cm): 50-100 (moderately deep)
DEPTH LIMITING FACTOR: rotten rock COLOUR SUBSOIL: brown
SURFACE STONINESS AND ROCKINESS (%): 1-15 (stony and/or fairly rocky)
PARTICLE SIZE, TOPSOIL (0-30 cm): loamy sand to sandy loam
PARTICLE SIZE, SUBSOIL (>30 cm): sandy loam to sandy clay loam, skeletal

SOIL DRAINAGE CLASS: well
FREQUENCY OF FLOODING: none PONDING: none

SOIL CHEMICAL PROPERTIES (0-50 cm),

SOIL REACTION (pH):	5.5-6.5
SALINITY (EC in mmhos/cm):	0-2 (non saline)
CATION EXCHANGE CAPACITY (CEC in me/100g soil):	5-10 (low)
NITROGEN (N in %):	0.08-0.12 (low)
PHOSPHORUS (P in ppm):	<6 (very low)
POTASSIUM (K in me/100g soil):	>0.2 (medium to very high)

APPENDIX II

LAND SUITABILITY INVENTORY

This Appendix contains a tabular description of the land suitability of Lilongwe ADD. The tables are presented in the following order: rainfed agriculture under traditional management (tm), rainfed agriculture under improved traditional management (itm), irrigated agriculture under traditional management (r), and forestry (f).

Explanation of land suitability classes:

S1 - Highly suitable.

S2 - Moderately suitable.

S3 - Marginally suitable.

N - Not suitable.

S1/2, S2/S3 and S3/N. These classes are used to show intermediate land suitabilities.

Land suitability subclasses. Lower-case letter suffixes are added to the suitability classes S1/2, S2, S2/3, S3, S3/N and N. They indicate the type of limitation to the given land use. If more than three types of limitation occur, only the three most important ones are indicated. The suffixes used are:

- c: Temperature regime
- e: Erosion hazard
- f: Flooding hazard
- k: Soil workability
- m: Moisture regime
- n: Nutrient availability
- r: Rooting conditions
- s: Soil related factors
- t: Nutrient retention capacity
- w: Oxygen availability
- x: Toxicity/acidity

For more information the reader is referred to Chapter 5.

APPENDIX IIa: Land suitability for rainfed agriculture under traditional management

LAND SUITABILITY MATRIX — Model: traditional management (TM) — Study Area: LADD

Land Unit	Soil Unit	AC IN	Area (ha)	BULRUSH MILLET	CASSAVA	CITRUS	COTTON	COWPEA	GROUND NUTS	IRISH POTATO	MAIZE	PHAS. BEANS	PIGEON PEA	SORGHUM	SOYBEAN	SUN FLOWER	SWEET POTATO	WHEAT
1256	A1e7	(34)	1,950	S3c	S3en	S3en	S3cn	S3n	S3n	S3cn	S3n	S3n	S3n	S3n	S3n	S3n	S3n	S3cn
1257	A1f2	(41)	2,850	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw
1258		(43)	1,300	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw
1590		(44)	900	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw
96	A1f7	(7)	300	S2en	S3e	Ne	S2/3n	S2/3n	S3e	Nc	S3/Ne	S2/3en	S2/3n	S3e	S2/3en	S2/3n	S3e	Nc
1259		(18)	1,050	S2cn	S3e	S3/Ne	S2/3n	S2/3n	S2/3n	Nc	S2/3en	S2/3en	S2/3n	S2/3n	S2/3en	S2/3n	S3e	Nc
1260		(32)	700	S3c	S3e	S3/Ne	S3c	S2/3n	S2/3n	S3c	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S3c
1261		(58)	1,950	S3c	S3e	S3fe	S3c	S2/3n	S2/3n	S3c	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S3c
1262	A1g8	(34)	300	S3cw	S3ew	Nw	S3cw	S3w	S3w	S3cw	S3w	S3w	S3w	S2/3n	S2/3n	S3w	S3w	S3cw
1586		(41)	500	S3cw	S3ew	Nw	S3cw	S3w	S3w	S3cw	S3w	S3w	S3w	S2/3n	S2/3n	S3w	S3w	S3cw
1263		(42)	2,450	S3cw	S3cew	Nw	S3cw	S3w	S3w	S3cw	S3w	S3w	S3w	S2/3n	S2/3n	S3w	S3w	S3cw
1264	A1g13	(23)	200	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1265		(34)	1,350	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1266		(41)	5,700	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1267		(42)	1,500	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1268		(43)	22,600	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1269		(44)	24,300	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1270		(62)	1,050	Ncw	Nw	Nw	Ncw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1271		(143)	1,150	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1272		(144)	1,800	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1273		(146)	650	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1274	A1x1	(32)	3,650	S3c	S3e	S3/Ne	S3c	S2cnx	S2nx	S3c	S2n	S2nx	S2cn	S2n	S2cnx	S2nx	S2cen	S3c
1275	A2a3	(62)	3,950	Nc	S3/Nn	S3/Nn	Nc	S3/Nn	S3/Nn	S3/Nn	S3/Nn	S3/Nn	S3/Nn	S3/Nn	S3/Nn	S3/Nn	S3/Nn	S3/Nn
1276		(147)	7,250	Nce	Ne	S3/Nn	Nce	S3/Nn	S3/Nn	S3/Nn	S3/Nn	S3/Nn	Ne	Ne	S3/Nn	Ne	S3/Nn	S3/Nn
210	A2e5	(7)	300	S2en	S3e	Ne	S2/3n	S2/3n	S3e	Nc	S3/Ne	S2/3en	S2/3n	S3e	S2/3en	S2/3n	S3e	Nc
1277	A2f7	(32)	1,150	S3c	S3e	S3/Ne	S3c	S2/3n	S2/3n	S3c	S2/3n	S2/3n	S2/3en	S2/3en	S2/3n	S2/3en	S2/3n	S3c
1278		(34)	500	S3c	S3e	S3e	S3c	S2/3n	S2/3n	S3c	S2/3n	S2/3n	S2/3en	S2/3en	S2/3n	S2/3en	S2/3n	S3c
1279		(41)	4,250	S3c	S3e	S3/Ne	S3c	S2/3n	S2/3n	S3c	S2/3n	S2/3n	S2/3en	S2/3en	S2/3n	S2/3en	S2/3n	S3c
1280	A2f8	(32)	900	S3cw	S3ew	Nw	S3cw	S3w	S3w	S3cw	S3w	S3w	S3w	S2/3e	S2cnw	S3w	S3w	S3cw
1281		(41)	950	S3cw	S3ew	Nw	S3cw	S3w	S3w	S3cw	S3w	S3w	S3w	S2/3e	S2cnw	S3w	S3w	S3cw
1282		(42)	2,250	S3cw	S3cew	Nw	S3cw	S3w	S3w	S3cw	S3w	S3w	S3w	S2/3e	S2cnw	S3w	S3w	S3cw
1283		(62)	500	Nc	S3cew	Nw	Nc	S3cw	S3w	S3w	S3w	S3w	S3cw	S3c	S3c	S3w	S3cw	S3w

LIMITING FACTORS: c - temperature regime; e - erosion hazard; f - flooding hazard; k - soil workability; m - moisture regime; n - nutrient availability; r - rooting conditions; w - oxygen availability; x - toxicity/acidity

APPENDIX IIa (continued)

LAND SUITABILITY MATRIX — Model: traditional management (TM) — Study Area: LADD

Land Unit	Soil Unit	AC IN	Area (ha)	BULRUSH MILLET	CASSAVA	CITRUS	COTTON	COWPEA	GROUND NUTS	IRISH POTATO	MAIZE	PHAS. BEANS	PIGEON PEA	SORGHUM	SOYBEAN	SUN FLOWER	SWEET POTATO	WHEAT
1284	A2f8	(145)	350	Nc	S3caw	Nw	Nc	S3cw	S3w	S3w	S2w	S2w	S3cw	S3c	S3c	S3w	S3cw	S3w
1285	A3e1	(28)	2,500	Ne	Ne	S3ea	Ne	S3e	S3e	Nc	S2e	S2e	Ne	Ne	S3e	Ne	S3e	Nc
1286	A3f2	(32)	350	Ne	Ne	S3/Na	Ne	S3e	S3e	S3ce	S3e	S3e	Ne	Ne	S2e	Ne	S3e	S3ce
1287		(37)	100	Ne	Ne	S3/Na	Ne	S3e	S3e	Nc	S3e	S3e	Ne	Ne	S3e	Ne	S3e	Nc
1288		(41)	2,350	Ne	Ne	S3/Na	Ne	S3e	S3e	S3ce	S3e	S3e	Ne	Ne	S3e	Ne	S3e	S3ce
1289		(42)	200	Ne	Ne	S3/Na	Ne	S3e	S3e	S3ce	S3e	S3e	Ne	Ne	S2e	Ne	S3e	S3ce
1290		(62)	1,650	Nce	Ne	S3ea	Nce	S3ce	S3e	S3e	S3e	S3e	Ne	Ne	S3ce	Ne	S3ce	S3e
1291		(75)	1,000	Nce	Ne	S3ea	Nce	S3ce	S3e	S3e	S3e	S3e	Ne	Ne	S3ce	Ne	S3ce	S3e
1292		(145)	450	Nce	Ne	S3ea	Nce	S3ce	S3e	S3e	S3e	S3e	Ne	Ne	S3ce	Ne	S3ce	S3e
1293	B2p1	(32)	1,450	Ne	Ne	Na	Ne	S3r	S3r	S3cr	S3r	S3r	Ne	Ne	S3r	Ne	S3r	S3cr
1294		(41)	3,750	Ne	Ne	Na	Ne	S3r	S3r	S3cr	S3r	S3r	Ne	Ne	S3r	Ne	S3r	S3cr
1295		(42)	10,500	Ne	Ne	Na	Ne	S3r	S3r	S3cr	S3r	S3r	Ne	Ne	S3r	Ne	S3r	S3cr
1296		(75)	600	Nce	Ne	S3/Nar	Nce	S3cr	S3r	S3r	S3r	S3r	Ne	Ne	S3cr	Ne	S3cr	S3r
1297	B3u1	(41)	1,600	Ne	Ner	Near	Ner	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
5003	R	(0)	38,000	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
5004	V	(0)	10,450	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
316	X1e4	(18)	950	S2c	S3a	S3/Na	S2an	S2an	S2an	Nc	S2/3a	S2/3a	S2an	S2an	S2/3a	S2an	S3a	Nc
317		(20)	1,650	S2c	S3a	S3a	S2an	S2an	S2an	Nc	S2/3a	S2/3a	S2an	S2an	S2/3a	S2an	S3a	Nc
1298		(23)	3,250	S3c	S3a	S3/Na	S3c	S2can	S2an	S3c	S2an	S2an	S2can	S2an	S2can	S2an	S3a	S3c
318		(28)	3,350	S2c	S3a	S3a	S2n	S2n	S2n	Nc	S2n	S2n	S2n	S2n	S2n	S2n	S2an	Nc
323		(32)	2,050	S3c	S3a	S3/Na	S3c	S2cn	S2n	S3c	S2n	S2n	S2cn	S2n	S2cn	S2n	S2can	S3c
319		(34)	9,200	S3c	S3a	S3a	S3c	S2cn	S2n	S3c	S2n	S2n	S2cn	S2n	S2cn	S2n	S2can	S3c
1299		(41)	24,300	S3c	S2a	S3/Na	S3c	S2cn	S2n	S3c	S2n	S2n	S2cn	S2n	S2cn	S2n	S2can	S3c
1300		(42)	2,600	S3c	S3ca	S3/Na	S3c	S2cn	S2n	S3c	S2n	S2n	S2cn	S2n	S2cn	S2n	S2can	S3c
320		(43)	99,000	S3c	S3a	S3a	S3c	S2cn	S2n	S3c	S2n	S2n	S2cn	S2n	S2cn	S2n	S2can	S3c
1301		(44)	77,600	S3c	S3ca	S3a	S3c	S2cn	S2n	S3c	S2n	S2n	S2cn	S2n	S2cn	S2n	S2can	S3c
324		(58)	4,500	S3c	S3a	S3a	S3c	S2cn	S2n	S3c	S2n	S2n	S2cn	S2n	S2cn	S2n	S2cn	S3c
1302		(142)	750	S3c	S3a	S3a	S3c	S2can	S2an	S3c	S2an	S2an	S2can	S2an	S2can	S2an	S3a	S3c
1303		(143)	7,800	S3c	S3ca	S3/Na	S3c	S2can	S2an	S3c	S2an	S2an	S2can	S2an	S2can	S2an	S3a	S3c
1304	X1e6	(34)	4,550	S3c	S3a	S3a	S3c	S2/3n	S2/3n	S3c	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S3c
1307		(43)	5,800	S3c	S3a	S3a	S3c	S2/3n	S2/3n	S3c	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S3c
1305		(144)	3,400	S3c	S3ca	S2/3n	S3c	S2/3n	S2/3n	S3c	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S3c
1306		(146)	1,550	S3c	S3ca	S2/3n	S3c	S2/3n	S2/3n	S3c	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S2/3n	S3c

LIMITING FACTORS: c - temperature regime; e - erosion hazard; f - flooding hazard; k - soil workability; m - moisture regime; n - nutrient availability; r - rooting conditions; w - oxygen availability; x - toxicity/acidity

APPENDIX IIa (continued)

LAND SUITABILITY MATRIX — Model: traditional management (TM) — Study Area: LAGO

Land Unit	Soil Unit	AC ZN	Area (ha)	PULPUSH MILLET	CASSAVA	CITRUS	COTTON	COWPEA	GROUND NUTS	IRISH POTATO	MAIZE	PHAS. BEANS	PIGEON PEA	SORGHUM	SOYBEAN	SUN FLOWER	SWEET POTATO	WHEAT
1307	I2e2	(27)	31,250	S3c	S3e	S3/Ne	S3c	S2can	S2an	S3c	S2an	S2an	S2/3e	S2/3e	S2can	S2/3e	S3e	S3c
367		(28)	1,150	S2/3e	S3e	S3e	S2/3e	S2n	S2n	Nc	S2n	S2n	S2/3e	S2/3e	S2n	S2/3e	S2an	Nc
1308		(32)	17,350	S3c	S3e	S3/Ne	S3c	S2cn	S2n	S3c	S2n	S2n	S2/3e	S2/3e	S2cn	S2/3e	S2can	S3c
369		(34)	60,600	S3c	S3e	S3e	S3c	S2cn	S2n	S3c	S2n	S2n	S2/3e	S2/3e	S2cn	S2/3e	S2can	S3c
1309		(41)	16,600	S3c	S3e	S3/Ne	S3c	S2cn	S2n	S3c	S2n	S2n	S2/3e	S2/3e	S2cn	S2/3e	S2can	S3c
1310		(42)	9,950	S3c	S3ce	S3/Ne	S3c	S2cn	S2n	S3c	S2n	S2n	S2/3e	S2/3e	S2cn	S2/3e	S2can	S3c
1311		(43)	53,950	S3c	S3e	S3e	S3c	S2cn	S2n	S3c	S2n	S2n	S2/3e	S2/3e	S2cn	S2/3e	S2can	S3c
1312		(44)	44,500	S3c	S3ce	S3e	S3c	S2cn	S2n	S3c	S2n	S2n	S2/3e	S2/3e	S2cn	S2/3e	S2can	S3c
1389		(45)	2,050	Nc	S3ce	S3/Ne	Nc	S3c	S2/3c	S2cn	S2n	S2n	S3c	S3c	S3c	S2/3e	S3c	S2cn
371		(56)	4,550	S3c	S3e	S3e	S3c	S2cn	S2n	S3c	S2n	S2n	S2/3e	S2/3e	S2cn	S2/3e	S2cn	S3c
1313		(59)	2,750	S3c	S3ce	S3e	S3c	S2cn	S2n	S3c	S2n	S2n	S2/3e	S2/3e	S2cn	S2/3e	S2cn	S3c
1314		(62)	4,600	Nc	S3ce	S3e	Nc	S3c	S2/3c	S2cn	S2n	S2n	S3c	S3c	S3c	S2/3e	S3c	S2cn
1315		(75)	1,250	Nc	S3ce	S3e	Nc	S3c	S2/3c	S2cn	S2n	S2n	S3c	S3c	S3c	S2/3e	S3c	S2cn
1316		(142)	12,600	S3c	S3e	S3e	S3c	S2can	S2an	S3c	S2an	S2an	S2/3e	S2/3e	S2can	S2/3e	S3e	S3c
1317		(143)	14,100	S3c	S3ce	S3/Ne	S3c	S2can	S2an	S3c	S2an	S2an	S2/3e	S2/3e	S2can	S2/3e	S3e	S3c
1318		(146)	2,900	Ne	Ne	S2cen	Ne	S2cen	S2en	S3c	S2en	S2en	Ne	Ne	S2cen	Ne	S2cen	S3c
1319	I2e5	(7)	2,850	S2an	S3e	Ne	S2/3n	S2/3n	S3e	Nc	S3/Ne	S2/3en	S2/3n	S3e	S2/3en	S2/3n	S3e	Nc
1320		(28)	2,300	S2/3e	S3e	S3e	S2/3en	S2/3n	S2/3n	Nc	S2/3n	S2/3n	S2/3en	S2/3en	S2/3n	S2/3en	S2/3n	Nc
1321		(41)	27,700	S3c	S3e	S3/Ne	S3c	S2/3n	S2/3n	S3c	S2/3n	S2/3n	S2/3en	S2/3en	S2/3n	S2/3en	S2/3n	S3c
1322		(42)	5,800	S3c	S3ce	S3/Ne	S3c	S2/3n	S2/3n	S3c	S2/3n	S2/3n	S2/3en	S2/3en	S2/3n	S2/3en	S2/3n	S3c
1323		(43)	6,400	S3c	S3e	S3e	S3c	S2/3n	S2/3n	S3c	S2/3n	S2/3n	S2/3en	S2/3en	S2/3n	S2/3en	S2/3n	S3c
1324		(44)	8,300	S3c	S3ce	S3e	S3c	S2/3n	S2/3n	S3c	S2/3n	S2/3n	S2/3en	S2/3en	S2/3n	S2/3en	S2/3n	S3c
1325		(62)	250	Nc	S3ce	S3e	Nc	S3c	S2/3cn	S2/3n	S2/3n	S2/3n	S3c	S3c	S3c	S2/3en	S3c	S2/3n
1326		(145)	4,550	Nc	S3ce	S3e	Nc	S3c	S2/3cn	S2/3n	S2/3n	S2/3n	S3c	S3c	S3c	S2/3en	S3c	S2/3n
411	I2e7	(18)	1,200	Ne	Ne	S3/Ner	Ne	S2ean	S2een	Nc	S2/3e	S2/3e	Ne	Ne	S2/3e	Ne	S3e	Nc
1327	I2e11	(62)	1,900	Nc	S3ce	S3e	Nc	S3c	S2/3cn	S2/3n	S2/3n	S2/3n	S3c	S3c	S3c	S2/3en	S3c	S2/3n
434	I2p2	(18)	1,650	Ne	Ne	Ne	Ne	S3r	S3r	Nc	S3er	S3er	Ne	Ne	S3er	Ne	S3/Ne	Nc
1328		(28)	6,050	Ne	Ne	S3/Ner	Ne	S3r	S3r	Nc	S3r	S3r	Ne	Ne	S3r	Ne	S3r	Nc
1329		(32)	7,250	Ne	Ne	Ne	Ne	S3r	S3r	S3cr	S3r	S3r	Ne	Ne	S3r	Ne	S3r	S3cr
1330		(41)	1,650	Ne	Ne	Ne	Ne	S3r	S3r	S3cr	S3r	S3r	Ne	Ne	S3r	Ne	S3r	S3cr
1331		(42)	9,250	Ne	Ne	Ne	Ne	S3r	S3r	S3cr	S3r	S3r	Ne	Ne	S3r	Ne	S3r	S3cr
1332		(43)	1,000	Ne	Ne	S3/Ner	Ne	S3r	S3r	S3cr	S3r	S3r	Ne	Ne	S3r	Ne	S3r	S3cr
1333		(44)	3,550	Ne	Ne	S3/Ner	Ne	S3r	S3r	S3cr	S3r	S3r	Ne	Ne	S3r	Ne	S3r	S3cr
1334	I2x2	(44)	4,000	S3c	S3ce	S3ex	S3cx	S3x	S3x	S3c	S2/3n	S3x	S2/3en	S2/3en	S3x	S3x	S2/3n	S3cx
1335		(62)	5,400	Nc	S3ce	S3ex	Nc	S3cx	S3x	S2/3n	S2/3n	S3x	S3c	S3c	S3cx	S3x	S3c	S3x
1336		(77)	2,250	Nce	Ne	S3x	Nce	S3cx	S3x	S2/3n	S2/3n	S3x	Ne	Ne	S3cx	Ne	S3c	S3x

