



# Rethinking Natural Resource Degradation in Semi-Arid Sub-Saharan Africa:

A review of soil and water conservation research and practice in Uganda, with  
particular emphasis on the semi-arid areas

**Editors:** Bob Nakileza, Edward N.B. Nsubuga

**Supervisors:** Moses M. Tenywa, Alex Lwakuba

**Soil and Water Conservation Society Of Uganda (SWCSU),**

University of Makerere,

Makerere University,

PO Box 7062, Kampala,

Uganda.

Kampala.

**Uganda, March 1999**

# Table of Contents

<b>TABLE OF CONTENTS</b> .....	<b>I</b>
<b>TABLES</b> .....	<b>III</b>
<b>BOXES</b> .....	<b>III</b>
<b>FIGURES</b> .....	<b>III</b>
<b>ACKNOWLEDGEMENTS</b> .....	<b>IV</b>
<b>ACRONYMS</b> .....	<b>V</b>
<b>EXECUTIVE SUMMARY</b> .....	<b>VII</b>
<b>1. INTRODUCTION</b> .....	<b>1</b>
1.1 PURPOSE OF THE REVIEW .....	1
1.2 OVERVIEW OF UGANDA .....	1
1.2.1 Location.....	1
1.2.2 Topography .....	1
1.2.3 Climate .....	2
1.2.4 Land use.....	2
1.2.5 Farming systems.....	3
1.2.6 Population .....	5
1.2.7 Economy.....	6
1.2.8 Soils .....	7
1.2.9 Natural Resource uses and users .....	8
<b>2. SEMI-ARID AREAS</b> .....	<b>9</b>
2.1 INTRODUCTION .....	9
2.2 LOCATION AND DISTRIBUTION.....	9
2.3 CHARACTERISTICS OF THE SEMI ARID AREAS .....	9
2.3.1 The Central Semi-Arid Corridor - (Zone A).....	11
2.3.2 The North - East Semi-Arid Zone (Zone B).....	11
2.3.3 Rwenzori/Kazinga Semi - Arid Zone (Zone C).....	12
2.3.4 Albert - River Nile belt semi - arid area (Zone D). .....	12
<b>3. PERCEPTIONS ON NATURAL RESOURCE DEGRADATION</b> .....	<b>13</b>
3.1 PUBLIC PERCEPTIONS OF DEGRADATION .....	13
3.2 FARMER PERCEPTIONS .....	14
<b>4. POLICIES ON SWC</b> .....	<b>16</b>
4.1 A BRIEF REVIEW OF UGANDA’S ECONOMIC POLICY .....	16
4.2 INSTITUTIONAL REFORMS .....	17
4.2.1 Public service reform .....	17
4.2.2 Current major administrative policies .....	17
4.2.3 Major economic policies .....	18
4.2.4 Transport, markets and infrastructure .....	19
4.3 EVOLUTION OF SWC POLICIES .....	20
4.4 CURRENT AND FUTURE TRENDS IN SOIL CONSERVATION POLICIES.....	22
4.5 LEGISLATION FOR SOIL CONSERVATION AND MANAGEMENT .....	22
4.6 LEGAL RESPONSIBILITY FOR SOIL MANAGEMENT .....	24
<b>5. INSTITUTIONS INVOLVED IN SWC</b> .....	<b>25</b>
<b>6. RESEARCH ON SWC IN UGANDA</b> .....	<b>26</b>

6.1. EVOLUTION OF SOIL PRODUCTIVITY RESEARCH.....	27
6.2 RUNOFF AND EROSION STUDIES.....	27
6.3 INTEGRATED NUTRIENT BUDGETS AND MANAGEMENT .....	28
6.3.1 Nutrient budgets .....	28
6.3.2 Integrated nutrient management.....	28
6.4 RESEARCH ON MAINTENANCE AND IMPROVEMENT OF SOIL PRODUCTIVITY.....	29
6.4.1 Mineral Fertilizers.....	29
6.4.2 Mineral Soil Amendments .....	31
6.4.3 Improved, Low-External Input Agroecosystems .....	31
6.5 RESEARCH ON DEVELOPMENT AND ADOPTION OF SWC .....	31
6.5.1 Soil and Water management/conservation.....	31
6.5.2 Soil Conservation Efforts in practice .....	33
6.5.3 Government and government institutions .....	33
6.5.4 Non-Government Organisations (NGOs) .....	35
6.5.5 International institutions .....	35
6.5.6 Farmers .....	35
<b>7. SWC PRACTICES IN UGANDA .....</b>	<b>37</b>
<b>8. CONSTRAINTS TO INVESTMENT AND ADOPTION OF SWC.....</b>	<b>38</b>
8.1 POLICY CONSTRAINTS AT NATIONAL AND REGIONAL LEVEL .....	38
8.1.2 Effect of Changes in Administration .....	38
8.1.3 Effect of Land Tenure.....	38
8.1.4 Effect of Decentralisation.....	39
8.1.5 Administrative Obstacles to the Realisation of Soil Conservation in the Past .....	40
8.1.6 Effect of Segregative Soils Legislation.....	41
8.1.7 Cattle Grazing .....	41
8.1.8 The Burning of Grass .....	41
8.1.9 Non-Communication of the Law .....	41
8.2 SOCIO ECONOMIC FACTORS AFFECTING INVESTMENT IN SWC AT HOUSEHOLD LEVEL.....	41
8.2.2 Unfavourable factors: .....	44
8.3 MIGRATIONS AND DECISION MAKING IN SWC.....	45
8.4 FACTORS AFFECTING ADOPTION OF INDIGENOUS SOIL AND WATER CONSERVATION (ISWC) METHODS .....	46
<b>9.CONCLUSION.....</b>	<b>47</b>
9.1 MAJOR FINDINGS .....	47
9.2 STATUS OF SEMI-ARID AREAS .....	48
<b>REFERENCES .....</b>	<b>50</b>
<b>APPENDIX A .....</b>	<b>57</b>
A.1 THE AGRO-CLIMATIC ZONES OF UGANDA .....	57
A.2 CURRENT FARMING SYSTEMS IN UGANDA AND THEIR ENVIRONMENTAL IMPACTS.....	58
A.4 SOIL SURVEYS IN UGANDA AT RECONNAISSANCE AND DETAILED LEVEL .....	60
A.4 THE CENTRAL E SEMI-ARID CORRIDOR (ZONE A) .....	55
A.5 THE NORTHEAST SEMI-ARID ZONE (ZONE B) .....	61
A.6 THE LAKE ALBERT NILE BELT SEMI-ARID AREA .....	65
A.7 THE LAKE ALBERT NILE BELT SEMI-ARID AREA .....	66
A.8 RESEARCH ACTIVITIES CARRIED OUT IN THE DEPARTMENT OF SOIL SCIENCE – MAKERERE UNIVERSITY .....	69
A.9 FERTILISER RECOMMENDATIONS IN UGANDA.....	71
A.10 LOCATION OF DISTRICTS AND AREAS WHERE SWC RESEARCH HAS BEEN CONDUCTED IN UGANDA .....	73
A.11 POPULATION DENSITY IN THE SEMI ARID AREAS IN UGANDA .....	74

## Tables

TABLE 1: LAND USE AND COVER IN UGANDA .....	2
TABLE 2: DEMOGRAPHIC TRENDS OF UGANDA, 1969-1991 .....	5
TABLE 3: POPULATION BY SEX AND GROWTH RATE, 1969-1991.....	6
TABLE 4 : POPULATION DENSITY TRENDS IN THE SEMI ARID AREAS BY DISTRICTS.....	10
TABLE 5: SUMMARY OF THE VARIOUS CHARACTERISTICS IN THE SEMI ARID AREAS. ....	13
TABLE 6: MAIN ROAD AND RAILWAY NETWORK BY REGION, 1996.....	19

## Boxes

BOX 1: SOIL MEMOIRS.....	7
BOX 2: PRINCIPLES OF THE LOCAL GOVERNMENT SYSTEM .....	18
BOX 3 : RESULTS OF FERTILIZER TRIALS ON THE FARMERS' FIELDS FOR DIFFERENT CROPS IN UGANDA .....	30

## Figures

Figures 1,2,3,4,5,6 and 7 are contained in the accompanying document Appendix B

## **Acknowledgements**

We are grateful to ODI and DFID for availing us the opportunity and funds to carry out and compile this literature review on soil and water conservation efforts and research in Uganda with special emphasis on the semi-arid areas. Our sincere thanks also go to Pippa Trench and Liz Drake for their invaluable assistance in the initial discussions and co-ordination in ensuring this undertaking is a success. We very much appreciate the invaluable comments and advice on the report structure by Cate Turton

Many other people have contributed to the success of this report in one way or the other. We are very grateful to them all.

## Acronyms

<b>AFRENA</b>	Agroforestry Research Network in Africa
<b>A.P.C</b>	Agriculture Policy Committee
<b>ARI</b>	Agricultural Research Institute
<b>CARE</b>	Carry American Relief Everywhere
<b>CIAT</b>	International Centre for Tropical Agriculture
<b>DFID</b>	Department For International Development
<b>DSCW</b>	District Soil and Water Conservation
<b>DSP</b>	Diphosphate
<b>FAO</b>	Food and Agricultural Organisation
<b>GDP</b>	Gross Domestic Product
<b>GOU</b>	Government of Uganda
<b>IBRAM</b>	International Board for Soil Research and Agricultural Management
<b>ICRAF</b>	International Centre for Research in Agroforestry
<b>IGAD</b>	Intergovernmental Agency for Desertification
<b>IITA</b>	International Institute for Tropical Agriculture
<b>ISWC</b>	Indigenous Soil and Water Conservation
<b>IUCN</b>	International Union for Conservation of Nature
<b>LC</b>	Local Councils
<b>LWF</b>	Lutheran World Foundation
<b>MAAIF</b>	Ministry of Agriculture, Animal Industry and Fisheries
<b>MUIENR</b>	Makerere Institute of Environment and Natural Resources
<b>MUK</b>	Makerere University Kampala
<b>NARO</b>	National Agricultural Research Organisation
<b>NCCD</b>	National Committee for Combating Desertification
<b>NEAP</b>	National Environment Action Plan
<b>NEMA</b>	National Environment Management Authority
<b>NGO</b>	Non-Governmental Organisation
<b>NPK</b>	Nitrogen Phosphorous and Potassium
<b>NRM</b>	National Resistance Movement
<b>NSWCP</b>	National Soil and Water Conservation Programme
<b>ODA</b>	Overseas Development Agency
<b>ODI</b>	Overseas Development Institute

<b>PFI</b>	Promoting Farmer Innovation
<b>RSCU</b>	Regional Soil and Water Conservation Unit
<b>SAARI</b>	Serere Agricultural and Research Institute
<b>SCS</b>	Soil Conservation Section
<b>SIDA</b>	Swedish International Development Agency
<b>SWC</b>	Soil and Water Conservation
<b>UNEP</b>	United Nations Environment Programme
<b>UNESCO</b>	United Nations Education scientific and Cultural Organisations
<b>UNFA</b>	Uganda National Farmers Association
<b>UNU-PLEC</b>	United Nations University Project on People, Land Management and Environmental Changes
<b>USCAPP</b>	Uganda Soil Conservation and Agroforestry Pilot Project
<b>USWCS</b>	Uganda Soil and Water Conservation Society

## **Executive summary**

The general purpose of this review was to analyse the available literature (grey and published) on SWC research and practice by farmers and institutions in Uganda with particular emphasis on semi arid areas.

Uganda's population is relatively high and the economy is heavily dependent on agriculture and the exploitation of natural resources. However, the agricultural sector is inadequately attended to in terms of investment for sustainable development and production. This situation is even worse in the semi arid areas as compared to other parts of the country.

The major findings of this review include the following:

The semi arid areas which cover about a third of the land surface area of Uganda are generally characterised by poor resources, low and unreliable rainfall, and sparse vegetation. The main land use is agro-pastoral production but crop cultivation is on the increase. The human population is also on the increase and this poses serious threats to sustainable resource management in such a fragile ecosystem. Already there is evidence of soil degradation due to soil erosion, compaction, crusting, reduced organic matter and gullyng. The problem is even further compounded by low investment, poor infrastructure and generally high poverty levels.

There are major natural resource management problems, which are widely but variedly recognised by the farmers and the general public. In a number of places, the farmers seem to be aware of natural resource degradation, especially as caused by soil erosion and soil fertility decline. But these problems can only be overcome if the related constraints are tackled through a multi-sectoral and interdisciplinary approach while considering issues such as investment, education and the adoption of more appropriate technologies. Research into these problems is still lacking in the semi-arid areas hence the need to address it.

Policies on natural resource management are now in place but as in the past are still fragmented among the different sectors with little co-ordination on the ground. Some of them, especially on SWC, are inadequate and need to be strengthened or reviewed. There is no soil or land use planning policy in Uganda. In certain circumstances the problem is with implementation which is influenced by such factors as lack of resources (funds and manpower) and technical advice.

In order to achieve success in sustainable development, key factors e.g. indigenous knowledge, socio-economic and cultural constraints need to be studied, understood and incorporated into the planning/ development process.

Most farmers in Uganda are involved in farming but for their own domestic consumption. In order to produce goods for sale to urban and rural markets as well, there is need to increase agricultural production. And this can be done among others through research, investment and appropriate policies geared towards sustainable land utilisation.

A number of studies have been conducted, especially in the humid areas compared to semi arid areas. However, this has not led to significant increase in productivity due to inappropriate research, failure to address the needs and priorities of the local people concerned, and poor relationships between researcher, farmer and extensionist. Thus research methods using new approaches like PRA are vital in addressing problems that smallholder farmers and agro-pastoralists are faced with. Considering that most of the semi arid areas are based on agro-pastoral activities, their land-resource relationship is therefore unique and needs to be studied in its own socio-cultural and economic context. Furthermore, households vary (spatially and

temporally) in sources and levels of incomes, access to resources and their management etc. These factors among others affect the decision making process regarding investment in SWC. There is need for the promoters of SWC (e.g. donors, NGOs and government) to understand such relationships and decision making processes so as to make appropriate interventions to enhance farmers' production capacity and hence contribute to poverty alleviation while ensuring sustainable natural resource utilisation.

The major areas of research and development focus should include:

- Research on the socio-economic factors influencing the investment and adoption of SWC techniques at household level in semi arid areas.
- The development of appropriate water harvesting, storage and utilisation methods for increased and sustainable crop and livestock production systems.
- Research and development of appropriate technologies, processing and packaging of agricultural produce including the expansion of existing market opportunities.
- Developments of appropriate infrastructure especially the major rural and feeder roads in the semi arid areas.
- Incorporation of gender analysis in the research and development of rural projects including that of SWC.

Most of the research in this country is donor driven. This is likely to continue but there is a need to make research more demand driven and tangible in its impact especially on the rural poor. Already NARO has initiated efforts towards this by conducting needs assessment surveys but there is still need for more support in implementing and widening this effort to cover all the different ecological regions.

There is widespread evidence of high population pressure on the land to produce food and other needs. However, this can only be attained on a sustainable basis if appropriate changes in the technical, economic and social strategies are taken into account.

# **1. Introduction**

## **1.1 Purpose of the Review**

A lot of literature points to the widespread natural resource degradation especially in sub-Saharan Africa. The reasons advanced, among others, are rapid human population growth placing pressure on land resources through intensive cultivation, and encroachment on marginal lands. There is need to reconsider the existing technologies of SWC with regard to their appropriateness and constraints involved.

Before making final decisions regarding which technologies to adopt, farmers usually base their decisions on their individual, local need's, available resources and priorities at hand. SWC technologies need investment and the decision to invest is inevitably not an easy one especially considering the local socio-economic constraints. However, the promoters of SWC need to know the decision making processes and also understand the underlying factors influencing the farmers' investment capacity before supporting household decision making processes, and develop ways of advising farmers accordingly. For a long time, semi-arid areas have been ignored in research on SWC in East Africa in general (Morse, 1996) and Uganda in particular.

The general purpose of this review is to analyse the available literature (grey and published) with respect to SWC research and efforts by farmers, government and other institutions involved in SWC but with a bias to the semi-arid regions in Uganda. It is hoped that the review will provide the necessary information for more detailed studies (needs assessment) yet to be conducted in these areas. The review will also provide an input for more detailed investigations relating to the capacity of the stakeholders to invest in sustainable soil and water management. This review has included incentives and disincentives for investment in sustainable SWC at household level resulting from a multitude of factors like institutional, policy and legislative procedures on the one hand and economic and household characteristics on the other. An overview of the past and present research and investment efforts in natural resource management in general and SWC in particular has been highlighted. The literature was largely drawn from the relevant institutions concerned with research, policy making and implementation/enforcement in Uganda.

## **1.2 Overview of Uganda**

### ***1.2.1 Location***

Uganda is a land locked country situated in East Africa within latitudes 1° 29', South and 4° 12' North of the equator, and longitudes 29° 33' East and 35° 20' East. The country has a total area of 241,000 square kilometres, of which 74% is cultivated land, 1.1% ranches, 0.2% urban area, 6.3% forest reserves, 7.9% open water, 3.2% mountains, 6.5% game reserves and 0.8% swamps.

### ***1.2.2 Topography***

The country consists of varied physiographical conditions including plateaux, highlands, mountains, rift valleys, and rolling hills. However, most of the country forms part of the interior plateau of the African continent (GOU, 1967). The central, west and parts of the east are characterised by flat topped hills which rise to an average height of about 1300m a.s.l. In a number of places like the eastern and central, the hills are separated by broad valleys sometimes occupied by papyrus swamps. In the south-western region the plateau rises to a height of 2000m a.s.l., such as the hills of Kabale and Kisoro. These plateaux are deeply incised with a rift oriented drainage system.

The country is also surrounded by impressive mountains, (e.g. Mounts Elgon, Rwenzori and Bufumbira) located along its borders with Kenya, and the Democratic Republic of Congo and Rwanda respectively. Along the western border is the remarkable Western Rift Valley, which covers the basins of Lakes Albert, Edward and George, extending to the north to include the Albert Nile.

### 1.2.3 Climate

Generally, the country has favourable but varied climatic conditions, which are influenced by such factors as: topography; water bodies; local and trade winds and distance from the sea. A greater part of the country receives an average of 1000 to 1500 mm rainfall per annum, though the highland areas (e.g. Elgon, Rwenzori and Bufumbira) and some islands (e.g. Ssesse) on lake Victoria receive well above 2000mm. The mean annual rainfall distribution in Uganda ranges from as low as <500mm in some places to as high as 3500mm in others as illustrated in Figure 1 (Appendix B). Braun, *et. al.*, (1997) citing Jameson and McCallum (1970) indicated that much of the area of Uganda receives between 1015mm and 1525 mm of rainfall annually. Most of the areas in the south have a bimodal pattern of rainfall, with one peak in April- May and the second in October- November. Rainfall generally declines towards the North and is received in one major peak in June-July. The North-eastern region, and the Western rift valley (i.e. the troughs near lakes Edward, George and Albert) are relatively drier, receiving rainfall as low as 500mm but less than 1050mm.

Temperatures also vary from place to place. They range from as low as 0° C or less on the highest Mountains, to as high as 39° C in the north (Gulu, Kitgum, the western Rift valley, and some parts of Karamoja).

### 1.2.4 Land use

The types and distribution of land use/cover are shown in Table 1 (below) and Figure 2 (Appendix B). This data was developed by the National Biomass Study of 1996, basing on the interpretation of SPOT XS satellite images and field checks.

**Table 1: Land use and cover in Uganda**

Land use/cover	Area(Km <sup>2</sup> )	Area (% of total land)	Area (% of Total)
Deciduous plantation	193	0.1	0.1
Coniferous plantation	185	0.1	0.1
THF-fully stocked	5, 743	2.8	2.4
THF-depleted/ encroached	2, 836	1.4	1.1
Woodland	40, 991	20.0	16.9
Bush	14, 240	6.9	5.9
Grassland	50, 822	24.7	21.0
Wetland	4, 872	2.4	2.0
Small-scale	84, 514	41.1	34.9

farmlands			
Uniform large-scale farmlands	616	0.3	0.3
Built up areas	362	0.2	0.2
Impediments	39	0.0	0.0
<b>TOTAL LAND AREA</b>	205, 414	100	84.8
Open water	36, 906	-	15.2
<b>Total Area</b>	242, 320	-	100

As shown in Table 1 above the major land use/ cover types include small scale farmlands, grasslands and woodlands. The semi arid areas are generally covered by savannah or grasslands.

### **1.2.5 Farming systems**

A farming system can be defined as an agricultural activity being practised by particular groups of people as dictated by the agro-ecological environment they live in Republic of Uganda, 1994). Farming systems in Uganda exhibit variability depending on population density, rainfall pattern and elevation (Braun *et. al.*, 1997).

There have been several classifications of the farming systems in Uganda. In general, the classifications are similar, but the details have tended to vary with who does the classification and the purpose for which it is done. According to Parsons (1970), five main systems of agriculture can be distinguished for Uganda. They are described in detail in the Research Division memoirs of the department of Agriculture (Parsons, 1960) but listed as follows:

- The Teso system;
- The Banana and Robusta coffee systems in southern Uganda and their modifications in the banana, millet and cotton areas.
- The Northern systems, including the West Nile System
- The Montane systems
- The pastoral system

Splitting up the above banana and northern systems gave a total of seven farming systems, namely:

- Teso system
- Banana and coffee system
- Banana, Millet and cotton system
- Northern systems
- West Nile system
- Montane systems
- Pastoral systems

At that time of classification, the Teso system was unique because of its use of ox draught for primary cultivation. The system was based on the production of annual crops in an environment characterised by light soils that were also said to be infertile, heavy precipitation in the two rain seasons and fairly prolonged dry season from December to March. Management of livestock (cattle) was mainly traditional with integration in the agricultural systems through their use as draught animals.

However, Teso lost its cattle population during 1986-1990 due to cattle rustling and looting during the years of insurgency. This led to the modification of the system as the livestock element had been removed resulting in widespread use of the hand hoes. However, a restocking programme is now in place, and the cattle component in the farming system is thus being restored.

IDRC (1982) recognised and described seven farming systems and also showed the districts where they are found (see appendix 1). This classification was adapted by COWI consult (1988).

The IGADD study by van Velthuisen and Verelst (1995) defined crop production zones, which happened to correspond with the earlier work of the Agricultural Task Force (anonymous 1987) and Djimide and Hoesktra (1988).

Johnston and Sekitoleko (1989) who were interested in identifying uniform recommendation areas for agriculture also came up with 11 broad farming systems, which had 46 sub-divisions. They used seven criteria namely:

1. Climate (including rainfall cumulative total distribution patterns) and temperatures
2. Soil type
3. Vegetation
4. elevation and landscape
5. Crops grown and cropping patterns
6. Crop and livestock production systems
7. Population density including settlement patterns.

The NEAP secretariat also in 1992 adopted the seven farming systems recognised by IRDC (1982). This structure was also adopted by the Republic of Uganda (1994), for compiling the state of the environment report 1994. This classification was deemed reasonably detailed and provided usable information with which to assess farming practices among these farming system (see appendix 2).

Like many others elsewhere, farmers in Uganda are highly responsive to changes in a number of circumstances. They react rapidly to external stimuli by adapting their farming systems, particularly as far as cash cropping is concerned. So the farming systems are not exactly static but are dynamic.

