3. Present Situation for Each Sector

3.1 Meteorology, Hydrology and Ground Water

3.1.1 Meteorology

1) Overview

Although the four districts in the Study Area lie directly on the equator, the Study Area is sandwiched between Lake Victoria and Lake Kyoga and thus has a lacustrine rather than tropical climate. Also, since it lies on a high altitude plateau (1,000 ~ 1,500 m), there is little variation in temperature throughout the year, the average being a comfortable 21.5C°. The overall average annual rainfall is 1,300 mm, though this is lower to the north of Luwero and the west of Masaka District.

2) Meteorological stations

As data up to 1970 is recorded in the "East African Meteorological Department Climatological Statistics for East Africa", meteorological data was collected from 1971 onwards.

In the four districts in the Study Area there are ninety agromets, hydromets, and rainfall observation stations, of which a third are closed indefinitely. Most of the remainder suffer periods during which observation is interrupted. Given the abundance of data and the geographical distribution of the observation stations, ten stations were chosen for data collection as shown in Figure 3.2.1.1 on an isohyet map.

(1) Luwero District

Bukalasa was selected to represent the southern area and Kakoge the central area. Nakasongola station was originally considered for the northern area, but unfortunately due to the lack of data on account of the civil war there was no choice but to remove it from consideration.

(2) Masaka District

Ntusi was selected as being representative of the western area, while Masaka was selected in the central area, and Katigonda in the eastern area. Consideration was also given to Kamenyamigo for rainfall distribution, but Ntusi was finally selected as being more representative of the area.

(3) Mpigi District

Entebbe was chosen to represent the southern area, and Kabanyoro and Namulonge were selected in the northern areas.

(4) Mukono District

Including the islands, Mukono extends a considerable distance from north to south, but the only good observation station is at Kituza in the southwest. It was therefore decided to incorporate data from the Jinja observation station where data is comparatively abundant, even though this is in an adjacent district and outside the Study Area.

3) Collection and analysis of meteorological data

(1) Types of data

The following data was collected.

a) Location, observation period, and parameters of observation stations in the Study Area.

b) Monthly meteorological data

i) Temperature

ii) Dew point

iii) Rainfall, number of days

iv) Sunshine

v) Radiation

vi) Evaporation

vii) Wind velocity

c) Daily rainfall

Data from the four observation stations in Kakoge, Katigonda, Entebbe, and Namulonge

(2) Data analysis

Data was collected according to each parameter in monthly and yearly units. The annual summary is shown in Table 3.1.1.1. In the process of this analysis, meteorological information given in the 1963 Uganda Atlas was checked and found to be more or less consistent with recent data.

a) Temperature

The four districts in the Study Area have virtually identical temperature patterns throughout the year. Luwero is closer to a continental climate, with both maximum and minimum temperatures differing slightly from other districts.

b) Rainfall

The north of Luwero and west of Masaka have less rainfall compared to the area around Lake Victoria. Because the sun moves north-south on either side of the equator, air currents near the ground surface are affected by both southwest and northeast monsoons, as a result of which there are two dry seasons and two rainy seasons per year. The rainy seasons run from March to May and September to November, while the dry seasons are from June to August and December to February. April marks the peak of the rainy season and January the dry season.

Figure 3.1.1.1. Meteorological Stations and Isohyet Lines

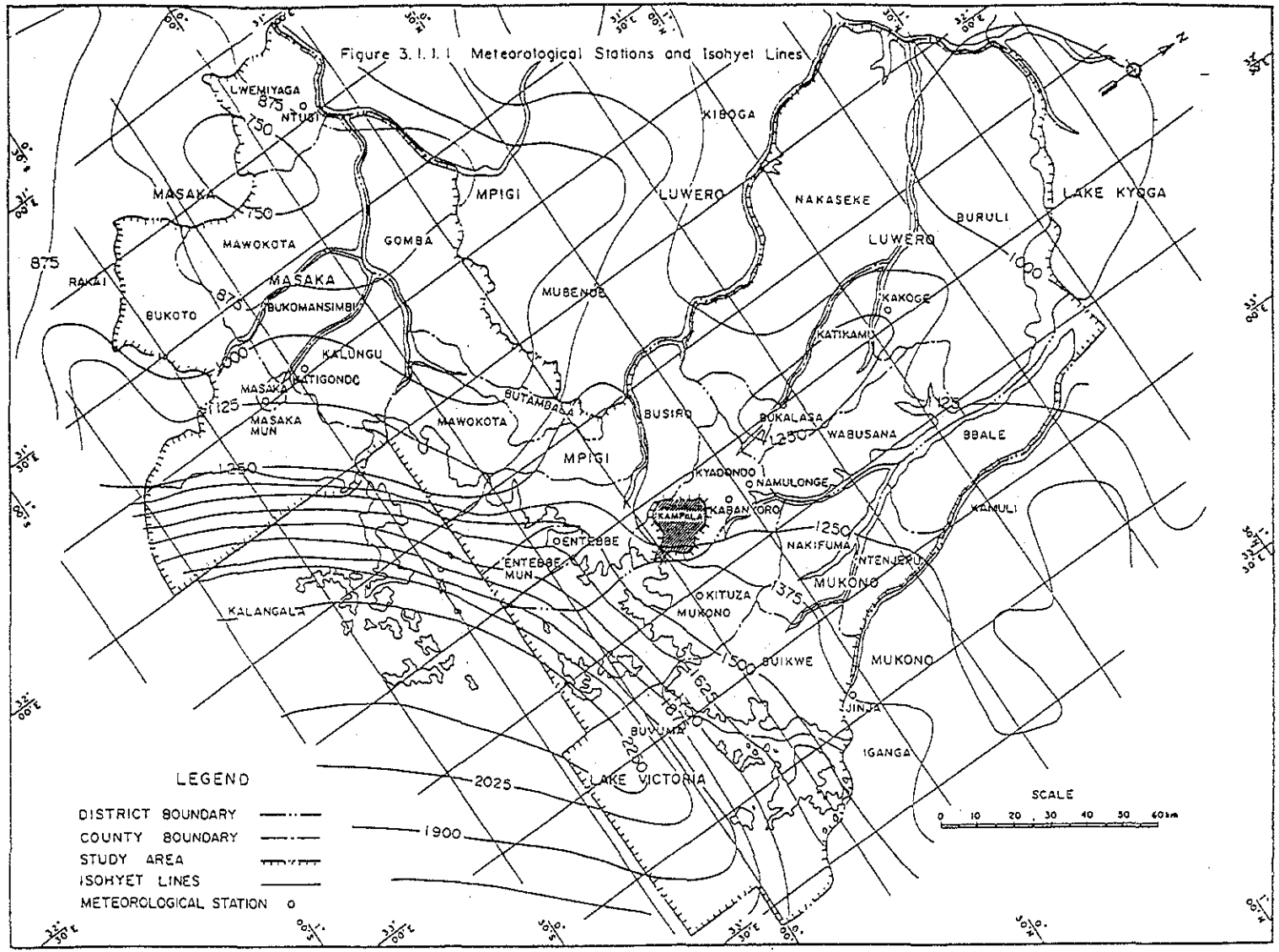


Table 3.1.1.1 Annual Average Meteorological Data (1/2)