LIMITING FACTORS: c - temperature regime k - soil workability r - rooting conditions
e - erosion hazard m - moisture regime w - oxygen availability
f - flooding hazard n - nutrient availability x - toxicity/acidity

APPENDIX IIa (continued)

LAND SUITABILITY MATRIX — Model: traditional management (TM) — Study Area: LADO

Land Unit	Soil Unit	AC ZN	Area (ha)	BULRUSH MILLET	CASSAVA	CITRUS	COTTON	COWPEA	GROUND NUTS	IRISH POTATO	MAIZE	PHAS. BEANS	PIGEON PEA	SORGHUM	SOYBEAN	SUN FLOWER	SWEET POTATO	WHEAT
1337	I3e1	(41)	3,550	Ne	Ne	S3/Ne	Ne	S3e	S3e	S3ce	S3e	S3e	Ne	Ne	S3e	Ne	S3e	S3ce
1338		(75)	14,950	Nce	Ne	S3en	Nce	S3ce	S3e	S3e	S3e	S3e	Ne	Ne	S3ce	Ne	S3ce	S3e
1124	I3e9	(32)	4,700	Ne	Ne	S3/Ne	Ne	S3e	S3e	S3ce	S3e	S3e	Ne	Ne	S3e	Ne	S3e	S3ce
1339		(44)	6,550	Ne	Ne	S3en	Ne	S3e	S3e	S3ce	S3e	S3e	Ne	Ne	S3e	Ne	S3e	S3ce
1340		(62)	6,900	Nce	Ne	S3en	Nce	S3ce	S3e	S3e	S3e	S3e	Ne	Ne	S3ce	Ne	S3ce	S3e
1341	I3e10	(26)	7,600	Ne	Ne	S3/Ne	Ne	S3e	S3e	Nc	S3e	S3e	Ne	Ne	S3e	Ne	S3e	Nc
1342		(27)	1,050	Ne	Ne	S3/Ne	Ne	S3e	S3e	Nc	S3e	S3e	Ne	Ne	S3e	Ne	S3e	Nc
1343		(28)	3,900	Ne	Ne	S3en	Ne	S3e	S3e	Nc	S3e	S3e	Ne	Ne	S3e	Ne	S3e	Nc
1344		(32)	17,000	Ne	Ne	S3/Ne	Ne	S3e	S3e	S3ce	S3e	S3e	Ne	Ne	S3e	Ne	S3e	S3ce
1345		(34)	3,450	Ne	Ne	S3en	Ne	S3e	S3e	S3ce	S3e	S3e	Ne	Ne	S3e	Ne	S3e	S3ce
1346		(37)	2,450	Ne	Ne	S3/Ne	Ne	S3e	S3e	Nc	S3e	S3e	Ne	Ne	S3e	Ne	S3e	Nc
1347		(41)	14,500	Ne	Ne	S3/Ne	Ne	S3e	S3e	S3ce	S3e	S3e	Ne	Ne	S3e	Ne	S3e	S3ce
1348		(42)	8,900	Ne	Ne	S3/Ne	Ne	S3e	S3e	S3ce	S3e	S3e	Ne	Ne	S3e	Ne	S3e	S3ce
1388		(45)	4,850	Nce	Ne	S3/Ne	Nce	S3ce	S3e	S3e	S3e	S3e	Ne	Ne	S3ce	Ne	S3ce	S3e
1349		(56)	3,950	Ne	Ne	S3en	Ne	S3e	S3e	S3ce	S3e	S3e	Ne	Ne	S3e	Ne	S3e	S3ce
1391		(59)	1,200	Ne	Ne	S3en	Ne	S3e	S3e	S3ce	S3e	S3e	Ne	Ne	S3e	Ne	S3e	S3ce
1350		(62)	1,500	Nce	Ne	S3en	Nce	S3ce	S3e	S3e	S3e	S3e	Ne	Ne	S3ce	Ne	S3ce	S3e
1351		(75)	11,450	Nce	Ne	S3en	Nce	S3ce	S3e	S3e	S3e	S3e	Ne	Ne	S3ce	Ne	S3ce	S3e
1352		(145)	11,250	Nce	Ne	S3en	Nce	S3ce	S3e	S3e	S3e	S3e	Ne	Ne	S3ce	Ne	S3ce	S3e
1353	I3p2	(7)	200	Ne	Ne	Ne	Ne	S3r	S3/Ne	Ncn	Ne	S3ar	Ne	Ne	S3ar	Ne	S3/Ne	Nc
549		(27)	2,500	Ne	Ne	Nen	Ne	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Nce
550		(32)	4,300	Ne	Ne	Nen	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1354		(34)	5,900	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
552		(58)	3,500	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1355	I3p3	(28)	1,050	Ne	Ne	Ne	Ne	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Nce
1356		(32)	3,250	Ne	Ne	Nen	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1385		(34)	7,450	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1357		(41)	17,450	Ne	Ne	Nen	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1358		(42)	5,050	Ne	Ne	Nen	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1359		(58)	10,450	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1360		(145)	1,750	Nce	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
574	I3r2	(77)	600	Nce	Ne	S2/3en	Nce	S3c	S2/3cen	S2/3en	S2/3en	S2/3en	Ne	Ne	S3c	Ne	S3c	S2/3en
1361	I3r7	(62)	2,350	Nce	Ne	S3en	Nce	S3ce	S3e	S3e	S3e	S3e	Ne	Ne	S3ce	Ne	S3ce	S3e
1362		(77)	14,650	Nce	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1363		(146)	1,200	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne

LIMITING FACTORS: c - temperature regime; e - erosion hazard; f - flooding hazard; k - soil workability; m - moisture regime; n - nutrient availability; r - rooting conditions; w - oxygen availability; x - toxicity/acidity

APPENDIX IIa (continued)

LAND SUITABILITY MATRIX — Model: traditional management (TM) — Study Area: LADD

Land Unit	Soil Unit	AC ZN	Area (ha)	BULRUSH MILLET	CASSAVA	CITRUS	COTTON	COWPEA	GROUND NUTS	IRISH POTATO	MAIZE	PHAS. BEANS	PIGEON PEA	SORGHUM	SOYBEAN	SUN FLOWER	SWEET POTATO	WHEAT
1364	X3x7	(147)	3,600	Nce	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1365	X4e4	(41)	10,000	Ne	Ne	Nea	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1366		(43)	350	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1367		(62)	6,650	Nce	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1368		(78)	600	Nce	Nce	Ne	Nce	Nce	Nce	Ne	Ne	Ne	Nce	Nce	Nce	Ne	Ne	Ne
1369		(145)	27,450	Nce	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1370	X4e5	(62)	600	Nce	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1371		(77)	3,250	Nce	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
650	X4p2	(26)	1,150	Ne	Ne	Nea	Ne	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Nce
651		(27)	500	Ne	Ne	Nea	Ne	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Nce
652		(28)	1,650	Ne	Ne	Ne	Ne	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Nce
1372		(32)	8,400	Ne	Ne	Nea	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1373		(37)	4,150	Ne	Ne	Nea	Ne	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Nce
1374		(41)	17,850	Ne	Ne	Nea	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1287		(43)	1,450	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
657		(58)	6,600	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1375		(75)	10,200	Nce	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1376		(145)	1,850	Nce	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1202	X4s5	(75)	3,550	Nce	Ne	S3/Ne	Nce	S3c	S2/3c	S2cen	S2en	S2enx	Ne	Ne	S3c	Ne	S3c	S2cen
1377	X5p5	(37)	9,750	Ne	Ne	Nea	Ne	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Nce
1378		(41)	10,000	Ne	Ne	Nea	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1379		(43)	9,850	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1380		(70)	1,900	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1381		(77)	250	Nce	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1382		(145)	1,700	Nce	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1383	X5p6	(32)	2,800	Ne	Ne	Nea	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1384		(41)	3,000	Ne	Ne	Nea	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne

LIMITING FACTORS: c - temperature regime; e - erosion hazard; f - flooding hazard; k - soil workability; m - moisture regime; n - nutrient availability; r - rooting conditions; w - oxygen availabiltiy; x - toxicity/acidity

APPENDIX IIb: Land suitability for rainfed agriculture under improved traditional management

LAND SUITABILITY MATRIX — Model: improved traditional management (ITM) — Study Area: LADO

Land Unit	Soil Unit	AC IN	Area (ha)	BULRUSH MILLET	CASSAVA L	CASSAVA S	CITRUS	COFFEE ARABICA	COTTON	COWPEA	GROUND NUTS-L	GROUND NUTS-S	IRISH POTATO	MAIZE L	MAIZE S	PHAS. BEANS-L	PHAS. BEANS-S	PIGEON PEA	SORGHUM	SOYBEAN	SUN FLOWER	TOBACCO AFC	TOBACCO FC	WHEAT
1256	A1e7	(34)	1,950	S3c	S3e	Ne	S3e	S3/Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2/3e	S2ct	S2/3e	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S3c
1257	A1f2	(41)	2,850	Nfw	Nfw	Nfaw	Nfw	Nfaw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw
1258		(43)	1,300	Nfw	Nfw	Nfaw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw
1390		(44)	900	Nfw	Nfw	Nfaw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw	Nfw
96	A1f7	(7)	300	S2e	S3e	Ne	Ne	Ne	S2tx	S2ex	S2e	S2ex	Nc	S3/Ne	S2/3e	Nc	S2/3e	S2e	S2e	S2/3e	S2ex	S3/Ne	S3/Ne	Nc
1259		(18)	1,050	S2c	S3e	Ne	S3/Ne	Ne	S2tx	S2ex	S2ex	S2x	Nc	S3/Ne	S2/3e	S3/Ne	S2/3e	S1/2ft	S1/2ft	S2/3e	S2x	S2/3e	S2/3e	Nc
1260		(32)	700	S3c	S3e	Ne	S3/Ne	Ne	S3c	S2cx	S2x	S2/3c	S3c	S2/3e	S2ct	S2/3e	S2cx	S2c	S1/2cft	S2cx	S2x	S2tw	S2tw	S3c
1261		(58)	1,950	S3c	S3e	Ne	S3/Ne	S3/Ne	S3c	S2cx	S2x	S2/3c	S3c	S2et	S2ct	S2x	S2cx	S2c	S1/2cft	S2cx	S2x	S2tw	S2tw	S3c
1262	A1g8	(34)	300	S3cw	S3ew	Ne	Nw	Ne	S3cw	S3w	S3w	S3w	S3cw	S3w	S3w	S3w	S3w	S3w	S2w	S2cwx	S3w	Nw	Nw	S3cw
1086		(41)	500	S3cw	S3ew	Ne	Nw	Naw	S3cw	S3w	S3w	S3w	S3cw	S3w	S3w	S3w	S3w	S3w	S2w	S2cwx	S3w	Nw	Nw	S3cw
1263		(42)	2,450	S3cw	S3cew	Ne	Nw	Naw	S3cw	S3w	S3w	S3w	S3cw	S3w	S3w	S3w	S3w	S3w	S2w	S2cwx	S3w	Nw	Nw	S3cw
1264	A1g13	(23)	200	Nw	Nw	Naw	Nw	Naw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1265		(34)	1,350	Nw	Nw	Naw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1266		(41)	5,700	Nw	Nw	Naw	Nw	Naw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1267		(42)	1,500	Nw	Nw	Naw	Nw	Naw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1268		(43)	22,600	Nw	Nw	Naw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1269		(44)	24,300	Nw	Nw	Naw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1270		(62)	1,050	Ncw	Nw	Ncaw	Nw	Nw	Ncw	Nw	Nw	Ncw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1271		(143)	1,150	Nw	Nw	Naw	Nw	Naw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1272		(144)	1,800	Nw	Nw	Naw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1273		(146)	650	Nw	Nw	Naw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw	Nw
1274	A1x1	(32)	3,650	S3c	S3e	Ne	S3/Ne	Ne	S3c	S2cx	S2x	S2/3c	S3c	S2/3e	S2ct	S2/3e	S2cx	S2c	S1/2ct	S2cx	S2x	S2tw	S2tw	S3c
1275	A2a3	(62)	3,950	Nc	S3cw	Ncw	S3e	S3/Ne	Nc	S3c	S2/3c	Nc	S2ct	S2/3t	S3c	S2tx	S3c	S3c	S3c	S3c	S2ctx	S2/3ct	S2/3t	S2/3t
1276		(147)	7,250	Nc	S3cw	Ncw	S2cet	S3e	Nc	S3c	S2/3c	Nc	S2ct	S2/3t	S3c	S2tx	S3c	S3c	S3c	S3c	S2ctx	S2/3ct	S2/3t	S2/3t
210	A2e5	(7)	300	S2e	S3e	Ne	Ne	Ne	S2t	S2e	S3e	S2e	Nc	S3/Ne	S2/3e	Nc	S2/3e	S2e	S2e	S2/3e	S2e	S3/Ne	S3/Ne	Nc
1277	A2f7	(32)	1,150	S3c	S3e	Ne	S3/Ne	Ne	S3c	S2cx	S2x	S2/3c	S3c	S2/3e	S2ct	S2/3e	S2cx	S2c	S1/2ct	S2cx	S2x	S2t	S2t	S3c
1278		(34)	500	S3c	S3e	Ne	S3e	S3/Ne	S3c	S2cx	S2x	S2/3c	S3c	S2/3e	S2ct	S2/3e	S2cx	S2c	S1/2ct	S2cx	S2x	S2t	S2t	S3c
1279		(41)	4,250	S3c	S3e	Ne	S3/Ne	Ne	S3c	S2cx	S2x	S2/3c	S3c	S2et	S2ct	S2ex	S2cx	S2c	S1/2ct	S2cx	S2x	S2t	S2t	S3c
1280	A2f8	(32)	900	S3cw	S3ew	Ne	Nw	Naw	S3cw	S3w	S3w	S3w	S3cw	S3w	S3w	S3w	S3w	S3w	S2w	S2cwx	S3w	Nw	Nw	S3cw
1281		(41)	950	S3cw	S3ew	Ne	Nw	Naw	S3cw	S3w	S3w	S3w	S3cw	S3w	S3w	S3w	S3w	S3w	S2w	S2cwx	S3w	Nw	Nw	S3cw
1282		(42)	2,250	S3cw	S3cew	Ne	Nw	Naw	S3cw	S3w	S3w	S3w	S3cw	S3w	S3w	S3w	S3w	S3w	S2w	S2cwx	S3w	Nw	Nw	S3cw
1283		(62)	500	Nc	S3cew	Ncw	Nw	Nw	Nc	S3cw	S3w	Nc	S3w	S3w	S3cw	S3w	S3cw	S3cw	S3c	S3c	S3w	Nw	Nw	S3w

NOTE: L = Long cycle varieties; S = Short season varieties.
See also Table of cultivars in the main text.