Apart from a few tea and sugar estates, the farmers are predominantly small holders with the average farm per family being 2.5-3ha and from which they produce most of their food requirements. These farms are characterised by low yields averaging one tone per hectare, and low rates of investment. Most farms are not mechanised. Human muscle is the major source of farm power. The implements used in cultivation are rudimentary, consisting of mainly the hand hoe, panga and axe. Fertiliser is hardly used but some farm manure is used. A survey of coffee farmers in 1991 by Ngambeki, *et al.* (1992) found that in the Robusta coffee growing area only 4% of the respondents had used any chemical fertiliser in 1990 and 1991. A baseline survey of agriculture (Anonymous, 1970) indicated that average farm expenditure per family was only US\$9 indicating very low rates of saving and capital formation. The survey also found that 69% of the farmers had

only a hoe and panga as farm investments. This low level of investment reinforces the vicious circle of poverty among Ugandan farmers.

The farming potential is not uniform. High and medium potential farming areas are in the central, southern and western Uganda and in Busoga/Bukedi of eastern Uganda (Braun, *et. al.*, 1997). The highly productive Lake Victoria Crescent is a major supplier of food for the domestic and export market. Horticulture is also becoming an important activity in this region.

### 1.2.6 Population

The population of Uganda has increased tremendously from about 2.5 million in 1911 to about 17 million in 1991 (MFEP, 1992). The post independence demographic trends and population density are shown in Table 2 for 1969-1991 population censuses. The population varied from just over 9.5 million in 1969 to about 16.7 million in 1991. Within the regions, the western region experienced the highest growth rates of 2.9%. The western and central region (with a growth rate of 2.8%), had growth rates above the national average of 2.6%. Eastern had the least growth rate with 2.3%. The overall population growth had, however, slowed down; whereas the 1969 to 1980 intercensal period experienced a growth rate of 2.7%, the rate for 1980-1991 of 2.5% was lower. The current population growth rate of 2.5% per annum and fertility rate of 7.1, are relatively high. Population density has also increased nationally from 48 persons per Sq. Km in 1969 to 85 persons in 1991. The Eastern region had the highest density at 148 whereas Northern had the least at 38. There is great variation in population density. As further illustrated in Figure 4 (Appendix B), population density varies from less than 10 persons per km<sup>2</sup> in the dry areas to approximately 750 persons per sq. km in a number of mountainous rural areas (e.g. Kabale and Mbale), see table 2 for more details.

About 90% of the population live in the rural areas and are largely dependent on agriculture. The high population growth rate has serious consequences such as intensifying pressures on the economy and natural environment for provision of basic requirements (e.g. shelter, food, energy and social services).

Table 2 and 4 show the population by sex and growth rate and reveals that currently the females are slightly more than males, the gap is widening with time as the rate of increase of females is greater than that of males. This had overturned the situation in 1969 when there were more males than females.

**Table 2: Demographic trends of Uganda, 1969-1991**

Region	Total population ('000)			Total population Average growth rate			Population Density (per km <sup>2</sup> )		
	1969	1980	1991	1969	1980	1969-1991	1969	1980	1991
Central	2,672.0	3,582.4	4,843.6	2.8	2.7	2.8	71	96	126
Eastern	2,528.14	3,237.4	4,128.5	2.4	2.2	2.3	90	116	148
Northern	1,922.2	2,424.2	3,152.0	2.3	2.4	2.4	23	30	38
Western	2,432.6	3,392.1	4,547.7	3.2	2.7	2.9	49	68	92
Total	9,535.1	12,636.2	16,671.7	2.7	2.5	2.6	48	64	85

**Source: Republic of Uganda (1994). The 1991 population and housing census (National Summary)**

**Table 3: Population by Sex and growth rate, 1969-1991**

Year					Average Annual growth Rate		
	Male	Female	Total	Female: male ratio	Male	Female	Total
1969	4,811,428	4,723,623	9,535,051	0.98			
1980	6,259,837	6,376,342	12,636,179	1.02	2.53	2.88	2.71
1991	8,185,747	8,485,958	16,671,705	1.04	2.44	2.60	2.52

**Source: compiled from republic of Uganda (1994). The 1991 population and housing census (National summary).**

Population movements from one part of the country to another and also from outside have been experienced for a long time (see Figure 5 Appendix B). These migrations have been triggered by socio-economic, political and environmental factors. Among the major contributory factors to the internal migrations are: the search for better employment opportunities (especially by the rural migrants in the urban areas and plantation farms); political insecurity; land resource scarcity and poor returns from the land (as a result of soil fertility decline and inappropriate farming practices).

Migration is associated with both negative and positive effects. From the negative point of view migration may lead to social conflicts, pressure on land resources hence sometimes degradation (as witnessed by the migration of Bakiga from Kabale, Bagisu and Banyankole to other areas) among others. Positively, migration may contribute to the development of the recipient area in terms of availing more labour supply, increased market potential for crops and other goods/services, introduction of favourable practices in the area of farm management and more revenue.

### **1.2.7 Economy**

Uganda's economy has been very dynamic since independence but is still largely dependent on the agricultural sector (food and cash crops, forestry, livestock and fisheries). The country's arable land (75% of the total surface area) supports high population densities (more than 88 persons per km<sup>2</sup>). In a greater part of the districts in the western, eastern and southern regions, high population densities of more than 180 persons per km<sup>2</sup> are supported on the arable land.

Agriculture contributes more than 50 % of the country's GDP and employs more than 80% of the population directly or indirectly (NEMA, 1995, 1996). The main crops contributing to this include coffee, tea, sugar, tobacco and to a lesser extent cotton, Non-traditional agricultural export crops and products include: beans, simsim, maize, hides and skins and fish. Although Uganda's GDP per capita in 1996 was estimated to be only US \$220, it represents a greater improvement over the past years of political turmoil when it was less than US \$180 (GOU, 1997). Domestic savings are relatively low and the country largely depends upon external assistance for domestic investments. However, the heavy external debt greatly hinders the pace of development of the country. In an attempt to improve on the economy, the government has since 1987 pursued an economic reform programme aimed at achieving sustainable economic growth and stabilising of the economy.

### **1.2.8 Soils**

Soil resources inventories were started in 1933 by Martin and Biggs, 1937). The results are in the provisional soil map of East Africa compiled by Milne (1935). Between 1935 and 1954 several attempts were made to improve the first map. The first detailed countrywide resource inventories

were carried out between 1955 and 1960. The soil surveys were presented in six memoirs (see Box1):

**Box 1: Soil memoirs**

- The introduction to the soils of Uganda Protectorate (Chenery, 1960).
- The soils of the Eastern Province of Uganda (Ollier and Harrop, 1959).
- The soils of the Northern Province of Uganda (Ollier, 1959)
- The soils and land use of Buganda (Radwanski, 1960).
- The soils of Karamoja District, Northern province of Uganda (Wilson, 1959) and
- The soils of the Western Province of Uganda (Harrop, 1960).

Memoir 1 (Chenery 1960) shows 138 soil units and their distribution mapped on a scale of 1:500000. Soils maps attached to the memoirs are in black and white at a scale 1:500000, which are later revised to more detailed coloured maps at 1:250000, adding up to 17 map sheet. Units on the maps are soil series or soil associations and complexes. It was envisaged that the reconnaissance surveys would be followed by detailed surveys of selected areas and further in depth pedagogical studies. However, this did not happen.

Although soil surveys in Uganda had a head start compared with those in other countries in eastern and southern Africa, no national exploratory surveys were carried out after the work in the 1950s and 1960s. Although the need for such surveys was recognised (FAO/UNEP 1992) no funding has been obtained by 1998. Yost and Eswaran (1990) attempted to classify the soils of the 18 geomorphic units recognised by Harrop (1960) according to the USDA (United States Department of Agriculture) system but found that the information is in fact insufficient in detail (Braun *et. al.*, 1997).

Milne (1935a, 1935b) developed his catena concept during his work in the eastern Africa region. Yost and Eswaran (1990) further assessed the soil, landscape, climate, vegetation and water resources of Uganda and established the major land resources area of Uganda.

Since the early 1970s onwards, detailed soil investigation have been carried out on request for development projects individuals and government institutions. Institutions covered since the early 1970s are listed in appendix 3. However, so far, Uganda soils have not been classified in greater details nation-wide.

The major soil types of Uganda include: ferrasols; vertisols; histosols; gleysols; andosols and podsols (Yost and Eswaran, 1990). Orthic ferrasols, ferric acrisols and humic gleysols occupying about 70% of the country, are the most widely distributed soils (Anonymous, 1973; FAO & UNESCO, 1990). The dominant red ferrasols cover about 40% of the country and are mainly in the central region. The yellow ferrasols, covering about 30%, are in the south central, east and north-western part of the country. These ferrasols (Ferralitic soils) are very old and in their last stages of development with little remaining mineral reserves. According to Sanchez *et. al.*, (1989) these soils are of low inherent fertility being strongly weathered and consisting of low activity clays

with low cation exchange capacity and base saturation. They also have high phosphorus fixation capacities. Therefore, their productivity greatly depends upon the delicate balance of nutrient recycling propagated by dense vegetation cover with deep rooting systems. Most of the Acrisols are found in the savannahs supporting subsistence agriculture and livestock production. However, the Andosols though not widely distributed are the most fertile soils in the country.

The Vertisols occurring in the low lying plains of Karamoja and West Nile, possess low to medium and occasionally high productivity.

In the papyrus swamps and marshes, the main underlying soil type are the hydromorphic gleysols which if well drained and fertilised can support banana growing and intensive agriculture (Zake *et al.*, 1992).

The Nitisols are found at high altitudes, in the highland volcanic areas of western and eastern Uganda. Humic, Eutric and Dystric Nitisols are among the dominant soils of south-western region. Nitisols are suitable for growing coffee, tea and food crops and can support dairy farming activity and ranching.

The rating of these soils for the land suitability assessment of the FAO's Agro-ecological zoning procedure (FAO, 1978) is at best marginally suitable for the major chemical characteristics have been confirmed through laboratory analysis.

### ***1.2.9 Natural Resource uses and users***

The country is rich in various resources ranging from water, soils, plants and animals and topography. However, the increasing human population coupled with widespread mismanagement threatens the sustainable utilisation of these resources.

Range land areas cover most of the semi arid areas which constitute the 'cattle corridor areas' (see Figure 6 Appendix B). However, these areas are experiencing increased individualisation of the communal land rights; there are untitled parcels of land on customary tenure, which the rights to use have been individualised (NEMA, 1996). It is observed that this practice is particularly common in the districts of Ntungamo and Mbarara. This practice has caused serious tension between the Basongora and Bakonzo tribal groups who are largely cattle keepers and cultivators respectively. The Basongora are almost landless (GOU, 1993). In the north-east, the Karamojong are also experiencing a trend towards individualisation of grazing rights hence the likely problems of rangeland resource use conflicts including the displacement of traditional pastoralists.

In Uganda the general agricultural sector policy aims at augmenting the agricultural productivity to ensure foremost food security and self-sufficiency in raw materials for industrial processing and export of the surplus (MAAIF, 1995). The policy also aims at promoting non-traditional agricultural export crops (e.g. sunflower, flowers, fruits etc.) and poverty alleviation through income accruing from sale of the surplus produce. Quite a number of both small and large scale farmers are benefiting from this development. Nevertheless, there are negative environmental consequences associated with the policy of pursuing increased output without consideration of land limitations and the technologies applied by the farmers. Thus, there are already observed and reported problems of widespread natural resource degradation in many parts of this country.

In summary Uganda is a country endowed with a diversity of people, environmental conditions (climate, topography, vegetation and soils) and hence good but varying resource potential for development. These resource potential areas are reflected in the different ecological zones. The economy is heavily dependent on the exploitation of natural resources e.g. agriculture. However, the agricultural sector is not adequately attended to in terms of investment for sustainable development and production.

This report focuses on the semi- arid areas as described below.

## 2. Semi-Arid Areas

### 2.1 Introduction

Uganda is endowed with a wide range of ecological conditions (e.g. soils, topography, and climate) which explains the diversity of flora and fauna. Broadly speaking according to the Uganda Agricultural Task Force (1987) and Langlands (1971) there are 4 major ecological zones in Uganda. These include:

- high altitude zone- covering most of the highlands
- southern and western tall grass zone
- northern and eastern short grass zone
- pastoral dry -semiarid range land zone

However, as described by IDRC (1982) and adopted by COWI (1988) there are 11 ecological zones (agro-climatic zones); the details of which are given in appendix 1. The semi-arid areas being considered are distributed over the zones III - Teso; IV - Karamoja; VI - West Nile/Madi; VII - Bunyoro/Toro; VIII - Ankole; XI - Northern Buganda.

### 2.2 Location and distribution

The location and distribution of semi-arid areas, also referred to as the Dry zones, in Uganda is shown in Figure 6 (Appendix B). The semi-arid areas are distributed in four blocks, which for the purposes of this report are distinguished as zones A, B, C and D. Approximately a third of Uganda's area made up semi arid areas.

**Zone A:** Is a semi arid livestock belt which stretches from the borders of Rwanda and Tanzania in the South,-Northwards through part of Mbarara, Rakai, Masaka, Mpigi, Mubende, Kiboga, Luwero and Nakasongola districts.

**Zone B:** Is located in the North-east and stretches through the districts of Katakwi, Moroto and Kotido (Karamoja) and part of Kitgum district.

**Zone C:** Is a small patch in Western Uganda located in the Rwenzori and Kazinga area. It covers parts of Kasese and Kabarole districts.

**Zone D:** Is a narrow stretch located in the Rift Valley in the Lake Albert/River Nile Belt. It stretches northwards from the Districts of Bundibugyo, through Hoima, Masindi, Nebbi, Moyo and Adjuman Districts towards the Uganda - Sudan border.

### 2.3 Characteristics of the Semi arid Areas

In general, these areas are characterised by low and erratic rainfall with short rainy seasons, severe long dry seasons, high temperatures and evaporation rates (Langlands, 1974; Kabera, 1985). They also have poor water catchment thus water scarcity, especially in the dry seasons, and poor soils and scanty pastures which deteriorate markedly during dry seasons. Apart from the general aridity these dry land areas receive unfavourable climatic fluctuations (e.g. heavy rainfall storms and long drought) which affect the socio-economic and ecological conditions (Kabera, 1985). The soils of the semi-arid areas of Uganda are varied in terms of fertility and productivity as described among others by Kabera (1985) and GOU (1985).

The semi-arid areas are largely covered by climax vegetation cover of various types. This includes: dry combretum; dry acacias and grass savannahs (Langdale-Brown *et. al.*, 1963; Langlands, 1974). The only exceptions are the drier eastern areas of Karamoja and along Lake Albert where bush lands and dry thickets are pronounced. More sparse vegetation is dominant in drier areas. The vegetation in most of these areas is also greatly affected by human practices such as burning, and overgrazing.

The population of the dry land areas has been generally low since the start of this century. The factors explaining this include low rainfall and diseases like sleeping sickness and Nagana. However, as revealed at the various population censuses (1959, 1969, 1980, 1991) there has been an increasing trend in population densities in these areas (Table 4). This is partly attributed to immigration, tsetse fly eradication, improvement in the infrastructure (e.g. schools, roads, health centres).

**Table 4 : Population density trends in the Semi Arid areas by districts**

<b>District</b>	<b>1969</b>	<b>1980</b>	<b>1991</b>	<b>Area Total</b>	<b>(Km<sup>2</sup>) Land</b>
Luwero	315, 200	412, 500 (48)*	449, 200 (53)	9, 198	8, 539
Kiboga	-	138, 700 (30)	140, 800 (31)	4, 336	4, 583
Moroto	164, 700	188, 600 (13)	171, 500 (12)	14, 113	14, 113
Kotido	105, 600	161, 400 (12)	190, 700 (14)	13, 208	13, 208
Masindi	167, 800	223, 200 (26)	275, 300 (33)	9, 334	8, 452

**NB: \* Population density is given in Brackets**

**Source: MPED 1991 Population and Housing Census**

At the national level only seven districts (Kiboga, Gulu, Moyo, Kitgum, Kotido and Moroto) were in the least population density of category (0-49 persons per km<sup>2</sup>) as compared to the national one which stood at 96.5 persons per km<sup>2</sup> at the time of 1991 population census (Republic of Uganda, 1991). Taking the number of sub-counties as a proxy for the are represented, Appendix 8 shows that more than half (57%) of the sub counties in the four semi arid zones were in the population density range of 0-49. The North- Eastern zone was the most sparsely populated, with 94% of the sub counties in this range. Incidentally this area naturally has the largest area of grazing land available per household (8.8 – 49 %). About half of Karamoja has a population density of 0-9 people per sq. Km. As revealed by data in Table 5, the most widely populated zone is A (Central corridor) with virtually all the population ranges represented. The detailed characterisation of these zones is given below.

**2.3.1 The Central Semi-Arid Corridor - (Zone A)**

Appendix 4a provides the details of the Central Semi-arid corridor as given by Johnson and Ssekitoleko (1986). The nomenclature of the political administrative units (i.e. names of areas) has been updated to 1998 status. The topography of the zone consists of gently to very gently rolling hills and plains, at an altitude of mostly 1,000 - 1,400 m. But the hill tops may rise to 1,300 - 1,700 m.

The east Ankole- west Masaka and Mubende sub-zone receives mainly convectional rainfall varying from 750-1000 mm. This area is drier in June and July probably due to the effect of the dry SE trade winds blowing over L. Victoria

The vegetation mostly consists of short savannah grasslands of *Cymbopogon*, *Themeda*, *Chloris*, *Loudetia*, *Hyparrhenia* and sometimes *Echinochloa* and *Terminalia* grasses. The common shrubs and thickets found in associations include *Combretum* and *Acacia* and sometimes thorn scrubs.

The soils are mostly loams, sandy - loams and clay - loams. Sometimes there are also humic loams from phyllites and red gravelly soils. However, these soils are heavily leached, have a fine granular structure and are very friable and porous (Kabera, 1985). Generally these soils are of low production potential for crops. The erosion potential was rated as mostly low. But some hilly areas were rated high probably due to the steep slope effect. The central dry zone is covered by soils of fair productivity that are ferrallitic in nature.

The people depend on both crops and livestock and mixed farming. A small portion of the population also engages in fishing where fishing water bodies exist. Crops become progressively more important as compared to livestock the further north you move. The farming population per square kilometre of arable land ranges from 48 to 111 but the commonest was 62 - 68. On the other hand, grazing land in hectares per household ranged from 3.8 to 13.7. It was one of the biggest or the main pastoral area. But pastoralism is declining in importance, and giving way to settled livestock farming and cultivation.

### ***2.3.2 The North - East Semi-Arid Zone (Zone B)***

Appendix 4b summarises the north-eastern semi arid zone. The zone stretches from northern Teso (Katakwi District), through Karamoja (Moroto and Kotido districts), and Agago County of Kitgum District. In December to February the North Eastern monsoon contributes to the dry conditions.

The north-east sub-zone (Karamoja) is drier and has the lowest total rainfall (650-1000mm per annum) and longest dry season with pronounced drought in Nov- March. Rainfall occurs in April-August with peaks in May to July and minimum in June. Some orographic rainfall is received on the eastern slopes of the hills and mountains.

The topography consists of a low plateau and rolling plains, and broadly rolling to flat plains at an altitude of 1000 - 1440 m. The plains are interrupted by occasional outcrops of hills, and volcanic outcrops in Bokora (Moroto district).

The vegetation consists mainly of grass savannah made up of *Hyparrhenia*, *Combretum* and *Brachiaria* and *Acacia* trees and thickets. Karamoja also has steppes and savannah woodlands and bushlands. *Acacia* is a common tree species.

The soils are of sands, loamy sands of low water holding capacity in Katakwi, and also black clays in Moroto. In addition, there are also Ferralitic soils. Most soils are of low productivity and low erosion hazard.

The people depend extensively on cattle keeping, though some areas in Moroto and Kotido districts were gazetted as Game Reserves, Forest Reserves and National Game Parks. There is some crop cultivation especially in the wetter areas in the valleys and mountain slopes. The rainfall amount ranges from 656 to 1245 mm.

### ***2.3.3 Rwenzori/Kazinga Semi - Arid Zone (Zone C)***

The details of this semi-arid zone are summarised in appendix 4c. This is the smallest of all the semi-arid zones, and located in western Uganda in the Rwenzori-Kazinga area. It covers a part of Kasese District and part of Kabarole district.

The topography is one of mountain slopes of the Rwenzori at an altitude of 1,000 - 1,800 m. At lesser altitudes of 1,200 - 1,500 m, the topography is made up of steep, stony hills. These drop to flat plains at an altitude of 900 - 1,200 m.

The vegetation consists of dry Acacia - Cymbopogon - Themeda savannah and moist Combretum savannah with forest-savannah forms on lower ground, and Themeda - Heteropogon grass savannah and high altitude moor land and heath. High altitude forests dominate the mountain slopes, while elephant grass is dominant on the flats and papyrus swamps in the valleys.

The soils are clay-loams and sandy-clay-loams of low to high productivity though they have been little used for crop farming. In some areas they are gravelly or stony and are mostly of low erosion hazard.

#### ***2.3.4 Albert - River Nile belt semi - arid area (Zone D).***

This belt stretches through Bundibugyo, Hoima, Masindi, Nebbi, Moyo and Adjuman Districts. Appendix 4d summarises the characteristics of this zone. The relief is high with altitude dropping from over 1,800 m in the south to less than 900 m in the north. The topography in some parts is of low, broadly rolling plains with isolated hills and mountain masses.

The sub-zone lying in the west rift valley and around Lakes Edward George and Albert receives low rainfall due to the rain shadow effect. High temperatures (90-95 F in the dry season and 80 during the wet season) are experienced thus explaining the high evaporation rate. Long drought conditions are experienced in Jan-Feb and June-July.

The vegetation is of moist, semi-deciduous Cynometra - Celtis forest, moist Combretum Savannah, dry Combretum, Combretum - Hyparrhenia Savannah in the higher lands in the south. It gives way to Borassus - Hyparrhenia palm savannah with Themeda - Heteropogon grass savannah on the lower ground, and Acacia - Imperata Savannah where drainage is impeded. It then gives way to dry savannah.

In Moyo and Adjuman, Butyrospermum - Hyparrhenia savannah, with undifferentiated moist semi-deciduous thickets on the lower ground predominates.

The soils range from sands, sandy-clay-loams and clays, of high soil productivity in the south. Productivity drops from medium to low further north. Erosion hazard is moderate to very low.

The farming population per square kilometre of arable land ranges from 23 to 77 persons, while the grazing area in hectares per household ranges from 4.2 to 34.4.

Livelihood is predominantly based on crops, from 27 - 80% of the population. Livestock declines from 22% in the south to less than 2% in the north. There are no available statistics on the quantities per household. Other sources of livelihood are mixed farming and fishing. Fishing as a source of livelihood is highest in this semi-arid zone, where it ranges from 1% to 16%. Mixed farming is from 10% - 23%.

Table 5 provides a summary of the main physical and socio-economic conditions in the semi arid areas. In general the semi arid areas are characterised by very diverse ecological and socio-economic conditions. Rainfall is not only low but erratic in most areas. The temperatures are high (>25 degrees on average). The vegetation varies largely from dry grass savannah to dry thickets/shrubs. The major land use includes agro-pastoral activities. Thus they are the main livestock keeping areas in the country. Crop farming is limited but increasingly practised. The human population density is the lowest in the country though on the increase hence when coupled with the unpredictable climatic conditions constitutes a potential threat to the environment.