Station	Temperature					Dewpoint			Evapolation			Sunshine		
	Max.		Min.		Mean	Mean	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.
	Mean (℃)	Max. (℃)	Mean (℃)	Min. (℃)	(℃)	(℃)	(℃)	(℃)	mm/day	mm/day	mm/day	hr/day	hr/day	hr/day
Luwero	29.3	32.4	13.1	6.4	21.2	17.7	19.9	14.6	3.5	5.1	2.5	6.4	9.6	2.1
Bukalasa	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kakoge	29.3	32.4	13.1	6.4	21.2	17.7	19.9	14.6	3.5	5.1	2.5	6.4	9.6	2.1
Masaka	26.2	29.0	15.5	14.0	20.9	16.4	18.7	14.7	3.6	6.3	2.3	5.8	8.4	3.9
Katigondo	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Masaka	25.3	27.4	15.6	14.3	20.5	16.6	18.7	14.5	3.6	5.7	2.3	5.9	9.2	4.0
Ntsui	27.0	30.6	15.3	13.6	21.2	16.2	18.7	14.9	3.6	6.9	2.3	5.6	7.6	3.8
Mpigi	27.3	30.7	16.5	13.2	21.9	17.8	19.3	14.8	4.4	6.4	2.9	6.5	8.2	4.4
Entebbe	26.0	29.5	17.6	15.4	21.8	18.0	19.4	12.9	4.8	7.4	2.9	6.7	8.8	4.4
Kabanyoro	27.9	31.0	16.2	10.3	22.0	18.0	19.3	17.1	4.0	5.3	2.9	6.2	7.5	4.4
Namulonge	27.9	31.6	15.8	13.8	21.9	17.5	19.1	14.4	-	-	-	-	-	-
Mukono	27.4	30.1	16.5	15.0	21.9	17.8	19.6	15.4	4.2	6.3	2.5	6.9	10.1	4.7
Kituza	26.7	29.1	16.1	14.8	21.4	18.0	19.8	15.7	3.6	5.1	2.7	6.7	9.1	4.7
Jinja	28.1	31.0	16.8	15.1	22.4	17.6	19.4	15.1	4.8	7.5	2.3	7.0	11.0	4.7
Average (4 Districts)	27.5	30.5	15.4	12.1	21.5	17.4	19.4	14.9	3.9	6.0	2.6	6.4	9.1	3.8

Station	Rainfall								Radiation			Wind Velocity		
	Y-Mean	Y-Max.	Y-Min.	D-Max.		Number of Days			Mean	Max.	Min.	Mean	Max.	Min.
				Mean	Max.	Mean	Max.	Min.	cal/cm2/	cal/cm2/	cal/cm2/			
	mm/year	mm/year	mm/year	mm/day	mm/day	day/year	day/year	day/year	year	year	year	km/day	km/day	km/day
Luwero	1,233	2,008	571	30.9	65.7	100.7	156.0	50.0	-	-	-	110.5	163.0	82.0
Bukalasa	1,233	2,008	571	30.9	65.7	100.7	156.0	50.0	-	-	-	-	-	-
Kakoge	-	-	-	-	-	-	-	-	-	-	-	110.5	163.0	82.0
Masaka	1,191	2,458	372	32.7	115.5	96.0	167.5	46.0	4,692	5,764	3,791	150.0	197.0	107.5
Katigondo	1,343	3,336	251	36.2	128.6	104.6	188.0	42.0	-	-	-	-	-	-
Masaka	1,217	2,259	486	29.1	102.3	87.4	147.0	50.0	4,751	5,603	3,999	174.2	214.0	128.0
Ntsui	1,012	1,779	381	-	-	-	-	-	4,632	5,924	3,582	125.8	180.0	87.0
Mpigi	1,277	2,683	361	32.2	109.4	118.1	200.3	48.7	4,789	5,286	4,144	88.8	159.0	57.5
Entebbe	1,527	3,440	458	36.4	109.3	124.7	215.0	54.0	4,640	5,290	3,860	119.7	223.0	73.0
Kabanyoro	1,205	2,328	381	31.8	106.1	120.3	193.0	57.0	4,939	5,282	4,427	57.8	95.0	42.0
Namulonge	1,099	2,283	246	28.3	112.8	109.2	193.0	35.0	-	-	-	-	-	-
Mukono	1,377	2,614	432	34.6	103.8	116.3	191.5	55.0	5,328	5,800	4,796	75.9	125.5	37.0
Kituza	1,503	2,974	505	37.5	124.5	117.6	198.0	57.0	5,443	5,947	4,806	53.0	89.0	39.0
Jinja	1,252	2,253	360	31.6	83.0	114.9	185.0	53.0	5,213	5,653	4,785	98.8	162.0	35.0
Average (4 Districts)	1,270	2,441	434	32.6	98.6	107.8	178.8	49.9	4,936	5,617	4,243	106.3	161.1	71.0

3.1.2 Hydrology

1) Outline

In the Study Area there are 25 hydrological observation stations where WDD carries out observations of water levels and discharge. These include four main rivers (the Lugogo, Katonga, Mayanja and Sezibwa) and three water basins (Lake Victoria, the Victoria Nile and Lake Kyoga). The Lake Victoria basin includes Masaka and Mpigi and has a surface area of 60,500 km^2. The main river is the Katonga. The Victoria Nile basin includes part of Luwero and Mpigi, and has a surface area of 27,390 km^2. The main rivers are the Lugogo and the Mayanja. The Lake Kyoga basin includes northern part of Luwero and Mukono, and has a surface area of 56,120 km^2. Its main river is the Sezibwa. (Figure 3.1.2.1)

2) Analysis of data

After examining data from the 25 observatories (listed in Appendix 2.1.2), the following facts were founded.

i) The WDD suffered extensive damage during the civil war. Since then it has only been able to monitor the Nile (due to its international significance) and various tributaries. These discharge volumes, governed by the outflow from Lake Victoria, are of limited use as hydrological water resource data for use in irrigation and wetland development schemes within the Study Area.

ii) Other than the Nile, all rivers are in wetland areas, with widely dispersed flow area. Reliable, accurate data is largely unavailable.

iii) Data is all in the simplest form of water level observations, which compounds the time and effort required for analysis.