LIMITING FACTORS: c - temperature regime; e - erosion hazard; f - flooding hazard; k - soil workability; m - moisture regime; r - rooting conditions; t - nutrient retention capacity; w - oxygen availability; x - toxicity/acidity

APPENDIX IIb (continued)

LAND SUITABILITY MATRIX Model: improved traditional management (ITM) Study Area: LADO

Land Unit	Soil Unit	AC ZN	Area (ha)	BULRUSH MILLET	CASSAVA L	CASSAVA S	CITRUS	COFFEE ARABICA	COTTON	COWPEA	GROUND NUTS-L	GROUND NUTS-S	IRISH POTATO	MAIZE L	MAIZE S	PHAS. BEANS-L	PHAS. BEANS-S	PIGEON PEA	SORGHUM	SOYBEAN	SUN FLOWER	TOBACCO AFC	TOBACCO FC	WHEAT
1284	A2f8	(145)	350	Nc	S3cew	Nce	Nw	Nw	Nc	S3cw	S3w	Nc	S3w	S3w	S3cw	S3w	S3cw	S3cw	S3c	S3c	S3w	Nw	Nw	S3w
1285	A2e1	(28)	2,500	S2ce	S3e	Ne	S3e	S3/Ne	S2e	S1/2e	S1/2e	S1/2e	Nc	S2/3e	S1/2ew	S2/3ce	S1/2ew	S2e	S2e	S1/2ew	S2e	S2ew	S2ew	Nc
1286	A3f2	(32)	350	S3c	S3e	Ne	S3/Ne	Ne	S3c	S2c	S1/2et	S2/3c	S3c	S2/3e	S2ct	S2/3e	S2c	S2ce	S2e	S2c	S2e	S2et	S2et	S3c
1287		(37)	100	S2ce	S3e	Ne	S3/Ne	Ne	S2et	S1/2et	S1/2et	S1/2et	Nc	S2cet	S2t	S2/3c	S1/2et	S2e	S2e	S1/2et	S2e	S2et	S2et	Nc
1288		(41)	2,350	S3c	S3e	Ne	S3/Ne	Ne	S3c	S2c	S1/2et	S2/3c	S3c	S2et	S2ct	S2e	S2c	S2ce	S2e	S2c	S2e	S2et	S2et	S3c
1289		(42)	200	S3c	S3ce	Ne	S3/Ne	Ne	S3c	S2c	S1/2et	S2/3c	S3c	S2et	S2ct	S2e	S2c	S2ce	S2e	S2c	S2e	S2et	S2et	S3c
1290		(62)	1,650	Nc	S3ce	Nce	S3e	S3/Ne	Nc	S3c	S2/3c	Nc	S2c	S2et	S3c	S1/2et	S3c	S3c	S3c	S3c	S2ce	S2/3c	S2cet	S2ct
1291		(75)	1,000	Nc	S3ce	Nc	S3e	S3/Ne	Nc	S3c	S2/3c	Nc	S2c	S2t	S3c	S1/2et	S3c	S3c	S3c	S3c	S2ce	S2/3c	S2cet	S2ct
1292		(145)	450	Nc	S3ce	Nce	S3e	S3/Ne	Nc	S3c	S2/3c	Nc	S2c	S2et	S3c	S2e	S3c	S3c	S3c	S3c	S2ce	S2/3c	S2cet	S2ct
1293	B2p1	(32)	1,450	S3cr	S3/Ne	Ne	Ne	Ne	S3cr	S3r	S3r	S3r	S3cr	S3er	S3r	S3er	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3cr
1294		(41)	3,750	S3cr	S3/Ne	Ne	Ne	Ne	S3cr	S3r	S3r	S3r	S3cr	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3cr
1295		(42)	10,500	S3cr	S3/Ne	Ne	Ne	Ne	S3cr	S3r	S3r	S3r	S3cr	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3cr
1296		(75)	600	Nc	S3/Ne	Nc	S3/Ner	Ne	Nc	S3cr	S3r	Nc	S3r	S3r	S3cr	S3r	S3cr	S3cr	S3cr	S3cr	S3r	S3r	S3r	S3r
1297	B3u1	(41)	1,600	Ne	Ner	Neer	Ner	Ner	Ner	S3/Ne	S3/Ne	S3/Ne	S3/Ne	S3/Ne	S3/Ne	S3/Ne	S3/Ne	Ne	Ne	S3/Ne	Ne	Ner	Ner	S3/Ne
5003	R	(0)	38,000	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
5004	V	(0)	10,450	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
316	Ile4	(18)	950	S2c	S3e	Ne	S3/Ne	Ne	S2t	S2e	S2e	S1/2t	Nc	S3/Ne	S2/3e	S3/Ne	S2/3e	S1/2t	S1/2t	S2/3e	S1/2et	S2/3e	S2/3e	Nc
317		(20)	1,650	S2c	S3e	Ne	S3e	S3/Ne	S2t	S2e	S2e	S1/2t	Nc	S3/Ne	S2/3e	S3/Ne	S2/3e	S1/2t	S1/2t	S2/3e	S1/2et	S2/3e	S2/3e	Nc
1298		(23)	3,250	S3c	S3e	Ne	S3/Ne	Ne	S3c	S2ce	S2e	S2/3c	S3c	S3e	S2cet	S3e	S2ce	S2c	S1/2ct	S2ce	S1/2et	S2et	S2et	S3c
318		(28)	3,350	S2c	S3e	Ne	S3e	S3/Ne	S2t	S1/2t	S1/2t	S1/2t	Nc	S2/3e	S2t	S2/3ce	S1/2et	S1/2t	S1/2t	S1/2et	S1/2t	S2t	S2t	Nc
323		(32)	2,050	S3c	S3e	Ne	S3/Ne	Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2/3e	S2ct	S2/3e	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S3c
319		(34)	9,200	S3c	S3e	Ne	S3e	S3/Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2/3e	S2ct	S2/3e	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S3c
1299		(41)	24,300	S3c	S3e	Ne	S3/Ne	Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2et	S2ct	S2e	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S3c
1300		(42)	2,600	S3c	S3ce	Ne	S3/Ne	Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2et	S2ct	S2e	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S3c
320		(43)	99,000	S3c	S3e	Ne	S3e	S3/Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2et	S2ct	S2e	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S3c
1301		(44)	77,600	S3c	S3ce	Ne	S3e	S3/Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2et	S2ct	S2e	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S3c
324		(58)	4,500	S3c	S3e	Ne	S3e	S3/Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2et	S2ct	S1/2t	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S3c
1302		(142)	750	S3c	S3e	Ne	S3e	S3/Ne	S3c	S2ce	S2e	S2/3c	S3c	S3e	S2cet	S3e	S2ce	S2c	S1/2ct	S2ce	S1/2et	S2et	S2et	S3c
1303		(143)	7,800	S3c	S3ce	Ne	S3/Ne	Ne	S3c	S2ce	S2e	S2/3c	S3c	S3e	S2cet	S3e	S2ce	S2c	S1/2ct	S2ce	S1/2et	S2et	S2et	S3c
1304	Ile8	(24)	4,550	S3c	S3e	Ne	S3e	S3/Ne	S3c	S2ct	S2t	S2/3c	S3c	S2/3et	S2/3t	S2/3e	S2ct	S2ct	S2t	S2ct	S2t	S2/3t	S2/3t	S3c
1392		(43)	5,800	S3c	S3e	Ne	S3e	S3/Ne	S3c	S2ct	S2t	S2/3c	S3c	S2/3t	S2/3t	S2et	S2ct	S2ct	S2t	S2ct	S2t	S2/3t	S2/3t	S3c
1305		(144)	3,400	S3c	S3ce	Ne	S2cet	S3e	S3c	S2ct	S2t	S2/3c	S3c	S2/3t	S2/3t	S2et	S2ct	S2ct	S2t	S2ct	S2t	S2/3t	S2/3t	S3c
1306		(146)	1,550	S3c	S3ce	Ne	S2cet	S3e	S3c	S2ct	S2t	S2/3c	S3c	S2/3t	S2/3t	S2t	S2ct	S2ct	S2t	S2ct	S2t	S2/3t	S2/3t	S3c

NOTE: L = Long cycle varieties; S = Short season varieties. See also Table of cultivars in the main text.

LIMITING FACTORS: c - temperature regime; e - erosion hazard; f - flooding hazard; k - soil workability; s - moisture regime; r - rooting conditions; t - nutrient retention capacity; w - oxygen availability; x - toxicity/acidity

APPENDIX IIb (continued)

LAND SUITABILITY MATRIX Model: Improved traditional management (ITM) Study Area: LADO

Land Unit	Soil Unit	AC IN	Area (ha)	PULRUSH MILLET	CASSAVA L	CASSAVA S	CITRUS	COFFEE ARABICA	COTTON	COWPEA	GROUND NUTS-L	GROUND NUTS-S	IRISH POTATO	MAIZE L	MAIZE S	PHAS. BEANS-L	PHAS. BEANS-S	PIGEON PEA	SORGHUM	SOYBEAN	SUN FLOWER	TOBACCO AFC	TOBACCO FC	WHEAT
1367	I2e2	(23)	31,250	S3c	S3e	Ne	S3/Ne	Ne	S3c	S2ce	S2e	S2/3c	S3c	S3e	S2cet	S3e	S2ce	S2c	S1/2ct	S2ce	S1/2et	S2et	S2et	S3c
367		(28)	1,150	S2c	S3e	Ne	S3e	S3/Ne	S2t	S1/2t	S1/2t	S1/2t	Nc	S2/3e	S2t	S2/3ce	S1/2et	S1/2t	S1/2t	S1/2et	S1/2t	S2t	S2t	Nc
1368		(32)	17,350	S3c	S3e	Ne	S3/Ne	Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2/3e	S2ct	S2/3e	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S3c
369		(34)	60,600	S3c	S3e	Ne	S3e	S3/Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2/3e	S2ct	S2/3e	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S3c
1369		(41)	16,600	S3c	S3e	Ne	S3/Ne	Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2et	S2ct	S2e	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S3c
1370		(42)	9,950	S3c	S3ce	Ne	S3/Ne	Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2et	S2ct	S2e	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S3c
1371		(43)	53,950	S3c	S3e	Ne	S3e	S3/Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2et	S2ct	S2e	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S3c
1372		(44)	44,590	S3c	S3ce	Ne	S3e	S3/Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2et	S2ct	S2e	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S3c
1389		(45)	2,050	Nc	S3ce	Nce	S3/Ne	Ne	Nc	S3c	S2/3c	Nc	S2c	S2et	S3c	S2e	S3c	S3c	S3c	S3c	S2c	S2/3c	S2ct	S2ct
371		(56)	4,550	S3c	S3e	Ne	S3e	S3/Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2et	S2ct	S1/2t	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S2c
1373		(59)	2,750	S3c	S3ce	Ne	S3e	S3/Ne	S3c	S2c	S1/2t	S2/3c	S3c	S2et	S2ct	S1/2t	S2c	S2c	S1/2ct	S2c	S1/2t	S2t	S2t	S3c
1374		(62)	4,600	Nc	S3ce	Nce	S3e	S3/Ne	Nc	S3c	S2/3c	Nc	S2c	S2et	S3c	S1/2t	S3c	S3c	S3c	S3c	S2c	S2/3c	S2ct	S2ct
1375		(75)	1,250	Nc	S3ce	Nc	S3e	S3/Ne	Nc	S3c	S2/3c	Nc	S2c	S2t	S3c	S1/2t	S3c	S3c	S3c	S3c	S2c	S2/3c	S2ct	S2ct
1376		(142)	12,600	S3c	S3e	Ne	S3e	S3/Ne	S3c	S2ce	S2e	S2/3c	S3c	S3e	S2cet	S3e	S2ce	S2c	S1/2ct	S2ce	S1/2et	S2et	S2et	S3c
1377		(143)	14,100	S3c	S3ce	Ne	S3/Ne	Ne	S3c	S2ce	S2e	S2/3c	S3c	S3e	S2cet	S3e	S2ce	S2c	S1/2ct	S2ce	S1/2et	S2et	S2et	S3c
1378		(146)	2,900	S3c	S3ce	Ne	S2ce	S3e	S3c	S2c	S1/2et	S2/3c	S3c	S2et	S2ct	S1/2et	S2c	S2c	S1/2tet	S2c	S1/2et	S2t	S2t	S3c
1379	I2e5	(7)	2,850	S2e	S3e	Ne	Ne	Ne	S2tx	S2ex	S3e	S2ex	Nc	S3/Ne	S2/3e	Nc	S2/3e	S2e	S2e	S2/3e	S2ex	S3/Ne	S3/Ne	Nc
1380		(28)	2,300	S2c	S3e	Ne	S3e	S3/Ne	S2tx	S2x	S2x	S2x	Nc	S2/3e	S2t	S2/3ce	S2x	S1/2t	S1/2t	S2x	S2x	S2t	S2t	Nc
1381		(41)	27,700	S3c	S3e	Ne	S3/Ne	Ne	S3c	S2cx	S2x	S2/3c	S3c	S2et	S2ct	S2ex	S2cx	S2c	S1/2ct	S2cx	S2x	S2t	S2t	S3c
1382		(42)	5,800	S3c	S3ce	Ne	S3/Ne	Ne	S3c	S2cx	S2x	S2/3c	S3c	S2et	S2ct	S2ex	S2cx	S2c	S1/2ct	S2cx	S2x	S2t	S2t	S3c
1383		(43)	6,400	S3c	S3e	Ne	S3e	S3/Ne	S3c	S2cx	S2x	S2/3c	S3c	S2et	S2ct	S2ex	S2cx	S2c	S1/2ct	S2cx	S2x	S2t	S2t	S2c
1384		(44)	8,390	S3c	S3ce	Ne	S3e	S3/Ne	S3c	S2cx	S2x	S2/3c	S3c	S2et	S2ct	S2ex	S2cx	S2c	S1/2ct	S2cx	S2x	S2t	S2t	S3c
1385		(62)	250	Nc	S3ce	Nce	S3e	S3/Ne	Nc	S3c	S2/3c	Nc	S2c	S2et	S3c	S2x	S3c	S3c	S3c	S3c	S2cx	S2/3c	S2ct	S2ctx
1386		(145)	4,550	Nc	S3ce	Nce	S3e	S3/Ne	Nc	S3c	S2/3c	Nc	S2c	S2et	S3c	S2ex	S3c	S3c	S3c	S3c	S2cx	S2/3c	S2ct	S2ctx
411	I2e7	(18)	1,200	S2c	S3e	Ne	S3/Ner	Ne	S2t	S2e	S2e	S1/2t	Nc	S3/Ne	S2/3e	S3/Ne	S2/3e	S1/2t	S1/2t	S2/3e	S1/2et	S2/3e	S2/3e	Nc
1387	I2e11	(62)	1,900	Nc	S3ce	Nce	S3e	S3/Ne	Nc	S3c	S2/3c	Nc	S2ct	S2/3t	S3c	S2tx	S3c	S3c	S3c	S3c	S2ctx	S2/3ct	S2/3t	S2/3t
434	I2p2	(18)	1,650	S3r	S3/Ne	Ne	Ne	Ne	S3r	S3r	S3r	S3r	Nc	Ne	S3er	Ne	S3er	S3r	S3r	S3er	S3r	S3er	S3er	Nc
1388		(28)	6,050	S3r	S3/Ne	Ne	S3/Ner	Ne	S3r	S3r	S3r	S3r	Nc	S3er	S3r	S3er	S3r	S3r	S3r	S3r	S3r	S3r	S3r	Nc
1389		(32)	7,250	S3cr	S3/Ne	Ne	Ne	Ne	S3cr	S3r	S3r	S3r	S3cr	S3er	S3r	S3er	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3cr
1390		(41)	1,650	S3cr	S3/Ne	Ne	Ne	Ne	S3cr	S3r	S3r	S3r	S3cr	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3cr
1391		(42)	9,250	S3cr	S3/Ne	Ne	Ne	Ne	S3cr	S3r	S3r	S3r	S3cr	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3cr
1392		(43)	1,000	S3cr	S3/Ne	Ne	S3/Ner	Ne	S3cr	S3r	S3r	S3r	S3cr	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3cr
1393		(44)	3,550	S3cr	S3/Ne	Ne	S3/Ner	Ne	S3cr	S3r	S3r	S3r	S3cr	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3r	S3cr
1394	I2x2	(44)	4,000	S3c	S3ce	Ne	S3ex	S3/Ne	S3cx	S3x	S3x	S3x	S3c	S2etx	S2ctx	S3x	S3x	S2cx	S2x	S3x	S3x	S2tx	S2tx	S3cx
1395		(62)	5,400	Nc	S3ce	Nce	S3ex	S3/Ne	Nc	S3cx	S3x	Nc	S2cx	S2etx	S3c	S3x	S3cx	S3c	S3c	S3cx	S3x	S2/3c	S2ctx	S3x
1396		(77)	2,250	Nc	S3ce	Nc	S3x	S3e	Nc	S3cx	S3x	Nc	S2cx	S2tx	S3c	S3x	S3cx	S3c	S3c	S3cx	S3x	S2/3c	S2ctx	S3x

NOTE: L = Long cycle varieties; S = Short season varieties.
See also Table of cultivars in the main text.