**Table 5: Summary of the various characteristics in the semi arid areas.**

<b>Semi arid zone</b>	<b>Vegetation</b>	<b>Soils</b>	<b>Topography</b>	<b>Farming population/ persons per. km<sup>2</sup></b>	<b>Grazing area per. HH (Ha)</b>
<b>A</b> (Central corridor )	Varied but generally dry and moist savannah	Varies greatly but loams, sandy clay loams dominate	Gently rolling plateau with some hills and broad valleys in certain areas	49-111	3.8-13.7
<b>B</b> (North east – Karamoja)	Largely dry savannah of combretum and acacia, and thicket/ bush	Highly varied but Black clays and sandy loams are widespread	Generally Low plains/ plateau with a few scattered hills or rock outcrops	24-50	8.8-49.9
<b>C</b> (Kasese/Kazinga)	Dry acacia and combretum savannah	Sandy loams and clay loams are dominant	Lower mountain foot hills and plains	79-137	2.7-7.0
<b>D</b> (Lake Albert- R. Nile belt)	Dry and moist savannah	Sandy or sandy clay loams with low to mod. erosion	Varied from low plains to steep slopes and hills/uplands	23-77	4.2-34.4

### **3. Perceptions on Natural Resource Degradation**

#### **3.1 Public perceptions of Degradation**

According to Tukahirwa (1992), natural resources can be defined in economic terms as assets that have been furnished by nature and can be used for man's welfare. They include the minerals, water, soils, water and plant and animal species of all kinds. The natural resource concept regards all creation as an asset which man has been passing on from one generation to another.

However, since the beginning of the 20th Century, man has in the quest for economic advancement tended to over-exploit those elements of creation which are directly usable, while at the same time underrating the importance of others to the extent of sometimes simply destroying them.

Likewise resource degradation has been rampant in Uganda in the quest for economic prosperity. Until 1986, natural resources were of interest mainly from the point of view of exploiting them. Consequently, resource degradation became widespread, causing public concern. The realisation of the destructiveness of the lack of co-ordination of policies on natural resources management, led

government in 1986 to set up a Department of Environment Protection within the Ministry of Water, Energy Minerals and Environment Protection (Tukahirwa (1992)). The objective of the Department was to co-ordinate and regulate national efforts towards the National Management of life supporting natural resources.

MAAIF (1993) observed that the combination of moisture deficiency and soil erosion was resulting into progressive decline in vegetative cover hence increasing the bare land and subsequent advancement of desertification. Overgrazing, indiscriminate bush burning and leaving land bare before planting were blamed as the main contributing factors towards soil erosion. Poorly maintained reservoirs are silted and unable to capture and store rainwater.

NEAP (1993) observed that the majority of the farmers are involved in subsistence production which is typically characterised by poor or excessive cultivation. This has resulted in soil degradation including flooding, water logging and biological degradation. It was further noted that grazing in Uganda is largely on communal lands with less improved pastures. This, coupled with the traditional nomadic sentiments of overstocking, has led to considerable land degradation.

Agriculture, which is the main stay of Uganda's economy and generating over 50% of the GDP, is associated with some environmental problems. Some of the current agricultural practices present a number of ecological problems such as soil erosion, soil compaction, agro-chemical pollution, siltation of the water bodies, bush fires and overgrazing (Republic of Uganda, 1994).

### **3.2 Farmer Perceptions**

#### **(a) General Resource Degradation**

As part of the efforts to better understand the relationship between public policy and local resource management, Makerere University Institute of Environment and natural resources (MUIENR), and the World Resources Institute (WRI) in Washington, D.C., have conducted a series of policy studies comparing the intended impact of government policy and legislation with the actual behaviour of farmers' on the ground (Tukahirwa, 1992). The national survey, which covered nine districts, established that people were largely aware of resource degradation, which they blamed for a number of new problems in their lives.

According to the study report above some areas had cleared swamps for agriculture. This practice first became widespread in the south west but has spread more recently to the east, being particularly prevalent where there are seasonal grass swamps.

However, it was found that contrary to common belief, farmers are aware of resource degradation in the form of wetland degradation. Most parishes in the survey contained some kind of wetland. Among the activities carried on in these areas, but mostly by a few people, are cultivation, hunting, grazing livestock or collecting building materials. In some areas most swamps have already been reclaimed. Nationally, 61% of the people reported that reclamation is still proceeding.

Although data showed that attempts to drain papyrus swamps have not been very successful so far, many people, especially in the south west, thought that natural resource degradation in the form of the drainage of wetlands was negatively affecting their lives. In four out of the nine areas, at least half of the people considered swamp drainage to be the cause of increasing water shortages. Indeed springs and wells, which are often adjacent to swamps, were the source of water for more than 80% of the national sample.

A number of people were also aware of natural resource degradation in the form of deforestation, and they thought that it also negatively affected their lives. In Uganda the word 'forest' can be used to mean anything from a small clump of trees to a rain forest of several hundred square kilometre. Of the people who were questioned, 93 - 100% of people said they had a forest nearby, except

Gulu, where the figure was only 69%. It can be safely assumed that the forests of which the people spoke were mainly small fragments, or perhaps Eucalyptus wood lots and plantations. Most people claimed to make little use of forests. Where used, forests were a source of building materials, while some people grazed cattle there, or went hunting. A few carried out cultivation. Where forests are cleared, they are generally used for agriculture.

Loss of building materials was also mentioned by 35% of the people in the south west, as a consequence of forest clearance. Some people thought deforestation is causing low rainfall. The people mentioned a number of ways in which they are affected by deforestation. Some people believed that deforestation was causing low rainfall although water availability (swamps) were not affected.

Declining productivity of land was widely perceived, as 93% of the people interviewed thought productivity was declining. Opinions varied as to the causes. Nationally, reduced soil fertility and over-farming were most often mentioned. In Nebbi droughts were the most significant factor, whereas in Mbale where the slopes are steepest, people recognised the importance of soil erosion. A farmer participatory diagnostic survey in the lakeshore banana-coffee system (Nielsen *et al.*, 1995) revealed that according to farmers, a 10 year fallow was necessary to restore soil fertility to levels comparable with virgin forest soil. The majority of farmers interviewed left part of their land fallow for between three and five years. The researchers estimated that 25% of the farmers have so little land that they apply no fallow at all.

#### **(b) Soil degradation**

In an informal survey by CARE in Rubanda County of Kabale district to learn about farmers' perceptions of soil erosion and their attitudes to various erosion control measures and limitations in controlling erosion, all farmers visited were reported to be aware of erosion and its effects on the soil and crops (Kisakye, 1992). Farmers are also very much aware of natural resource degradation, particularly soil erosion and loss of fertility. For example, in a study done in 1991 in nine parts of Uganda representing eight districts, almost all farmers complained of decreasing productivity though they varied considerably in their perception of the causes. Only 7% of the people interviewed thought that soil productivity was not declining. Nationally, reduced soil fertility and over-farming were most often mentioned. But in Nebbi a marginally semi-arid area, droughts were the most significant for the farmers, while in Mbale where the slopes are steepest, the importance of soil erosion was recognised (Tukahirwa, 1992).

This study deliberately excluded urban and pastoral areas for practical considerations. Nevertheless, the study team believed that their data was sufficiently representative of the agricultural areas where four fifth of Ugandans live.

Other studies have also widely reported declining soil productivity. For example, Zake (1992) deliberately targeted the tropical forest areas, the highlands, the savannahs as well as the urban areas in order to cover all the agro-ecological zones of Uganda. The tropical forest areas and the agricultural highlands which are the most cultivated appeared to have a higher perception of loss in productivity of the soil resource reflected from trends in productivity, with 81.4% in the tropical forest areas and 74.7% in the highlands reporting declining trends. The declining trends were reported by 49% of the respondents for both the savannah and urban areas. These trends were blamed mostly on land exhaustion by 55%, 40%, 38% and 30% of the respondents in the tropical forest areas, the highlands, urban areas and savannahs respectively. The second mostly cited cause was poor management, which embraces both crop and land management, including soil and water conservation. 25%, 35%, 44% and 37% of the respondents in the tropical highland, urban and savannah areas reported it, respectively. Lack of fertilizers ranked third, and urban areas (20%),

followed by tropical forest areas (13%) most frequently reported it. Only 7% in the highlands and 9% in the savannah mentioned it.

The savannah areas consistently showed lower rates of perception by farmers of degradation of the soil resource in terms of loss of productivity. This is not surprising given that the savannah areas are generally found in the drier parts of the country where cattle pastoralism becomes more and more important as compared to cultivation.

Kizito and Nsubuga (1997) also reported of declining soil productivity by over 97% of the farmers in a village in the savannah areas of Iganga and 93% in a village in hilly Kabale. Soil exhaustion was claimed by 82% of the farmers in Iganga and 92% in Kabale, respectively. Opio-Odongo *et. al.*, (1992) who did research from two sites from each of the districts of Mukono, Masaka, Mbale and Kabale reported that from each of the eight sites covered by the study, 81 - 94% of the respondents reported declining soil productivity.

In a national survey of coffee farmers, their perceptions of soil fertility was carried out on farm. At the national level, 61% and 34% perceived their soil as being fertile, and poor, respectively (Ngambeki *et. al.*, 1994). Generally coffee is grown in the more fertile areas of the country. However, many of these farmers reported declining productivity trends, which were mostly again blamed on soil exhaustion. It should, however, be noted that when farmers are citing soil exhaustion, they do not distinguish between loss in productivity due to nutrient depletion and that principally caused by loss of topsoil. The study also showed that over 80% of the coffee farmers did not use any form of fertiliser. The situation is not different from other farmers nationally. The little fertiliser applied was mostly organic fertiliser, namely: animal manure, coffee husks, and compost. Less than 2% used mineral fertiliser, and those used were mainly NPK and CAN.

In summary the deliberations above show that there is wide but varied recognition of natural resource degradation in the country by the public and farmers. Natural resource degradation is associated with a number of problems that impact negatively on the lives of the people depending on it. Resource degradation includes decline in vegetation cover, soil fertility, water and soil pollution among others. There are various causes advanced and recognised by the people as being responsible for the degradation (e.g. poor farming practices). This has aroused public concern and triggered the setting up of some institutions (e.g. Ministry of Natural Resources), streamlining and restructuring of departments (e.g. in MAAF) and further research. There has also been a change in the behaviour of the people (though still not so significant) as relates to resource use.

## **4. Policies on SWC**

### **4.1 A brief review of Uganda's economic policy**

To understand the current administrative events and economic initiatives, it is necessary to have at least a brief historical review of past economic.

The economy of Uganda was vibrant in the 1960s. However, in the early 1970s it suffered internal and external shocks. Internally, fiscal responsibility collapsed, leading to widespread misuse and corruption. The administrative system and efficiency in government and the parastatal sector declined. The parastatal sector expanded in the early 1970s with the "Nakivubo pronouncements" in which the government sought a 60% participation in a number of private industrial, commercial and financial undertakings. It became bloated with the abandoned and confiscated industries belonging to mostly Asians who were expelled in 1972. Many of the country's best entrepreneurs, managers and administrators and professionals also left the country (Republic of Uganda, 1986).

Furthermore, the Uganda economy was shaken by a series of external shocks during the mid-1970s. The 1973 rise in the price of petroleum products also had an adverse impact on the balance of payments, and increased the cost of production throughout the economy. This was exacerbated by a world slump in coffee prices, which reduced foreign exchange earnings. These problems were further compounded by the break up of the East African Community in 1977, a fact that had a negative bearing on trade relations and access to formerly shared infrastructure services like railways, posts and telecommunications. It is only recently that the three East African countries have rekindled their co-operation with the 1996 agreement.

## **4.2 Institutional Reforms**

### ***4.2.1 Public service reform***

The civil service reform programme implemented a number of measures. They included rationalisation of government structures and functions including decentralisation of power to the districts, right sizing the public service, pay reform through a salary enhancement programme and monetisation of non-cash benefits, personnel and establishment control, improvement of records management, introduction of result oriented management, and capacity building.

### ***4.2.2 Current major administrative policies***

Since 1995, Uganda has adopted a decentralised system of government. The 1995 constitution (Republic of Uganda, 1995) provides under the National Objectives and Directive Principle of State Policy that “the State shall be guided by the principles of decentralisation and devolution of government functions and powers to the people at appropriate levels where they can best manage and direct their own affairs”. The principles that apply to the Local Government are outlined in Box 2.

## **Box 2: Principles of the Local Government System**

The Constitution further provides in Chapter 11 that the following principles shall apply to the Local Government system:-

The system shall be such as to ensure that functions, powers and responsibilities are devolved and transferred from the Central Government to Local Governments units in a co-ordinated manner;

Decentralisation shall be a principle applying to all levels of Local Government and in particular, from higher to lower Local Government units to ensure people's participation and democratic control in decision making;

The system shall be such as to ensure the full realisation of democratic governance at all Local Government levels;

There shall be established for each Local Government unit a sound financial base with reliable sources of revenue;

Appropriate measures shall be taken to enable Local Government units to plan, initiate and execute policies in respect of all matters affecting the people within their jurisdiction;

Persons in the service of Local Government shall be employed by the Local Governments; and  
The Local Governments shall oversee the performance of persons employed by the Central Government to provide services in their areas and monitor the provision of Central Government services or the implementation of projects in their areas.

This principle is backed by The Local Governments Act, 1997 (Republic of Uganda, 1997). One of the objectives of the Act is to give full effect to the decentralization functions, powers, responsibilities and services at all levels of Local Governments.

The system of Local Government (and decentralisation centres) is based on the District as a unit under which there are lower Local Governments and Administrative Units. The Local Governments District rural area consists of the District Council and the Sub-county Councils. Below the Sub-county councils are the Parish and village councils. Those in the City consist of the City Council and the Municipal Division Councils, while the Local Government in a town is the Town Council.

### ***4.2.3 Major economic policies***

Prior to 1986, government was pursuing an economic policy of mixed economy. But since 1986, government has been pursuing an economic policy of liberalisation whereby it is divesting of the provision of services that the private sector can provide better.

Government is also committed to providing macro-economic stability as a vital foundation for private sector investment. Other important government objectives are encouraging the growth of the private sector, improving service delivery, poverty eradication, an efficient public service with the right skills and experience as a pre-requisite to the development of appropriate policies, implementation of laws, efficient provision of services, and management of public expenditure.

#### 4.2.4 Transport, markets and infrastructure

In a liberalised economy, the issue of access to markets is very critical for both the delivery of inputs and other production-related items, and for evacuation of outputs to the markets. In this respect cheap and reliable means of transportation are essential. In the case of Uganda, the urban centres are the major consumers of agricultural output, and the major suppliers of the inputs.

The modes of transport used in Uganda are road, rail, air and water. Road transport is the most used mode. Uganda has a total road network of 25,632 km grouped in three classes namely, all weather (Tarmac), all weather (murrum, gravel) and dry weather (dirt road) (See table 6). The main and trunk roads are under the responsibility of the Central Government, while the feeder roads are under the Local Government. The village roads are supposed to be maintained by the villagers under the self-help arrangements at the village council level.

Half the road network is dry weather roads, which means they are impassable in wet weather. This makes the areas served by such roads with access to both input and output markets only seasonally. The central region is better served by all classes of roads, making it a leader in trade and commerce.

Whereas there was a decline in the stock of vehicles in the country from the 1970s to mid-1980s, there has been an upward trend since 1986. There has also been a structural shift, whereby pick-up trucks have increased much faster than heavy commercial vehicles, while mini-buses have substituted buses. Overall, there has been a shift from large-sized commercial vehicles to smaller ones. (Republic of Uganda, 1986).

**Table 6: Main road and railway network by region, 1996**

Region	All weather (Tarmac) km	All weather (Murrum, gravel) km	Dry weather (Dirt road) km	Road Total km	Railway line km
Central	1009	2404	4136	7549	293
Eastern	565	2337	2288	5190	535
Northern	93	3700	3201	6994	258
Western	609	2194	3096	5899	142
<b>Total</b>	2276	10635	12721	25632	1228
<b>Column Percentage</b>	9	41	50	100	-

**Source: MFEP (1996): Statistical Abstract, 1996.**

Since 1986, there has been a dramatic increase in the use of motorcycle transport. This may be explained by the growing demand for intermediate transport, informally known as “boda-boda”, in many parts of Uganda. Whereas this transport used to be provided by bicycles, an improvement in the level of incomes, and an atmosphere conducive to free trade (including imports) has led to the replacement of bicycles by small motorcycles, especially in the suburbs of and around cities and towns. This form of transport is also attractive in the rural areas where the road network is still too poorly developed for use by cars and trucks, or where even if the roads are in existence, the cars are not readily available. Motor cycles have now come in handy in travelling along village paths. So they help to evacuate some amount of produce from the farms and deliver some inputs to the farms.

The rail system is extremely limited, and is now used to transport mainly cargo, particularly exports and imports. Water transport is also not used by many people. But Lake Victoria as a waterway supports trade between Kenya, Uganda and Tanzania. Very few people also use internal air transport, mostly business people a few civil servants, and those who work for some NGOs.

### **4.3 Evolution of SWC policies**

The Department of Agriculture has been the government agency most concerned with soil management, followed somewhat remotely by the Department of Veterinary services when it considers pastures for livestock. It is in the Department of Agriculture that most policies and guidelines on soil management have hitherto originated, and are concentrated (Tukahirwa, 1992). What should be realised, however, is that apart from the general pronouncements and routine actions by the government departments on how governments want or would want to have certain resources utilised, at present there is no specific policy addressing SWC issues in the country. There is however, some current efforts in different sectors geared towards promoting SWC.

The earliest evidence to attempts towards rational soil management and conservation can be traced to The Crown Lands Ordinance No.2 of 1903 and later laws referring to forests, overgrazing and bush burning in Uganda. Realising the problems of soil erosion and land degradation in general, the then British colonial government set up an agricultural committee to investigate the problem and design policies to overcome it. This marked the beginning of a deliberate policy approach to the problem of soil degradation in the country (Dramadri, 1996). The report of the investigations led by Wayland (1935) and later reviews by Stockdale (1937) all confirmed the seriousness of the early observations made. The most affected areas were the dry lands of Karamoja where erosion was worse probably due to overgrazing and bush burning activities. Another seriously affected area was Ankole and the highland areas of Elgon, Rwenzori, Kigezi and West Nile. Basing upon these reports therefore the colonial administration designed policies, legislation and bye-laws on soil and water conservation and which subsequently were reviewed and adopted in the 1940s and 1950s to 1960s. While the 1930s had witnessed a lot of emphasis on trying to understand the causes of soil degradation and plan for the empire, the 1940s saw much effort geared towards mobilisation of farmers to adopt imported SWC technologies. In the 1950s most of the emphasis was placed on legislation aimed at backing the adoption of the introduced soil and water conservation measures. It is important to note that these earlier interventions formed the foundation for the current practices and policies. The first succinct legislation on soil was the soil conservation Ordinance (for non- African land) No. 33 of 1958 (Cap.245). This law had a number of Provisions as described by Kamugisha (1993).

A number of bye-laws regarding soil conservation were common to all local administrations during the colonial era. For instance, village paths and cattle tracks were not allowed to degenerate into soil erosion channels and chiefs could order the protection, closure and /or diversion of these. In many districts, strict provisions were made in the bye-laws for the particular circumstances prevailing in the areas e.g. in Ankole under the burning of grass law of 1959, zoning of the kingdom had to be done according to some agreed procedure.

However, the implementation and effectiveness of the above laws was characterised by a number of limitations, which included:

- the Laws did not emanate from any soil management policy which could have had the provisions for the necessary training, research and extension.
- the Soil Conservation Ordinance (SCO) was limited to non-African lands

- Implementation of the bye-laws was solely entrusted to ill equipped local authorities (chiefs); a number of them lacked appropriate technical expertise and were quite subjective in the execution of their duties hence probably leading to widespread hatred and rejection.

The 1970s had a serious set back due to poor political leadership. Most of the programmes and institutions that had flourished during the previous years collapsed. Many programmes and institutions were weakened owing to lack of vision, tools, and resources to support and sustain the programmes inherited from the 'colonial era'. There is no any record regarding active programmes on soil and water conservation programmes except some voluntary activities in sloping environments (Biteete, 1996).

In 1983, the government of Uganda set up The Agricultural Policy Committee (APC), comprising of permanent secretaries of the ministries of planning, trade, agriculture, co-operatives, industry, finance, lands and survey and environment and the chief executive of the Uganda Commercial Bank (UCB). Its purpose was to formulate, co-ordinate, direct and receive key policies and prepare actionable programmes in the agricultural sector (Kamugisha, 1993). The APC identified soil and water conservation and land tenure as one of the problems and a working group was set up for purposes of recommending possible solutions. Realising insufficient information on the implication of the 1975 Land form decree, the working group recommended that the decree be re-examined in the light of formulating a sound national tenure policy conducive to agricultural development. A study was therefore commissioned. In order to effect the recommendations of this study, the APC proposed the Tenure and Control of the Land Bill of 1990. Whereas the APC had rightly recognised the intricate relationship between tenurial issues, soil conservation and agricultural development, the working group went off target and isolated the Land Reform Decree as being the key issue (Kamugisha, 1993). It was argued that this oversimplified and undermined the issues from policy to legal hence the land-use policy still remains a dream.

In view of the problems of land degradation and recognising the role of appropriate land-use and management through a sound soil policy, in 1989 the Government of Uganda assisted (technically and financially) by FAO/UNEP drafted a National soils policy to provide a framework for action to prevent and or reduce soil degradation and related resources and promote sustainable soil management. The policy places high priority on the need for updating soils surveys and mapping and the implementation of national land use planning. The soils policy was to be structured and implemented basing on three horizontally-linked levels (i.e. legal, technical and institutional). This policy document, though it had some weaknesses, was never implemented because of the failure to table it before the parliament. However, a revised soils policy document is being prepared by an interdisciplinary committee involving people from NEMA and MAAIF. NEMA has great interest in the sustainable management of soil resources (Executive Director, per. comm.). In the Environment Investment Programme of the NEAP, enhancing resource productivity is one of the key programme areas under which implementation of a National Soils Policy is crucial.

Issues related to the management of the natural resources have also been imbedded in the national constitution passed in 1995 (GOU, 1995). Thus, Chapter 17, Article 278 (1) of the 1995 Constitution states that Parliament shall by law provide for measures intended to protect and preserve the environment from abuse and degradation and to manage the environment for sustainable development. In this arrangement, NEMA will develop the regulations in consultation with the stakeholders and the local administration in the districts mandated to develop specific bye-laws subject to approval by NEMA.

#### **4.4 Current and Future Trends in soil Conservation Policies**

There is no adequate land use or soils policy. Guidelines in form of district bye-laws on certain aspects of land use are available though not strictly adhered to since they are not an effective system for addressing SWC in the respective districts. The available but few extension staff working on SWC do not have adequate training in this field. There are no incentives for sound agricultural practices and above all there are no funds allocated by the government specifically for soil research or SWC extension. In some cases the local administrations lack guidance and experience in promoting or implementing SWC

There is, however, renewed interest in soil management by both the Department of Agriculture and that of Environment Protection (Tukahirwa, 1997). Interest within the Department of Agriculture was revived in 1988, and the Department started to explore means of promoting the control of soil erosion. Consequently for the very time ever, a soil conservation unit was created. It was placed within the Agricultural Engineering division of the Department. An Officer specifically charged with soil conservation in each district was proposed. In the field, local administrations are supposed to recruit people who are to work as field assistants in soil conservation, to be trained by the Department of Agriculture and to be paid by the local authorities. After training, they work with the soil conservation officers in extending services to farmers. Currently there is a soil conservation officer in all the districts, and various districts are at various stages of implementing the arrangement of soil conservation field assistants.

#### **4.5 Legislation for soil conservation and management**

In order to be enforceable, a policy has to be backed by appropriate legislation. According to Tukahirwa (1992), legislation on soil management and conservation dates back to the 1950's. The then colonial government distinguished between African held and "non - African land" and created different legislative approaches and instruments for the control of soil erosion and the promotion of good soil husbandry.