By considering above-mentioned reasons it was decided to restrict WDD data for the Study to Sezibwa and Katonga observatories and field observations on discharge provided supplementary data for greater accuracy.

(1) Data of WDD

Raw data from the two stations -- one in the lower reaches of the Katonga river (latitude E:31°56', longitude S:0°07') and the other on a waterfall in the upper reaches of the Sezibwa river (E:32°52', N:0°22') was converted into discharge data being transferred onto floppy disk.

It was found that daily discharge at Katonga observatory, covering the entire 13,930 km^2 river basin area from the lowest point of the basin, was extremely low. Field surveys later revealed that the bulk of the discharge is dispersed into wetland areas along the banks of Lake Victoria. The analysis was abandoned at this point.

At the Sezibwa observatory, perched above a 10-metre waterfall, the fixed river course enables accurate measurement of discharge volume. The 175 km^2 river basin contains a more

representative mix of forest, farmland and wetlands, and thus serves as a more reliable source of hydrological data for water sources in the Study Area.

Table 3.1.2.1 shows monthly average hydrological indices at Sezibwa. The yearly average discharge per unit drainage area and runoff volume were calculated as follows:

Discharge per unit drainage area:

$(2.063\ m^3 \times 10^3) \div 175\ km^2 = 11.8\ l/s/km^2$

Runoff rate:

$(2.063\ m^3/s \times 365\ days \times 86\ 400\ sec) \div (1503\ mm/year \div 1000 \times 175\ km^2 \times 10^6)$

$= 0.247 = 25\%$

(2) Supplementary observations

Supplementary observations were conducted at two locations as shown in the table below (further details are given in Appendix 2.1.2).

Location	Period	Equipment	River basin area (km^2)
Sezibwa	Oct - Nov 1993	Current meter	175
Mr. Matovu's	Nov 1993	Staff gauge	9

It can clearly be seen that Sezibwa discharge per unit area is barely one-third of DWD. Mr. Matovu's is also a little low (see Appendix 2.1.2).

This is partly attributable to the poor rainfall this year. Monitoring should be continued in order to clarify the effect of rainfall on discharge volume and river basin area on runoff structure.

(3) Other considerations

The field studies were conducted from October to November 1993, during that time there was much less rainfall than expected. It is thus difficult to view the long-term DWD Sezibwa hydrological averages as excessive.

For these reasons, water resources for irrigation and wetland projects have been calculated based on the long-term Sezibwa averages.