LIMITING FACTORS: c - temperature regime; e - erosion hazard; f - flooding hazard; k - soil workability; m - moisture regime; r - rooting conditions; t - nutrient retention capacity; w - oxygen availability; x - toxicity/acidity

APPENDIX IIb (continued)

LAND SUITABILITY MATRIX — Model: improved traditional management (ITM) — Study Area: LADD

Land Unit	Soil Unit	AC IN	Area (ha)	BULRUSH MILLET	CASSAVA L	CASSAVA S	CITRUS	COFFEE ARABICA	COTTON	COWPEA	GROUND NUTS-L	GROUND NUTS-S	IRISH POTATO	MAIZE L	MAIZE S	PHAS. BEANS-L	PHAS. BEANS-S	PIGEON PEA	SORGHUM	SOYBEAN	SUN FLOWER	TOBACCO AFC	TOBACCO FC	WHEAT
1337	IIe1	(41)	3,550	S3c	S3a	Na	S3/Na	Na	S3c	S2c	S1/2et	S2/3c	S3c	S2at	S2ct	S2a	S2c	S2ce	S2e	S2c	S2e	S2et	S2et	S3c
1338		(75)	14,950	Nc	S3ca	Nc	S3a	S3/Na	Nc	S3c	S2/3c	Nc	S2c	S2t	S3c	S1/2et	S3c	S3c	S3c	S3c	S2ce	S2/3c	S2cet	S2ct
1124	IIe9	(32)	4,700	S3c	S3a	Na	S3/Na	Na	S3c	S2c	S1/2et	S2/3c	S3c	S2/3a	S2ct	S2/3a	S2c	S2ce	S2e	S2c	S2e	S2et	S2et	S3c
1339		(44)	6,550	S3c	S3ca	Na	S3a	S3/Na	S3c	S2c	S1/2et	S2/3c	S3c	S2at	S2ct	S2a	S2c	S2ce	S2e	S2c	S2e	S2et	S2et	S3c
1340		(62)	6,900	Nc	S3ca	Nca	S3a	S3/Na	Nc	S3c	S2/3c	Nc	S2c	S2at	S3c	S1/2et	S3c	S3c	S3c	S3c	S2ce	S2/3c	S2cet	S2ct
1341	IIe10	(26)	7,600	S2ce	S3a	Na	S3/Na	Na	S2etx	S2x	S2x	S2x	Nc	S2/3a	S2t	S2/3ca	S2x	S2e	S2e	S2x	S2ex	S2et	S2et	Nc
1342		(27)	1,050	S2ce	S3a	Na	S3/Na	Na	S2etx	S2x	S2x	S2x	Nc	S2/3a	S2t	S2/3ca	S2x	S2e	S2e	S2x	S2ex	S2et	S2et	Nc
1343		(28)	3,900	S2ce	S3a	Na	S3a	S3/Na	S2etx	S2x	S2x	S2x	Nc	S2/3a	S2t	S2/3ca	S2x	S2e	S2e	S2x	S2ex	S2et	S2et	Nc
1344		(32)	17,000	S3c	S3a	Na	S3/Na	Na	S3c	S2cx	S2x	S2/3c	S3c	S2/3a	S2ct	S2/3a	S2cx	S2ce	S2e	S2cx	S2ex	S2et	S2et	S3c
1345		(34)	3,450	S3c	S3a	Na	S3a	S3/Na	S3c	S2cx	S2x	S2/3c	S3c	S2/3a	S2ct	S2/3a	S2cx	S2ce	S2e	S2cx	S2ex	S2et	S2et	S3c
1346		(37)	2,450	S2ce	S3a	Na	S3/Na	Na	S2etx	S2x	S2x	S2x	Nc	S2cat	S2t	S2/3c	S2x	S2e	S2e	S2x	S2ex	S2et	S2et	Nc
1347		(41)	14,500	S3c	S3a	Na	S3/Na	Na	S3c	S2cx	S2x	S2/3c	S3c	S2at	S2ct	S2ax	S2cx	S2ce	S2e	S2cx	S2ex	S2et	S2et	S3c
1348		(42)	8,900	S3c	S3ca	Na	S3/Na	Na	S3c	S2cx	S2x	S2/3c	S3c	S2at	S2ct	S2ax	S2cx	S2ce	S2e	S2cx	S2ex	S2et	S2et	S3c
1368		(45)	4,850	Nc	S3ca	Nca	S3/Na	Na	Nc	S3c	S2/3c	Nc	S2c	S2at	S3c	S2ax	S3c	S3c	S3c	S3c	S2cex	S2/3c	S2cet	S2ctx
1349		(58)	3,950	S3c	S3a	Na	S3a	S3/Na	S3c	S2cx	S2x	S2/3c	S3c	S2at	S2ct	S2x	S2cx	S2ce	S2e	S2cx	S2ex	S2et	S2et	S3c
1391		(59)	1,200	S3c	S3ca	Na	S3a	S3/Na	S3c	S2cx	S2x	S2/3c	S3c	S2at	S2ct	S2x	S2cx	S2ce	S2e	S2cx	S2ex	S2et	S2et	S3c
1350		(62)	1,500	Nc	S3ca	Nca	S3a	S3/Na	Nc	S3c	S2/3c	Nc	S2c	S2at	S3c	S2x	S3c	S3c	S3c	S3c	S2cex	S2/3c	S2cet	S2ctx
1351		(75)	11,450	Nc	S3ca	Nc	S3a	S3/Na	Nc	S3c	S2/3c	Nc	S2c	S2t	S3c	S2x	S3c	S3c	S3c	S3c	S2cex	S2/3c	S2cet	S2ctx
1352		(145)	11,250	Nc	S3ca	Nca	S3a	S3/Na	Nc	S3c	S2/3c	Nc	S2c	S2at	S3c	S2ax	S3c	S3c	S3c	S3c	S2cex	S2/3c	S2cet	S2ctx
1353	IIIp2	(7)	200	S3r	S3/Na	Na	Na	Na	S3r	S3r	S3/Na	S3r	Nc	Na	S3er	Nca	S3er	S3r	S3r	S3er	S3r	Na	Na	Nc
549		(27)	2,500	S3er	S3/Na	Na	Na	Na	S3er	S3r	S3r	S3r	Nc	S3ar	S3r	S3ar	S3r	S3er	S3er	S3r	S3er	S3er	S3er	Nc
550		(32)	4,300	S3cer	S3/Na	Na	Na	Na	S3cer	S3r	S3r	S3r	S3cr	S3ar	S3r	S3ar	S3r	S3er	S3er	S3r	S3er	S3er	S3er	S3cr
1354		(34)	5,800	S3cer	S3/Na	Na	S3/Nar	Na	S3cer	S3r	S3r	S3r	S3cr	S3ar	S3r	S3ar	S3r	S3er	S3er	S3r	S3er	S3er	S3er	S3cr
552		(58)	3,500	S3cer	S3.Na	Na	S3/Nar	Na	S3cer	S3r	S3r	S3r	S3cr	S3r	S3r	S3r	S3r	S3er	S3er	S3r	S3er	S3er	S3er	S3cr
1355	IIIp3	(29)	1,050	S3er	S3/Na	Na	S3/Nar	Na	S3er	S3r	S3r	S3r	Nc	S3ar	S3r	S3ar	S3r	S3er	S3er	S3r	S3er	S3er	S3er	Nc
1356		(32)	3,250	S3cer	S3/Na	Na	Na	Na	S3cer	S3r	S3r	S3r	S3cr	S3ar	S3r	S3ar	S3r	S3er	S3er	S3r	S3er	S3er	S3er	S3cr
1385		(34)	7,450	S3cer	S3/Na	Na	S3/Nar	Na	S3cer	S3r	S3r	S3r	S3cr	S3ar	S3r	S3ar	S3r	S3er	S3er	S3r	S3er	S3er	S3er	S3cr
1357		(41)	17,450	S3cer	S3/Na	Na	Na	Na	S3cer	S3r	S3r	S3r	S3cr	S3r	S3r	S3r	S3r	S3er	S3er	S3r	S3er	S3er	S3er	S3cr
1358		(42)	5,050	S3cer	S3/Na	Na	Na	Na	S3cer	S3r	S3r	S3r	S3cr	S3r	S3r	S3r	S3r	S3er	S3er	S3r	S3er	S3er	S3er	S3cr
1359		(58)	10,450	S3cer	S3/Na	Na	S3/Nar	Na	S3cer	S3r	S3r	S3r	S3cr	S3r	S3r	S3r	S3r	S3er	S3er	S3r	S3er	S3er	S3er	S3cr
1360		(145)	1,750	Nc	S3.Na	Nca	S3/Nar	Na	Nc	S3cr	S3r	Nc	S3r	S3r	S3cr	S3r	S3cr	S3cer	S3cer	S3cr	S3er	S3er	S3er	S3r
574	IIIx2	(77)	600	Nc	S3ca	Nc	S2cax	S3a	Nc	S3c	S2/3c	Nc	S2c	S2t	S3c	S2x	S3c	S3c	S3c	S3c	S2cx	S2/3c	S2ct	S2ctx
1361	IIIx7	(62)	2,350	Nc	S3ca	Nca	S3e	S3/Na	Nc	S3c	S2/3c	Nc	S2ct	S2/3t	S3c	S2tx	S3c	S3c	S3c	S3c	S2cet	S2/3ct	S2/3t	S2/3t
1362		(77)	14,650	Nc	S3/Ne	Nc	S2car	S3a	Nc	S3ce	S3e	Nc	S3e	S3e	S3ce	S3e	S3ce	S3/Ne	S3/Ne	S3ce	S3/Ne	S3/Ne	S3/Ne	S3e
1363		(146)	1,200	S3/Ne	S3/Ne	Na	S2car	S3a	S3/Ne	S3e	S3e	S3e	S3ce	S3e	S3e	S3e	S3e	S3/Ne	S3/Ne	S3e	S3/Ne	S3/Ne	S3/Ne	S3ce

NOTE: L = Long cycle varieties; S = Short season varieties. See also Table of cultivars in the main text.

LIMITING FACTORS: c - temperature regime; e - erosion hazard; f - flooding hazard; k - soil workability; m - moisture regime; r - rooting conditions; t - nutrient retention capacity; w - oxygen availability; x - toxicity/acidity

APPENDIX IIb (continued)

LAND SUITABILITY MATRII — Model: Improved traditional management (ITM) — Study Area: LADD

Land Unit	Soil Unit	AC ZN	Area (ha)	BULRUSH MILLET	CASSAVA L	CASSAVA S	CITRUS	COFFEE ARABICA	COTTON	COWPEA	GROUND NUTS-L	GROUND NUTS-S	IRISH POTATO	MAIZE L	MAIZE S	PHAS. BEANS-L	PHAS. BEANS-S	PIGEON PEA	SORGHUM	SOYBEAN	SUN FLOWER	TOBACCO AFC	TOBACCO FC	WHEAT
1364	I3e4	(147)	3,800	Nc	S3/Ne	Nce	S2cer	S3e	Nc	S3ce	S3e	Nc	S3e	S3e	S3ce	S3e	S3ce	S3/Ne	S3/Ne	S3ce	S3/Ne	S3/Ne	S3/Ne	S3e
1365	I4e4	(41)	10,000	S3ce	S3es	Ne	S3/Ne	Ne	S3ce	S2/3e	S2/3e	S2/3ce	S3c	S2/3e	S2/3e	S2/3e	S2/3e	S3e	S3e	S2/3e	S3e	S3e	S3e	S3c
1366		(43)	350	S3ce	S3es	Ne	S3e	S3/Ne	S3ce	S2/3e	S2/3e	S2/3ce	S3c	S2/3e	S2/3e	S2/3e	S2/3e	S3e	S3e	S2/3e	S3e	S3e	S3e	S3c
1367		(62)	6,650	Nc	S3ces	Nce	S3e	S3/Ne	Nc	S3c	S2/3ce	Nc	S2/3e	S2/3e	S3c	S2/3e	S3c	S3ce	S3ce	S3c	S3e	S3e	S3e	S2/3e
1368		(78)	600	Nc	Nc	Nc	S3ce	S3/Ne	Nc	Nc	Nc	Nc	S2/3e	S2/3e	Nc	S2/3e	Nc	Nc	Nc	Nc	S3ce	Nc	S3ce	S2/3e
1369		(145)	27,450	Nc	S3ces	Nce	S3e	S3/Ne	Nc	S3c	S2/3ce	Nc	S2/3e	S2/3e	S3c	S2/3e	S3c	S3ce	S3ce	S3c	S3e	S3e	S3e	S2/3e
1370	I4e5	(62)	600	Nc	S3ces	Nce	S3e	S3/Ne	Nc	S3c	S2/3ce	Nc	S2/3e	S2/3e	S3c	S2/3e	S3c	S3ce	S3ce	S3c	S3e	S3e	S3e	S2/3e
1371		(77)	3,250	Nce	Ne	Nce	S2ces	S3e	Nce	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
650	I4p2	(26)	1,150	Ne	Ne	Nes	Ne	Ne	Ne	Ne	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Nce
651		(27)	500	Ne	Ne	Nes	Ne	Ne	Ne	Ne	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Nce
652		(28)	1,650	Ne	Ne	Nes	S3/Ner	Ne	Ne	Ne	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Nce
1372		(32)	8,400	Ne	Ne	Nes	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1373		(37)	4,150	Ne	Ne	Nes	Ne	Ne	Ne	Ne	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Nce
1374		(41)	17,850	Ne	Ne	Nes	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1387		(43)	1,450	Ne	Ne	Nes	S3/Ner	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
657		(58)	6,600	Ne	Ne	Nes	S3/Ner	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1375		(75)	10,200	Nce	Ne	Nce	S3/Ner	Ne	Nce	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1376		(145)	1,850	Nce	Ne	Nces	S3/Ner	Ne	Nce	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1202	I4x5	(75)	3,550	Nc	S3ce	Nc	S3e	S3/Ne	Nc	S3c	S2/3c	Nc	S2c	S2t	S3c	S2x	S3c	S3c	S3c	S3c	S2cx	S2/3c	S2ct	S2ctx
1377	I5p5	(57)	9,750	Ne	Ne	Nes	Nes	Nes	Ne	Ne	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Nce
1378		(41)	10,000	Ne	Ne	Nes	Nes	Nes	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1379		(43)	9,850	Ne	Ne	Nes	Ne	Nes	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1380		(70)	1,900	Ne	Ne	Ne	Ne	Nes	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1381		(77)	250	Nce	Ne	Nce	Ne	Ne	Nce	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1382		(145)	1,700	Nce	Ne	Nces	Ne	Nes	Nce	Ne	Ne	Nce	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1383	I5p6	(32)	2,800	Ne	Ne	Nes	Nes	Nes	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne
1384		(41)	3,000	Ne	Ne	Nes	Nes	Nes	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne	Ne

NOTE: L = Long cycle varieties; S = Short season varieties.
See also Table of cultivars in the main text.

LIMITING FACTORS: c - temperature regime; e - erosion hazard; f - flooding hazard; k - soil workability; m - moisture regime; r - rooting conditions; t - nutrient retention capacity; w - oxygen availability; x - toxicity/acidity

APPENDIX IIc Land suitability for wetland rice under traditional management

LAND SUITABILITY MATRIX
Model: wetland rice under traditional management (R)
Study Area: LADD

Land Unit	Soil Unit	AC ZN	Area (ha)	RICE
1256	A1e7	(34)	1,950	Nm
1257	A1f2	(41)	2,850	S2/3c
1258		(43)	1,300	S2/3c
1390		(44)	900	S2/3c
96	A1f7	(7)	300	Nm
1259		(18)	1,050	Nm
1260		(32)	700	Nm
1261		(58)	1,950	Nm
1262	A1g8	(34)	300	Nm
1386		(41)	500	Nm
1263		(42)	2,450	Nm
1264	A1g13	(23)	200	Nm
1265		(34)	1,350	Nm
1266		(41)	5,700	Nm
1267		(42)	1,500	Nm
1268		(43)	22,600	Nm
1269		(44)	24,300	Nm
1270		(62)	1,050	Nm
1271		(143)	1,150	Nm
1272		(144)	1,800	Nm
1273		(146)	650	Nm
1274	A1x1	(32)	3,650	Nm
1275	A2a3	(62)	3,950	Ncm
1276		(147)	7,250	Ncm
210	A2e5	(7)	300	Nm
1277	A2f7	(32)	1,150	Nm
1278		(34)	500	Nm
1279		(41)	4,250	Nm
1280	A2f8	(32)	900	Nm
1281		(41)	950	Nm
1282		(42)	2,250	Nm
1283		(62)	500	Ncm
1284	A2f8	(145)	350	Ncm
1285	A3e1	(28)	2,500	Nm
1286	A3f2	(32)	350	Nm
1287		(37)	100	Nm
1288		(41)	2,350	Nm
1289		(42)	200	Nm
1290		(62)	1,650	Ncm
1291		(75)	1,000	Ncm
1292		(145)	450	Ncm

LIMITING FACTORS: m - moisture regime
c - temperature regime

NOTE: ALL OTHER LAND UNITS ARE RATED AS Nm.