##### **a) Non-African Lands**

In the case of non-African lands, the soil conservation (Non-African Lands) Act <sup>1</sup> imposes a legal duty on every owner and occupier of land to use, cultivate and manage it in a manner that prevents soil erosion <sup>2</sup>. To facilitate the performance of this duty, soil conservation committees were created. An occupier or owner of land can apply to the committee of his area for advice as to the measures he/she should take to prevent soil erosion<sup>3</sup>

The soil conservation committees may also take the initiative if there is cause to suspect that any land in their area of operation is begin used, cultivated, or managed or is becoming so impoverished or so deteriorated that it is likely to cause soil erosion. The committee can then enter and inspect the land in question. If on inspection the committee is of the opinion that erosion has been or is likely to be caused, it may advise the District Executive Secretary to issue a conservation order to the occupier of the land concerned. The order may require him to adopt specified measures or prohibit him from doing any specified act.<sup>4</sup>

##### **b) African Lands**

---

1 First passed in 1958

2 Ibid., S.1

3 Ibid., S.4

4 Ibid , S.5

In areas occupied by Africans, soil conservation and management was largely left, by the colonial government, to local authorities. This approach persists to date. The Local Administration Act<sup>5</sup> empowers local authorities to make bye-laws to regulate a number of things, including soil conservation and the prevention of famine. A more-or-less standard by-law was adopted by all local administrations at independence for this purpose. The Ankole Soil Conservation Law<sup>6</sup> may be used here as an example. It requires all land under cultivation or cleared for cultivation, or land planted with black wattle trees to be provided with bunds of earth across the slope at intervals not exceeding sixteen yards apart. All bunds are required to be covered with vegetation and must have a minimum width of 3 ft (90 cm) and a height of not less than 1 ft (30 cm).

Where annual crops are planted on sloping land, trash lines consisting of dead vegetation must be laid parallel to and between the existing bunds. If they are planted on slopes, the lines shall be across the slope. Potatoes are to be grown on soil ridges across the slope. No annual crops are allowed to be grown within 9ft (2.7 m) of any perennial or seasonal water course or any maintained road. All paths, cattle tracks, ditches and access roads shall be protected against erosion by run-off channels, soak away pits or stakes. All house compounds, except those in crop growing area, and compounds around buildings shall be planted with a low-growing grass. Land planted to bananas or coffee shall be covered with a mulch where ever possible.<sup>7</sup>

These provisions, though originating from the colonial period, form the main body of rules of law for soil conservation and management throughout rural Uganda. Some districts have made a few additions and/ or variations to this main framework.<sup>8</sup>

### **c) The Cattle Grazing Act**

An important factor in soil erosion in many parts of Uganda has been overgrazing. Traditional value, social status and economic wealth have at times revolved around large numbers of cattle, goats and sheep regardless of the carrying capacity of the land. This practice has continued despite of the Cattle Grazing Act.<sup>9</sup> This Act empowers veterinary officers to prohibit grazing on any land or to prescribe the maximum number of cattle that may be grazed on any particular area of land. Such an order must be published either by affixing a copy there of in a conspicuous part of the area of land referred to, or in any other manner reasonably calculated to bring it to the notice of any person who may be affected thereby. Any cattle grazed on the land in contravention of such an order may be impounded and detained as security for any fines imposed by court. 'Cattle' is defined to include bulls, cows, oxen, calves, sheep and goats - a definition wide enough to cover almost all domesticated animals responsible for overgrazing in Uganda.

### **d) The Burning of Grass Decree**

Another important factor in soil degradation is the widespread seasonal burning of grass and bushes as part of land preparation for cultivation or for rejuvenation of pastures. It clears the land of vegetation, thereby exposing the soils to destructive forces by surface run-off at the beginning of the rains and to winds during the dry season. There is no clear government policy in the legislation to prevent soil degradation through this factor. The Prohibition of the Burning of Grass Decree of

---

5 Ibid, S.6

6 Act 18/67

7 Legal Notice 47 of 1962. New demarcations of administrative districts have resulted in sub\_ divisions of Kigezi, Ankole, Bunyoro, etc., but the gist of the bye-laws has remained the same.

8 It appears that some local administrations have modified some of the provisions though these modifications have not been formally approved or gazetted by the Minister for Local Government.

9 Cap. 223, Laws of Uganda.

1974<sup>10</sup> was an attempt to prevent the burning of grass and spread of fires, presumably with a view to controlling soil erosion. Section 1 of this decree provides thus:

"Notwithstanding the provisions of the Local Administration Act or any other written law to the contrary, the burning of grass by any person is hereby prohibited in all areas of Uganda."

In spite of this general prohibition, the Decree further provides that:

"Nothing in S.1 ... shall prevent any person or authority, while taking proper care to prevent the spreading of fire, from burning grass for the purposes of:"

- clearing a compound;
- clearing land for farming<sup>11</sup> Farming, for purposes of the Decree, is defined as including management of land for agricultural, forestry and livestock development.

#### **4.6 Legal Responsibility for Soil Management**

The legal provisions pertaining to soil management clearly impose an obligation on individual occupiers of land to use and manage it in a manner that controls and/or prevents soil erosion. It is the individual farmer, peasant or large scale corporation, who is expected to cultivate the land, graze cattle and generally use the land in accordance with the law.

In conclusion the evolution of policies in Uganda dates back to early this century when the colonial administration realised the threats to soil resource degradation in the country. The first deliberate policy approach to soil degradation was initiated in 1930s following a report by Wayland. This formed the basis for designing policies, legislation and by-laws on SWC. These laws were later reviewed and adopted vigorously in the 1940s and 1950s. A number of SWC were imported and farmers were mobilised with the help of chiefs to adopt them in various parts of the country. It is clear that effective implementation was marred by many problems e.g. lack of technical extension staff.

There were serious set backs after independence in 1962 and most especially in the 1970s due to poor leadership. Hence most of the previous achievements were neglected. In 1983 the government set up APC to formulate, co-ordinate and prepare action programmes in the agricultural sector. This committee proposed the Tenure and Control of the Land Bill of the 1990. After 1989 the GOU with assistance from FAO and UNEP started drafting a Soil Policy document. Though having some shortcomings this document was never implemented because it was not tabled before the parliament. Up to the present time there is no soils policy nor a land use policy. Efforts however, are now being made by MAAIF and NEMA to revise and table this soils policy document for adoption by the government.

Matters related to natural resources have been also embedded National Constitution of 1995 and the Land Bill of 1998. One can therefore only hope that there will be implementation and hence rational use of the resource especially the soils. Among others there is urgent need for harmonisation and sensitisation of the public in general and farmers in particular as regards the various policy issues and rational management of their resources.

---

<sup>10</sup> Decree 5 of 1974

<sup>11</sup> Ibid., S.4.

## 5. Institutions Involved in SWC

Soil and water conservation issues in Uganda are cross-sectoral; they are handled by such sectors as Natural resources (forestry and water), Agriculture, local government, NGOs (local and international) and research institutions. It should be noted that in general the conservation efforts by these institutions are complementary though sometimes they do overlap and may as well conflict. GOU (1994) observes that the inadequacy of the existing policies and legislation combined with lack of inter-sectoral co-ordination and co-operation have also contributed to the degradation of the environment and depletion of the country's natural resources. Figure 7 (Appendix B) summarises the institutional structure and linkages for SWC concerns in Uganda.

The MAAIF is fully responsible for the management and conservation of soils in Uganda. Within this ministry is the Soil Conservation Section (SCS) housed in the department of Farm planning and development. The SCS has got local divisions where there are extension officers operating at the district (DSWC) and county/sub-county level in various parts of the country. The SWCS is supposed to promote proper land utilisation in order to ensure sustainable agricultural production in the country. Among others, the activities of this section include: promoting SWC in farming systems through catchment protection; promoting water harvesting and harnessing for agricultural production and domestic use; provision of training and technical support for staff and other stakeholders, and the monitoring, evaluating and providing technical support on agricultural activities on the fragile lands.

Every extension worker of the Department of Agriculture is also responsible for soil conservation extension, while Chiefs who are employees of Ministry of Local Government are responsible for the enforcement of related bye-laws. The colonial government instituted a fine and a prison sentence for anyone who failed to comply with the law on his land. This has remained the policy of all the post-independence governments without any reviews (Tukahirwa, 1992), until 1992 when the new local government restructured the Local Councils (LC system).

The other cross-sectoral institutions involved in soil and water conservation issues either directly or indirectly include; MUK, USCS, NEMA, NCCD/IGAD, NARO, local and international NGOs (RSCU/SIDA in Nairobi, IUCN, CARE, FAO, WOCAT, UNFA, ICRAF).

Makerere university (especially the departments of soil science and forestry in the faculty of Agriculture, Geography department and MUIENR are actively involved in training and research on various aspects of soil and water conservation.

ICRAF has started some activities on SWC targeting highland zones (ranging from 1000 to 2500 M and receiving more than 1000mm of rainfall per annum). NARO is one of the autonomous institutions set up in 1992 in MAAIF with the mandate to supervise, manage and finance initially 8 ARI (Agricultural research institutes) which include Namulonge, Kawanda, Serere, Tororo, Jinja and Nakawa. Its other responsibilities are human resource development, recruitment and training in the ARI.

The mandate for research in crop and livestock production systems in the semi-arid areas of Uganda is with the Serere Agricultural and Animal Production Research Institute (SAARI). Akwanga *et al.*, (1998) noted that SAARI's priority research currently includes work on cotton, oil crops, cereals, grain legumes and livestock production. There is also research work on animal traction, soil fertility management, farming systems, seed production and research, pastures, range management, and integrated pest management, co-ordinated by other NARO Institutes. Soil and water conservation and management, however, are not particularly mentioned as focus areas. Currently its mandate is being reviewed to include extension of research results.

NEMA is a parastatal body (multi-sectoral and semi-autonomous) under the Ministry of Natural Resources with a strong mandate to co-ordinate lead sectoral agencies in various aspects of activities that have an impact on the environment to ensure sound environmental management while carrying out subsistence and developmental activities. NEMA also ensures the implementation of policies and compliance with legislation formulated by the NEAP. In 1994, a National Environmental Management Authority Umbrella legislation, referred to as the National Environmental Statute, was approved by the government and included the establishment of NEMA. Issues of soil and water conservation are adequately covered in the both the Umbrella policy and legislation. The statute also provides for the districts to form their Environmental offices and organise local environmental committees up to the village level; a number of districts have set up these and others are still being encouraged to do so. These committees at the local level are supposed to act as a link between the policy makers and the farmers. This linkage within the districts is very important for more effective implementation since it is at grassroots that the majority of the resource users are found.

UNFA is the Umbrella Association for all the farmers of Uganda; its major tasks are to co-ordinate farmers' activities in the country and promote sustainable farming practices including SWC through training, seminars and workshops. The Association is funded by its members and has set up offices at the districts to facilitate the access and mobilisation of its members.

In 1994 a National Soil and Water Conservation Programme (NSWCP) was formulated by the MAAIF through the assistance of SIDA/RSCU as a forward step towards improving strategies on SWC in Uganda. This was to be operated on a pilot basis in the three districts of Kabale, Mbale and Mbarara.

Various NGOs are involved in training of staff and the farmers but sometimes they do not adequately cover the SWC aspects. These NGOs organise seminars and workshops so that farmers and other stakeholders can learn through sharing their experiences and participation. Field trips and /or demonstrations are also sometimes arranged for the farmers and extension staff so that they learn from other farmers. For instance the Lutheran World Foundation (LWF) is involved in various activities related to agro-pastoralism development in Moroto, Adjumani and south-western Uganda. Recently they started helping farmers to contribute towards combating desertification (Adrian, pers. comm.).

In general the above deliberations show that SWC issues are handled by various institutions/sectors which fall under different departments and ministries. Though the conservation efforts are supposed to be complementary there is usually overlap and conflict which greatly undermine effective operations. Lack of inter-sectoral co-operation and co-ordination among these institutions coupled with inadequate policies/legislation are cited as contributory factors to resource degradation including soils and water.

The formation of inter-sectoral institutions e.g. NEMA will help to minimise conflicts and overlaps in SWC activities and thus also save on the scarce resources invested for other developments. The NGOs efforts are very important and will continue to play a complementary role in resource management in general and SWC in particular. However, their activities need to be co-ordinated or networked for effective performance.

## **6. Research on SWC in Uganda**

## 6.1. Evolution of Soil Productivity Research

Most of the SWC research done in Uganda (see appendix 7 for the study areas) is within the context of maintenance and improvement of soil productivity. In the early colonial days, research was triggered by the introduction of cash crops (cotton, tobacco, coffee and tea) into the indigenous farming systems (Braun *et. al.*, 1997). Agricultural trials in 1910 - 1925 suggested that climate was the main factor controlling cotton yields. It was, however, soon realised that yields go down after a few years of continuous cropping. This led to systematic investigations into maintenance of soil fertility through rotations. Studies also sought to understand nutrient depletion processes and how manure and fallows were able to improve soil productivity.

According to Braun, *et. al.*, (1997), the soils laboratory at Kawanda has been in charge of soil productivity research, soil surveys, and soil and plant analysis since 1937. During the days of the East African Community (1948-1976), the Agricultural Research Centre in Muguga in neighbouring Kenya conducted soils research in collaboration with national programmes. But close co-operation of Kawanda and Muguga broke off after the break up of the community. Agricultural Research in Uganda was later re-organised, culminating in the formation of the National Agricultural Research Organisation (NARO) in 1993. The Department of Agriculture used to publish work on soil productivity in its annual reports until 1975.

Since 1998, NARO has a soils programme with 12 scientists. The other concentration of soil scientists is in the Department of Soil Science in Makerere University with 9 scientists. National and international agricultural research centres and NGOs have also recently initiated collaborative projects relevant to soil productivity. They include the CIAT Regional Bean project, ICRAF AFRENA project, and work by IITA, CARE and Action Aid.

The Uganda government has sought, and is still seeking donor funds for various projects on the maintenance and improvement of soil productivity, including SWC. The projects include a national soil survey, a national land-use plan, enhancement of soil productivity through improved farming systems, and community based afforestation.

## 6.2 Runoff and Erosion Studies

Erosion studies were done in the 1950s and 1960s, as well as recently in the south-western highlands (Braun, *et. al.*, 1997). The studies have shown that runoff and erosion varies according to a number of factors. Early work on erosion in Uganda was reported by Hutchinson, *et al.*, (1958), Sperow and Keefer (1975), Ahn (1977), Moore (1979) and Edwards and Blackie (1981). Investigations at Namulonge research station showed that the runoff from bare plots was 10 times more than from grass-covered plots, while grass mulch was twice as effective as stone mulch in controlling runoff (Hutchinson, *et. al.*, 1958). Soil erosion losses from the same research station under seven different treatments was recorded as runoff losses of 41% of precipitation and relative soil loss of 81.5 tones per hectare per season under bare land (Sperow and Keefer, 1975). The measurements for other treatments were 23.4 and 34.0 under maize, 19.9 and 26.6 under cowpea, 5.3 and 26.6 under Rhodes grass, 10.8 and 2.5 for grazed under burned Veld, 5.6 and 4.4 for closely grazed Veld, and 0.5 and 0.1 for undisturbed veld. The above studies were in Mpigi district which is outside the semi arid areas. In more recent studies but out side the semi arid areas, Bagoora (1988, 1998) found that most slopes in the Rukiga highlands of Kabale, were seriously affected by all forms of soil erosion.

Moore (1979) examined rainfall erosivity parameters at several stations in Uganda. The intensity and kinetic energy parameters indicate that the highest erosivity hazards are in the Lake Victoria area, with R (i.e. the rainfall erosivity factor) being above 400.

Recent soil erosion research outside the semi arid areas have been carried out in the eastern and south western highlands by Nakileza (1992), Tukahirwa (1995) and Bagoora (1998), respectively. The experimental studies by Nakileza (1992) on Mt. Elgon slopes revealed that the cropping and management practices have a significant effect on reducing soil loss. In 1992 runoff and erosion experimental plots were also set up by IBSRAM to measure the effect of different land clearance methods on erosion loss and changes in soil properties at Kabanyolo research institute.

The modelling approach was tried on soil erosion studies by Tukahirwa (1995). She assessed the extent of accelerated erosion in south western Uganda at Kachwekano in the Kabale Highlands and evaluated the hill slope version of WEPP (Water Erosion Prediction Project) in predicting soil erosion trends. Whereas WEPP was found to be sensitive to trends of erosion dynamics and predicted the soil loss within the range of observed data, it tended to overestimate runoff and was unable to predict non inter-rill erosion processes.

The above studies have been done within limited places outside the semi arid environments and for a short period of barely 3 years. Hence they may not be very reliable in predicting long term trends and patterns of runoff and soil loss. Long term monitoring of erosion is required for effective planning and management of the problem in the environmental setting in Uganda.

## **6.3 Integrated nutrient budgets and management**

### **6.3.1 Nutrient budgets**

There have been limited Nutrient budget studies for Uganda. An assessment of the nutrient balance of Uganda as part of the sub-Saharan African study has been undertaken (Stoorvogel and Smaling, 1990; Stoorvogel, *et. al.*, 1993). Wortmann, *et. al.*, (1994b) carried out studies on nutrient flows from harvested banana pseudostems on the red sandy clay loam soils in central Uganda.

### **6.3.2 Integrated nutrient management**

Research has also been done on integrated nutrient management since 1946. Prior to 1946, researchers and policy makers did not expect the majority of farmers in Uganda to use chemical fertilizers mainly on account of lack of their availability and the associated costs (Braun *et. al.*, 1997). During 1946, however, the Tororo phosphate rock deposit was opened, making it possible to obtain cheap phosphate fertiliser. There was an initial research effort of 45 trials, and it included Ugandan phosphate rock, soda phosphate, DSP, lime and manure, applied to finger millet, cotton, sorghum, groundnut, sugarcane, and sweet potato. Expectations of large responses were not met, which signalled the need to consider other interacting factors (Manning and Griffith, 1949). After another 60 trials (Mills, 1954), the results indicated that in general N fertiliser had the greatest effect, K had the least, and P was intermediate. The results also indicated that no inorganic fertiliser was as effective as manure or a period under a grass rest. The 105 trials were in the eastern and central Uganda, and most of them lasted for only one or two years.

Early studies also tested Ugandan phosphate rock and soda phosphate against DSP. Responses to phosphate rock and soda phosphate were generally small compared to DSP. Soda phosphate was found to depress yields in some cases. But phosphate rock was recommended for building up soil phosphate levels (Manning and Griffith, 1949).

Long-term trials involving different mineral and organic fertilisers were conducted at Serere (located in the north eastern semi arid zone) in 1935. These experiments were triggered by the failure to maintain soil fertility in simple crop rotations (Martin and Biggs, 1937). A 5-year rotation was compared with continuous cropping, and with rotations with rest periods, with and without farmyard manure. Five different resting covers were compared. These were natural vegetation, undisturbed grass, velvet bean (*Mucuna deringiana*) as green manure, grass cut and

then grazed, and velvet bean dug in. Different rates of farm manure were used. The test crops were cotton, finger millet, groundnut, sweet potato and sorghum. Semeson and Kerkham (1960) evaluated the experiment after five cycles (15 years), Mills (1960) analysed the trends in crop yield data after 20 years, including a fourth cycle. The long-term experiments were modified several times to include grazing, ox-cultivation, legumes and the use of fertilisers in the rotations (Wadsworth, 1967).

The results indicated that the response of cotton, cassava and sorghum to Phosphate is slightly reduced after resting. Responses to fertilizers varied considerably from crop to crop. Data analysis after five cycles McWalter and Wimble (1976) showed similar findings. Rest treatments did not maintain or build up soil N. Soil analysis data showed that nutrient levels and the soil condition were maintained at higher levels where farmyard manure was applied, and were better under rotations with longer resting periods. Another long-term experiment was established at Serere in 1935. It included farmyard manure and lime.

## **6.4 Research on Maintenance and Improvement of Soil Productivity**

Braun, *et. al.*, (1997) note that research on maintenance and improvement of soil productivity technologies (MISP) in Uganda was mainly carried out on mineral fertilizers and fallow. Phosphate rock, liming, manure, mulch, intercropping, agroforestry and soil conservation also received reasonable attention. However, these studies have been undertaken mainly in the humid areas of Buganda in the central region and some in eastern Uganda on the volcanic soils of Mt. Elgon (e.g. Foster, 1973).

### **6.4.1 Mineral Fertilizers**

There were numerous fertiliser trials on farmers' fields under the Fertiliser Development Scheme on the response of various crops to various nutrients under different levels. The trials were conducted in parts of Central (Buganda), eastern southern and western Uganda. The results of the trials are summarised in Box 3 below.

### Box 3 : Results of fertilizer trials on the farmers' fields for different crops in Uganda

Period	Trials	Crops	Crops/Areas/Reference
1945 - 1954	100	finger millet, cotton, sorghum, groundnut, sugar cane	sweet potato tested N,P,K, phosphate rate, krall manure, grass rest at over 30 sites mainly of agricultural stations or government land; eastern Uganda and south Mengo (Manning and Griffith 1949; Mills 1953b and 1954)
1960 - 1964	290	Cotton	N and P on small farmers' fields in Busoga, bukeddi, Teso and Lango (Stephens 1968)
	78	Groundnut	N and P on small farmers' fields in Busoga, bukeddi, Teso and Lango (Stephens 1968)
	51	finger millet	N and P on small farmers' fields in Busoga, bukeddi, Teso and Lango (Stephens 1968)
1959 - 1973	26	maize	Agricultural stations, Buganda Western Uganda (Stephens 1969b)
	27	cotton	Agricultural stations, Buganda Western Uganda (Stephens 1969b)
	39	field millet	Agricultural stations, Buganda Western Uganda (Stephens 1969b)
	36	Sweet potato	Agricultural stations, Buganda Western Uganda (Stephens 1969b)
	16	Groundnut	Agricultural stations, Buganda Western Uganda (Stephens 1969b)
	18	finger millet	Agricultural stations, Buganda Western Uganda (Stephens 1969b)
1963 - 1973	3000	cotton	N and P on farmers' fields, Buganda, Eastern and Northern Uganda (Foster 1978)
	1300	groundnut	N and P on farmers' fields, Buganda, Eastern and Northern Uganda (Foster 1980a)
	900	finger millet	N and P on farmers' fields, Buganda, Eastern and Northern Uganda (Foster 1980b)
		maize	N and P on farmers' fields, Buganda, Eastern and Northern Uganda (Foster 1980b)
1967 - 1971	457	groundnut	tested SSP versus TSP on farmers' fields all over Uganda (Foster 1973a)
1965 - 1969	85	wheat	N and P on farmers' fields on soils derived from volcanic ash in the Mt. Elgon area (Foster 1973b)
	132	maize	N and P on farmers' fields on soils derived from volcanic ash in the Mt. Elgon area (Foster 1973b)
Total	6355		

In 1959, 18 medium term experiments were established at 9 agricultural stations covering central (Buganda) and western Uganda. The details and results of these experiments up to 1965 are presented by Stephens, (1969). The Ministry of Agriculture Officially released fertiliser recommendation in 1973 (Anonymous, 1973). The results are shown in appendix 6.

#### **6.4.2 Mineral Soil Amendments**

There have also been efforts to evaluate mineral soil amendments by various institutions. The International Fertiliser Development centre (IFDC) in collaboration with the Department of Soil Science of Makerere University evaluated beneficiated Sukulu phosphate rock, partially acidulated phosphate rock, phosphate rock compacted with SSP, and TSP using maize and field bean as test crops (Ssali pers. comm.) Although soil analysis indicated low levels of available P, responses to available phosphate were recorded in only three out of the seven seasons. There was no significant difference among the phosphate sources evaluated. CIAT evaluated the more soluble Bubutu phosphate rock on field beans. Although super phosphate increased the field bean yield, there was no response to the applied phosphate rock (Wortmann, pers. comm.)