Figure 3.1.2.1 Hydrological Stations and Catchment Area

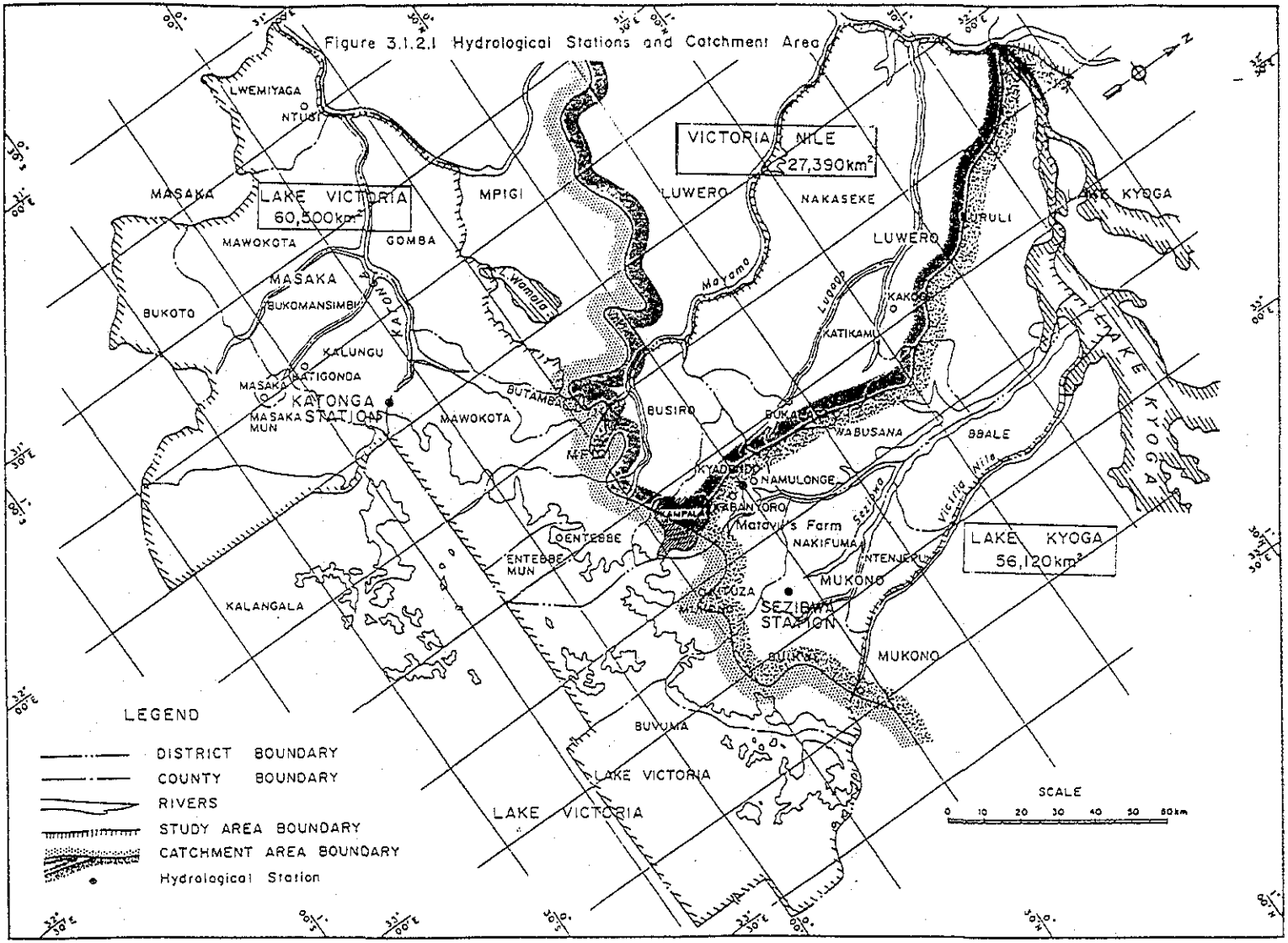


Table 3.1.2.1 Average Principal Hydrological Index Sezibwa Station

Item	Jan	Feb	Mar	Apr	Mar	Jun	July	Aug	Set	Oct	Nov	Dec	Total	Ave
Q:Discharge(m^3/s)	1.68	1.40	2.07	2.86	2.86	2.02	1.74	1.46	1.65	1.97	2.94	2.11	24.76	2.06
R:Rainfall(mm/M)	83	88	141	201	171	93	72	98	119	140	182	116	1,504	125
f:Runoff Coef(%)	30.1	23.6	21.7	21.1	24.8	32.2	35.8	22.1	20.5	20.8	23.9	26.9		24.7
q:Specific Disc ($l/s/km^2$)	9.6	8.0	11.8	16.3	16.3	11.5	9.9	8.3	9.4	11.2	16.8	12.1		11.8
qu:Specific Unit Disc($l/s/Km^2/mm$)	0.116	0.091	0.084	0.081	0.096	0.124	0.138	0.085	0.079	0.080	0.092	0.104		0.94

Note

1. $f=(Q \times 86{,}400 \times 30 \times 10^{2})/(R \times 10^{-3} \times A \times 10^{6})$
   $=(Q/R) \times (2.592/A) \times 10^{2}$
   where Q:Mean Monthly Discharge (m^3/s) ~ (1960 ~ 1962,1966 ~ 1974) for 12 years
   R:Mean Monthly Rainfall (mm/Month) ~ Kituza Station(1977 ~ 1992) for 16 years
   A:Area of water shed (Km^2) ~ $175Km^2$
2. $q=Q \times 1000/A$
3. $qu=Q \times 1000/(A \times R)$

3.1.3 Geology and Ground Water

1) Geology

Uganda is situated in the most eastern part of the Congo Craton which is widely underlain by Precambrian rocks in central Africa. These rocks were formed some 1.8 billion years ago. The Study Areas are widely underlain by Precambrian rocks composed of undifferentiated gneiss and partly granitized Buganda P Toro System. Aquifers occur in crystalline basement rocks under through most of Uganda, where over 95% of existing boreholes are completed, and less commonly in sedimentary formations (western rift valley region, local alluvial infills) and volcanic rocks (Mt. Elgon on the eastern border and Mfumbira in the southwest). The rift valley sediments are mostly lacustrine and only the more local sandy faces constitute potential aquifers. The alluvial infills are widespread in the drainage systems but associated aquifers are constrained by limited storage and variability of recharge. Volcanic rocks occur in regions of high relief while ground water is mainly associated with spring discharge and stream base-flow. Precambrian aquifer is the main source of ground water in Uganda. Basement aquifers occur in weathered zones and fractures. In most cases, three water bearing zones can be identified vertically:

Zone A) an upper zone of weathering products, typically clay and sandy clay

Zone B) a middle zone comprising an upper, highly weathered layer and a lower, less weathered fissure layer

Zone C) a lower zone of fresh rock

Most boreholes rely on the occurrence of ground water in Zone B. If the ground water resources are entirely within the fracture in the lower part of this zone and in Zone C, storage is likely to be inadequate for sustained yield from the borehole. The upper part of Zone B may be cased out by the driller, but it still forms the storage for the recharge to the lower fracture zone. The depth of weathering of granitic basement in the range 30~50 m occurs in the low relief central plateau region, thinner in the marginal highland region.

The mean yield of boreholes in each of the hydrogeological units of basement are 1,525 l/hour, for undifferentiated gneiss and 2,748 l/hour for Buganda - Toro System. Transmissitivity is highly variable for this type of basement rock. The mean specific yield in a sample from 25 boreholes was 0.07 l/m/s. Ground Water storage values are likely to be low due to the confined and semi-confined nature.

Springs occur either where the flow of unconfined ground water is interrupted by an impermeable formation or where the head of confined ground water is released by flow to the surface. In the first type the impermeable layer is caused by changes in lithology due to either a stratigraphic relationship or a structural change. The second occurs at confined aquifer outcrops. The sedimentary units tend to form topographic highs with steeper slopes and valleys. This means recharge to the higher areas forms a ground water head in the formation

and springs occur frequently on the adjacent lower slopes and in the river valleys. For example in Luwero District, no springs were seen on the gneisses. Most of the areas underlain by the gneiss are plateaus with little topographic contrast. If ground water rises to the top of fracture zones in the basement, it may still not reach the surface due to the thickness of the permeable weathered zone above the formation. In Luwero District, spring potential is good in the Precambrian sediments but poor in the gneisses, with yield at only 0.1~0.7 l/sec.

2) Ground Water

Although there are plans to expand the use of ground water as drinking water in rural regions, at present its use is limited to only small part of the population, since huge costs are required for development. Exploitation thus far has been by two means: boreholes, for comparatively deep ground water, and springs, for shallow ground water channeled onto low-lying ground surfaces. In order to extract a stable supply of safe drinking water from these existing facilities, many require rehabilitation and protection. Existing boreholes and springs in the Study Area are summarized in Table 3.1.3.1. The location of existing boreholes is shown in Figure 3.1.3.1.