APPENDIX IId: Land suitability for forestry

LAND SUITABILITY MATRIX — Model: forestry (F) — Study Area: LA00

Land Unit	Soil Unit	AC ZH	Area (ha)	ACACIA ALBIDA	AIRDIRACHTA INDICA	CALLITRIS CALCARATA	CALLITRIS MUELLII	CASSIA SIAMEA	CORDYLA AFRICANA	EUCALYPTUS CAMALDULEN.	EUCALYPTUS GRANDIS	EUCALYPTUS TERETICORN.	GMELINA ARBOREA	MELIA AZEDARACH	PINUS CARIBAEA	PINUS MESIYA	PINUS PATULA
1256	A1e7	(34)	1,950	S2/3a	S2a	S2a	S2ca	S2c	S2c	S1	S2a	S1	S2c	S1	S2/3a	S2/3a	S3a
1257	A1f2	(41)	2,850	S3s	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
1258		(42)	1,200	S3s	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
1260		(44)	900	S3cs	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns	Ns
96	A1f7	(7)	300	S1	S1	S3/Na	S2s	S2a	S2s	S2a	S2a	S2a	S3c	S2as	Na	Na	Na
1259		(18)	1,050	S1	S1	S3a	S2s	S2a	S2s	S2a	S2a	S2a	S3c	S2as	S3ca	S2/3a	S3ca
1260		(32)	700	S2c	S1	S3a	S2cs	S2ca	S2cs	S2a	S2a	S2a	S2ca	S2as	S3a	S2/3a	S3a
1261		(58)	1,950	S2/3a	S2a	S2as	S2cas	S2c	S2cs	S1	S2a	S1	S2c	S2s	S2/3a	S2/3a	S3a
1262	A1g8	(34)	300	Ns	Ns	Ns	Ns	Ns	Ns	S3s	Ns	Ns	S3s	Ns	Ns	Ns	Ns
1336		(41)	500	Ns	Ns	Ns	Ns	Ns	Ns	S3s	Ns	Ns	S3s	Ns	Ns	Ns	Ns
1263		(42)	2,450	Ns	Ns	Ns	Ns	Ns	Ns	S3s	Ns	Ns	S3s	Ns	Ns	Ns	Ns
1264	A1g13	(23)	200	Ns	Ns	Ns	Ns	Ns	Ns	S3s	Ns	Ns	S3s	Ns	Ns	Ns	Ns
1265		(34)	1,350	Ns	Ns	Ns	Ns	Ns	Ns	S3s	Ns	Ns	S3s	Ns	Ns	Ns	Ns
1266		(41)	5,700	Ns	Ns	Ns	Ns	Ns	Ns	S3s	Ns	Ns	S3s	Ns	Ns	Ns	Ns
1267		(42)	1,500	Ns	Ns	Ns	Ns	Ns	Ns	S3s	Ns	Ns	S3s	Ns	Ns	Ns	Ns
1268		(43)	22,600	Ns	Ns	Ns	Ns	Ns	Ns	S3s	Ns	Ns	S3s	Ns	Ns	Ns	Ns
1269		(44)	24,300	Ns	Ns	Ns	Ns	Ns	Ns	S3s	Ns	Ns	S3s	Ns	Ns	Ns	Ns
1270		(62)	1,050	Ns	Ns	Ns	Ns	Ns	Ns	S3s	Ns	Ns	S3s	Ns	Ns	Ns	Ns
1271		(143)	1,150	Ns	Ns	Ns	Ns	Ns	Ns	S3s	Ns	Ns	S3s	Ns	Ns	Ns	Ns
1272		(144)	1,800	Ns	Ns	Ns	Ns	Ns	Ns	S3s	Ns	Ns	S3s	Ns	Ns	Ns	Ns
1273		(146)	650	Ns	Ns	Ns	Ns	Ns	Ns	S3s	Ns	Ns	S3s	Ns	Ns	Ns	Ns
1274	A1x1	(32)	3,650	Ns	S1	S3a	S2c	S2cas	S2c	S2a	S3a	S2as	S2ca	S2a	S3a	S2/3a	S3a
1275	A2a3	(62)	3,950	S3cs	S2ca	S3s	S3c	S3cs	S3c	S2c	S2as	S2c	S1	S2c	S2/3a	S2/3a	S3a
1276		(147)	7,250	S3cs	S2ca	S3s	S3c	S3cs	S3c	S2c	S2as	S2c	S1	S2/3a	S2as	S2s	S2as
210	A2e5	(7)	300	S2rs	S1	S3/Na	S1	S2a	S1	S2a	S3a	S2a	S3c	S2a	Na	Na	Na
1277	A2f7	(32)	1,150	S2c	S1	S3a	S2c	S2ca	S2c	S2a	S3a	S2a	S2ca	S2a	S3a	S2/3a	S3a
1278		(34)	500	S2/3a	S2a	S2a	S2ca	S2c	S2c	S1	S2a	S1	S2c	S1	S2/3a	S2/3a	S3a
1279		(41)	4,250	S2c	S1	S3a	S2c	S2ca	S2c	S2a	S3a	S2a	S2ca	S2a	S3a	S2/3a	S3a
1280	A2f8	(32)	900	S3s	S3s	Ns	Ns	Ns	Ns	S3s	S3as	S3s	S3s	Ns	S3as	Ns	Ns
1281		(41)	950	S3s	S3s	Ns	Ns	Ns	Ns	S3s	S3as	S3s	S3s	Ns	S3as	Ns	Ns
1282		(42)	2,250	S3cs	S3s	Ns	Ns	Ns	Ns	S3s	S3as	S3s	S3s	Ns	S3as	Ns	Ns
1283		(62)	500	S3cs	S3s	Ns	Ns	Ns	Ns	S3s	S3s	S3s	S3s	Ns	S3s	Ns	Ns

LIMITING FACTORS: c - temperature regime r - rooting conditions
a - moisture regime s - soil related factors

APPENDIX IId (continued)

LAND SUITABILITY MATRIX — Model: forestry (F) — Study Area: LADD

Land Unit	Soil Unit	AO IV	Area (ha)	ACACIA ALBIDA	AZADIRACHTA INDICA	CALLITRIS CALCARATA	CALLITRIS HUGELLII	CASSIA SIAMEA	COPDYLA AFRICANA	EUCALYPTUS CAMALDULEN.	EUCALYPTUS GRANDIS	EUCALYPTUS TERETICORN.	GMELINA ARBOREA	MELIA AZEDARACH	PINUS CARIBAEA	PINUS KESIYA	PINUS PATULA
1284	A2f3	(145)	350	S3cs	S3s	Ns	Ns	Ns	Ns	S3s	S3s	S3s	S3s	Ns	S3s	Ns	Ns
1285	A3e1	(28)	2,500	S2/3a	S2a	S2/3c	S2a	S1	S1/2a	S1	S2ca	S1	S3c	S1	S3c	S2/3a	S3ca
1286	A3f2	(32)	350	S2c	S1	S3a	S2c	S2ca	S2c	S2a	S3a	S2a	S2ca	S2a	S3a	S2/3a	S3a
1287		(37)	100	S2c	S1	S3a	S2c	S2ca	S2c	S2a	S3a	S2a	S2ca	S2a	S3a	S2/3a	S3a
1288		(41)	2,350	S2c	S1	S3a	S2c	S2ca	S2c	S2a	S3a	S2a	S2ca	S2a	S3a	S2/3a	S3a
1289		(43)	200	S3c	S2c	S3a	S3c	S3c	S3c	S2ca	S3a	S2ca	S2a	S2ca	S3a	S2/3a	S3a
1290		(62)	1,650	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
1291		(75)	1,000	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
1292		(145)	450	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
1293	B2p1	(32)	1,450	S3rs	S2r	S2a	S2cr	S2cas	S2cr	S2ars	S3a	S2ars	S2car	S2ars	S3a	S2/3a	S3as
1294		(41)	3,750	S3rs	S2r	S2a	S2cr	S2cas	S2cr	S2ars	S3a	S2ars	S2car	S2ars	S3a	S2/3a	S3as
1295		(42)	10,500	S3crs	S2cr	S3a	S3c	S3c	S3c	S2car	S3a	S2car	S2ar	S2car	S3a	S2/3a	S3as
1296		(75)	600	S3crs	S2car	S2ar	S3c	S3c	S3c	S2crs	S2as	S2crs	S2r	S2crs	S2/3a	S2/3a	S3as
1297	B3u1	(41)	1,600	Nrs	Nrs	Nrs	Nr	S3rs	Nr	S3rs	S3ars	S3rs	Nrs	Nrs	Ns	S3rs	Ns
5003	R	(0)	38,000	N	N	N	N	N	N	N	N	N	N	N	N	N	N
5004	V	(0)	10,450	N	N	N	N	N	N	N	N	N	N	N	N	N	N
316	I1e4	(18)	950	S2s	S1	S3a	S1	S2a	S1	S2a	S3a	S2a	S3c	S2a	S3ca	S2/3a	S3ca
317		(20)	1,650	S2/3a	S2a	S2/3c	S2a	S1	S1/2a	S1	S2ca	S1	S3c	S1	S3c	S2/3a	S3ca
1298		(23)	3,250	S2cs	S1	S3a	S2c	S2ca	S2c	S2a	S3a	S2a	S2ca	S2a	S3a	S2/3a	S3a
318		(28)	3,350	S2/3a	S2a	S2/3c	S2a	S1	S1/2a	S1	S2ca	S1	S3c	S1	S3c	S2/3a	S3ca
323		(32)	2,050	S2cs	S1	S3a	S2c	S2ca	S2c	S2a	S3a	S2a	S2ca	S2a	S3a	S2/3a	S3a
319		(34)	9,200	S2/3a	S2a	S2a	S2ca	S2c	S2c	S1	S2a	S1	S2c	S1	S2/3a	S2/3a	S3a
1299		(41)	24,300	S2cs	S1	S3a	S2c	S2ca	S2c	S2a	S3a	S2a	S2ca	S2a	S3a	S2/3a	S3a
1300		(42)	2,600	S3c	S2c	S3a	S3c	S3c	S3c	S2ca	S3a	S2ca	S2a	S2ca	S3a	S2/3a	S3a
320		(43)	99,000	S2/3a	S2a	S2a	S2ca	S2c	S2c	S1	S2a	S1	S2c	S1	S2/3a	S2/3a	S3a
1301		(44)	77,600	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
324		(58)	4,500	S2/3a	S2a	S2a	S2ca	S2c	S2c	S1	S2a	S1	S2c	S1	S2/3a	S2/3a	S3a
1302		(142)	750	S2/3a	S2a	S2a	S2ca	S2c	S2c	S1	S2a	S1	S2c	S1	S2/3a	S2/3a	S3a
1303		(143)	7,800	S3c	S2c	S3a	S3c	S3c	S3c	S2ca	S3a	S2ca	S2a	S2ca	S3a	S2/3a	S3a
1304	I1e8	(34)	4,550	S2/3a	S2a	S2a	S2ca	S2c	S2c	S1	S2a	S1	S2c	S1	S2/3a	S2/3a	S3a
1292		(43)	5,800	S2/3a	S2a	S2a	S2ca	S2c	S2c	S1	S2a	S1	S2c	S1	S2/3a	S2/3a	S3a
1305		(144)	3,400	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2/3a	S2a	S1	S2a
1306		(145)	1,550	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2/3a	S2a	S1	S2a

LIMITING FACTORS: c - temperature regime r - rooting conditions
w - moisture regime s - soil related factors

APPENDIX IId (continued)

LAND SUITABILITY MAP II — Model: forestry (F) — Study Area: LADO

Land Unit	Soil Unit	AC ZN	Area (ha)	ACACIA ALBIDA	AZADIRACHTA INDICA	CALLITRIS CALCARATA	CALLITRIS HUGELLII	CASSIA SIAMEA	CORDYLA AFRICANA	EUCALYPTUS CAMALDULEN.	EUCALYPTUS GRANDIS	EUCALYPTUS TERETICORN.	GMELINA ARBOREA	MELIA AZEDARACH	PINUS CARIBAEA	PINUS KESIYA	PINUS PATULA
1307	X2e2	(23)	31,250	S2cs	S1	S2a	S2c	S2ca	S2c	S2a	S3a	S2a	S2ca	S2a	S3a	S2/3a	S3a
367		(28)	1,150	S2/3a	S2a	S2/3c	S2a	S1	S1/2a	S1	S2ca	S1	S3c	S1	S3c	S2/3a	S3ca
1308		(32)	17,350	S2cs	S1	S3a	S2c	S2ca	S2c	S2a	S3a	S2a	S2ca	S2a	S3a	S2/3a	S3a
369		(34)	60,600	S2/3a	S2a	S2a	S2ca	S2c	S2c	S1	S2a	S1	S2c	S1	S2/3a	S2/3a	S2a
1309		(41)	16,600	S2cs	S1	S3a	S2c	S2ca	S2c	S2a	S3a	S2a	S2ca	S2a	S3a	S2/3a	S3a
1310		(42)	9,950	S3c	S2c	S3a	S3c	S3c	S3c	S2ca	S3a	S2ca	S2a	S2ca	S3a	S2/3a	S3a
1311		(43)	53,950	S2/3a	S2a	S2a	S2ca	S2c	S2c	S1	S2a	S1	S2c	S1	S2/3a	S2/3a	S3a
1312		(44)	44,500	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
1389		(45)	2,050	S3c	S2c	S3a	S3c	S3c	S3c	S2ca	S3a	S2ca	S2a	S2ca	S3a	S2/3a	S3a
371		(58)	4,550	S2/3a	S2a	S2a	S2ca	S2c	S2c	S1	S2a	S1	S2c	S1	S2/3a	S2/3a	S3a
1313		(59)	2,750	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
1314		(62)	4,600	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
1315		(75)	1,250	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
1316		(142)	12,600	S2/3a	S2a	S2a	S2ca	S2c	S2c	S1	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
1317		(143)	14,100	S3c	S2c	S3a	S3c	S3c	S3c	S2ca	S3a	S1	S2ca	S1	S2/3a	S2/3a	S3a
1318		(146)	2,900	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2/3a	S2a	S2/3a	S3a
1319	X2e5	(7)	2,850	S2rs	S1	S3/Na	S1	S2a	S1	S2a	S3a	S2a	S3c	S2a	Na	S1	S2a
1320		(28)	2,300	S2/3a	S2a	S2/3c	S2a	S1	S1/2a	S1	S2ca	S1	S3c	S1	Na	Na	Na
1321		(41)	27,700	S2crs	S1	S3a	S2c	S2ca	S2c	S2a	S3a	S2a	S2ca	S2a	S3c	S2/3a	S3ca
1322		(42)	5,800	S3c	S2c	S3a	S3c	S3c	S3c	S2ca	S3a	S2ca	S2a	S2ca	S3a	S2/3a	S3a
1323		(43)	6,400	S2/3a	S2a	S2a	S2ca	S2c	S2c	S1	S2a	S1	S2c	S1	S2/3a	S2/3a	S3a
1324		(44)	8,300	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
1325		(62)	250	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
1326		(145)	4,550	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
411	X2e7	(18)	1,200	S3r	S2r	S3a	S2r	S2a	S2r	S2ar	S3a	S2ar	S3c	S2ar	S3ca	S2/3a	S3ca
1327	X2e11	(62)	1,900	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
434	X2p2	(18)	1,650	S3rs	S2r	S3a	S2r	S2as	S2r	S2ars	S3a	S2ars	S3c	S2ars	S3ca	S2/3a	S3cas
1328		(28)	6,050	S3rs	S2ar	S2/3c	S2ar	S2s	S2r	S2rs	S2cas	S2rs	S3c	S2rs	S3c	S2/3a	S3cas
1329		(32)	7,250	S3rs	S2r	S3a	S2cr	S2cas	S2cr	S2ars	S3a	S2ars	S2car	S2ars	S3a	S2/3a	S3as
1330		(41)	1,650	S3rs	S2r	S3a	S2cr	S2cas	S2cr	S2ars	S3a	S2ars	S2car	S2ars	S3a	S2/3a	S3as
1331		(42)	9,250	S3crs	S2cr	S3a	S3c	S3c	S3c	S2car	S3a	S2car	S2ar	S2car	S3a	S2/3a	S3as
1332		(43)	1,000	S3rs	S2ar	S2ar	S2car	S2cs	S2cr	S2rs	S2as	S2rs	S2cr	S2rs	S2/3a	S2/3a	S3as
1333		(44)	3,550	S3crs	S2car	S2ar	S3c	S3c	S3c	S2crs	S2as	S2crs	S2r	S2crs	S2/3a	S2/3a	S3as
1334	X2x2	(44)	4,000	Ns	S2ca	S2as	S3c	S3c	S3c	S2c	S2as	S2cs	S1	S2c	S2/3a	S2/3a	S3a
1335		(62)	5,400	Ns	S2ca	S2as	S3c	S3c	S3c	S2c	S2as	S2cs	S1	S2c	S2/3a	S2/3a	S3a
1336		(77)	2,250	Ns	S2ca	S2as	S3c	S3c	S3c	S2c	S2as	S2cs	S1	S2/3a	S2as	S2s	S2a

LIMITING FACTORS: c - temperature regime r - rooting conditions
a - moisture regime s - soil related factors

APPENDIX IId (continued)