Evaluations of the effect of liming were also done. Since most soils are acidic, large increase in yields were expected. However, the results showed that responses to lime occur only when Ca levels and pH drop below certain levels (Stephens, 1967a; Foster, 1970a, 1979). Areas where liming is recommended are in acid swamps (Chenery, 1954 a., Harrop, 1960).

#### **6.4.3 Improved, Low-External Input Agroecosystems**

Studies have been done to evaluate the effects of manure, mulching and different forms of mulch, crop residues mixed in soil, green manure, improved fallow, inter cropping, and agroforestry (Braun, *et. al.*, 1997). Early studies at Serere demonstrated the positive effects of manure on crop yields and soil productivity (Jameson and Kerham, 1960), though further studies demonstrated that manure basically fed the crop but had little effect on soil structure compared with grass leys (Stephens 1967c, 1969a, b). Following these studies, recommendations on application rates for manure so as to be of maximum benefit were made. Experiments were also subsequently conducted to study proper storage of manure so as to be of maximum benefit. Other research work on improved, low-external input agroecosystems includes that by Mills (1953 b), Bwamiki (1995) and Robinson (1961) on the effects of green manures. Meanwhile, the value of napier grass as an improved fallow in the 1930 triggered further investigations at Namulonge (Jones, 1968) and at Kawanda (Stephens, 1967 c; Foster, 1971). A study was also done on intercropping in bananas (Wortmann, *et. al.*, 1992). However, soil productivity research with an agroforestry component has not been done to any extent in the highlands (Braun, 1977), ICRAF has conducted diagnostic surveys (Djimde and Hoekstra, 1988), and there are currently investigations going on to regenerate scoured terraces (Atta - Krah and Wakhu, 1996).

### **6.5 Research on development and adoption of SWC**

#### **6.5.1 Soil and Water management/conservation**

Very little research has been done directly on soil and water management conservation as compared to other areas like fertiliser. Some of the main research projects include those by Walton (1962), Tumuhairwe *et. al.*, (1998), Tukahirwa (1995), Tenywa (1998) and Magunda (pers. comm.).

Among the earlier researches was that by Walton (1962) who studied the effect of ridging on soil moisture conservation at various depth and slope conditions under cotton and uncropped land, at Serere, located in the north eastern semi arid area. Over several months during the rainy season, he found little difference between ridged and flat plots in the moisture content to a depth of 30cm.

However, from 30cm to 180cm, there was consistently more moisture under the ridges on uncropped land and the differences between two treatments increasing with depth. The steeper the slope the greater was the increase in moisture content obtained by ridging as compared with flat cultivation. This was attributed to the increasing effect of the ridges in checking run-off. The benefits of contour ridging also varies depending upon the soil type and crop grown, as perceived by the farmers (Walton, 1962). Ridges were found not to be very effective in conserving moisture in light soils, but were found useful in weed management.

However, much of the more recent research in Uganda has been donor driven and, according to Zake (1992), farmers have not adopted many research findings to improve soil productivity. There is no research into appropriate methods in the use of local fertilising materials, as substitutes to imported ones. The low or non-adoption of technology is an old story that is currently generating serious debates and research. It has precipitated the participatory research approach as a spin off of farming systems approach.

Among the more recent projects/research involving SWC is one being undertaken by Tumuhairwe, Kahembwe, and Nsubuga who researching on Th Acceptance and Impact of Soil and Water Conservation and Biodiversity Approaches. This is an international collaborative project of different countries and scientists. The research is being undertaken under the United Nations University Project on `People, Land Management and Environmental Changes (UNU/PLEC). The project is a demonstration and capacity building, whose goal is to develop, with farmers, sustainable biodiversity conservation within agricultural systems. The principal method is through the establishment of demonstration sites where sustainable and conservationist resource use strategies are worked out through participation with farmers and other stakeholders. The research also examines the reasons for adoption and non-adoption of soil and water conservation technologies by farmers. It also tries to identify and document the indigenous soil and water conservation approaches under various farming systems, landscape types and socio-demographic and economic conditions. The main study area in south western Uganda is in Mbarara District. The semi-arid pastoral area which also undertakes cultivation is deliberately being brought into the study. The research in this area has been on-going since 1996.

Tenywa, *et. al.*, (pers. comm.) is conducting research under an EU-funded collaborative project entitled combining indigenous and scientific knowledge for developing and promoting sustainable land and water management in Katakwi district. Preliminary findings show that farmers have a wealth of knowledge concerning their resources which when tapped and strengthened by scientific knowledge is very promising in ensuring sustainable land management. In a preliminary Participatory Rural Appraisal, the farmers ranked soil moisture and infertility to be the first and second major crop production constraints, respectively. A manual for combining indigenous and scientific knowledge for frontline extension workers and researches is the expected output. It is hoped that this will enhance the robustness and transferability of on-farm trial results. This is one of the few SWC and Management Projects in semi-arid area.

Lwakuba (pers. comm.) is co-ordinating a research programme aimed at promoting the Farmer Innovation in Rainfed Agriculture in the dry lands of Uganda (PFI). This is funded by UNDP Trust Fund (from the year 1997-2000) to combat desertification and Drought. This programme focuses on improving water management, exchange of experience between farmer innovators and other land users in the field of Land Management and especially water harvesting and/ soil and water conservation, in the regional clusters in Eastern Africa, Western and Southern Africa.

Magunda (pers. comm.) is also co-ordinating the land use component of the Lake Victoria Environment Management Programme funded by IDB/World Bank. Soil and water conservation is one of the sub-components in which run off and soil erosion processes are being studied under

banana, coffee and pasture cropping sub system systems of the Lake Victoria Basin- Sango bay. Preliminary results indicate runoff generation in the following order pasture>annual crops>coffee>banana. Soil loss is greatest from the annual crop systems.

The Soil and Water Conservation Society of Uganda (SWCU) is also co-ordinating NGOs' activities nation-wide with the aim of sensitising communities on combating desertification and drought in the semi-arid districts.

Appendix 5 shows the list of research projects undertaken in the Department of soil Science, Makerere University directly on development of SWC, except by two projects. One was the IBSRAM/Rockefeller Foundation Sponsored research on land clearing and soil management for sustainable food production in the high rainfall zone around Lake Victoria by Zake J.Y.K that was carried out from 1991 to 1995. The second one is the UNU-PLEC sponsored research on acceptance and impact of soil and biodiversity conservation approaches in a dynamic biophysical and demographic agro-ecosystem. It aims at developing models for sustainable land management by building on indigenous knowledge and participatory methods.

### **6.5.2 Soil Conservation Efforts in practice**

The key players in SWC efforts in Uganda can be categorised into four namely:

- i) Government and its related institutions
- ii) Non governmental organisations (both indigenous and external) and CBOs
- iii) International Development and /or research institutions
- iv) Farmers' Organisations.

### **6.5.3 Government and government institutions**

(A) Government efforts in SWC are evidenced by policies and legislation initiated. Government efforts to ensure the adoption of SWC by farmers have been evident since colonial times.

In the 1950s, the colonial government made policies and legislated on soil management and conservation. The legislation reflected the concern of the colonial government over trends and farm practices tending to promote soil erosion. The laws required the owner/occupiers of land to use and manage it in a manner that is consistent with SWC have been inherited, and sometimes improved upon by the post-colonial governments. The laws also cover overgrazing and the burning of grass (Tukahirwa, 1992). For example, Tukahirwa (1998) reports that in Lango (now Lira and Apach Districts) contours and land consolidation were emphasised. In Kigezi (Kabale, Kisoro and Rukungiri districts), emphasis was put on grass strips and soil bunds. Grass strips or bushes were planted the contours at specified vertical intervals, so that soil being eroded down between two successive soil bunds would be trapped by the bund. By soil accumulation, the area between two successive bunds kept levelling out, and this reduced the gradient between successive strips, eventually forming a bench. This process led to the formation of the terraces in Kabale as opposed to constructed terraces. It is only in Sebei (Kapchorwa District) where terraces were actually constructed using machinery from the Department of Agriculture. In Buganda, graded channels were constructed and the lower parts were planted to grass, mainly *Paspalum notatum*. The purpose of the graded channels was to control and conserve water from the upper slopes.

Mulching was emphasised everywhere as both an aspect of good husbandry and for control of soil erosion. Overgrazing and bush burning were also strongly discouraged as they expose the soil and make it vulnerable to erosion. The SWC measures described above, were backed by relevant policy and legislation, as out lined in section 4.

Other recommended conservation measures reviewed by Braun, *et. al.*, (1997) were:

- (i) Planting grass wash stops for gentle slopes for Teso (Soroti, Kumi and Katakwi Districts) and northern Uganda except parts of West Nile. Long and continuous bands were to be planted with *Paspalum notatum* on steeper slopes of the rolling landscape of southern Uganda. They were fairly well made in Mengo (Mpigi, Mukono and Luwero Districts) and Bugisu (Mbale) and as well in Masaka (Sembabule, Rakai and Kalangala Districts) and the highlands of West Nile.
- (ii) Separate wide terraces by grass bunds or stones for steeper slopes in Kigezi. Stone bunds were also used on the slopes of Mt. Moroto in Karamoja.
- (iii) Planting of home compounds with grass and collection of runoff from roofs in tanks (to provide a family water supply) or by constructing stone gutters around the house.
- (iv) Leaving the steepest slopes for extensive grazing or preferably planting them with forest trees.
- (v) Mulching perennial crops (e.g. coffee and banana), is a usual practice in Ankole, (Mbarara, Ntungamo and Bushenyi Districts), though it is also common in Masaka (Masaka, Rakai, Sembabule and Rakai Districts) and Mubende (Mubende and Kiboga districts) but less frequent in Mengo (Mpigi, Mukono and Luwero Districts), where both the cost and the risk of fire are high.
- (vi) Protecting roads and paths against erosion. This was well done in Teso (Soroti, Kumi and Katakwi Districts), but less so elsewhere.
- (vii) Other practices included planting row crops on contours, tie-ridging sweet potatoes and hoeing weeds into rows across the slope (trash lines).

During the late 1960s and early 1970s erosion was nevertheless still serious in many areas. According to Braun, *et al.*, (1997) it was especially still serious in:

- the steep, cultivated slopes of the Rwenzori
- the hilly and thickly populated south western corner of West Nile.
- the communal grazing lands (e.g. in Karamoja, Luwero), mainly because of overgrazing.
- areas where indiscriminate burning encouraged sheet erosion, despite bye-laws to discourage burning. This was especially so in the southern and central uplands of Ankole (Mbarara, Buhsenyi and Ntungamo district), the Koki hills in Rakai district and the overgrazed hillsides of Kigezi (Kabale, Kisoro and Rukungiri districts) and Mt. Elgon (Mbale and Kapchorwa districts).
- National parks overgrazed by wild animals had led to sheet and gully erosion.

Nevertheless according to Braun, *et. al.*, (1997) SWC was relatively widely practised, taught in schools, and enforced by the administration throughout the country. Up to the late 1960s, protection of arable land in Uganda was often good, and soil conservation featured heavily in annual agricultural shield competitions for many years. These competitions were beneficial in building confidence, creating and promoting soil conservation practices in the country

- (B) Through MAAIF government has carried out sensitisation work on SWC countrywide (Lwakuba, pers. comm.) since the time of independence in 1962.
- (C) Government set up a SWC section in MAAIF in 1989 (Tukahirwa, 1992).

(D) In conjunction with the Regional Soil Conservation Unit (RSCU/SIDA) based in Nairobi, government has trained and retrained district soil conservation officers to do extension work on SWC. Currently about 35 districts have participated (Omoding, 1998, pers. comm.).

(E) MAAIF has initiated a number of research and development/extension projects (Lwakuba, 1999). Some of these, like USCAPP (in Mbarara) are based in degradation prone areas, whereas others like the ODA funded environment project in Kamwezi sub-county of Kabale, is in a relatively dry area. This particular one is in part of the cattle corridor characterised by frequent droughts.

This project, originally known as Conserve Moisture to Save Soil and the Environment, is now known as indigenous soil and water conservation. It has changed from purely research to development/extension.

In Kumi, MAAIF is implementing a pilot project whereby farmer innovators are used for accelerating diffusion of better land management, in particular SWC and water harvesting practices.

(F) MAAIF is in the process of drafting a National soils/land use policy.

#### **6.5.4 Non-Government Organisations (NGOs)**

There are several NGOs, both indigenous and foreign, that are involved in extension work in farming practices that are consistent with SWC. Among the leading foreign NGOs are CARE International, Action Aid and Environment Alert.

Among the indigenous ones is the SWCSU which, since its inception in 1997, has been actively involved in SWC and related research. SWCSU is actively involved in fighting desertification in nine districts in the country. In Soroti and Katakwi districts, the Soroti Catholic Diocese Development Organisation (SOCADIDO) is involved in agroforestry with the farmers as a component of SWC. The Lutheran World Foundation is also implementing a project in Karamoja that involves anti-desertification/ degradation efforts (Brian, pers. comm.)

#### **6.5.5 International institutions**

International institutions like the Global Environment Facility (GEF) and the overseas Development Institute (ODI) are also involved in SWC related research and development. The People, Land management and Environment Change (PLEC) project being sponsored by GEF through Makerere University is doing research and development in south western Uganda, particularly in Mbarara (Tumuhairwe *et. al.*, 1998). Its interest is in helping farmers develop sustainable agricultural systems that are also rich in biodiversity. It has a strong SWC component.

DFID is involved in various programmes related to renewable natural resources in semi arid areas and hill slopes area in Uganda.

ODI is also currently exploring how best it can participate in SWC research and development in Uganda. Its interest is in the semi-arid areas, and for now Katakwi district.

#### **6.5.6 Farmers**

Data from national studies conducted by Tukahirwa (1992) and Ngambeki, *et. al.*, (1994) show that whereas farmers profess to be aware and concerned about declining fertility, they are not actively doing much about it. Even though the farmers do a number of soil conservation practices, they are not used consistent and their use varies from one part of the country to another. The soil conservation practices used include erecting grass bands, digging trenches, constructing and

maintaining terraces across the slope, fallowing, erecting diversion channels and the use of water crops.

In summary the above review indicates that most of the research undertaken is donor driven and very little research has focused on SWC management. Most of the research in SWC management has been focussed on the high crop potential areas with little regard to the semi arid areas.

There is generally, a lack of research into appropriate methods in the utilisation of local fertilising materials as substitutes, instead of imported material. The discussions show emerging new approaches (e.g. the use of PRA) to research and other developments in adoption /or non-adoption of technologies in farming systems in general and SWC in particular.

There have been a number of SWC research studies undertaken in the country since the time of colonial administration. Though it is hard to split the SWC research due to the integrated nature of the research quite often carried out, the researches in general have ranged from soil productivity, maintenance and improvement of soil productivity technologies and soil erosion and run off. Most of the researches were conducted way back before 1970. As revealed by the literature, recent research especially in SWC is inadequate and mostly focused on the high crop potential areas.

It is also clear from the above discussions that there are many key players in SWC efforts (e.g. government, NGOs, international agencies and farmers). This has its own advantages and disadvantages. The SWC measures including their policies/laws made during the colonial government have been inherited and improved upon by the postcolonial administration. The adoption of SWC was and is still poor in the country due to a number of factors. However, there are renewed efforts in SWC work through MAAIF and other stakeholders. One can only hope that the situation will improve to meet the challenges and constraints involved in SWC.

## 7. SWC Practices in Uganda

There are various SWC practices used in Uganda. However, the practices and their mix vary depending on the landscape type, topography, land use type, tradition, level of exposure of the farmers and the vigilance of the extension staff.

Miir (1997) has documented the SWC practices in south western Uganda (Kabale). He established that about 15% of the farmers use terraces. Terraces in this highland area were introduced and enforced by the colonial administration way back in 1940s. Due to the steep nature of the slopes it is almost imperative for the farmers to adopt use of terraces or else they experience serious loss of the crops and the top -soils. Other practices in declining order of use after the terraces include trenches, fallowing, tree planting, mulching, grass strips, hedge rows, cover crops, contour cultivation, soak pits, strip cropping, mixed cropping, cultivation across the bench heaping of soil and incorporating trash in the soil.

Ngambeki, *et. al.*, (1994) found that in the coffee plantations, farmers practised grass bunding, mulching, ditches, fallowing diversion channels and cover crops. However, these practises are not well maintained or systematically applied in Mt. Elgon coffee growing area (Nakileza, pers. comm.)

The national survey by Tukahirwa *et. al.*, (1992) revealed that the most frequently used SWC measures are mulching (60%) and terracing and/or bunding (20% each). This survey did not include the pastoral areas nor the semi arid areas in general.

There is little variation in the types of SWC practices use in the humid and semi arid areas. Probably the only main difference lies in the level and intensity. According to Tenywa and Amamure (pers. comm.), the major indigenous SWC practices in the semi arid areas of Teso, (which is largely a gently undulating plain with porous soils), include the following: fallowing; minimal weeding; selective agroforestry; grass bunds; bush and trash burning; dry planting; shifting kraals and the incorporation of organic matter when the trash rots. During a short survey to Katakwi district by Turton, Nakileza and Lwakuba (Nakileza, pers. comm.) a number of these practices were observed to be practised by farmers. However, these practices are not uniformly applied in this area due to the factors indicated above.

Recently, the use of cover crops in Teso as a method of SWC has been introduced to a few farmers for maize and cassava crops. This was introduced after a few farmers made a short visit to Iganga district. Pasture legumes are a popular cover crop. However, the practice is yet to spread widely to a number of other related areas.

In other semi arid areas, there are SWC practices used. For instance, in Nakasongola district some of these practices used in cultivated areas include fallowing, mixed cropping, agroforestry and minimal cultivation (Nakileza, pers. comm.). Recently in an attempt to combat desertification and with some assistance from UNDP and CCD, the pastoral communities in this district have been organised to adopt some conservation measures. Among others these include agroforestry and grass bunding.

A few indigenous SWC practices are used by farmers in Karamoja. These include agroforestry, stone bunds and the incorporation of crop residues in the field during cultivation. However, there is a decline or neglect in the use of these measures due to lack of motivation and sensitisation of the farmers about the benefits of SWC practices. Apart from this other farmers are discouraged to invest in some SWC practices (e.g. grass bunds) due to the disturbance from the free range grazing practice especially during the dry season when the cattle roam around in search of pastures (Nakileza, pers. comm.)

## **8. Constraints to Investment and Adoption of SWC**

The constraints on investment in SWC have socio-economic, political or environmental dimensions. These constraints also manifest at national, regional or household levels.

### **8.1 Policy Constraints at national and regional level**

These are outlined and discussed (Tukahirwa, 1992) below:

- Sectoral management of SWC. SWC cuts across a number of ministries and yet there is little collaboration amongst the various ministries and government departments (e.g. in formulation of uniform policies).
- Local administration often lacks the expertise to implement the SWC policies formulated by the district authorities or the department of Agriculture.
- The extension staff are not motivated to work effectively due to low pay.
- Lack of transport for the extension and agricultural officers to reach farmers.
- Interference of politicians with the activities of the extension workers.

#### ***8.1.2 Effect of Changes in Administration***

Uganda has witnessed quite a number of changes in the governing of the country. Quite often the changes in the political systems are followed by administrative re-organisation which results into significant changes in terms of management of its resources including the soils. Prior to the 1960 the colonial government had its own system of governance. After independence, the old system was rejected and a new system was embraced though some of the old administrative structures remained. In 1972, there was a coup leading to the reinstating of another government that changed a number of things including the management of natural resources. Following the 1979 political overthrow, a new system of governance came into force with different political organisation involving the ten house cells at the village level and the National consultative councils at the parliamentary level. This system was dropped after the 1980 and a multiparty one adopted but later overthrown in 1986, and substituted with the National Resistance Movement (NRM). The NRM system, which is still in force today, is based on the Resistance councils, now referred to as Local councils, organised from the grassroots (village level) up to the district level.

#### ***8.1.3 Effect of Land Tenure***

Land tenure is one of the socio-economic factors that has been and is believed to be a root cause of accelerated soil and land degradation (Kamugisha, 1993).

There are four land tenure systems in existence in Uganda viz:

##### **i. Leasehold tenure system**

This is not limited to any part of the country or an individual. The land user leases land from other or government (as in the case of public land) and pays rent for a certain period of time (49,60,99 years). This system has tended to favour the rich who have acquired big pieces of land at the expense of the poor and yet in most cases have not developed that land. In some circumstances, these leaseholders sublet some pieces of their land to tenants. However, due to the temporary nature of the tenancy the tenants rarely invest on the land in terms of SWC or even in controlling resource degradation in general by say planting trees. Even the terms and conditions of the lease do not adequately spell out aspects related to SWC. But even what is in the agreement is not closely

monitored and enforced. Under these conditions there is no adequate mechanism to control soil erosion on leased land.

## **ii. Communal land tenure system**

This system is common in northern, north eastern, Nakasongola and Mbarara. The land is owned communally and the individuals (tenants) are free to use the land but not own it. This system is associated with some major limitations. For instance the farmers (users) tend to exploit the land without developing it. Thus, the land suffers from what is referred to as ‘tragedy of the commons.’ This system is also threatened by the increasing human population. The users have no incentive to protect the land since it is not theirs. At the same time even if they wanted to use SWC practices, they have no exclusive rights to prevent the others from coming in to degrade the land.

## **iii. Customary systems**

This system is the most widespread in the country, and is regarded as the most secure one in terms of land acquisition. The land is owned without conditions and inherited by children or even sold by the owner as he/she wishes. The problem with this system is that the user has only usufructory rights. The real ownership remains with representatives of the community (e.g.. clan heads) who may have the ultimate authority to evict anyone. There is therefore no incentive to invest in SWC practices as tenure is not secure.

## **iv. Mailo System**

This is most common in central Uganda (Buganda). This system emanated from the Buganda Agreement in 1900 with the Colonial Government (British). About 49% of the land was given to the Kabaka or King of Buganda as freehold. The rest remained public land on which lived the squatters. The problem with this system was that there were many squatters who could not easily be evicted. Therefore, whereas the land lord had no ability to enforce SWC on encumbered land , the squatters did not have the incentive to make long term investments on the land for they knew it was not theirs and anytime they could be evicted.

The land tenure system in Uganda as described above is very complex and it affects the nature, character and quality of land resources, their user and conservation. As explained above each system has got some constraints to the promotion of land or soil resource conservation and improvement of soil productivity.

The Land Reform Decree of 1975 abolished the mailo, communal and customary tenures and converted these into Leaseholds vested in the state. Although the Decree was never enforced , it increased the insecurity of tenure and further eroded the motivation for investment in SWC practices. However, The Land Act of 1998 has restored security of tenure though it is yet to be implemented fully. Apart from recognising the traditional free hold systems and leases, customary ownership and communal ownership are also recognised. An individual, or a community does not have to go all the way to acquire a land title. A Certificate of Customary ownership can be issued to an owner of land held under traditional tenure. A certificate of occupancy can be issued, with the consent of the registered owner to a tenant. Indigenous communal associations can also obtain a Certificate of Ownership for the land they occupy. One can only hope that the new Land Act of 1998 will enhance occupiers perception of security of tenure to the point where they feel it is worthwhile to invest in SWC.