Table 3.1.3.1 Boreholes and Springs by District

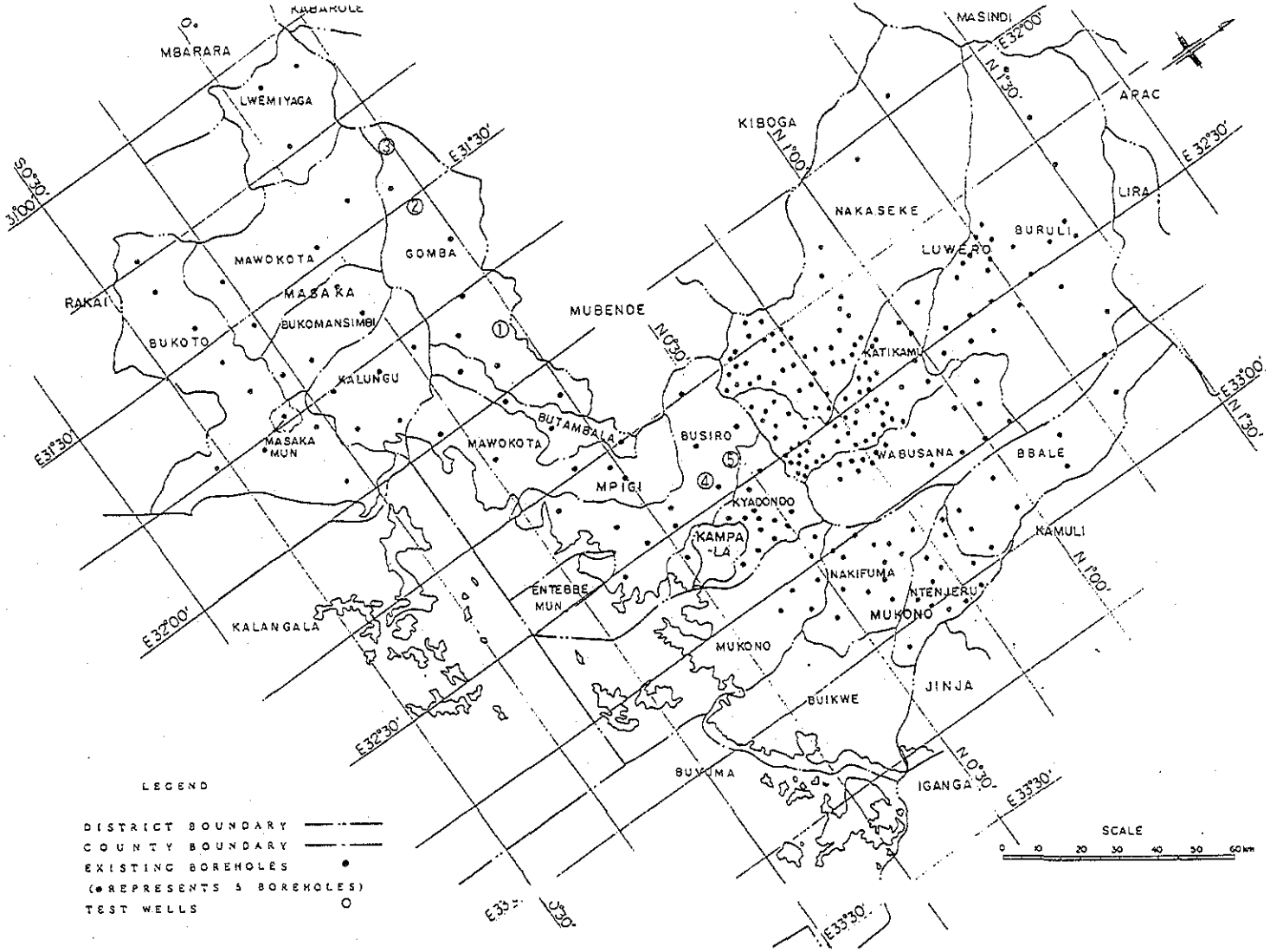
District	Boreholes		Spring	
	Total	Requiring Rehabilitation	Total	Requiring Protection
Luwero	544	0	79	31
Masaka	65	5	150	57
Mpigi	140	53	1,010	784
Mukono	160	72	514	305
Total	909	130	1,753	1,177

Sources: National Rural Water Programme (April 1990)

At present, South West Integrated Project (SWIP) and Rural Water and Sanitation Project (RUWASA) are implementing ground water development projects in Masaka and Mukono districts respectively, while Halcrow carried out a feasibility study in Luwero district.

The state of ground water was investigated in Mpigi District by drilling five boreholes for this Study, since there is no survey data other than boring logs.

Figure 3.1.3.1 Existing Boreholes and Test Wells



(1) Well yields and water levels

There are no detailed survey results on yield or depth, which are important when carrying out borehole development to develop new water resources.

Table 3.1.3.2 shows the survey results from the RUWASA Project in 1992. 60% of all boreholes now have a well yield of 0.5 m^3/hour, which is regarded as the minimum practical requirement. There is a tendency for well yield to decline as water depth increases. Boreholes must have a static water level at a depth at which it is possible to pump water with hand pumps, as well as adequate well yield.

Table 3.1.3.2 Yield and Water Level of Deep Wells by RUWASA

Well Yield (m^3/hr)	Number of Boreholes	%	Static Water Level (Average-m)	Draw Down Below SWL	Pump Water Level (Average-m)
Dry wells	101	26	-	-	-
<0.3	33	9	21.6	22.2	43.8
0.3-0.5	21	6	16.2	23.0	39.2
0.5-0.7	26	7	19.3	18.5	37.8
0.7-1.0	40	10	18.0	16.7	34.7
1.0-1.5	51	13	17.3	14.2	31.5
1.5-2.0	42	11	14.9	13.1	28.0
>2.0	69	18	13.0	11.5	24.1
TOTAL	383	100	16.3	15.3	31.5

Sources: RUWASA Project

(2) Borehole success rate

When considering the development of deep boreholes, it should first be ascertained via an advance survey that usable water exists at the excavation point. However, actual figures for Uganda in the past show that water is not necessarily available in all boreholes, the borehole success rate according to NRWSP being as shown in Table 3.1.3.3. While in the country as a whole 84% of boreholes are still operating, in the four districts of the Study Area, the figure falls to only 66–76%.

The chief cause of failure is inadequate surveying prior to drilling. Advance surveys mainly involve hydrogeological surveys, using aerial photography are useful. Introducing the latest ground water surveying technology is one of the most urgent issues in raising the reliability of borehole drilling.

In many cases, borehole capacity drops after installation. This is thought to be due to phenomena such as clogging caused by chemical substances or fine-particle earth clinging to

the screen, damage to the screen or other elements due to sand pumping, and impediments to the functions of the pump.

Table 3.1.3.3 Borehole Success Rates up to 1969

Former District Names	Total Boreholes to 1969	Percentage Success Rates (%)	Present District Names
Masaka	114	76	Masaka, Rakai
Mengo East	228	68	Luwero, Mukono, Kampala
Mengo West	136	66	Mpigi
Whole/Mean	5,477	84	

Sources: Geological Survey Records, DWD, MNR

(3) Survey results from Mpigi district

a) Well yield survey of existing boreholes

Records on the well yield and static water level of existing boreholes in Mpigi district were compiled (Table 3.1.3.4).