LAND SUITABILITY MATRIX — Model: forestry (F) — Study Area: LADD

Land Unit	Soil Unit	AC IN	Area (ha)	ACACIA ALBIDA	AZADIRACHTA INDICA	CALLITRIS CALCARATA	CALLITRIS HUGELLII	CASSIA SIAMEA	CORDYLA AFRICANA	EUCALYPTUS CAMALDULEN.	EUCALYPTUS GRANDIS	EUCALYPTUS TERETICORN.	GMELINA ARBOREA	MELIA AZEDARACH	PINUS CARIBAEA	PINUS KESIYA	PINUS PATULA
1337	X3e1	(41)	3,550	S2cs	S1	S3e	S2c	S2ce	S2c	S2e	S3e	S2e	S2ce	S2e	S3e	S2/3e	S3e
1338		(75)	14,950	S3c	S2ce	S2e	S3c	S3c	S3c	S2c	S2e	S2c	S1	S2c	S2/3e	S2/3e	S3e
1124	X3e9	(32)	4,700	S2crs	S1	S3e	S2c	S2ce	S2c	S2e	S3e	S2e	S2ce	S2e	S3e	S2/3e	S3e
1339		(44)	6,550	S3c	S2ce	S2e	S3c	S3c	S3c	S2c	S2e	S2c	S1	S2c	S2/3e	S2/3e	S3e
1340		(62)	6,900	S3c	S2ce	S2e	S3c	S3c	S3c	S2c	S2e	S2c	S1	S2c	S2/3e	S2/3e	S3e
1341	X3e10	(26)	7,600	S2rs	S1	S3e	S1	S2e	S1	S2e	S3e	S2e	S3c	S2e	S3ce	S2/3e	S3ce
1342		(27)	1,050	S2crs	S1	S3e	S2c	S2ce	S2c	S2e	S3e	S2e	S2ce	S2e	S3e	S2/3e	S3e
1343		(28)	3,900	S2/3e	S2e	S2/3c	S2e	S1	S1/2e	S1	S2ce	S1	S3c	S1	S3c	S2/3e	S3ce
1344		(32)	17,000	S2crs	S1	S3e	S2c	S2ce	S2c	S2e	S3e	S2e	S2ce	S2e	S3e	S2/3e	S3e
1345		(34)	3,450	S2/3e	S2e	S2e	S2ce	S2c	S2c	S1	S2e	S1	S2c	S1	S2/3e	S2/3e	S3e
1346		(37)	2,450	S2crs	S1	S3e	S2c	S2ce	S2c	S2e	S3e	S2e	S2ce	S2e	S3e	S2/3e	S3e
1347		(41)	14,500	S2crs	S1	S3e	S2c	S2ce	S2c	S2e	S3e	S2e	S2ce	S2e	S3e	S2/3e	S3e
1348		(42)	8,900	S3c	S2c	S3e	S3c	S3c	S3c	S2ce	S3e	S2ce	S2e	S2ce	S3e	S2/3e	S3e
1388		(45)	4,850	S3c	S2c	S3e	S3c	S3c	S3c	S2ce	S3e	S2ce	S2e	S2ce	S3e	S2/3e	S3e
1349		(58)	3,950	S2/3e	S2e	S2e	S2ce	S2c	S2c	S1	S2e	S1	S2c	S1	S2/3e	S2/3e	S3e
1391		(59)	1,200	S3c	S2ce	S2e	S3c	S3c	S3c	S2c	S2e	S2c	S1	S2c	S2/3e	S2/3e	S3e
1350		(62)	1,500	S3c	S2ce	S2e	S3c	S3c	S3c	S2c	S2e	S2c	S1	S2c	S2/3e	S2/3e	S3e
1351		(75)	11,450	S3c	S2ce	S2e	S3c	S3c	S3c	S2c	S2e	S2c	S1	S2c	S2/3e	S2/3e	S3e
1352		(145)	11,250	S3c	S2ce	S2e	S3c	S3c	S3c	S2c	S2e	S2c	S1	S2c	S2/3e	S2/3e	S3e
1393	X3p2	(7)	200	S3rs	S2r	S3/Ne	S2r	S2es	S2r	S2ers	S3e	S2ers	S3c	S2ers	Ne	Ne	Ne
549		(27)	2,500	S3rs	S2r	S3e	S2cr	S2ces	S2cr	S2ers	S3e	S2ers	S2cer	S2ers	S3e	S2/3e	S3es
550		(32)	4,300	S3rs	S2r	S3e	S2cr	S2ces	S2cr	S2ers	S3e	S2ers	S2cer	S2ers	S3e	S2/3e	S3es
1354		(34)	5,800	S3rs	S2er	S2er	S2cer	S2cs	S2cr	S2rs	S2es	S2rs	S2cr	S2rs	S2/3e	S2/3e	S3es
552		(58)	3,500	S3rs	S2er	S2er	S2cer	S2cs	S2cr	S2rs	S2es	S2rs	S2cr	S2rs	S2/3e	S2/3e	S3es
1355	X3p3	(28)	1,050	S3rs	S2er	S2/3c	S2er	S2s	S2r	S2rs	S2ces	S2rs	S3c	S2rs	S3c	S2/3e	S3ces
1356		(32)	3,250	S3rs	S2r	S3e	S2cr	S2ces	S2cr	S2ers	S3e	S2ers	S2cer	S2ers	S3e	S2/3e	S3es
1385		(34)	7,450	S3rs	S2er	S2er	S2cer	S2cs	S2cr	S2rs	S2es	S2rs	S2cr	S2rs	S2/3e	S2/3e	S3es
1357		(41)	17,450	S3rs	S2r	S3e	S2cr	S2ces	S2cr	S2ers	S3e	S2ers	S2cer	S2ers	S3e	S2/3e	S3es
1358		(42)	5,050	S3crs	S2cr	S3e	S3c	S3c	S3c	S2cer	S3e	S2cer	S2er	S2cer	S3e	S2/3e	S3es
1359		(58)	10,450	S3rs	S2er	S2er	S2cer	S2cs	S2cr	S2rs	S2es	S2rs	S2cr	S2rs	S2/3e	S2/3e	S3es
13e0		(145)	1,750	S3crs	S2cer	S2er	S3c	S3c	S3c	S2crs	S2es	S2crs	S2r	S2crs	S2/3e	S2/3e	S3es
574	X3x2	(77)	600	Ns	S2ce	S2es	S3c	S3c	S3c	S2c	S2es	S2cs	S1	S2/3e	S2es	S2s	S2e
1761	X3x7	(62)	2,350	Ns	S2ce	S2es	S3c	S3c	S3c	S2c	S2es	S2cs	S1	S2c	S2/3e	S2/3e	S3e
13e2		(77)	14,650	Ns	S2ce	S2es	S3c	S3c	S3c	S2c	S2es	S2cs	S1	S2/3e	S2es	S2s	S2e
13e3		(14e)	1,200	Ns	S2ce	S2es	S3c	S3c	S3c	S2c	S2es	S2cs	S1	S2/3e	S2es	S2s	S2e

LIMITING FACTORS: c - temperature regime r - rooting conditions
e - moisture regime s - soil related factors

APPENDIX IId (continued)

LAND SUITABILITY MATRIX Model: forestry (F) Study Area: L40D

Land Unit	Soil Unit	AC IN	Area (ha)	ACACIA ALBIDA	AZADIRACHTA INDICA	CALLITRIS CALCARATA	CALLITRIS MUELLII	CASSIA SIAMEA	CORDYLA AFRICANA	EUCALYPTUS CAMALDULEN.	EUCALYPTUS GRANDIS	EUCALYPTUS TERETICORN.	GMELINA ARBOREA	MELIA AZEDARACH	PINUS CARIBAEA	PINUS KESIYA	PINUS PATULA
1364	X3x7	(147)	3,800	Ns	S2ca	S2as	S3c	S3c	S3c	S2c	S2as	S2cs	S1	S2/3a	S2as	S2s	S2a
1365	X4e4	(41)	10,000	S2crs	S1	S3a	S2c	S2ca	S2c	S2a	S3a	S2a	S2ca	S2a	S3a	S2/3a	S3a
1366		(43)	350	S2/3a	S2a	S2a	S2ca	S2c	S2c	S1	S2a	S1	S2c	S1	S2/3a	S2/3a	S3a
1367		(62)	6,650	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
1368		(78)	600	Nc	S3c	S2/3c	Nc	Nc	Nc	S3c	S2ca	S3c	S2c	S3c	S2/3a	S2/3a	S3a
1369		(145)	27,450	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
1370	X4e5	(62)	600	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2c	S2/3a	S2/3a	S3a
1371		(77)	3,250	S3c	S2ca	S2a	S3c	S3c	S3c	S2c	S2a	S2c	S1	S2/3a	S2a	S1	S2a
650	X4p2	(26)	1,150	S3rs	S2r	S3a	S2r	S2as	S2r	S2ars	S3a	S2ars	S3c	S2ars	S3ca	S2/3a	S3cas
651		(27)	500	S3rs	S2r	S3a	S2cr	S2cas	S2cr	S2ars	S3a	S2ars	S2car	S2ars	S3a	S2/3a	S3as
652		(28)	1,650	S3rs	S2ar	S2/3c	S2ar	S2s	S2r	S2rs	S2cas	S2rs	S3c	S2rs	S3c	S2/3a	S3cas
1372		(32)	8,400	S3rs	S2r	S3a	S2cr	S2cas	S2cr	S2ars	S3a	S2ars	S2car	S2ars	S3a	S2/3a	S3as
1373		(37)	4,150	S3rs	S2r	S3a	S2cr	S2cas	S2cr	S2ars	S3a	S2ars	S2car	S2ars	S3a	S2/3a	S3as
1374		(41)	17,850	S3rs	S2r	S3a	S2cr	S2cas	S2cr	S2ars	S3a	S2ars	S2car	S2ars	S3a	S2/3a	S3as
1387		(43)	1,450	S3rs	S2ar	S2ar	S2car	S2cs	S2cr	S2rs	S2as	S2rs	S2cr	S2rs	S2/3a	S2/3a	S3as
657		(58)	6,600	S3rs	S2ar	S2ar	S2car	S2cs	S2cr	S2rs	S2as	S2rs	S2cr	S2rs	S2/3a	S2/3a	S3as
1375		(75)	10,200	S3crs	S2car	S2ar	S3c	S3c	S3c	S2crs	S2as	S2crs	S2r	S2crs	S2/3a	S2/3a	S3as
1376		(145)	1,850	S3crs	S2car	S2ar	S3c	S3c	S3c	S2crs	S2as	S2crs	S2r	S2crs	S2/3a	S2/3a	S3as
1202	X4x5	(75)	3,550	Ns	S2ca	S2as	S3c	S3c	S3c	S2c	S2as	S2cs	S1	S2c	S2/3a	S2/3a	S3a
1377	X5p5	(37)	9,750	S3rs	S2r	S3a	S2cr	S2cas	S2cr	S2ars	S3a	S2ars	S2car	S2ars	S3a	S2/3a	S3as
1378		(41)	10,000	S3rs	S2r	S3a	S2cr	S2cas	S2cr	S2ars	S3a	S2ars	S2car	S2ars	S3a	S2/3a	S3as
1379		(43)	9,850	S3rs	S2ar	S2ar	S2car	S2cs	S2cr	S2rs	S2as	S2rs	S2cr	S2rs	S2/3a	S2/3a	S3as
1380		(70)	1,900	S3rs	S2ar	S2ar	S2car	S2cs	S2cr	S2rs	S2as	S2rs	S2cr	S2rs	S2/3a	S2/3a	S3as
1381		(77)	250	S3crs	S2car	S2ar	S3c	S3c	S3c	S2crs	S2as	S2crs	S2r	S2/3a	S2ars	S2rs	S3s
1382		(145)	1,700	S3crs	S2car	S2ar	S3c	S3c	S3c	S2crs	S2as	S2crs	S2r	S2crs	S2/3a	S2/3a	S3as
1383	X5p6	(32)	2,800	S3rs	S2r	S3a	S2cr	S2cas	S2cr	S2ars	S3a	S2ars	S2car	S2ars	S3a	S2/3a	S3as
1384		(41)	3,000	S3rs	S2r	S3a	S2cr	S2cas	S2cr	S2ars	S3a	S2ars	S2car	S2ars	S3a	S2/3a	S3as

LIMITING FACTORS: c - temperature regime r - rooting conditions
w - moisture regime s - soil related factors

APPENDIX III

INDEX OF AERIAL PHOTOGRAPHS, SATELLITE IMAGERY AND TOPOGRAPHICAL MAPS

Three different sets of black & white aerial photographs were used for different parts of the ADD. Block MW7A/82 (1982) at scale 1:25,000, blocks MW2/86 (1986) and DP/MLW/85/011 (1990) at scale 1:40,000, were used for the survey of soils and physiography in respectively Ntcheu District, Lilongwe and Dedza Districts (excluding the escarpment zone) and Lilongwe and Dedza Districts (escarpment zone). Blocks MW2/86 and DP/MLW/85/011 were used for the survey of present land use and vegetation. An index map is presented in Figure 10 for the most recent photographs.

DP/MLW/85/011
Central & Southern block
flown: 1990
scale: 1:40,000

RUN	PHOTO NOs (north to south)
19	0015-0011
20	0072-0068
21	1031-1025
22	1016-1024
23	1015-1007
24	0999-0990
25	0979-0988
26	0978-0969 & 0380-0385
27	1217-1205
28	0957-0986
29	1219-1230
30	0586-0591
31	0597-0592
32	0598-0605
33	0615-0607
34	0618-0627
35	0639-0629
36	0640-0646 & 0845-0841
37	0654-0647 & 0371-0367
38	0655-0662 & 0382-0389
39	0670-0663 & 0453-0447
40	0671-0678 & 0454-0460
41	0688-0680 & 0490-0487
42	0689-0696 & 0492-0496
43	0298-0294
44	0260-0264

MW2/86 'Lilongwe Revision'
flown: 1986
scale: 1:40,000

RUN	PHOTO NOs
5	868-870
6	815-813
7	645-650
8	596-589
9	523-540
10	484-460
11	179-210
12	149-116
13	035-004
14	075-109
15	250-216
16	254-286
17	330-296
18	334-367
19	407-377
20	412-442
21	737-705
22	745-760

MW7A/82
'ADD Project'
flown: 1982
scale: 1:25,000

RUN	PHOTO NO's
75	8307-8309 & 6500-6506
74	7178-7171
73	5244-5255
72	5238-5230
71	7501-7510
70	4434-4428 & 4407-4413
69	7538-7548 & 4465-4461
68	4467-4453
67	7573-7587
66	5370-5357
65	7616-7608 & 4680-4683
64	7621-7637
63	5357-5395
62	5512-5491
61	5519-5528
60	5658-5640
59	5673-5690
58	3462-3429
57	3210-3226
56	3182-3166
55	3189-3204
54	3061-3047
53	3255-3250

Four Landsat-5 TM false colour composites, bands 2, 3 and 4, were used mainly for the survey of present land-use and vegetation in conjunction with air photographs and field observations. See Figure 11 and table below.

Landsat Scene No.	Date
TM 167-071	1 Jul 1989
TM 168-070	11 Jul 1990
TM 169-069	31 Jul 1989
TM 169-070	31 Jul 1989

The 1:50,000 and 1:250,000 scale topographical map series were used. Index maps are presented in Figures 12 and 13.

FIG.10 INDEX OF AERIAL PHOTOGRAPHS

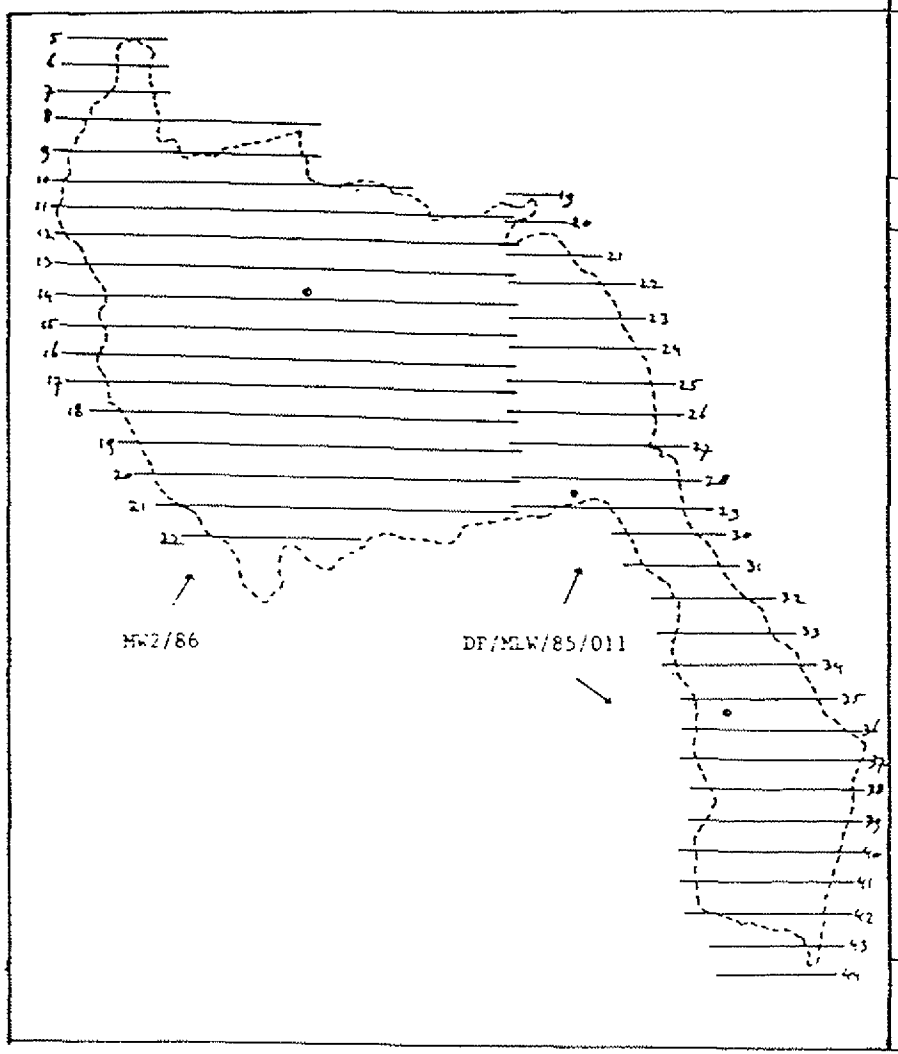


FIG.11 INDEX OF SATELLITE IMAGERY (Landsat-5 TM)