### ***8.1.4 Effect of Decentralisation***

In an effort to empower the local administrative units at grassroots level, the NRM government introduced Decentralisation in 1995 (Local Government Act, 1994). Decentralisation has also

affected SWC (Omoding, pers. comm.). The local councils have prioritised their interests; they may choose to lay emphasis in areas from which they stand to benefit more directly, or which are popular with the electorates. Since SWC is not frequently high on such agendas, it does not receive substantial budgetary allocations.

The government policy of retrenchment, combined with decentralisation, has had a negative effect, in the short run, on the delivery of extension services, including SWC. First to be retrenched were the field assistants, who were certificate holders, and from trade schools. These are the people who used to be on the ground, and could easily reach the farmers. This link was removed, thus thinning manpower on the ground. Some districts were reluctant to hire certain professions. Those that were foresighted, however, retained their full manpower, and they revive the activities as they get more funds. Generally, retrenchment in the face of persistent low morale of the remaining employees due to low pay and lack of facilitation has resulted in thinning of extension manpower available for SWC

### ***8.1.5 Administrative Obstacles to the Realisation of Soil Conservation in the Past***

According to Braun *et. al.*, (1997), soil conservation was widely practised in Uganda prior to 1972; during the Amin era, and it was enforced by the administration throughout the country. Protection of arable land was often good up to the late 1960s, and for many years soil conservation featured heavily in annual agricultural shield competitions.

However, after independence, the local administration, which used to enforce soil conservation bye-laws, was weakened, as were other systems in society. Following the collapse of administrative structures and destabilisation in rural areas that started in the early 1970s' soil conservation was practised only by a few progressive farmers.

According to Tukahirwa (1992), the way soil conservation policies were administered and enforced had flaws, which militated against spontaneous application of conservation practices, either in the absence of the bye-laws, or in the event that enforcement was relaxed as happened after independence.

One of the flaws was that nobody was specifically charged with soil conservation, even within the Department of Agriculture itself. Consequently, no professional interest and expertise was cultivated in the field of soil conservation. Expertise development was often tied to specific commodities like coffee and cotton. The development of specialists in soil conservation was simply ignored. Secondly, an effective system of incentives and sanctions and sensitisation/persuasion for soil conservation was lacking. Consequently, rural people regarded soil conservation bye-laws as simply oppressive interference of the colonialists. Stopping to obey "oppressive" colonial laws was one of the expected benefits of independence. So after independence the seemingly oppressive laws like those on soil conservation could not easily be replaced, through they remained largely on paper.

To many farmers, though they remained largely on paper. To many farmers, soil conservation activities represented extra demand on their labour and financial resources with no immediate visible benefits. Finally, because no interest was cultivated in soil conservation, coupled with lack of trained workers in the subject, when the laws were relaxed, extension staff simply left soil conservation alone and concentrated on other areas where they had expertise. Much as there is now more audible concern talk about soil degradation, the lack of interest and capacity seems to persist, as reflected by government budgets. There is a persistent absence of financial allocations for either soil conservation extension or soil science in general.

There are also legislative constraints to the adoption of SWC. Amongst these are the following:

### ***8.1.6 Effect of Segregative Soils Legislation***

Different legal strategies were adopted for the so-called 'non-African Lands' and the rest of Ugandans. In the case of the non-African Lands, there is an underlying assumption that the occupier of land appreciates or is capable of appreciating soil erosion as a major problem and only needs advice from the soil conservation committees as to how to prevent, or control it. The approach in the case of African occupiers of land is to lay down specific orders for the former to obey or face penal sanctions. The significance of the difference of approach is that in the case of non-Africans, the government would only have to 'advertise' the existence of the soil conservation committees and invite farmers to make use of them. In 'African areas/on the other hand, government agents 'advertised' the bye-laws and attendant penalties for non-compliance. Here the farmer is more likely to abide by law so long as there is continuous enforcement and supervision by government.<sup>12</sup> The tendency is to regard the measures as oppressive and unnecessary interference by chiefs and other government agents.

The dual-system of local administration (Chief and Local Committees) has also created confusion as to who has power both to make 'local law' and to enforce existing bye-laws. In some areas, LCs have made rules which they enforce, although such rules have not gone through the formal procedures of establishing bye-laws.

### ***8.1.7 Cattle Grazing***

There is total lack of substantive rules of law in the Cattle Grazing Act. The law is at a complete standstill until or unless the veterinary officers activate it. The seriousness of this approach can be appreciated if one takes into account widespread apathy among civil servants due to low pay, lack of transport for regular field visits and inadequate resources for data collection on the carrying capacity of various lands in Uganda.

### ***8.1.8 The Burning of Grass***

The decree prohibiting the burning of forest/bush does not prohibit the burning of grass. As mentioned above, the burning of vegetation in the dry season is part of land clearing for agricultural purposes. It is also to ensure that cattle, goats and sheep have rejuvenated pastures - in other words, grass is burnt as part of agricultural and livestock development. It is therefore, not prohibited by the Decree despite its role in soil degradation.

### ***8.1.9 Non-Communication of the Law***

Legal provisions impose the obligation to use and manage land in a manner that controls and/or prevents soil erosion on the individual occupiers of land. Therefore it would be appropriate to put in place a legal or policy requirement for communicating the law and its rationale to the people. However, no such requirements are in place. As a result, the law is not effectively enforced.

## **8.2 Socio economic factors affecting investment in SWC at household level**

### ***8.2.1 Favourable factors***

A number of factors have been documented as affecting investment in SWC at the household level. Their presence, or absence, may affect investment in SWC either positively or negatively. For example in Nyarurembo sub-parish in the Kabale highlands, Tukahirwa and Veit (1993) noted that good adoption was attributed to mainly four factors:

---

<sup>12</sup> For instance the Kabale District Soil Conservation bye-laws.

- (a) The district SWC bye-laws were legitimised and empowered local authorities to see to it that the practices were performed for the good of the community and the environment.
- (b) Farmers were educated, and they realised the need for soil and water conservation practices.
- (c) A good relationship was established between extension officers and farmers which facilitated the design of appropriate conservation strategies.
- (d) Farmers had a sense of security and confidence in land tenure.

In a case study to determine the factors influencing decision making in the use of trenches and mulch as soil conservation practices in two highland parishes in Mbarara district, Busingye (1998) found farmer awareness about the practices or technologies and their awareness of the effectiveness of the technologies in trapping the soil to be the two most widely given reasons for adoption of the practice.

Awareness was cited as the reason for adopting a SWC technique by 68% of farmers for mulching and 54% of farmers for trenches. Effectiveness to trap soil was cited as the reason behind adoption by 66% of farmers for mulching and 46% of farmers for trenches. Awareness and effectiveness to reap soil were followed by the following reasons: effectiveness of extension, or the extension effort, which was given by 26% of farmers for the mulching technique and 36% of farmers as a reason for digging trenches. Expectation of high yields were cited by 26% of farmers that used trenches, while 26% of farmers' said that they were practising mulching because it was a traditional technique.

Tumuhairwe *et. al.*, (1998) reported that the reasons for non-adoption of SWC technologies in Mbarara and Ntungamo districts were many and diverse, differing from locations to location and technology to technology. The main ones were lack of awareness, shortage and/or lack of inputs including mulch materials, seedlings for agroforestry technologies, labour and cash for digging trenches.

Tukahirwa (1992) asked the farmers the constraints to implementing policies on tree planting, erosion control and swamp and forest conservation. At national level, the reasons in declining order were too little land (42%), shortage of labour (21%), shortage of money (18%), and lack of extension advice (4%). Land fragmentation was last (3%). However, it was cited by 19% in Kabale and 5% in Mbale which are highland areas with high population.

Miiró (1997) found that 95% of the farmers in Kabale use terraces. This high figure for terraces is not surprising for Kabale given that the farmers had been forcefully made to construct them during the colonial period. Now a more useful indicator of the farmers' use of terraces to control erosion would be the tendency to maintain the terraces. He found that 63% had ever destroyed their terraces, the most frequent reason given being the search for fertile soil (28%).

Miiró (1997) also documented the soil conservation practices in the Kabale highland area. The first declining order of frequency of use was as follows: terraces, trenches, fallowing, tree planting, compost manure, mulching, grass strips, hedgerows, cover crops, contour cultivation, avoiding bush burning, soak pits, strip cropping, mixed cropping, cultivating across the bench, heaping of soil, crop rotation and mixing trash with soil. All of the above methods except terracing can also be used in the drylands.

A diagnostic survey in hilly banana growing areas of Uganda (Rubaihayo, 1991) indicated that in most villages farmers were aware of soil erosion control methods. However, control measures were not widely practised. Many farmers described themselves as negligent in soil conservation, partly because of time demands imposed by farm activities other soil conservation practices. Farmers were

also aware that following, crop rotation, and the addition of farmyard manure, mulches and compost help to maintain or regenerate soil productivity. However, many of them felt that they did not have enough land to practice fallowing and rotations. They also indicated that organic manures were in short supply and, even where the materials were available, labour for transporting and applying them was limiting.

Tumuhairwe *et. al.*, (1998), in a study in Mbarara and Rubare districts in south western Uganda identified the following factors as among the most important ones in influencing the adoption of SWC approaches.

**(a) Type of land use**

SWC practices were adopted almost exclusively in cultivated areas. None were practised on the grazing lands. The cattle keepers were very poor adopters of SWC measures.

**(b) Tradition**

Tradition seemed to play some role in the adoption of some conservation practices under particular land uses. For example, mulching in bananas and ploughing into the soil weeds during the land preparation in annual crop fields were practised regardless of the landscape type or the ethnicity of the farmers. The grazers were poorer adopters of introduced SWC practices than the traditional cultivators.

**(c) Farmers' perception of the severity of the erosion problem**

In one village, the people actively and extensively adopted trenches and band stabilisation because of the experience they had of a gigantic valley passing through their villages and numerous other small ones.

**(d) Example from fellow farmers**

Farmers seemed to prefer learning by example from fellow farmers. A successful practice by a fellow farmer served as a method and result demonstration, which gave the more cautious farmers confidence. Initially, many farmers did not adopt introduced SWC practices owing to ignorance or not being aware, or uncertainties. But they gradually adopted after seeing the early adopters in the neighbourhood reaping benefits of the technology especially in terms of increased banana crop yields. Learning by example was particularly important for introduced technologies like trenches, grass strips, improved mulch and galley management.

**(e) Presence of external assistance and extension effort**

This seemed to have favourable effects on the adoption of SWC. Adoption was higher where there was an active government extension project and where an externally funded NGO operated.

**(f) Market forces and perceived value of crop to farmer**

Market forces were found to be a powerful factor influencing the adoption of some SWC practices. This was particularly so for bananas, when the banana market improved. When bananas became a hot cash crop in south-western Uganda, farmers were encouraged to invest more in good banana management for increased yields and income. Consequently, SWC technologies like trenches, soak pits, retention and water harvesting from roads, and the traditional and improved mulching practices were adopted steadily. Some traditional cattle keepers have also settled down to cultivation as a result. They have also taken up settled livestock farming whereby the pastures are fenced and given proper management.

Rotational grazing practised hence overgrazing that would lead to soil erosion is controlled. This is in a bid to increase production (especially milk) for market unlike the traditional thinking of having large numbers for prestige.

**(g) Extent of decline in fertility**

Some traditional SWC practices like fallowing have continued in use, especially where the soil has become so unproductive that it has inevitably to be rested because no meaningful yield could be obtained from it.

**(h) Value of crop to farmer**

More care was taken where the crop was highly valued by farmers as the source of food, or as a source of cash.

**(i) Gender interests and household power distribution**

The Uganda community is a patrilineal one where normal households are headed and controlled by males. When men are interested in the crop, they can cause the allocation of family resources (including labour) to its proper maintenance. So husbands can instruct their wives to perform good husbandry practices including SWC on those crops. For bananas where men have a major interest for cash, they personally undertake the digging of the trenches, or directly supervise their construction as a SWC measure.

**(j) Availability of labour or money for SWC**

SWC requires some resources for investment. Resources are expended in anticipation of gains in the future. The resources may be in the form of family labour, or cash. Where both labour and cash were not readily available, only those SWC practices requiring minimal labour inputs could be attempted.

**(k) Incentives**

The incentives associated with the adoption of a SWC practice also influence the investment decisions of farmers in SWC and better land management practices. The incentives may be offered in the form of tangible assets like farm tools and equipment. Incentives may also not be tangible such as recognition, appreciation, and being offered study tours. Lwakuba (pers. comm.) attributes the apparently high adoption rate in the PFI project to a field trip. After a month, all the 14 farmers had adopted at least one of the practices they had seen during the field tour. However, he does not distinguish between a trial and adoption. Some farmers may backslide when the sweetener is no more. The problem with incentives of that type may be that the farmers may see them as payment for their efforts. When the incentives dry up farmers may also drop the practices. Much more powerful are result demonstrations from similar or worse off farmers.

### **8.2.2 Unfavourable factors:**

While the nature, extent and risk of soil degradation would be determined by the soils bio-physical nature, the way the land is used is a decision based on the prevailing socio-economic and political circumstances of the user. Adams (1992) indicated that social and cultural factors could cause people to forego economic gain and stick to unprofitable methods according to Tenywa *et al.*, (1998) farmers in Wera-katakwi were reported to prefer planting large grained crops (e.g., ground nuts, soya beans) on contour ridges rather than small grained crops like millet and sorghum.

The study of environmental and natural resource management policy and law in Uganda (Tukahirwa 1992) showed it was obvious that significant efforts to combat soil erosion to increase soil fertility are minimal. The data suggested strongly that most farmers, whilst professing to be concerned about declining fertility and food production are not doing much about it.

Miir0 (1997) found that for Kabale district in south western Uganda, 36% of the respondents indicated that maintaining terraces as a soil conservation measure was very tedious and required a lot of labour. This was the major constraint that discouraged farmers from maintaining the terraces.

Tumuhairwe *et. al.*, (1998) reported that the reasons for non-adoption of SWC technologies in Mbarara and Ntungamo districts were many and diverse, differing from location to location and technology to technology. The main ones were lack of awareness, land shortage and lack of inputs including mulch materials, seedlings for agroforestry technologies, and labour and cash for digging trenches.

A study of constraints to the adoption of fertiliser use found that in Pallisa the application of animal and plant manure was constrained by the heavy work involved. To a number of farmers in the country, soil conservation activities represented extra demands on labour without any visible immediate benefits (Pulkol, 1996).

### **8.3 Migrations and Decision Making in SWC**

Some of the cultures had some distinct indigenous methods of soil management. For example, the Bakiga, an immigrant group, traditionally practice rough tillage, whereby they simply plough the weeds and trash under the soil. This method of land preparation makes the land less vulnerable to erosion, and preserves more fertility. On the other hand, the Banyankole who are cultivators, and are an indigenous group, practise fine tillage. They prepare a fine seedbed, and remove all trash from it. This makes the soil very susceptible to erosion. As noted by Kabera (1985) there is little monitoring of the agricultural practices in these recently occupied areas.

However, when the two ethnicities inter-mixed, they influenced each other. The immigrant ethnicity of the Bakiga, which was a minority, came under social pressure to conform to the practices of the recipient community. Many of them subsequently dropped altogether or stopped practising regularly the practice of rough tillage. On the other hand, some of the recipient community also got influenced so that some individuals started practising rough tillage introduced by the immigrant Bakiga ethnicity (Kabera, 1985).

The study also showed that the perceived seriousness of a soil problem, and enforcement could cause farmers to adopt or drop particular SWC technologies. The Bakiga immigrant population had come from Kabale district where terracing is a widespread SWC practice. But on migrating, they dropped the practice. They did not continue practising it where they had migrated. It has been claimed that lack of education and mobilisation of farmers for voluntary adoption of the technology in Kabale, ensured that people dropped the practice as soon as enforcement was relaxed. However, it seems that the perception of land abundance in the new place played a big role in not bringing the practice to the new areas. The major reason for people migrating was land shortage. While in their home areas they knew that they could not move to a new piece of land when theirs got exhausted, or if they mismanaged theirs, because there was none to move to. So they had to look after it properly. Their home area being hilly made the soil very vulnerable to erosion. So they had to construct and maintain terraces. However, this was a tedious job. So when they migrated to areas where land was plentiful such that one could afford either to fallow, or to open up a new area, the need for investing in SWC in the form of terraces was no more. So terracing was not practised in the recipient areas, simply because they felt there was no shortage of land to warrant investment in costly SWC practices.

## **8.4 Factors affecting adoption of indigenous soil and water conservation (ISWC) methods**

Farmers' management strategies are conditioned by both the environment under which they operate and their own circumstances and resource endowments. According to Richards (1985, 1986), farmers respond to ecological, environmental and socio-economic changes by flexible and dynamic management strategies. This equally applies to indigenous soil and water conservation (ISWC) practices (Tengbeg *et al.*, 1998). Most are characterised by their multiple functions, spread of labour demands and gender roles (Reij *et al.*, 1996). Some have been shown to be more economically viable than introduced technologies (Kiome and Stocking, 1993). Tenberg (1998) postulated that understanding of these functions of ISWC is a prerequisite to any external intervention to promote agricultural sustainability and minimise environmental impact of land use.

Different farmers adopt different strategies according to their socio-economic circumstances and resource endowments. There are also farmer-specific sets of practices.

In south western Uganda among the cultivators, Tumuhairwe *et al.*, (1998) found ISWC practices to include rough tillage and blocking gullies with stones and crop residues like banana stems. The banks of a permanent stream that passes through gardens were protected by planting on it crops with tough fibrous root systems known to be effective in holding the soil together. Such crops included sugar canes, coco-yams and bananas (for beer brewing). Such ISWC measures were not present in the grazing areas. In the grazing areas, Euphorbia trees were planted around species around homesteads and kraals for protection against winds and livestock encroachment on crop fields.

In summary, the investment in SWC is constrained by various factors including socio-economic and political factors that operate at national, regional or household level. Whatever the dimension these factors need to be addressed when making decisions regarding intervention approaches to SWC. There is also much talk about soil degradation but the interest, financial resources and capacity is lacking as reflected in the national budgets. The discussions show that there have been inadequate policies and laws since colonial time. Most of the policies related to SWC were regarded as oppressive and discriminatory hence were dropped soon after independence in 1962. The consequences have been disastrous.

The present dual local administration system (composed of chiefs and LCs) has generated some conflict concerning the enacting and enforcement of the bye-laws. In certain cases the laws are clearly laid down but enforcement is lacking/inadequate.

The discussions have also revealed that the decisions to investment in SWC, at household level, are affected by many factors e.g. awareness, resource availability, type of land use, relationship of a farmer with extension staff, prevailing, market forces and perceived value of crop to farmers.

The adoption or non-adoption of SWC by the immigrants is governed by a number of factors such as tradition, amount of land in the new area and previous knowledge and experience in SWC problems in their old farming areas.

## 9. Conclusion

### 9.1 Major findings

Uganda is a country with a rich bio-physical and social diversity. There are varied topographic, climatic, vegetation and soils conditions. The population is also diverse in terms of tribal groups and cultures. A number of political changes have been witnessed in the last two and a half decades leading among others to mismanagement of the resources in many areas including the semi-arid environment.

There is general lack of data on characteristics of semi-arid areas that have been neglected when compared with the more favoured areas of high production potential. However, the available general information indicates that characteristically the Semi Arid environments are areas of unpredictable, low and erratic rainfall, and relatively high temperatures throughout the year. They have a low human population density if only the land area is considered and not the ecological limitations. These areas can also be described as areas of great difficulty in view of frequent scarcity of water resources, which often prompts migration to other areas for survival. The economies of semi arid areas are greatly dependent on pastoral activities though crop farming is on the increase. The main crops grown include cereals (e.g.. sorghum, millet) and cassava. Despite the difficulties observed there has been and there is still much neglect of these areas by the government in terms of development. The infrastructure is poorly developed thus adding on to further isolation.

In general, agriculture and environmental research in Uganda has been and is donor driven and this trend is unlikely to change in the near future. As shown by the available literature over 70% of the research has been focused in the high potential crop areas. There is especially lack of research on soil and its management in the semi arid lands.

There is also almost total lack of economic analysis of SWC in the literature - both in terms of costs and opportunity costs, and impact of SWC on livelihoods, and also in terms of its attractiveness as an investment option and returns to investment.

The semi arid lands have not received much attention in terms of socio-economic development and yet they support an increasing human population and also constitute an important resource for the supply of national livestock products (meat, hides and skins). There is thus need to help them to improve upon their food security and in issues related to poverty alleviation considering the unpredictable climatic conditions, poor infrastructure and limited financial base to support research.

There are a number of factors affecting the farming systems and most particularly in the use of appropriate practices. The adoption or non-adoption of SWC practices by farmers is governed by many factors, which prevail and operate at various levels (i.e. national, regional and household). These factors include policies, legislation, education, funds, extension services, type of farming system, available labour etc. More specifically in relation to factors favouring SWC there are lists of factors but they are considered in isolation from each other. It is the interaction of the effect of these factors on household decisions where the real information gap exists. This will explain the inter- household differences in both how households perceive and prioritise degradation/erosion and the SWC approaches they choose to adopt. Factors that are important for Uganda include: land tenure; migration into areas; selective migration of household members; availability of markets/ infrastructure and access to credit/ extension / knowledge.

Most of the people in these areas are poor (earning below US \$ 3 per month) as revealed by the World Bank report of 1994. Thus any intervention for improved crop and livestock yields (e.g.. through SWC management) should consider the existing socio-economic constraints of cost and impact on other household/farm activities among others.

The extension services are still relatively poor as in other parts of the country. There is a perceptible changing trend in research towards on-farm other than experimental on-station and more use of participatory methods. These methods encourage working in partnership with the farmers in identifying and developing possible solutions together by using scientific knowledge and interpersonal skills. Greater emphasis is also being placed on further research and use of indigenous SWC practices. Considering a greater scarcity of available financial resources to finance research and other developments in SWC it is likely that foreign assistance will continue to be sought in the future.

In view of widespread resource mismanagement in Uganda, a number of attempts have been made in setting up the necessary institutions, policies and legislation. However, the institutions still lack co-ordination/co-operation in the management of common resources, causing conflicts and overlaps. Generally, the policies (especially as regards SWC) are not only inadequate but the implementation is lacking. However, people need to be further sensitised about the dangers of not managing their resources in a more plausible manner. This will require building the capacity to address such issues at lower local levels while taking into account the existing and potential constraints.

During the presentation and discussions of the major issues arising from the literature review, at a seminar in Makerere University, the participants (mainly researchers) were in unison that:

- Decentralisation is a key issue and adds further complexity to the debate over who is responsible for environment and SWC.
- Decentralisation does allow development of more site specific approaches but there is a need for strong support and broad directions from the centre.
- The needs and priorities of donors have driven much of the work on SWC and that this limits the ability to adopt a strategic and holistic approach to SWC.
- There is lack of socio-economic /or economic analyses on SWC. There is need to develop appropriate economic analysis just because the western methodologies may not be appropriate.
- A large quantity of research materials relating to SWC is available but the key issue is how to collate it. One other problem related to this is general lack of outlet or dissemination channels.
- The role of women in SWC is very crucial since they are the ones largely responsible for many conservation activities on the farm.
- Semi arid areas are located on the periphery, which exacerbates the problem of research and extension neglect.

## **9.2 Status of semi-arid areas**

The semi-arid areas in Uganda were traditionally principally cattle grazing areas, where the inhabitants practised pastoralism of varying intensity depending on the culture under communal land tenure. The communities had preferential grazing rights over specific areas where animals were always on the move in search of pasture and water. Stocking rates were not based on carrying capacity. Rather, everybody had to strive to own as many animals as they could acquire, because numbers were a source of social prestige. This frequently resulted in overgrazing. Pastures were exploited without any maintenance. But although in those areas land tenure is increasingly becoming more and more individualistic, it is not socially acceptable to exclude others from any part of the grazing lands. This is a constraint to SWC, because the owner of the land cannot control the number of animals on his land nor manage the grazing for sustainability of the pasture.