Table 3.1.3.4 Yield and Static Water Level of Deep Wells in Mpigi District

Well Yield (m^3/hr)	Number of Boreholes	Percentage (%)	Static Water Level (Average-m)
Dry wells	35	18	-
< 0.3	7	4	48.0
0.3 - 0.5	17	9	35.2
0.5 - 0.7	18	9	24.4
0.7 - 1.0	28	15	26.1
1.0 - 1.5	31	16	23.0
1.5 - 2.0	20	10	19.7
> 2.0	37	19	19.6
TOTAL	193	100	24.1

Sources: Geological Survey Records, DWD, MNR

Comparing the table above with Table 3.1.3.2 for the survey taken in the RUWASA project, it can be seen that the proportion of boreholes with a low yield of 0.3 m^3/hr or less is 19% in Mpigi, lower than 25% in RUWASA. On the other hand, 30% of Mpigi wells have a stable yield ratio of 2.0 m^3/hr or more, higher than RUWASA at 18%. Therefore, in terms of well yield as a whole, Mpigi produces a more favorable result.

For the pumping water level, static water levels were surveyed and were found to be an average of 24 m at Mpigi compared to 16 m for RUWASA.

b) Boring survey results

Five boring surveys were carried in this survey out in order to ascertain ground water conditions in regions where there were particularly high demands for development (for details, see appendices). The survey confirmed the available ground water in four of the five boreholes (see Table 3.1.3.5). The well yield was 0.75–1.80 m^3/hr and the aquifer lay at a depth of 24–36 m, indicating that these four holes have acceptable water quality.

Figure 3.1.3.1 shows the location o f the five test wells together with existing boreholes in Mpigi district.

Table 3.1.3.5 Data of Test Wells in Mpigi District

	Country	Sub-country	Location	Depth	Struck Level(1)	Struck Level(2)	Yield m^3/hr
1	Gomba	Kyegonza	Mamba	54m	24m	30m	0.75
2	Gomba	Maddu	Kyai	93m	-	-	-
3	Gomba	Maddu	Kasambya	60m	30m	42m	1.80
4	Busiro	Wakiso	Buloba	81m	36m	72m	1.30
5	Busiro	Wakiso	Wakiso	51m	27m	42m	1.50

Sources: Master Plan Study Team, 1993

3.2 Topography, Soils and Land Use

3.2.1 Topography

1) Data

In Uganda, topographical maps such as scale 1:50,000 (East Africa, Series Y732) and 1:250,000 (East Africa, Series Y503) are available. To cover the Study Area 63 sheets of the former and 7 sheets of the latter are required.

The first edition of the 1:50,000 scale maps was produced between the early 1950's and the mid-1960's, and although several sheets were revised in the early 1970's there have been made no revisions since then. Furthermore, changes in administrative boundaries and their names made in recent years have only been altered by hand on some sheets, while basic information on issues such as vegetation or topography remains the same as when the maps were first produced. The contour intervals on these maps take two forms, either 50 ft and 100 ft depending on the sheet, and of the maps within the Study Area 30 of the 63 sheets have intervals of 100 ft.

The 1:250,000 scale maps have essentially been edited on the basis of the 1:50,000 scale maps. Contour intervals are mostly 200 ft, although some are 100 ft.

Coloured maps of both scales are in scant supply, and for the most part only black and white copies are available. Since there are no alternative maps, these two types were used as the basic maps for this Study with review whenever necessary, as well as 1:250,000 maps of administrative boundaries especially prepared for us by the Statistics Department of MFEP.

2) Land area

Concerning land area, the data found in Population and Housing Census for official use is shown only at district level, not at lower administrative levels. For formulation of the Master Plan, land areas by Sub-county have been calculated on the basis of an unpublished area list issued from the Statistics Department of MFEP.

The lists were prepared as follows:

i) Basic topographical maps (scale 1:25,000) were made by expansion of the maps, scale 1:50,000 published by Ministry of Lands and Surveys.

ii) Delineation has been made on the maps between water areas (including permanent swamps) and others.

iii) The areas have been obtained by planimeter by sub-county and totaled up for each district.

Since the areas by district shown in the list have little discrepancy with the areas in the census, adjustment was made to the areas by sub-county in the list to correspond with the areas in the census.

After adjustment of mesh data the computerized mesh method (see Appendix 2.1) showed that the total Study Area consists of 37,028 meshes (1 mesh equal to 1 km^2) which closely corresponds to the official data, 36,703 km^2 in census. Even though mesh method holds inevitable errors, such as incomplete meshes on border areas, the difference in area (less than 1%) between the data from the mesh method and census data is acceptable.

Areas by district are shown in Table 3.2.1.1.

Table 3.2.1.1 Area of the Study Area

Unit: km^2

District	Total area
Luwero	9,198
Masaka	6,986
Mpigi	6,278
Mukono	14,241
Total	36,703

Source: The 1991 Population and Housing Census

3) Topography

(1) Outline

The Study Area is situated between 1°41'N and 0°43'S (water area extending to 1°0'S), and 31°01'E to 33°32'E (Nambuga Island) (water area extending to 33°32'E).

The area, is located in the center of Uganda, extending to the north-west of Lake Victoria, the third-largest lake in the world. The region has four Districts: Mpigi in the center, Luwero to the north, Mukono to the east, and Masaka to the west. The capital of Kampala, situated between Mpigi and Mukono Districts, is not included in the area.

While the area ranges from 1,000m to 1,500m above sea level, the area around Lake Victoria has annual rainfall of around 1,200 mm and enjoys relatively rich conditions of climate for agricultural production. However, the northern and western parts have less annual rainfall and the dry season is longer, as a result of which they have savanna-type vegetation.

Three of the four Districts (the exception being Luwero) border on Lake Victoria, and include part of the lake in their respective territories. Beside that Lake Kyoga locates in the northeast part of the Study Area and Lake Nabugabo in Masaka District. Mukono District includes a number of islands in Lake Victoria, the largest of which, Buvuma Island, is some 200 km^2. Victoria Nile, an upstream branch of the River Nile with its water source at Jinja, to the east of the Study Area, traces the eastern border of the area in a north-north-easterly direction.

Lake Victoria is approximately 1,120m above sea level. Expansive wetlands are found in the lakeside areas of Masaka and Mpigi. The plateau extends over several tens of kilometres at a height ranging from 1,200 to 1,300m. The height of hills varies within a range of approximately 100 metres. Many have slopes of 12% or more. Hills are separated by wetlands, restricting the overall hill area. To the north the land becomes lower and the slopes more gentle. Near Lake Kyoga, a lowland some 1,000m above sea level extends.

In the western part of the area, centered around the Masaka District, the plateau rises to over 1,300m with some independent small mountains over 1,450m to the south west.