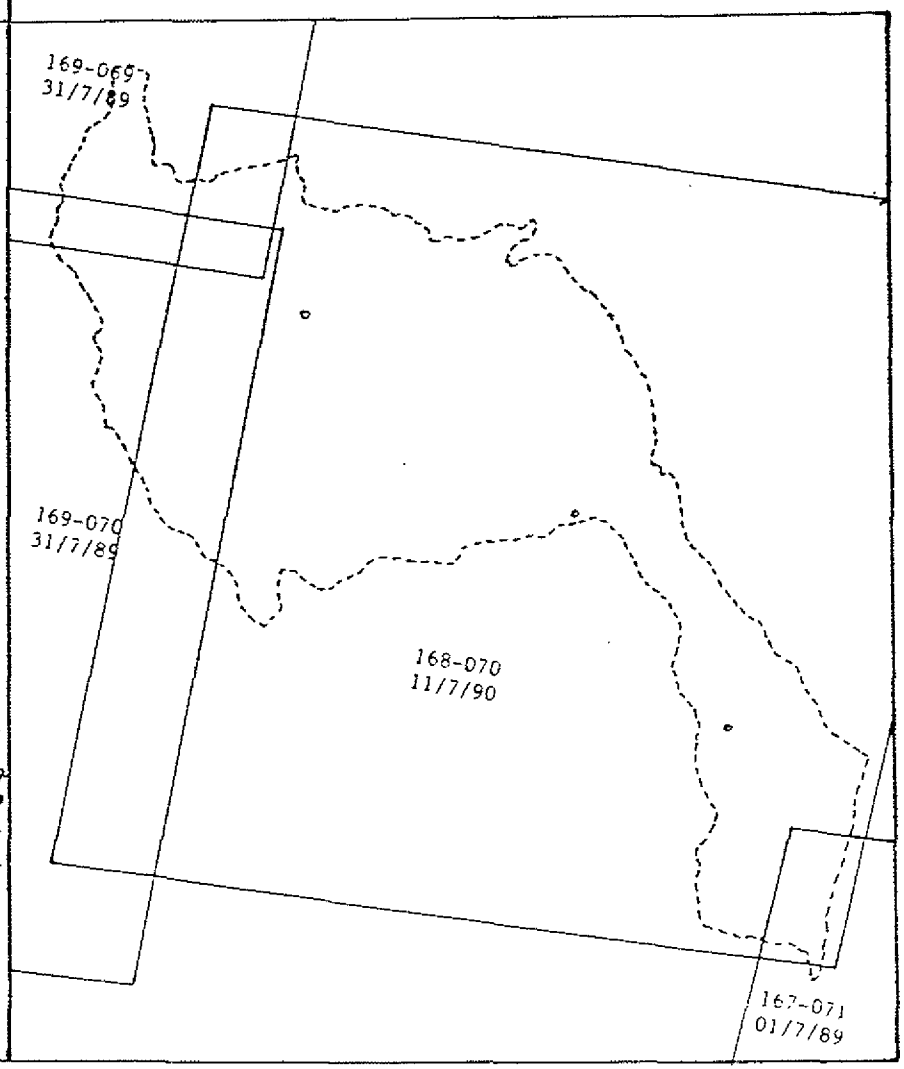


FIG. 12 INDEX OF TOPOGRAPHICAL MAPS AT SCALE 1:250,000

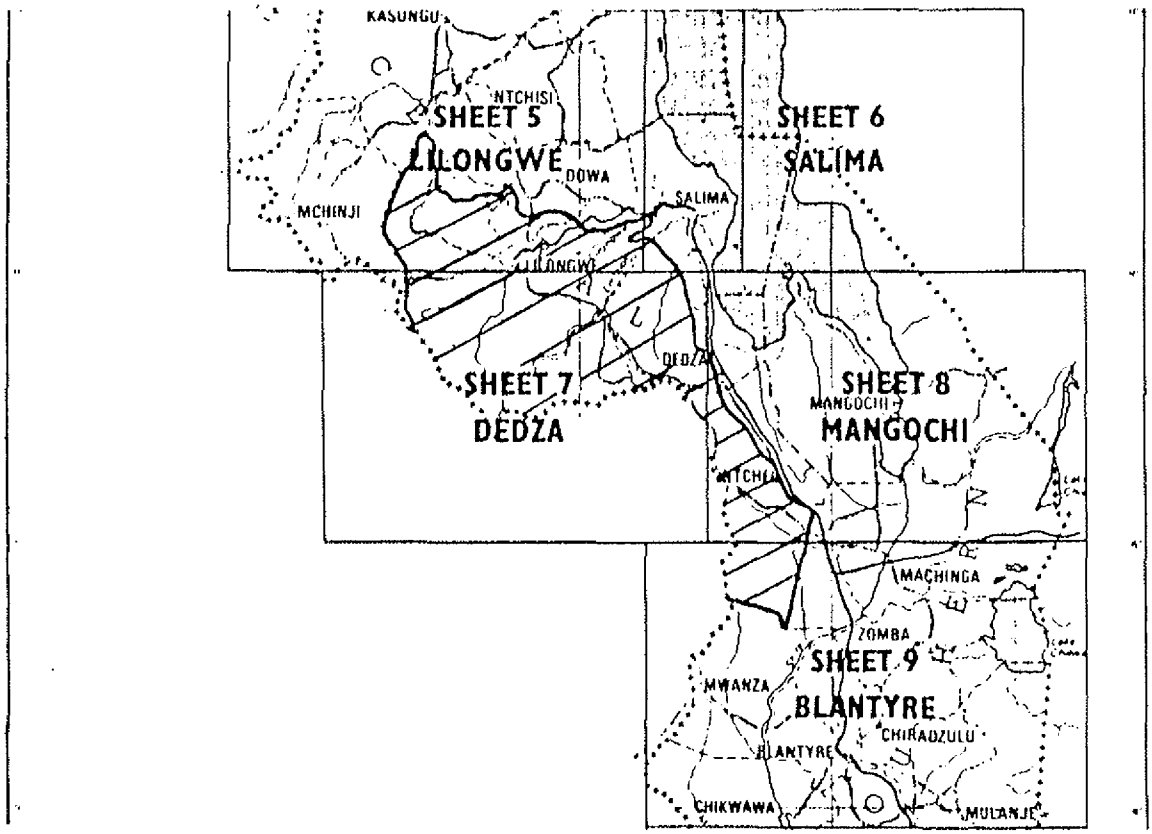
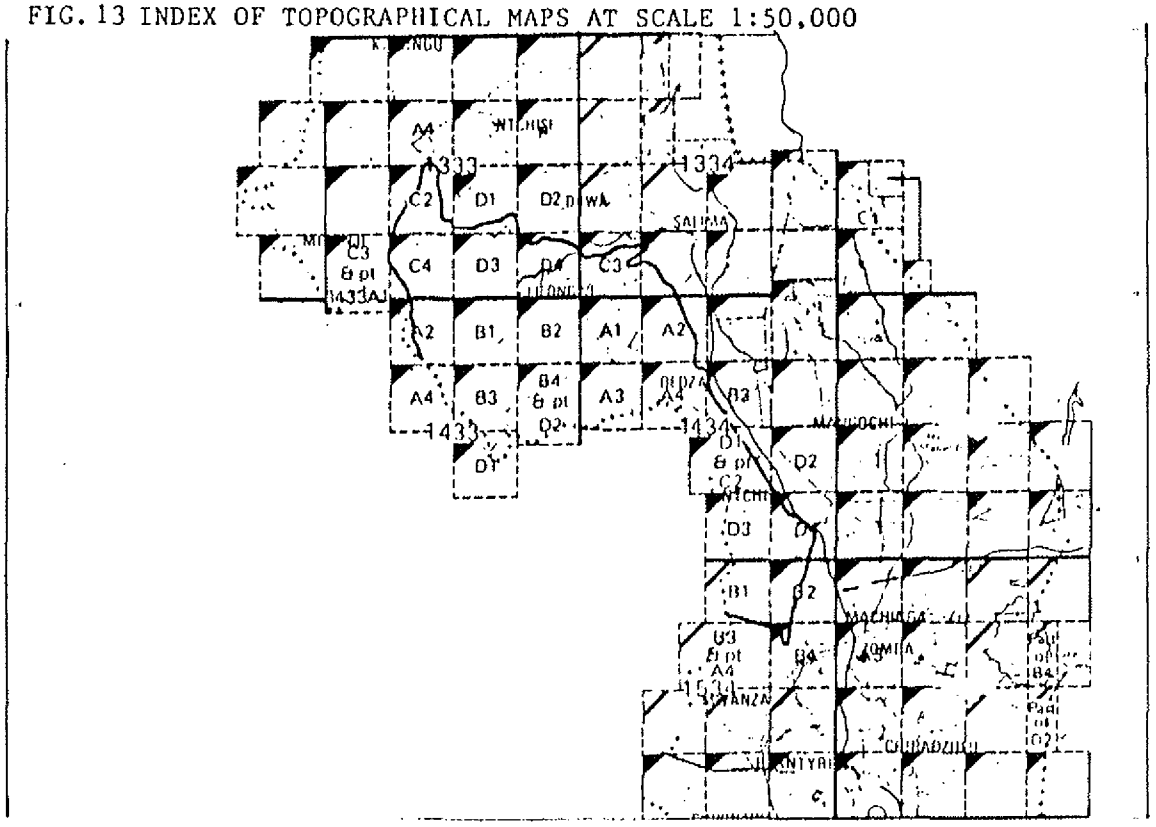


FIG. 13 INDEX OF TOPOGRAPHICAL MAPS AT SCALE 1:50,000



APPENDIX IV

ANNOTATED BIBLIOGRAPHY OF RELEVANT RESOURCE STUDIES

- Brown, P. and A. Young, 1965.
  The physical environment of Central Malawi, with special reference to soils and agriculture.

  The report is accompanied by a 1:500,000 scale map entitled "Natural Regions and Areas" (Sheet 2, Central Malawi). This study provides a useful overview of the land resources of Central Malawi, and covers most of the land area of Lilongwe ADD. It gives for each natural area information on climate, soil, landform, vegetation, land use, and agricultural potential. The information on land use is outdated. This study is the most important and best known general description to date of the land resources for the ADD.

- Stobbs, A.R. 1971.
  Malawi natural regions and areas. Sheet 3: Southern Malawi, scale 1:500,000. Environmental conditions and agriculture.

  This map is similar to the one above but for Southern Malawi. A memoir, which was supposed to accompany the map, was never published. Reference is made in the legend to soil series of which no published descriptions exist. The southern part of Lilongwe ADD is covered by it.

APPENDIX V. EXAMPLE OF SOIL PROFILE DESCRIPTION SHEET

FAO/MoA MLW/85/011 SOIL SURVEY FIELD SHEET

LOCATION			MAPSHEET		FIELD No.
PHOTO No.		SAT.IMAGE No.			GRID REF.
AUTHOR(S)			DATE		LAND UNIT
PARENT MATERIAL					ROCKINESS(%)
PHYSIOGRAPHIC UNIT					ALTITUDE(m)
TOPOGRAPHY Macro			Micro		
SLOPE Length		Shape	Gradient		Position
SURFACE CONDITIONS:	MIN.FRAGM.(%) Bld.		St.		Cr.
	CAPPING		SALTS		
EROSION					
PERMEABILITY (0-50cm)		(50-100cm)		PONDING	
(RIVER)FLOODING			(FLASH)FLOODING		
GROUNDWATER			SEEPAGE		
MOISTURE COND. PROFILE					DRAINAGE CLASS
VEGETATION/LAND USE					
SUITABILITY					

HORIZON SYMBOL					
DEPTH(cm)					
COLOUR moist dry					
MOTTLING					
TEXTURE					
STRUCTURE					
CRACKS					
CONSISTENCE d m w					
CUTANS					
SLICKENSIDES					
CEMENTATION					
PORES					
ROCK FRAGM.					
MIN. NODULES					
ROOTS					
BOUNDARY					
REACTION HCl					
pH (field)					
SAMPLES					

SOIL CLASSIFICATION	(FAO)
	(ST)

APPENDIX VI

LABORATORY METHODS

- texture

Hydrometer method. The soil sample is dispersed with a calgon solution: a mixture of sodium hydroxide and sodium hexametaphosphate. Clay and silt are read with a hydrometer after the samples have stood two hours.

- soil reaction

pH values are read with a pH meter in a suspension of a 1:2.5 soil:water mixture

- total organic carbon

Walkley and Black method: wet combustion of the organic matter with a potassium dichromate/sulphuric acid mixture and titration of residual dichromate with ferrous sulphate. Organic matter content is derived from total organic carbon by the following formula: org.matter = org.C x 1.724

- total nitrogen

Kjeldahl method: a 40-mesh sieved soil sample is digested with the use of concentrated sulphuric acid. The digest is distilled and the distillate, containing the ammonium nitrogen, is titrated against a weak hydrochloric acid solution. The amount of HCl used in the titration correlates with the amount of nitrogen in the sample.

- available phosphorus

Bray(I) method: an extracting solution is used, consisting of a mixture of hydrochloric acid and ammonium fluoride. After filtering the soil suspension an aliquot is taken. Ammonium molybdate is added and with the use of stannous chloride indicator a blue colour is developed which is read colorimetrically.

- exchangeable cations

Cations are extracted with a neutral ammonium acetate solution. After filtering the suspension aliquots are taken which are passed on to a flame photometer for determination of sodium (Na) and potassium (K). Another aliquot is taken to be passed on to an atomic absorption spectrophotometer for magnesium (Mg) and calcium (Ca) determination.

- cation exchange capacity (CEC)

After percolation with ammonium acetate at pH 7, the sample is percolated with sodium acetate at pH 7, washed free of excess salt and percolated with ammonium acetate. Sodium in the percolate is measured spectrophotometrically.

APPENDIX VII. LIST OF SOIL MAPPING UNITS AND MISCELLANEOUS UNITS, LILONGWE ADD

Soil Mapping Unit	Area (ha)	Soil Mapping Unit	Area (ha)
A1e7	1900	X3e1/X3e10	21400
A1f2	4950	X3e1/X3p3	4100
A1f7	3950	X3e9	18200
A1g8	3250	X3e10	55150
A1g13	53000	X3e10/A3f2	750
A1x1	3650	X3e10/R	7350
A2a3	11200	X3e10/X2e2	6900
A2e5	300	X3e10/X3e1	3600
A2f7	5900	X3e10/X3p3	5350
A2f8	4000	X3e10/X4p2	16250
A2f8/X2e5	1350	X3p2	12600
A3e1/X3p3	3600	X3p2/X3e10	1800
A3f2	5850	X3p3	26050
B2p1	12550	X3p3/X2p2	6750
B2p1/B3u1	5400	X3p3/X3e10	2250
R	14450	X3x2	600
R/X3e10	1350	X3x7	8500
R/X4e4	8650	X3x7/R	17400
R/X4p2	2200	X3x7/X4e5	1950
V	750	X4e4	36500
X1e4	237050	X4e4/R	1200
X1e8/A1g13	21900	X4e4/X4p2	7350
X2e2	236400	X4e5/R	4650
X2e2/X2e5	21350	X4p2	34400
X2e2/X2p2	31050	X4p2/A3f2	450
X2e2/X2x2	6600	X4p2/R	6300
X2e5	9950	X4p2/X3e10	5850
X2e5/R	4150	X4p2/X5p5	4100
X2e5/X2p2	11900	X4x5	3450
X2e5/X3e10	5100	X5p5	6550
X2e5/X3p3	33900	X5p5/R	8600
X2e7	1200	X5p5/V	28050
X2e11/A1g13	2750	X5p6	2800
X2p2	8200	X5p6/V	4300
X2p2/R	500		
X2p2/X2e5	9750	TOTAL AREA	1171800
X2x2	9650		
X3e1	650	Total nr. Units	72

APPENDIX VIII. LIST OF LAND MAPPING UNITS

Land mapping unit	Area (ha)	Land mapping unit	Area (ha)	Land mapping unit	Area (ha)	Land mapping unit	Area (ha)
96	300	1282	2250	1330	500	1365/5003	1200
210	300	1283	500	1331/1322	9750	1366	350
316	950	1284	350	1332/5003	500	1367	4650
317	1650	1285/1355	3600	1334	4000	1369	23800
318	3350	1286	350	1335	3400	1369/1376	5150
319	9200	1288	2350	1336	2250	1371/5003	4650
320	99000	1290	1650	1337	650	1372	500
323	2050	1291	1050	1337/1357	4100	1372/1344	5850
324	4500	1292	450	1338/1351	21400	1372/5003	5450
367	1150	1293	1450	1339	6550	1373	3350
369	60600	1294/1297	5400	1340	6900	1373/1287	450
371	4550	1295	10500	1341	4850	1374	12850
411	1200	1296	600	1341/650	3950	1374/1378	4100
434	1650	1298	3250	1343/652	5600	1375	9550
549/1342	3600	1299	24300	1344	15250	1376/5003	450
550	4300	1300	2600	1345	2900	1377/5004	13950
552	3500	1301	77600	1346	1200	1378	3950
574	600	1302	750	1346/1373	1750	1378/5003	6900
651	500	1303	7800	1347	3750	1379/5004	14100
657	6300	1304/1269	6500	1347/1357	5350	1380	1900
657/5003	450	1305/1272	4850	1347/1374	5000	1381	250
1124	4750	1306/1273	2250	1347/5003	2850	1382	500
1202	3450	1307	31200	1348	6000	1382/5003	1700
1256	1900	1308	450	1348/1289	750	1383	2800
1257	2800	1308/1329	23450	1348/5003	2500	1384/5004	4300
1258	1250	1309	16600	1349	3950	1385	7450
1259	1050	1310	6150	1350/5003	2000	1386	500
1260	750	1310/1331	5400	1351	5050	1387	1450
1261	1900	1311	37500	1352	10950	1388/1389	6900
1262	300	1311/1323	21350	1353	200	1390	900
1263	2500	1311/1332	2200	1354	4550	1391	1200
1264	200	1312	44500	1354/1345	1800	1392/1268	8300
1265	1350	1313	2750	1356	3250	5003	14450
1266	5700	1314/1335	6600	1357	1650	5003/1350	350
1267	1500	1315	1250	1357/1330	3950	5003/1352	950
1268	20150	1316	12600	1358	1500	5003/1367	6650
1269	22400	1317	14100	1358/1331	2800	5003/1368	2000
1270	250	1318	2900	1358/1348	2250	5003/1375	2200
1271	1150	1319	2850	1359	10450	5004	750
1272	350	1320	2300	1360	1750		
1274	3650	1321/1347	5100	1361/1370	1950	TOTAL	1171800
1275	3950	1321/1357	33950	1361/5003	1400		
1276	7250	1322/5003	4150	1362	7250		
1277	1150	1324/1333	11850	1362/5003	10550		
1278	500	1325	250	1363	1200		
1279	4250	1326	4550	1364/5003	5450		
1280	900	1327/1270	2750	1365	7650		
1281/1321	1350	1328	6050	1365/1374	2200		

APPENDIX IX

REFERENCES

Brown, P. and A. Young. The physical environment of Central Malawi. 1965 Government printer, Zomba.

Brunt, M.A., A.J.B. Mitchell and R.C. Zimmermann. Environmental effects 1984 of development (in) Malawi. Consultant report AG:/DP/MLW/81/001. FAO, Rome.

Department of Agricultural Research. A description of crop varieties 1986 grown in Malawi. Ministry of Agriculture.

Department of Agricultural Research. Annual report 1989. 1990

Department of Surveys. Vegetation/Biotic communities Malawi (map, colour 1979 print, scale 1:1,000,000)

D'Hoore, J.L. Soil Map of Africa (1:5,000,000). Commission for 1964 technical cooperation in Africa, Publ.93. Lagos, Nigeria.

Drayton, R.S. A preliminary survey of the water resources of Malawi. 1980 Department of Lands Valuation and Water.

Duchaufour, P. Pedology. English edition, Allen and Unwin, London. 1982

Eschweiler, J.A., S. Paris, J.H. Venema, A.J.M. Lorkeers and R.I. Green. 1991 Methodology for land resources survey and land suitability appraisal. MOA/UNDP/FAO, MLW/85/011, Field document No. 30.

Extension Aids Branch. Guide to agricultural production in Malawi, 1988 1988-1989. Ministry of Agriculture, Lilongwe.