However, this is beginning to change where the *de facto* and *de jure* tenure systems are being harmonised such that owners can exercise exclusive rights over their land. This is established in parts of south - western Uganda, particularly in Bushenyi, and to a lesser extent, Mbarara and Ntungamo districts.

Apart from the changes in the land tenure, the rising population density and in-migration are critical in the semi – arid areas. As population increases more land is being cultivated, such that even the marginal areas which are traditionally grazing lands are being colonised. Even where open grazing lands still exist, they may not be accessible any more because the areas where the cattle used to pass have been cultivated. Consequently, pastoralists' are being 'forced' to settle, and manage their pastures properly. The values and attitudes of the communities are also changing. Emphasis is being shifted from cattle numbers to quality. So some cattle keepers are going in for fewer but high yielding animals on well managed pastures. These developments may have got important implications on the investment and adoption of SWC practices that needs to be investigated. The approach and strategy to these previously uncultivated areas with limited indigenous use of SWC technologies may differ from that in the high crop potential areas.

The perceptions of the public and farmers regarding the causes and status of resource degradation in semi-arid areas are varied. However, SWC in the semi-arid areas has been driven by two concerns that is control of overgrazing and burning. This dominates legislation. Unfortunately these SWC policies/legislation have been largely developed basing on findings from the humid areas.

## References

- Abdi Noor (1995) *Strengthening National Agricultural Systems in Eastern and Central Africa - framework for action*. World Bank Technical Paper No. 290. Washington D.C.: World Bank.
- Adams, M.E., (1988) *Agricultural Extension in Developing Countries*. London, UK: Longman.
- Ahn, P.M., (1977) 'Erosion hazard and farming systems in Eastern Africa.' In: Greenland, D. J. and Lal. R., (eds.). *Soil Conservation and Management in the humid tropics*. Chichester, U.K: John Wiley and Sons. p. 165-176
- Anonymous, (1973) *Geochemical Atlas of Uganda*. Geological Survey and Mines Department, Entebbe, Uganda Edition 1. pp 7.
- Anonymous, (1973) Fertiliser recommendations for some of the major crops in Uganda. Uganda: Information and Visual Aids Centre, Ministry of Agriculture.
- Anonymous, (1987) Strengthening Agricultural Research in Uganda Agricultural Task Force-Group 4 (Agricultural Research) Kampala, Uganda.
- Atta-Krah, K. and Wakhu, P., (1996) Agroforestry research Network for Africa - Eastern and Central Africa: annual report 1995 and research plans, 1996. Nairobi: ICRAF.
- Bagoora F.K., (1988) Soil erosion and Mass wasting risk in the highland areas of Uganda. *Mountain Research and Development*, 8: 173 - 182.
- Bagoora. F.K., (1989) A preliminary investigation into the consequences of inadequate conservation policies on the steep slopes of the Rukiga Highlands, South-western Uganda. In: Thomas, D.B., Biamah, E.K., Kilewe, A.M., Lungren, L. and Mochoge, B.O., *Soil and Water Conservation in Kenya*. Proceedings of the 3<sup>rd</sup> National workshop, 16-19 Sept. 1986, Nairobi: University Press, p. 496-508.
- Braun, A.R., Smaling, E.M.A., Muchugu, E.L., Shepherd, K.D. and Corbett, J.D., (eds.) (1997). Maintenance and improvement of soil productivity in the highlands of Ethiopia, Kenya, Madagascar and Uganda. An inventory of spatial and non-spatial survey and research data on natural resources and land productivity. AHI Technical Report Series No. 6. African Highland Initiative.
- Biteete T. M., (1996) 'Status and trends in soil and water conservation in Uganda.' In: Tenywa, M.M. and Bekunda, M.A. (eds) *Past, present and prospects of soil and water conservation in Uganda*. Proceedings of the Soil and Water Conservation Society (SWCS) Workshop, on 28th March 1996. Uganda: (SWCS).
- Busingye, P., (1988) Factors influencing decision making in the use of trenches and mulch. A case of Ngoma and Rukarabo Parishes of Mwizi Sub-county. Makerere University, Kampala: Department of Soil Science. MSc Thesis.

Bwamiki, D.P., (1995) Effect of coffee husks application methods on oil fertility and banana production. Makerere University, Kampala: Department of Soil Science. MSc Thesis.

Chenery, E.M., (1954a) Acid sulphate soils in Central Africa. *Transactions of the 5th International Congress on Soil Science*, 4: 45 - 198.

Chenery, E.M., (1960) Introduction to the soils of the Uganda Protectorate. Memoirs of the Research Division, series 1-soils No. 1. Uganda: Department of Agriculture.

Ollier, C.D., and Harrop, J.F., (1959) The soils of the Eastern Province of Uganda. Memoirs of the Research Division, Series 1- Soils, No. 2. Uganda: Department of Agriculture.

COWI Consult, 1988) Agro-climatic zones of Uganda. Coffee Farming systems development project. Final Draft Report prepared for the Republic of Uganda, Ministry of Agriculture/ European Development Fund.

Djimde M. and Hoekstra, D., (1988) Agroforestry potentials for the land use systems in the bimodal highlands of eastern Africa, Uganda. AFRENA No. 2. Nairobi. ICRAF.

Dramadri B.Z. (1996) 'An evaluation of policy, legislation, by Laws on soil and water conservation in Uganda'. In: Tenywa M.M., and Bekunda M.A., (eds.) *Past, present and Prospects of Soil and Water Conservation in Uganda*, Proceedings of the SWCS Workshop, on 28th March 1996.

Edwards, K.A and Blackie, J.R. (1981) 'Results of the Eastern African catchment experiments 1958 - 1974.' In: Lal, R. and Russell, E.W, (eds.), *Tropical Agriculture Hydrology: Watershed management and land use*. Chichester: John Wiley and Sons. p 163-188.

FAO, (1978) Report on the agroecological zones. Methodology and results for Africa. World Resources Report , (48) Italy: Rome, 158 pp.

FAO/ UNEP (1992) A suggested national soils policy for Uganda. FAO/UNEP Advisory services to Syria and Uganda on the formulation of National soils policies.

Foster, H.L., (1971) 'Crop yields after different elephant grass ley treatments at Kawanda Research Station, Uganda.' *East Africa Agricultural and Forestry Journal*, 37: 63-72.

Foster, H.L., (1970a) 'Liming continuously cultivated soils in Uganda.' *East African Agriculture and Forestry Journal*, 36: 58-69.

Foster, H.L., (1973) 'Fertiliser recommendation for cereals grown on soils derived from volcanic rocks in Uganda.' *East African Agricultural and Forestry Journal*, 38: 303-33.

Foster, H.L., (1979) 'Yields and responses to lime and potassium fertilizers in different cropping years in Uganda.' *Experimental Agriculture*, 15: 193 - 20.

GOU, (1967) The Atlas of Uganda. Departments of Lands and Survey, Entebbe.

GOU (1994) The National Environment Management Policy. Ministry of Natural Resources.

Harrop, J.F. (1960) The soils of the Western Provinces of Uganda. Memoirs of the Research Division, Series 1-Soils, No. 6., Department of Agriculture, Uganda.

Hutchinson, Manning, H.L. and Farbrother, H.G., (1958) 'On the characterisation of tropical rainstorms in relation to runoff and Percolation.' *Quarterly Journal of Royal Meteorological Society*, 84: 250-258.

International Development Research Centre (IDRC), (1982) Agricultural Research in Uganda: A programme for Rehabilitation. Ottawa, IDRC.

Jameson, J.D. and Kerham, R.K., (1960) 'The maintenance of soil fertility in Uganda. Soil fertility at Serere.' *Empire Journal of Experimental Agriculture* 28: 179 - 192.

Jameson, J. D. and McCallum, D., (1970) 'Agriculture in Uganda.' In Jameson, J.D., (ed.), *Agriculture in Uganda*. Oxford: Oxford University Press. p 12-13.

Johnston, D.T. and Ssekitoleko, G.W., (1989) Current and proposed farming systems in Uganda. F.M.E Report 1/89. Farm management and economic research section, planning division ministry of Agriculture, Entebbe.

Jones E., (1968) Nutrient cycle and soil fertility on red ferrallitic soils. In: *Transactions of the 9th Congress of the International Soil Society*, Vol. 3 p. 419 - 427.

Kabera, J. B., (1985) Populating Uganda's Dry Lands In: Clarke J. I., Mustafa Khogali and L. A., Kosinki (eds). *Population and development projects in Africa*.

Kamugisha J.R., (1993) Management of natural resources and the environment in Uganda, policy and Legislation landmarks, 1890-1990. SIDA/ RSCU.

Keefer, R.F. and Singh, R.N., (1997) Assessing soil degradation with emphasis on soil productivity in the Ajeni area. In: Natural Resource Management for Conservation and Development. Proceedings of the 2nd Natural Resource Conservation Conference, 10th - 13th May 1990, Ethiopia. Addis Ababa: IAR. p. 78-91.

Kiome, R. and Stocking, M., (1993) Soil and Water Conservation in semi-arid Kenya. *Natural Resource Institute Bulletin 61*, Chatham, pp 59.

Kisakye, J., (1992) Farmers' attitudes to soil erosion and its control in Rubanda County, Kabale District, Uganda. Kampala: CARE International

Lal R., (1984) *Soil Conservation and Management in the Humid Tropics*, Chichester, U.K.: John Wiley and Sons. pp. 165.176.

Lal, R and Russell, E.W., (eds). (1984) *Tropical agriculture hydrology: watershed management and land use*. Chichester, U.K.: John Wiley and Sons P. 163 - 188.

Langdale-Brown,I., Osmaston. H.A and Wilson.J.G., (1963) The Vegetation of Uganda and its bearing on land use. Kampala: Government of Uganda.

Langlands, B.W. (1974) *The Geography of Uganda; Gospels*. Kampala: Geography Dept., Makerere University.

Lundgren, L. and Mochoge, B.O., (eds.), (1986) *Soil and Water Conservation in Kenya. Proceedings of the 3rd National Workshop, 16-19 September 1986, Nairobi*. University of Nairobi. pp. 496 -508.

MAAIF (1993) *Uganda National study in support of the Inter-governmental Negotiating Committee on Drought and Desertification (IGAD)*.

Manning, H.L. and Griffin, G.A.P., (1949) *Fertiliser studies on Uganda soils*. *East African Agriculture and Forestry Journal* 15: 87-97.

Martin, W.S. and Biggs, C.E.J., (1937) 'Experiments with maintenance of soil fertility in Uganda.' *East African Agricultural Journal*, 2: 371-378.

McWalter, A.R., and Wimble, R.H., (1976) 'A long-term rotational and Manorial trial in Uganda.' *Experimental Agriculture* 12: 305-317.

MFEP, (1992) *Population and Housing Census*, Ministry of Finance and Economic Planning, Uganda.

Mills, W.R., (1953) 'Recent fertiliser trials in Uganda.' *East African Agricultural Journal*, 19: 40-42.

Mills, W.R., (1954) 'A review of recent trials with fertilisers in Uganda.' In: *Proceedings of 2nd Inter-African Soil Conference* Vol. 2 pp. 1132 - 1142.

Mills, W.R., (1960) *The long-term rotation and manorial trial at Serere, Uganda: The relationship between twenty years of crop yields and soil fertility*. East African Specialist Committee on soil fertility, Kawanda Conference Paper, Muguga, Kenya, KARI.

Miir, R., (1997) *Factors that affect the sustainability of terraces in Kabale District*. M.Sc. Thesis. Makerere University, Kampala.

Milne, G., (1935a) 'Complex unit for the mapping of complex soil associations.' *Transactions of the 3<sup>rd</sup> International Congress of Soil Science* 1: 345-345

Milne, G., (1935b) 'Some suggested Units for classification and mapping particularly for East Africa soils.' *Soil Research*, 4: 183-198.

Moore, R.R., (1979) *Rainfall Erosivity in East Africa: Kenya, Tanzania, Uganda*. *Geografiska Annaler. Series A. Physical Geography*, 61: 147-156.

NEAP, (1993) *Land Management: Agriculture, Livestock and Rangelands*. Topic Paper. Vol III. B.

Ngambeki, D.S, Nsubuga, E.N.B., Adupa, L., Kitale, C. and Munyambonera, E.F., (1992) Coffee based farming systems baseline survey in Uganda. Farming systems support programme, Ministry of Agriculture, Animal Industry and Fisheries.

Nielsen, F., Guiand, Y., Okorio, J., (1995) Farmer Participatory Diagnostic Incomplete Research: Lakeshore Banana-Coffee Land Use Systems of Uganda. Nairobi, Kenya: AFRENA-ECA, ICRAF.

Nsubuga, E.N.B., (1994) A critical review of the farmers response to soil conservation policies in Uganda. The proceedings of the soil 14th Conference of the Soil Science Society of East Africa (SSSEA). Mbarara, Uganda.

Ollier,C.D and Harrop, (1959) The soils of the Northern province of Uganda (excluding Karamoja district). Memoirs of the Research Division, Series 1 - Soils, No. 3. Uganda: Department of Agriculture.

Ollier,C.D., and Harrop, (1959) The Soils of the Eastern province of Uganda. Memoirs of the Research Division, Series 2 - Soils, No. 3. Uganda: Department of Agriculture.

Parsons, D.J. (1970) 'Agricultural systems.' In: Jameson, J.D., (1970) *Agriculture in Uganda*. Oxford: Oxford University Press, 2nd Edition.

Parsons, D.J. (1960) The systems of agriculture practices in Uganda, Memoirs Resources Division Sep. Agriculture, Uganda series 3

Memoir No. 1 Introduction and Teso systems

Memoir No. 2 the plantain-Robusta Coffee systems with a note on the plantain-millet cotton areas

Memoir No 3 the northern systems

Memoir No. 4 the Mountain systems

Memoir No 5 the Pastoral system

Radwanski, S.A., (1960) The Soils and land use of Buganda. Memoirs of the Research Division, Series 1- Soils no. 4. Uganda: Department of Agriculture.

Reij, C., Scoones, I. and Toulmin, C., (1996) *Sustaining the soil: Indigenous soil and water conservation in Africa*. London: Earthscan, pp 260.

Republic of Uganda, (1991) The Population Census (district summaries). Stastical Department, Ministry of Finance and Economic Planning, Entebbe.

Republic of Uganda, (1994) State of the Environment Report for Uganda. Ministry of Natural Resources. National Environment Information Centre.

Republic of Uganda, (1995) State of the Environment Report for Uganda. Ministry of Natural Resources. National Environment Information Centre.

Republic of Uganda, (1996) State of the Environment Report for Uganda. Ministry of Natural Resources. National Environment Information Centre.

Richards, P., (1985) *Indigenous agricultural revolution: Ecology and Food Production in West Africa*. London: Hutchinson, pp 192. Ph.D. (1962 b).

Rubaihayo, P.R., (1991) Banana - based cropping systems. A report on a Rapid Rural Appraisal survey of banana production. Research Bulletin 2. Kampala, Uganda: Banana programme, Kawanda Agricultural Research Institute, NARO.

Sanchez, P.A., Palm, C.A., Szott, L.T., Cuevas, E., and Lal, R., (1989) 'Organic input management in tropical agroecosystems.' In Coleman D.C., Oades, J.M., and Vehara, G., (eds.) *Dynamics of soil organic matter in tropical ecosystems*. Niftal Project, Paia Hawaii, USA, pp. 125 - 152.

Sperow, C. and Keffer, R.F., (1975) *An Introduction to Soil Science Applied to East Africa*. West Virginia University

Stephens, D. (1970) Soil fertility. In: Jameson, J.D. (Ed.), *Agriculture in Uganda*. Oxford: Oxford University Press.

Stephens, D., (1969) 'The effects of fertilizers, manure and trace elements in continuous cropping rotations in South-western Uganda.' *East African Agriculture and Forestry Journal*, 34: 401 - 417.

Stephens, D., (1967a) 'The effects of different nitrogen treatments and potash, lime and trace elements on cotton Buganda clay loam soil.' *East African Agriculture and Forestry Journal*, 32: 320 - 325.

Stephens D., (1967c) 'Effects of grass fallow treatments in restoring soil fertility of Buganda clay loam in South Uganda.' *Journal for Agricultural Sciences*, 68: 391 - 403.

Tengberg, A., Ellis-Jones, J., Kiome, R., Stocking, M., (1998) Agro-diversity - Applying the concept of indigenous soil and Water Conservation practices in eastern Kenya. Modern methods from traditional soil and water conservation technologies. Proceedings of a DFID Land Management Workshop. January 13-15th, 1998. White Horse Inn, Kabale, Uganda.

Tukahirwa, S.M. and Veit, P., (1991) *Public Policy and Legislation in Environmental Management. Terracing in Nyarurembo, Uganda*.

Tukahirwa, E.M., (ed.) (1992) *Environment and natural resource management Policy and Law. Issues and options*.

Tukahirwa, J.M.B., (1995) *Measurement, prediction and social ecology of soil erosion in Kabale, South-western Uganda*. PhD Thesis Institute of Environment and Natural Resources. Makerere University.

Tumuhairwe, J.K., Nsubuga, E.N.B., Kahembwe, F., (1998) *Acceptance and Impact on soil and biodiversity conservation approaches in South-western Uganda*. A draft report in production of the Ugandan subcluster of the EAPLEC project to the United Nations University. Makerere University.

Walton, P.D., (1962a) 'The effect of ridging on the cotton crop in the Eastern Province of Uganda.' *African Crop Science Journal*, 2: 179-182.

Walton, P.D., (1962b) 'Estimates of the water use by cotton crops at Serere, Uganda.' *Empirical Cotton Growers Review*, 39, 241 - 51.

Wilson, J.G., (1959) The soils of Karamoja District, Northern Province of Uganda. Memoirs of the Research Division Series 1 - Soils, No. 5 Uganda: Department of agriculture.

Weijenberg, J., Dagga, M., Kampen, J. Kalunda, M. Mailu, A.W Seyfu Kelema, Navarro., Land Mohamood Stoorvogel, J.J., Smaling, E.M.A., and Jansen, B.H., (1993) 'Calculating soil nutrient balances in Africa at different scales: 1 Supra-natural scale.' *Fertilizer Research*, 35: 227 - 235.

Wortmann, C.S., Karamura, E.B., and Gold, C.S., (1994) 'Nutrient flows from harvested banana pseudostems.' *African Crop Science Journal*, 2: 179-182.

Yorst, D. and Eswaran, H., (1990) Major land resources areas of Uganda. Washington, D.C: Soil management support services, USAID.

Zake, J.Y., (1992) Issues arising from the decline of soil conservation: the Uganda example. In: Tato, K., Hurni, *Soil Conservation for Survival*. Soil and Water Conservation Society. pp 59-64.

Zake, F.Y.K., Nsubuga, E.N.B., Nkwiine, C., (1992) Field survey of soil and water resources in Uganda. A research report submitted to the UN University Programme on Natural Resources in Africa.

## Appendix A

### A.1 The Agro-climatic Zones of Uganda

ZONE	AREA	AGRICULTURAL SYSTEM
I	Busoga/Bukedi	Banana, millet and cotton system with outliners of the main coffee-banana system.
II	Bugishu/Sebei	Montane systems: Arabica coffee, banana (wheat and maize in Sebei)
III	Teso	Teso system: Fingers millet, cotton and cattle keeping (Mixed agriculture)
IV	Karamoja	Pastoral system-cattle keeping
V	Lango/Acholi	Northern systems: Finger millet, cotton tobacco (some mixed agriculture also)
VI	West Nile/Madi	West Nile System: Basing agriculture like Zone V, but with predominance of cassava as staple food.
VII	Bunyoro/Toro	Arabica and robusta coffee and banana system, montane systems: heterogeneous agriculture but basically bananas, coffee and tea.
VIII	Ankole	Montane systems in the west, Pastoral to the east. Arabica and Robusta coffee, tea bananas and cattle.
IX	Kigezi	Montane system but with larger annual crop acrege than other montane system systems. Sorghum is a major staple, Arabica coffee and tea
X	L. Victoria crescent	Main robusta coffee and banana system robusta coffee, bananas, tea, cocoa, and sugar.
XI	Northern Buganda	Western Extension of the banana-millet, cotton system, but now larger taken up by big ranching projects

*Source: Annex 4-Table1: Agro-climatic zones of Uganda in COWI Consult, 1988 Coffee farming systems Development Project. Final Draft Report. Prepared for the Republic of Uganda. Ministry of Agriculture/European Development Fund.*

## A.2 Current farming systems in Uganda and their environmental impacts

<b>AGRICULTURAL SYSTEM</b>	<b>AREAS</b>	<b>ENVIRONMENTAL IMPACTS</b>
I. INTENSIVE BANANA-COFFEE SYSTEM.	(south Mukono Rakai, east Masaka, Mpigi, southern Mubende, south Luwero, Ssese Islands, Kampala /Entebbe, most of Jinja and Iganga districts.	Soil degradation in unprotected areas
II. WESTERN BANANA-COFFEE-CATTLE SYSTEM	(most parts of Mbarara and Kabarole, Bushenyi, Rukungiri)	Shorter or even absent fallow periods. Intensive grazing in sparsely populated parts Soil degradation on overgrazed hilly areas and around watering
III. FOREST SAVANNA MOSAIC BANANA-COFFEE SYSTEM	(north Mukono, Kamuli, south Luwero, most of Bunyoro, central Mubende, north Kabarole)	Much arable land available for cultivation Some soil erosion and compaction in limited area due to overgrazing
IV. MEDIUM ALTITUDE COFFEE SYSTEM	(parts of Bukonjo and Bwamba counties, slopes of Mt. Elgon and Kapchorwa, Rukiga county of Kigezi, Okoro county in West Nile.)	Soil erosion and degradation has reached alarming proportions on steep slopes due to poor cultivation techniques; Land highly fragmented due to customary land tenure and high population density.
V. KIGEZI ANNUAL FOOD COUP MONTANE SYSTEM	(northern slopes of Mufumbira Mts. Altitude above 1800m of Kigezi)	Tremendous land shortages; Serious land fragmentation; Livestock herded and grazed on marginal hillsides, road and valley bottoms.  Serious decline in soil fertility as a result; Evidence of silting of streams and small lakes.
VI. THE NORTHERN AND EASTERN CEREAS COTTON-CATTLE SYSTEM	Gulu, Apac, Lira Karamoja, Kitigum, Kumu, Soroti, Tororo, Pallisa, parts of Mbale	Fallow period becoming shorter or have been abandoned altogether in some parts where population density is high; Generally low soil fertility; Excessive communal grazing is a common practice; Soil erosion by water and wind serious in densely populated areas;  Siltation of rivers beginning to appear
VII. THE WEST NILE CEREAL-CASSAVA-TOBACCO SYSTEM	Arua and most parts of Nebbi	Excessive grazing on communal land

TOBACCO SYSTEM		
----------------	--	--

*Source: Adapted from NEAP Secretariat. Draft Topic on Land Management: Agriculture.*