There are also many swamps dispersed throughout the plateau. The largest in the area is Sezibwa in the Lake Kyoga basin, on the border between Luwero and Mukono Districts.

(2) Land slope

a) Land slope grading

Land slope is an important factor when drawing up plans for land use. In order to gain an understanding of the land slope conditions in the Study Area, grades of land slope were classified on maps. Although reference was made to the standards of the Ugandan Ministry of Agriculture and Forestry (the forerunner of the MAAIF) for the grading standards, some of the categories were combined with a view to precision in grading, forming five classifications of 0–2%, 2–6%, 6–12%, 12–25%, and over 25%. In this work, special rulers were used to identify the slope, and the maps were coloured (1:50,000 topographical maps) according to the classifications.

The lands slope classification charts prepared in this way were converted into mesh data and incorporated into the database system.

b) Land slope conditions

In the area as a whole, flat land of between 0 and 2% accounts for about 59% of the total, reaching about 80% when combined with land between 2 and 6%. On the other hand, only about 6% of the total land area is 12% or more in slope. Therefore, it is said that gently sloping land is prevalent. Flat land is broadly distributed in the whole parts of Luwero, north parts of Mukono, and also extends into the eastern parts of Masaka.

Sloping land of 6% or more is mainly distributed in the hilly zone surrounding Lake Victoria and extends into Masaka, Mpigi, and Mukono.

In terms of individual districts, in Luwero 78% of the land is between 0% and 2%, while about 96% is less than 6%, making it the District with the gentlest land slope in the Study Area. Sloping land of 6% or more exists near the border with Mpigi, in the south of the District.

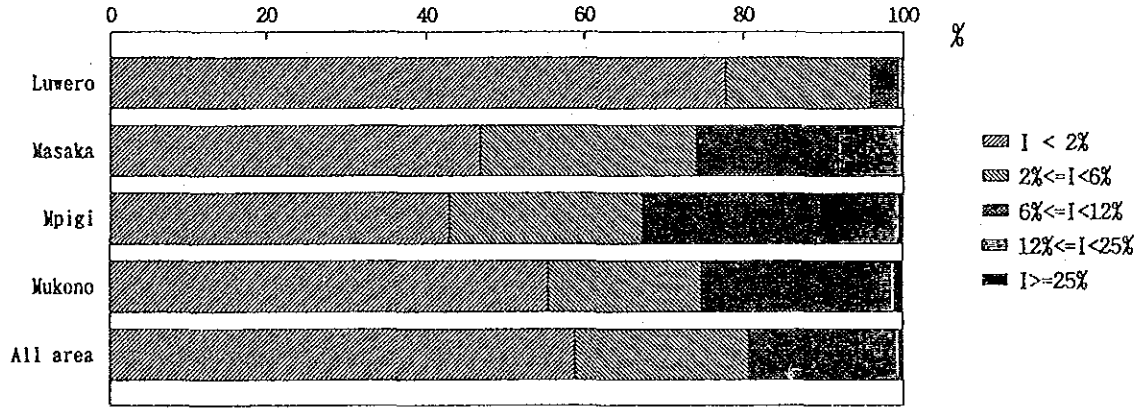
In Masaka, sloping land of 12% or more is concentrated in Bukoto County, southwest of Masaka District, where some small mountains are 1,400m above sea level exist. Apart from this, in the central and northwest parts hilly land of 12% or more is interspersed with flat swampy land. Meanwhile, the swampy zone in the eastern part consists of flat land of less than

2%. Land of less than 6% makes up 74% of the total, thus compared to the area as a whole there is a somewhat smaller proportion of gentle sloping land.

In Mpigi, sloping land of 6% or more is distributed throughout the district, while flat land of less than 6% is distributed widely along the shores of Lake Victoria. Land of less than 6% accounts for 67%, the lowest in the Study Area.

Mukono district extends from north to south along the Victoria Nile. In the northern part the land is flat. On the other hand, the hilly zone along Lake Victoria consists of sloping land with a great many undulations; 75% of the land is less than 6% in slope. Buvuma Island, in Lake Victoria, has relatively abundant sloping land showing more than 12% of the land with 12% in slope.

Figure 3.2.1.1 Land Slope Classification by District



Source: Mesh Database in the Study

3.2.2 Soils

1) Distribution and characteristics of soils

Investigations were carried out in the Study Area to complement 1:250,000 maps issued by the then Research Division in 1960 and accompanying references (*The soils and land use of Buganda*, S.A. Radwansky). Some 19 catena/series were found for typical soil mapping units. A catena is defined as a consistent occurrence of a certain sequence of soil profiles from summit to valley over an area of similar relief. Each of the different profiles in the sequence is separated at the soil series level by criteria such as soil colour, texture and structure.

Below is described the morphological character, productivity, distribution and current usage of each typical catena/series in the Study Area. Table 3.2.2.1 gives overall productivity assessments. Appendix 2.2.2 also contains 1:1,000,000 meshed soil maps produced from 1:250,000 soil maps, as well as principal soil characteristics, analysis data, and distribution of soil types.

a) Buganda Catena

This catena, found over a large area including Mpigi and southern Mukono and eastern Masaka, consists of shallow skeletal soils with iron concretion on hilltops and slopes, deep red or reddish-brown clay loams occurring on the middle, and lower slope. Areas of shallow skeletal soil, unsuitable for agriculture, are generally only used as grasslands or forests. But, due to population pressure, these marginal soils are gradually being converted for farming.

Soil in the middle of slopes is reasonably productive and often used for agricultural purposes. Exchangeable potassium and available phosphorus content tends to be low.

b) Buyaga Catena

Found in southern Luwero and central Mukono, this catena has low soil productivity on hilltops, where the soil layer is thin and iron concretion is seen. Further down there are long, gently undulating slopes with deep soil strata and reasonable soil productivity.

c) Lukaya and d) Mirambi Catenas

Lukaya, found in a limited area of north Mpigi, consists of shallow skeletal soils on hilltops and thin quartz stone line with red-brown loam soil in the lower strata of slopes.

Mirambi is found in limited areas of south Luwero and central Masaka. In catenary sequence it is the same as the Lukaya catena except that the quartz stone line is somewhat thicker.