FAO. A framework for land evaluation. Soils Bulletin no.32, Rome. 1976

FAO. Guidelines for soil profile description. Rome. 1977

FAO. Guidelines: land evaluation for rainfed agriculture. Soils Bulletin 1984. No. 52, Rome.

FAO. FAO/Unesco Soil Map of the World, Revised Legend. World Soil 1988 Resources report No.60. Rome.

FAO. Agriculture, forestry and natural resources sector review and 1990 programming mission, Malawi, mission findings and recommendations. UNDP/FAO, RAF/89/B37, Rome.

FSNM (Food Security and Nutrition Monitoring Survey). Food security,
1991 Lilongwe ADD. Draft. Evaluation Section, Lilongwe ADD.

Geological Survey of Malawi. Geological maps 1:100,000 and reports.
1973-1975

Lilongwe ADD. Annual survey of agriculture, results of unweighted data
1990 1989/90. Evaluation Section, Lilongwe ADD.

Lilongwe ADD. Information gathered from subject matter specialists in
1991 the ADD offices in Lilongwe, usually in unpublished printed form.

Maida J.H.A. (ed.). Research highlights and constraints to crop
1987 production. Proceedings of 1986 research and extension workshop (Malawi).

Nanthambwe S.J. Agro-climatic resources inventory part III: Central
1990 Region. MOA/UNDP/FAO, MLW/85/011, Field Document No.20.

National Atlas Co-ordination Committee. The national atlas of Malawi.
1983 Dept. of Surveys, Blantyre.

NSO (National Statistics Office). Malawi, population and housing census,
1987 1987. Preliminary report. Government printer, Zomba.

Paris, S. Land evaluation, the FAO approach to land suitability
1988 assessment. MOA/UNDP/FAO, MLW/85/011, Field Document No.4.

Paris, S. Land resources appraisal of Mzuzu ADD. MOA/UNDP/FAO,
1991 MLW/85/011, Field Document No. 27.

Pike, J.G. and G.T. Rimmington. Malawi, a geographical study. Oxford
1965 University Press, London.

OPC. Statement of Development Policies 1987-1996. Office of the President
1987 and Cabinet, Dept. of Economic Planning and Development. Government Printer, Zomba.

Rossiter, D.G. and A.R. van Wambeke. Automated land evaluation system
1989 (ALES). Version 2, users manual. Agronomy Dept., Cornell University, Ithaca, New York.

Sichra, U.W. Land Resources Data Base, LRDB, version 2.0. User manual and
1991 technical manual. MOA/UNDP/FAO, MLW/85/011. Consultant's Report No. 4.

Soil Conservation Service. Soil Taxonomy. Agriculture handbook No.436.
1975 U.S.Dept.of Agric., Washington D.C.

Stobbs, A.R. Malawi natural regions and areas. Sheet 3: Southern Malawi.
1971 Environmental conditions and agriculture, scale 1:500,000, D.O.S. (map only)

Stobbs, A.R. and J.N.R. Jeffers. Land use survey of Malawi, 1965-1967. 1985 ODA, LRDC, England.

UNDP/UNCHS. National physical development plan, volume 1: Policy 1987 document and volume 2: Background study report. Office of the President and Cabinet, Dept. of Town and Country Planning, National physical development plan project UNDP, MLW/79/012.

Venema, J.H. Methods of description, classification and mapping of the 1990 physiography and soils of Malawi (2nd edition). MOA/UNDP/ FAO, MLW/85/011, Field Document No.3, Lilongwe.

Venema, J.H. Soil families of Malawi (Blantyre, Karonga, Lilongwe, 1991 Liwonde, Mzuzu and Ngabu ADDs). MOA/UNDP/FAO, MLW/85/011, Field document No.29.

Water Resources Branch. Water resources data, 1985-86 year book. Water 1987 Department, Ministry of Works, Lilongwe.

Young, A. and P.F. Goldsmith. Soil survey and land evaluation in 1977 developing countries, a case study in Malawi. In: Geographical Journal, Vol. 143, No.3.

LEGEND OF MAP No. 1: SOILS AND PHYSIOGRAPHY LILONGWE ADD

SOIL UNIT	AREA (ha)	SOIL FAMILY	SOIL CLASSIFICATION (FAO, 1988)	SOIL DEPTH (cm)	SOIL DRAINAGE	PARTICLE SIZE topsoil (0-30cm)	PARTICLE SIZE subsoil (>30cm)	pH(H2O) (0-50cm)	CEC-soil (me/100g) (0-50cm)	NPK * (0-50cm)	COLOUR (subsoil)	SURFACE STONINESS + ROCKINESS (%)	PRESENT EROSION	FLOODING	LANDFORM
A - LAND WITH SOILS IN FLUVIAL, COLLUVIAL AND/OR LACUSTRINE SEDIMENTS															
A1 - Flat or almost flat land (0-2%)															
A1e - With EUTRIC-FERSIALIC soil characteristics															
A1e7	1,900	Mikaju	Haplic Luvisols + Chromic Cambisols	>150	well	coarse + medium	medium	5.5-6.5	5-10	=:+	brown	<1	slight	none	footslopes; river terraces; outwash plains
A1f - With FLUVIC soil characteristics															
A1f2	5,100	Nanitalala	Eutric Fluvisols + Mollic Fluvisols	>150	poor	variable	variable	5.0-6.5	5-10	-v+	variable	<1	none	frequent	floodplains
A1f7	3,950	Lisungwe	Eutric Fluvisols	>150	mod.well	coarse + medium	coarse + medium	5.0-6.5	5-10	=:+	brown	<1	slight	exceptional + none	outwash plains; footslopes
A1g - With GLEYIC soil characteristics															
A1g8	3,250	Mpasa	Gleyic Cambisols + Eutric Gleysols	>150	imperfect	medium	medium + fine	5.0-6.0	5-10	-=-	grey	<1	slight	none	plains; depressions
A1g13	60,350	Tenthema	Eutric Gleysols	>150	poor	variable	variable	5.5-6.5	5-10	v=v	grey	<1	none	exceptional + none	dambo's
A1x - With EUTRIC-FERRALIC soil characteristics															
A1x1	3,600	Liphala	Haplic Lixisols	>150	mod.well	medium	medium + fine	5.0-6.0	5-10	--+	dark brown	<1	slight	none	footslopes
A2 - Gently sloping land (2-6%)															
A2a - With ARENIC soil characteristics															
A2a3	11,200	Thangadzi	Cambic Arenosols	>150	well	coarse	coarse	5.0-6.5	<5	===	brown	<1	slight	none	footslopes
A2e - With EUTRIC-FERSIALIC soil characteristics															
A2e5	300	Kachingwe	Eutric Cambisols + Chromic Cambisols	100-150	well	coarse	coarse + medium	6.0-7.0	5-10	+=+	reddish brown	1-15	slight	none	footslopes
A2f - With FLUVIC soil characteristics															
A2f7	5,850	Lisungwe	Eutric Fluvisols	>150	mod.well + well	coarse + medium	coarse + medium	5.0-6.5	5-10	=:+	brown	<1	slight	exceptional	footslopes
A2f8	4,900	Gwelewela	Eutric Fluvisols	>150	imperfect	coarse + medium	variable	5.0-6.5	5-10	-v-	greyish brown	<1	slight	exceptional	footslopes; outwash plains

(*) N (Nitrogen): = <0.08 % (very low)
- 0.08-0.12 % (low)
+ >0.12 % (medium-very high)
v very variable

P (Phosphorus): = < 6 ppm (very low)
- 6-18 ppm (low)
+ >18 ppm (medium-very high)
v very variable

K (Potassium): = <0.1 me/100g (very low)
- 0.1-0.2 me/100g (low)
+ >0.2 me/100g (medium-very high)
v very variable

LEGEND OF MAP No. 1: SOILS AND PHYSIOGRAPHY LILONGWE ADD (Cont'd)

SOIL UNIT	AREA (ha)	SOIL FAMILY	SOIL CLASSIFICATION (FAO, 1988)	SOIL DEPTH (cm)	SOIL DRAINAGE	PARTICLE SIZE topsoil (0-30cm)	PARTICLE SIZE subsoil (>30cm)	pH(H2O) (0-50cm)	CEC-soil (me/100g) (0-50cm)	NPK * (0-50cm)	COLOUR (subsoil)	SURFACE STONINESS + ROCKINESS (%)	PRESENT EROSION	FLOODING	LANDFORM
A - LAND WITH SOILS IN FLUVIAL, COLLUVIAL AND/OR LACUSTRINE SEDIMENTS															
A3 - Sloping land (6-13%)															
A3e - With EUTRIC-FERSIALIC soil characteristics															
A3e1	2,500	Jombo	Haplic Luvisols / Eutric Cambisols	>150	mod.well + well	medium	medium	5.5-7.0	>10	-v+	dark brown	1-15	moderate	none + exceptional	footslopes
A3f - With FLUVIC soil characteristics															
A3f2	6,150	Chiradzulu	Eutric Fluvisols	>150	well	medium + coarse	medium + coarse	5.5-7.0	5-10	=-+	brown	1-15	moderate	none + exceptional	footslopes
B - LAND WITH SOILS DERIVED FROM MAFIC IGNEOUS OR METAMORPHIC ROCKS															
B2 - Gently sloping land (2-6%)															
B2p - With PARALITHIC soil characteristics															
B2p1	16,300	Chaleathuwa	Eutric Cambisols / Haplic Phaeozems	50-100	well	medium	medium skeletal	6.5-7.5	>10	-=+	dark brown	1-15	slight	none	uplands
B3 - Sloping land (6-13%)															
B3u - With LITHIC soil characteristics															
B3u1	1,600	Chambuluka	Eutric Regosols	30-50	well	medium	medium skeletal	6.0-7.5	>10	+=+	dark brown	1-15	slight	none	uplands
X - LAND WITH SOILS DERIVED FROM FELSIC AND INTERMEDIATE IGNEOUS AND METAMORPHIC ROCKS															
X1 - Flat or almost flat land (0-2%)															
X1e - With EUTRIC-FERSIALIC soil characteristics															
X1e4	237,050	Mpili	Chromic Luvisols	>150	well	coarse + medium	medium + fine	5.5-6.5	5-10	--+	reddish brown	<1	slight	none	plains; footslopes
X1e8	15,300	Buthini	Chromic Luvisols	>150	well	coarse	coarse + medium	5.5-6.5	<5	=vv	reddish brown	<1	none + slight	none	uplands; plains

(*) N (Nitrogen): = <0.08 % (very low)
- 0.08-0.12 % (low)
+ >0.12 % (medium-very high)
v very variable

P (Phosphorus): = < 6 ppm (very low)
- 6-18 ppm (low)
+ >18 ppm (medium-very high)
v very variable

K (Potassium): = <0.1 me/100g (very low)
- 0.1-0.2 me/100g (low)
+ >0.2 me/100g (medium-very high)
v very variable

LEGEND OF MAP No. 1: SOILS AND PHYSIOGRAPHY LILONGWE ADD (Cont'd)

SOIL UNIT	AREA (ha)	SOIL FAMILY	SOIL CLASSIFICATION (FAO, 1988)	SOIL DEPTH (cm)	SOIL DRAINAGE	PARTICLE SIZE topsoil (0-30cm)	PARTICLE SIZE subsoil (>30cm)	pH(H2O) (0-50cm)	CEC-soil (me/100g) (0-50cm)	NPK * (0-50cm)	COLOUR (subsoil)	SURFACE STONINESS + ROCKINESS (%)	PRESENT EROSION	FLOODING	LANDFORM
I - LAND WITH SOILS DERIVED FROM FELSIC AND INTERMEDIATE IGNEOUS AND METAMORPHIC ROCKS															
I2 - Gently sloping land (2-6%)															
I2e - With EUTRIC-FERSIALIC soil characteristics															
I2e2	280,250	Mpili	Chromic Luvisols	>150	well	coarse + medium	medium + fine	5.5-6.5	5-10	--+	reddish brown	1-15	slight	none	uplands; plains
I2e5	58,200	Neno	Chromic Luvisols; Luvic Phaeozems	100-150	well	medium + coarse	medium + fine	5.0-6.5	5-10	==+	(reddish) brown	1-15	slight	none	uplands; valleysides
I2e7	1,200	Katema	Haplic Luvisols	50-100	well	medium + coarse	medium + fine	5.5-6.5	5-10	--+	brown	1-15	moderate	none	uplands; dissected footslopes
I2e11	1,900	Kuthini	Chromic Luvisols	>150	well	coarse	coarse + medium	5.5-6.5	<5	=vv	brown	<1	slight + moderate	none	uplands; plains
I2p - With PARALITHIC soil characteristics															
I2p2	38,400	Walkers Ferry	Eutric Cambisols; Chromic Cambisols	50-100	well	coarse + medium	medium skeletal	5.5-6.5	5-10	-=+	brown	1-15	slight	none	uplands
I2x - With EUTRIC-FERRALIC soil characteristics															
I2x2	11,600	Mkwepela	Haplic Lixisols	>150	well	coarse	medium + fine	5.0-6.0	5-10	=-+	(reddish) brown	<1	slight	none	plains; uplands
I3 - Sloping land (6-13%)															
I3e - With EUTRIC-FERSIALIC soil characteristics															
I3e1	18,500	Mpili	Chromic Luvisols; Luvic Phaeozems	>150	well	coarse + medium	medium + fine	5.5-6.5	5-10	--+	reddish brown	<1	slight + moderate	none	uplands; footslopes
I3e9	18,200	Neno	Chromic Luvisols; Luvic Phaeozems	100-150	well	coarse + medium	medium + fine	5.0-6.5	5-10	==+	brown	<1	slight + moderate	none	uplands; low hills
I3e10	95,600	Neno	Chromic Luvisols; Luvic Phaeozems	100-150	well	coarse + medium	medium + fine	5.0-6.5	5-10	==+	brown	1-15	slight + moderate	none	uplands; low hills
I3p - With PARALITHIC soil characteristics															
I3p2	13,850	Walkers Ferry	Eutric Cambisols; Chromic Cambisols	50-100	well	coarse + medium	medium skeletal	5.5-6.5	5-10	-=+	brown	>15	moderate	none	dissected uplands; ridges; escarpments
I3p3	46,450	Walkers Ferry	Eutric Cambisols; Chromic Cambisols	50-100	well	coarse + medium	medium skeletal	5.5-6.5	5-10	-=+	brown	1-15	slight + moderate	none	uplands; escarpments

(*) N (Nitrogen): = <0.08 % (very low)
- 0.08-0.12 % (low)
+ >0.12 % (medium-very high)
v very variable

P (Phosphorus): = < 6 ppm (very low)
- 6-18 ppm (low)
+ >18 ppm (medium-very high)
v very variable

K (Potassium): = <0.1 me/100g (very low)
- 0.1-0.2 me/100g (low)
+ >0.2 me/100g (medium-very high)
v very variable

SOIL UNIT	AREA (ha)	SOIL FAMILY	SOIL CLASSIFICATION (FAO, 1988)	SOIL DEPTH (cm)	SOIL DRAINAGE	PARTICLE SIZE topsoil (0-30cm)	PARTICLE SIZE subsoil (>30cm)	pH(H2O) (0-50cm)	CEC-soil (me/100g) (0-50cm)	NPK * (0-50cm)	COLOUR (subsoil)	SURFACE STONINESS + ROCKINESS (%)	PRESENT EROSION	FLOODING	LANDFORM
X - LAND WITH SOILS DERIVED FROM FELSIC AND INTERMEDIATE IGNEOUS AND METAMORPHIC ROCKS															
X3x - With EUTRIC-FERRALIC soil characteristics															
X3x2	600	Motheriwa	Haplic Luvisols	>150	well	medium	fine	5.0-6.0	5-10	=+	red	1-15	slight	none	uplands; hillsides
X3x7	22,000	Kapalola	Haplic Luvisols	100-150	well	coarse + medium	medium	5.0-6.5	<5	-=+	(yellowish) brown	1-15	slight	none	hillsides
X4 - Moderately steep land (13-25%)															
X4e - With EUTRIC-FERSIALIC soil characteristics															
X4e4	45,050	Neno	Chromic Luvisols Luvic Phaeozems	100-150	well	coarse + medium	medium	5.0-6.5	5-10	=+	reddish brown	1-15	slight + moderate	none	hillsides
X4e5	3,800	Dzalanyama	Eutric Cambisols	100-150	well	coarse	medium skeletal	5.5-6.5	5-10	=+	yellowish brown	1-15	slight	none	hillsides
X4p - With PARALITHIC soil characteristics															
X4p2	53,800	Walkers Ferry	Eutric Cambisols Chromic Cambisols	50-100	well	coarse + medium	medium skeletal	5.5-6.5	5-10	-=+	(reddish) brown	>15	moderate + severe	none	dissected hills
X4x - With EUTRIC-FERRALIC soil characteristics															
X4x5	3,500	Chisope	Haplic Lixisols Haplic Ferralsols	100-150	well	medium	medium	5.0-6.5	5-10	--+	reddish brown	1-15	moderate	none	hillsides; dissected plateaux
X5 - Steep land (25-55%)															
X5p - With PARALITHIC soil characteristics															
X5p5	33,400	Walkers Ferry	Eutric Cambisols Chromic Cambisols	50-100	well	medium	medium skeletal	5.5-6.5	5-10	-=+	brown	1-15	slight + moderate	none	hills; escarpments
X5p6	5,800	Walkers Ferry	Eutric Cambisols Chromic Cambisols	50-100	well	medium	medium skeletal	5.5-6.5	5-10	-=+	brown	1-15	moderate + severe	none	hills; escarpments

MISCELLANEOUS LAND UNITS

R - LAND WITH VERY SHALLOW SOILS (<30cm)	38,000	hills
V - LAND WITH PREDOMINANTLY VERY STEEP SLOPES (>55%)	10,400	hillsides; escarpments

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v very variable

P (Phosphorus): = < 6 ppm (very low)
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K (Potassium): = <0.1 me/100g (very low)
- 0.1-0.2 me/100g (low)
+ >0.2 me/100g (medium-very high)
v very variable