#### A.4 Soil surveys in Uganda at reconnaissance and detailed level

<b>Title/area</b>	<b>Year</b>	<b>Scale</b>
Soil map of Uganda (Atlas of Uganda)	1962	1:1 500 000
Soil map of Uganda (5 sheets, black and white)	1960	1:500 000
Colour soil map of Uganda, sheet Arua	1961	1:250 000
Colour soil map of Uganda, sheet Kitgum	1959	1:250 000
Colour soil map of Uganda, sheet Kaagong	1959	1:250 000
Colour soil map of Uganda, sheet Pakwach	1961	1:250 000
Colour soil map of Uganda, sheet Gulu	1959	1:250 000
Colour soil map of Uganda, sheet Aloii	1960	1:250 000
Colour soil map of Uganda, sheet Moroto	1960	1:250 000
Colour soil map of Uganda, sheet Hoima	1965	1:250 000
Colour soil map of Uganda, sheet Masindi	1968	1:250 000
Colour soil map of Uganda, sheet Mbale	1970	1:250 000
Colour soil map of Uganda, sheet Kapenguria	1961	1:250 000
Colour soil map of Uganda, sheet Fort Portal	1965	1:250 000
Colour soil map of Uganda, sheet Kampala	1961	1:250 000
Colour soil map of Uganda, sheet Jinja	1971	1:250 000
Colour soil map of Uganda, sheet Mbarara	1961	1:250 000
Colour soil map of Uganda, sheet Masaka	1960	1:250 000
Colour soil map of Uganda, sheet Kabale	1960	12:500
Kawanda Agricultural Research Institute	1973/1988	12:500
Serere Agricultural Research Institute	1971	12:500
Namulonge Agricultural Research Institute	1975/1988	12:500
Kabanyolo (MUARIK)	1988	12:500
Mityana D.F.I	1975	12:500
Kamenyanmiggo D.F.I	1975	12:500
Mukono D.F.I	1976	12:500
Kiige Citrus Plantation	1976	12:500
Bukalasa	1977	12:500
Mpigi D.F.I	1978	12:500
Kisindi (Uganda Seed Project Farm)	1985	12:500
Mubuku Grain Legume Project Farm	1990	12:500
Kalegyere Highlands Centre	1992	12:500
Kachwekano D.F.I	1992	12:500

#### A.4 The Central E semi-arid Corridor (Zone A)

DOMA IN NO.	AREA NAME	DISTRI CT	COUN TY	SUB- COUNTIES	TOPOGRAPHY	VEGETATI ON	SOILS	FARMI NG POP PER SQ KM AGRIC LAND	GRAZIN G LAND PER HH (ha)	TOTA L RAINF ALL MEAN (mm)	FARMIN G SYSTEM MODE OF LIVING
8C	ANKO LE- MBUR O	Mbarara	Isingiro	Birere	Very greatly rolling plains at 1,200 - 1,500m 1,400 - 1,700 m in the SW. Hilltops between 1,300 on the Masaka border, rising 1500 - 1700 m in the SW	Acacia - Savannah, most of the west is dry rolling grass-land and thorn scrub	Loams and Sandy loams. <b>Low erosion hazard</b>	62	11.6	865	The West is cultivated (bananas), the west is for ranching
			Bukanga	Kashurumba, Rugaaga, Nyakitanda							
			Nyabushozi	Kensunga, Nyakasharara, Kashongi, L. Mburo							
		Rakai	Kabula	Mpumudde, Kasagama, Lyantonde, Kaliiro							

DO MA IN NO.	AREA NAME	DISTRI CT	COUN TY	SUB- COUNTIES	TOPOGRAPHY	VEGETATI ON	SOILS	FARMI NG POP PER SQ KM AGRIC LAND	GRAZIN G LAND PER HH (ha)	TOTA L RAINF ALL MEAN (mm)	FARMIN G SYSTEM MODE OF LIVING
		Sembabu le	Lwemi yaga	Lwemiyaga, Ntusi							
8E	ANKO LE- SOUT H	Mbarara	Bukang a	Ngarama, Kikagati, Nyakitunda	Mainly 1300 - 1700 m; livestock areas of gently rolling hills	Themeda, Chloris, Loudetia, Acacia, Cimbopogan, Nyaparrhenia, Tehmeda grass lands.  A dry grazing area with short grass mixed with Acacia	Loams, sandy- loms, and silly-clay loams.  <b>High- erosion hazard</b>	49	13.7	970	Traditional ly grazing area. Now population pressure has enticed people in area, and now cropping (plainly banana) occurs.
			Isingiro	Kabingo							
10A	VICTO RIA- RAKAI	Rakai	Kakuto	Kyebe, Kakuto, Kibanda, Kifamba	Rolling plateau with branching drainage patterns.  Altitude: 1,000 - 1,400m	Acacia and Themeda grass savannas	Humic loams from phyllites and humic sandy -	111	3.8	1,021	Crops - 76%; mixed farming - 13%

DO MA IN NO.	AREA NAME	DISTRI CT	COUN TY	SUB- COUNTIES	TOPOGRAPHY	VEGETATI ON	SOILS	FARMI NG POP PER SQ KM AGRIC LAND	GRAZIN G LAND PER HH (ha)	TOTA L RAINF ALL MEAN (mm)	FARMIN G SYSTEM MODE OF LIVING
							clay loams over humic clays from rivers aluminu m. Also brown loamy sands from sandy shore deposits				Livestock 3% fishing 2%
			Kyoter a	Kirumba, Kasasa							
			Kooki	Lwanda, Lwamaggwa, Kagamba, Byakabanda, Kachera, Kyalulangira							

DOMA IN NO.	AREA NAME	DISTRI CT	COUN TY	SUB- COUNTIES	TOPOGRAPHY	VEGETATI ON	SOILS	FARMI NG POP PER SQ KM AGRIC LAND	GRAZIN G LAND PER HH (ha)	TOTA L RAINF ALL MEAN (mm)	FARMIN G SYSTEM MODE OF LIVING
10D	VICTO RIA- MUBE NDE SOUT H	Mubende	Buwek ula	Bageza, Kasambya, Madudu, Kiyuni, Kitenga, Mubende T.C, Butoloogo	1,00 - 1,400. Gently rolling hills with broad valleys in the south and east, turning to rough country with many rock out crops and patches of bare rock in NW and W	Dry Cymbopogan and moist Acacia Savannah	Red gravely loams with alluvial soils and <b>sands in the valley bottoms</b>	68	6.8	1,201	Crops - 67%;Mixe d farming - 13%  Livestock - 6%
			Kassan da	Kassanda, Bukuya, Kiganda, Myazi							

DOMA IN NO.	AREA NAME	DISTRI CT	COUN TY	SUB- COUNTIES	TOPOGRAPHY	VEGETATI ON	SOILS	FARMI NG POP PER SQ KM AGRIC LAND	GRAZIN G LAND PER HH (ha)	TOTA L RAINF ALL MEAN (mm)	FARMIN G SYSTEM MODE OF LIVING
11A	MIDDLE - KIBOGA	Kiboga	Kiboga	Kiboga, Butemba, Bukomero, Ntwetwe, Nsambya, Gayaza	1,000 - 1,400 m. A generally flat plateau. Inadequate water supply largely influences the settlement pattern	Savannah, elephant grass	Brown sandy soils over laterite and grey to yellowish brown sands	61	6.4	1,297	Crops - 76%; Mixed farming - 12%  Livestock - 3%; Fishing 2%
	LUWERO	Luwero	Nakaseke	Kapeeka, Semuto, Nakaseke, Kikamulo, Wakyato, Ngoma							
11B	MIDDLE- LUWERO	Luwero	Katika mu	Butuntumula	A generally flat plateau at 1,00 - 1,400 m	Dry and moist savannah, papyrus swamp in valleys	Fertility quite good; slightly acid loams and strongly	48	8.9	1,240	Crops - 82%; Mixed farming - 10%.  Livestock - 2% Fishing

DOMA IN NO.	AREA NAME	DISTRICT	COUNTY	SUB-COUNTIES	TOPOGRAPHY	VEGETATION	SOILS	FARMING POP PER SQ KM AGRIC LAND	GRAZING LAND PER HH (ha)	TOTAL RAINFALL MEAN (mm)	FARMING SYSTEM MODE OF LIVING
							sandy- loams				- 1%
			Bamun anika	Kamira							
		Nakason gola		Kalungi, Kakooge, Nabisweera, Nabinyonyi, Lwampanga							

### A.5 The Northeast semi-arid zone (Zone B)

DO MAI N NO.	AREA NAME	DIST RICT	COUN TY	SUB- COUNTIES	TOPOGRAPHY	VEGETA TION	SOILS	FAR MIN G POP PER SQ KM AGR IC LAN D	GRA ZING LAN D PER HH (ha)	TO TA L RA IN FA LL (Me an mm )	FARMING SYSTEM/ MODE OF LIVELIHO OD
3C	TESO- NORT H	Katak wi	Usuk	Usuk, Toromo, Kapjan  Katakwi, Mogoro, Ngariam	Low plateau (1,000 - 1500m) with occasional outcrops/hills	Mainly Butyrosoer um - Hyporrheri a, and Acacia - Compretu m - Hyparrahen ia	Sands and loamy sands  <b>Moderate to low erosion hazard</b>	50	8.8	1,12 3	Cattle Keeping used to be the most extensive than anywhere in the short grass zone of Uganda
			Amuria	Kuju, Asaamuk, Achoma, Wera, Orungo							
			Kapeleb yong	Achowa, Obolang Kashongi, L.							

DO MAI N NO.	AREA NAME	DIST RICT	COUN TY	SUB- COUNTIES	TOPOGRAPHY	VEGETA TION	SOILS	FAR MIN G POP PER SQ KM AGR IC LAN D	GRA ZING LAN D PER HH (ha)	TO TA L RA IN FA LL (Me an mm )	FARMING SYSTEM/ MODE OF LIVELIHO OD
				Mburo							
4A	KARA MOJA - SOUTH	Morot o	Upe	Karita, Amudat, Loroo,	Part of large plain of alluvial clay, etc.  Altitude: 1,000 - 1400 m	Savannah of combretum - Acacia  - Hyoarrheni a in lower areas. High altitude maintain forest and forest savannas	Black clays over dark grey clay; hard setting and deep cracking. Compact brown or red clay and sandy loams. Low productivity, moderate to low erosion hazard	24	46.8	656	-
			Pine	Lolachat, Nabilatak, Lorengedwat,							
			Chikwi	Namalu,							

DO MAI N NO.	AREA NAME	DIST RICT	COUN TY	SUB- COUN TIES	TOPOGRAPHY	VEGETA TION	SOILS	FAR MIN G POP PER SQ KM AGR IC LAN D	GRA ZING LAN D PER HH (ha)	TO TA L RA IN FA LL (Me an mm )	FARMING SYSTEM/ MODE OF LIVELIHO OD
				Moruita							
4B	KARA MOJA- CENTR AL	Morot o	Baroka		Vast rolling plain in east, fairly flat in no west. Volcanic outcrops, e.g.. Mt. Moroto 3,082.	Succulent steppe grass lands/ steppe), tree - shrub - steppe	Deep, black cracking clays on main plains browning red sandy - clay in higher ground, modern to low erosion hazard.	27	49.9	850	60% Game Reserve, 40% grazing
4C	KARA MOJA- NORT H	Kotid o	Dodotha	Lopei, Lotome, Matany, (Lokopo Iriri)	Altitude: 1,000 - 1,400m.	Succulent steppe, tree-shrub steppe, bush land and thickets in parts	Red ferralitic soils; grey and brown clay low erosion hazard, moderate n south east			724	Forest Reserve, National Park
			Labwor	Aterek, Abim, Nyakwai							

DO MAI N NO.	AREA NAME	DIST RICT	COUN TY	SUB- COUNTIES	TOPOGRAPHY	VEGETA TION	SOILS	FAR MIN G POP PER SQ KM AGR IC LAN D	GRA ZING LAN D PER HH (ha)	TO TA L RA IN FA LL (Me an mm )	FARMING SYSTEM/ MODE OF LIVELIHO OD
			Jie	Bengen, Kotido, Nakapeliora, Paryangara							
5C	LANG O/ACH OLI	Kitgu m	Agago	Adilang, Lira- Palaro, Parabango, Patongo	Broadly rolling to flat, alluvial plains, mountains masses, rocks. Altitude: 800 - 1,400 m.	Dry Savannah	Sands, red ferralitic loams over murram and laterite; clay loams, Low natural fertility, low erosion hazard	41	14.1	1,20 5	Cultivation (also livestock in past)

## A.6 The Lake Albert Nile belt semi-arid area

DO MAI N NO.	AREA NAME	DISTR ICT	COUN TY	SUB- COUNTIES	TOPOGRAPHY	VEGETATI ON	SOILS	FAR MIN G POP PER SQ KM AGR IC LAN D	GRA ZING LAN D PER HH (ha)	TO TA L RA IN FA LL (Me an mm )	FARMING SYSTEM/ MODE OF LIVELIHO OD
7G	WEST- RWEN ZORI	Kasese	Busongo ra	Kicwamba, Bugoye, Kilembe	Mountain Slopes of Rwenzori. 1,000 - 1,800 m	Dry Acacia - Cymbopogan  Themeda Savannah	Clay loams and sandy loams	79	7.0	1,76 0	Crops; Livestock Mixed farming
7C	WEST- LAKES HORE	Hoima	Busongo ra	Rukooki, Muhokya, L. Katwe	Altitude: 1200 - 1,500 m; Steep; stony hills to flat plains 900 - 1200 m around L. George (Katwe).	Combretum and Acacia Savannas, with Cymbopogan, Combretum.	Loams, Sandy- loams and clay loams	137	2.6	1,00 9	Crops - 49%; Mixed farming - 10%; Fishing - 6%;
		Kabarol e	Kitagwe nda	Kicheche, Nyabani, Mahyoro							

### A.7 The Lake Albert Nile belt semi-arid area

DO MAI N NO.	AREA NAME	DISTR ICT	COUN TY	SUB- COUNTIES	TOPOGRAPHY	VEGETATI ON	SOILS	FAR MIN G POP PER SQ KM AGR IC LAN D	GRA ZING LAN D PER HH (ha)	TO TA L RA IN FA LL (Me an mm )	FARMING SYSTEM/ MODE OF LIVELIHO OD
7H	WEST- SEMILI KI	Bundib ugyo	Ntoroko	Rwebisengo	Bwamba Valley Drops to 900m	Bwamba Valley moist, semi- decidious forest; moist and dry savannas.	Sands, sandy- clay - loams and clays.  <b>Moderate to very low erosion hazard</b>	35	15	1,02 1	Crops - 27%; Livestock - 22% Mixed farming - 18% Fishing - 16%
7C	WEST- LAKES HORE	Hoima	Buhaguz i	Kyangwali	Lake Albert/Nile Belt. Flat Valley bounded by steep scarps and deeply incised valleys	Moist and Dry Savannas, with undifferentiate d deciduous thickets	Sands of no productivity in north. Also sandy loams and clay loams. Moderate to low erosion hazard.	77	4.2	761	Crops - 80%; Fishing - 10%; Fishing is n important activity.

DO MAI N NO.	AREA NAME	DISTR ICT	COUN TY	SUB- COUNTIES	TOPOGRAPHY	VEGETATI ON	SOILS	FAR MIN G POP PER SQ KM AGR IC LAN D	GRA ZING LAN D PER HH (ha)	TO TA L RA IN FA LL (Me an mm )	FARMING SYSTEM/ MODE OF LIVELIHO OD
			Bugahya	Kigoroby, Buseruka,							
		Masindi	Buliisa	Biiso, Buliisa							
6B	WEST NILE- LOW LANDS	Nebbi	Jonam	Panyimur, Pakwach, Panyango, Wadelai	Low plains broken by valleys running to the Nile, in some places eroded to virtually soil-less conditions. Altitude 700 m	Dry Savannah	Grayish - brown sands over weathered rock in the west. Highly leached, red sands and loamy - sands along the Nile.  Moderate to low erosion hazard	38	19.6	1,01 3	Crops - 72%; Mixed farming - 15%; Fishing - 11%; Livestock - 2%.
			Madi- Okolo	Ogoko, Rhino Camp, Rigbo							
			Moyo	Obongi							

DO MAI N NO.	AREA NAME	DISTR ICT	COUN TY	SUB- COUNTIES	TOPOGRAPHY	VEGETATI ON	SOILS	FAR MIN G POP PER SQ KM AGR IC LAN D	GRA ZING LAN D PER HH (ha)	TO TA L RA IN FA LL (Me an mm )	FARMING SYSTEM/ MODE OF LIVELIHO OD
				Hura							
6A	WEST NILE- MOYO	Adjuma n	-	Ciforo, Adropi	<p>Broadly rolling plain with isolated rough hills and mountain masses.</p> <p>Extensive parts are too rocky for crop production.</p> <p>A few remnants of lateritic plateau.</p> <p>Broad strips of alluvium at northern end of Nile.</p> <p>Altitude 980 m.</p>	Savannah, with undifferentiated semi-deciduous thicket on lower ground	Worn out, shallow, brown and sandy soils with irregular patches of deeper, red loams, especially on smooth plains.	23	34.4	1,311	Crops - 72%; Mixed farming - 23% Fishing - 1%

## **A.8 Research Activities Carried Out in the Department of Soil Science – Makerere University**

1. Aniku J.R.F. Long term changes in physical and chemical properties of reclaimed wetland soils in Uganda. Funded by IUCN through National Wetland Conservation Programme.
2. Aniku J.R.F. A review of the wetland soils of Uganda. funded by IUCN - Uganda National Wetlands conservation and Management Programme.
3. Aniku J.R.F. Soil resources and agricultural potential of Entebbe - Kampala Corridor. GTZ - Urban Planning Assistance Department of Physical Planning.
4. Basamba, T.A., B.r. Singh, and J.R.F. Aniku. Land use changes and their effects on formerly natural forest soils: The case of Mabira Forest Reserve, Mukono district, Uganda. Sponsored by Makerere University.
5. Bekunda M.A. Enhancing soil fertility through the use of Francolites. International Development Research Centre (IDRC) Sponsored.
6. Bekunda, M. A. Utilization of organic residues for sustainable crop production. rockefeller Foundation sponsored.
7. Bekunda M. A. and P. Ebanyat. Determination of reactivity of Busumbu phosphate rock applied to selected Uganda soils. Makerere University sponsored.
8. Bekunda, M. A. Evaluation of the potential of Leucaena as nitrogen fixing tree, using isotopic methods. Atomic Energy Agency sponsored.
9. Ebanyat, P. and M. A. Bekunda Transformation of phosphorus in soils amended with Phosphate Rock, IDRC/Makerere University sponsored.
10. Ebanyat P. and M. A. Bekunda combating Nutrient Depletion. Sponsored by TSBF - SWNM network.
11. Mufumbiro P., J.S., Tenywa and C. Wotmann. Correlation and collaboration of available phosphorus for bean production in Uganda. AEP/World Bank sponsored.
12. Murekezi C., Tenywa J.S. and Bekunda M.A. Coffee husks influence on the status and availability of N, P, and K on a pineapple cropped soil.
13. Nkwiine C., Evaluation of bradyrhizobia that nodulate promiscuous soybean. Funded by Makerere University.
14. Olani, N., M.A. Bekunda and J.R.F. Aniku. Phosphorus status and sorption characteristics in some Vertisols of Uganda. Sponsored by AEP/World Bank.

15. Rwakaikara-Silver M.C and M. Magunda. Evaluation of soil physical factors and mycorrhizae associations influencing cyanide content in cassava tubers. Makerere University sponsored.
16. Silver M.R. Evaluation of soil physical factors and mycorrhizae associations influencing cyanide content in cassava tubers. Makerere University Sponsored.
17. Siriri D., J.Y.K. Zake and M. Tenywa. Characterisation of spatial variation in soil properties and yields across bunch terraces in Kabale. ICRAF funded.
18. Tumuhairwe J.K. and D. Miro. Conserve water for soil conservation and improved agricultural production in Kamwezi subcounty, Kabale District.
19. Tumuhairwe J.K. and D. Miro, Indigenous Soil and Water Conservation. Adoptive research and extension and development phase. Sponsored by Dutch government.
20. Tumuhairwe J.K. Soil fertility management for banana. Sponsored by NARO.
21. Tumuhairwe J.K. Acceptance and impact of soil and water conservation and biodiversity approaches. UNU-PLEC sponsored.
22. Tumuhairwe J.K. Kahembwe, F., Nsubuga E.N.B. Acceptance and impact of Soil and Water Conservation and Biodiversity approaches. UNU-PLECV Sponsored.
23. Wanaku B., J.S. Teywa and M.C. Rwakaikara-Silver. Vertical distribution of nutrients in the soil under the influence of coffee husks. Sponsored by Makerere University.
24. Zake J.Y.K., Land clearing and soil management for sustainable food production in the high rainfall zone around Lake Victoria. IBSRAM/Rockefeller Foundation Sponsored.
25. Zake J.Y.K., C. Nkwiine, D.P. Bwanmiki, S. Sessanga, J.C.M. Ddungu, W. Muwonge and J.K. Tumuhairwe. Evaluation of coffee response to different fertiliser regimes. EEC sponsored.

## A.9 Fertiliser recommendations in Uganda

Crop	Region	Recommendation
	North and Central Arua, May,	250 kg SSP ha <sup>-1</sup> at planting 250 kg (NH <sub>4</sub> ) SO <sub>4</sub> ha <sup>-1</sup> after 4 - 5 weeks
	Apac, Gulu, Soroti and Mbarara	
	Central Arua, Nebbi, Kumi, South Soroti, Pallisa, Kamuli, Jinja, Iganga, Luwero, Mukono and Tororo	125 kg SSP ha <sup>-1</sup> at planting 250 kg (NH <sub>4</sub> ) SO <sub>4</sub> ha <sup>-1</sup> after 4 - 5 weeks
	Kitgum, Rakai, Masaka, Mpigi and Mubende	250 kg (NH <sub>4</sub> ) SO <sub>4</sub> ha <sup>-1</sup> after 4 - 5 weeks
	Other areas	none
Ground nuts		125 kg SSP ha <sup>-1</sup> at planting
		none
		125 kg SSP ha <sup>-1</sup> at planting 250 kg (NH <sub>4</sub> ) SO <sub>4</sub> ha <sup>-1</sup> after 4 - 5 weeks
		250 kg (NH <sub>4</sub> ) SO <sub>4</sub> ha <sup>-1</sup> at 50cm height or split application (first at planting, second at 50cm height)
		125 kg SSP ha <sup>-1</sup> and 250 kg (NH <sub>4</sub> ) SO <sub>4</sub> ha <sup>-1</sup> at planting
		125 kg SSP ha <sup>-1</sup> and 250 kg (NH <sub>4</sub> ) SO <sub>4</sub> ha <sup>-1</sup> sulphate of ammonia at planting or after 4 weeks
		125 kg SSP ha <sup>-1</sup> at planting
		125 kg SSP ha <sup>-1</sup> before planting
		125 kg SSP ha <sup>-1</sup> at planting and 125 kg (NH <sub>4</sub> ) SO <sub>4</sub> ha <sup>-1</sup> before planting*

Source: Anonymous (1973) \*In acid areas (NH<sub>4</sub>)SO<sub>4</sub> should be replaced by CAN; below pH 5.8, 2.5 lime ha<sup>-1</sup> is recommended and below pH 5.2, 5 t lime ha<sup>-1</sup>

**A.10 Location of districts and areas where SWC research has been conducted in Uganda.**

### A.11 Population density in the semi arid areas in Uganda

Semi arid zones	Sub -county overall population density (persons/sq.km) in percentages* for the different ranges					
	0-49	50-99	100-149	150-199	200+	Total %
Central corridor (A)	31	38	22	7	2	100
North east – Karamoja (B)	94	6	-	-	-	100
Kasese/Kazinga (C)	20	10	30	40	-	100
L. Abert-Nile belt	56	22	17	-	6	100
Total	57	22	14	6	1	

**Source: The 1991 Population and housing census**

**\* These percentages are computed basing on the frequency of the sub-counties that fall under semi arid areas in the different zones.**