Both catena have reasonable productivity levels.

d) Mawogola Catena and f) Makole Series

Mawogola is distributed widely through western Masaka. Both surface and lower strata are gravely, with low pH and low exchangeable base and available phosphorus content. The Makole Series is found in north-west Masaka and western Mpigi, and occurs within the Mawogola catena. The chemical properties of the soil are similar to Mawogola, but with much higher exchangeable base content. Both soils are low in productivity, and generally these areas are used as grasslands only.

e) Kabira Catena

This catena occurs only in a small area around Lake Victoria. Bases tend to leach out of the acidic and unproductive soil, which is used as forest land.

f) Buruli Catena and i) Lwampanga Series

Buruli occurs widely in gently undulating slopes in the north of both Luwero and Mukono. Deep soil in slopes tends to be sandy, acidic, and lacking in any nutrients or organic matter. This catena is used as grassland. At the foot of Buruli catena slopes there is Lwampanga series loamy sand, similar in nutrient content to Buruli.

g) Mabira Catena

Found in limited areas of south Mukono, this catena has high clay and exchangeable base content and hence good productivity, attracting intensive farming operations.

h) Nakabango Catena

This catena is also found is southern Mukono. The undulations closely resemble Mabira, in some places resulting in a complex association of the two catena. The dark red-brown, clayey soil is derived from basic rocks, with reactivity around neutral to slightly acidic. With high cation exchange capacity and base saturation percentage, this is the most productive soil type in all Uganda. Most of the land with this catena is taken up with sugarcane plantations and forest reserves.

i) Koki Catena and m) Tolero Series

Distributed in limited areas of south-west Masaka, Koki is red on hilltops but changes gradually to brown and then yellow further down the slopes. Koki Red has little exchangeable magnesium or calcium, and Koki Brown little exchangeable magnesium. Both are reasonably productive, with neutral acidity and medium available phosphorus content. The productivity of Koki Yellow is low however due to its high acidity and extremely low available phosphorus content. Tolero Series, found occasionally within the Koki catena, is a skeletal soil unsuitable for agriculture.

j) Sango Series

This series is found in flat ground, on the shores of Lake Victoria in both Mpigi and Masaka. The soil in all layers is coarse, with low pH and very low nutrient content. However available phosphorus content is relatively high. Agriculture on this series is rare due to the low productivity and tendency for frequent flooding.

k) Kifu Series

This sandy soil type, found in the lower regions of Buganda catena, is unsuitable for cultivation of upland crops because of the (sometimes only seasonal) high underground water level. Vegetables can however be grown on the fringes of valleys where the underground water level is lower. Surface soil is rich in organic carbon. All strata are strongly acidic with low exchangeable base content.

l) Kaku Series

Soils in this series are found near rivers and valleys over a relatively wide area of western Mukono. The clayey surface and lower strata are rich in organic carbon, available phosphorus and exchangeable bases, with excellent cation exchange capacity and high productivity. Most Kaku series land, being wetlands either all year round or according to the season, is unsuitable for farming. Proper water control however would enable the cultivation of rice and other water-tolerant crops.

m) Mulembo Series

Found in the lowlands of Masaka and northern Luwero, this series consists of highly acidic sandy soils, with almost no nutrients besides available phosphorus.

n) Sesse Series

Found in the Buvuma Islands within the Study Area, this series is subdivided into Sesse Red and Sesse Brown. Both have high clay content and are strongly acidic but lacking in exchangeable bases, particularly magnesium. Available phosphorus content is high due to the accumulation of guano residue through all strata.

o) Bukora Series

This series is often found in low-lying river areas in south Luwero and south-west Masaka, bordering with the Mulembo series. Soil colour varies between bright and dull yellow, with silty loam texture and strong acidity. Productivity is reasonable due to high content of exchangeable magnesium and available phosphorus.

2) Conclusions

a) With the exception of Mabira and Nakabanbo catenas, soil productivity in the Study Area ranges from reasonable to low. Soil improvement is required.

b) Most soils in the Study Area are in danger of erosion and in urgent need of engineering and vegetative soil conservation.

c) Soil on hilltops, which tends to be thin and unsuitable for cultivation, should be classified as grasslands or woodlands in land use planning.

d) Clayey and/or sandy soil found in or on the fringes of wetlands is quite productive and suitable for wetland rice or vegetable cultivation. Draining and drying wetlands for cultivation could acidify the ground and produce acid sulphate soils. However, an investigation of wetland soils in the Study Area to assess suitability for paddy fields found no evidence of potentially acid sulphate soils (see Section 3.7.1).

Table 3.2.2.1 Soil Productivity of Main Catena/Series

Soil Catena/Series	Soil type	Effective depth of soil	PH	Exchangeable bases	Available phosphorus	Organic Carbon (%)	Soil productivity
Buganda Catena	"Ferruginized" Sandy loam	Shallow	Slightly acid	Low K. bases	Low	3.5 - 4.0	Low
	Clay Loam	Deep	Medium acid	Low k	Low	2.5 - 3.0	Medium
	"Brown Ferruginized" Sandy Loam	Shallow	Strongly acid	Low bases	Moderate	2.0 - 2.5	Low
Mirambi Catena	"Brown Deep" Sandy Loam	Deep	Slightly acid	High	High	1.5 - 2.5	Medium
Mawogola Catena	"Medium" Gravelly Loam	Deep	Strongly acid	Low bases	Low	1.0 - 1.5	Low
Mabira Catena	"Red" Clay	Deep	Medium acid	High	Moderate	4.0	High
Nakabango Catena	"Red" Clay	Deep	Neutral	High	High	4.0 - 7.0	High
Lukaya Catena	Loam	Deep	Medium acid	Low bases	Low	1.5 - 2.0	Medium
Bugaya Catena	"Red" Deep Clay Loam	Deep	Slightly acid	Moderate	Moderate	2.5 - 3.0	Medium
Buruli Catena	"Red" Deep Sandy Loam	Deep	Strongly acid	Low bases	Low	0.5 - 1.0	Low
Kabira Catena	"Medium" Sandy Loam	Deep	Very strongly acid	Low bases	Moderate	2.5 - 4.0	Low
Koki Catena	"Red" Clay	Deep	Medium acid	Low Ca. Mg	Moderate	2.5 - 3.0	Medium
	"Brown" Clay	Deep	Medium acid	Low Mg	Moderate	2.0 - 2.5	Medium
	"Yellow" Clay	Deep	Strongly acid	Low bases	Low	2.0 - 2.5	Low
Lwampanga Series	Loamy Sand	Deep	Strongly acid	Low bases	Low	0.5 - 1.0	Low
Mulembo Series	Sand	N.D.	Strongly acid	Low bases	Moderate	1.5 - 2.0	Low
Kifu Series	Sand	N.D.	Extremly acid	Low bases	Low	4.0 - 7.0	Low
Kaku Series	Clay	N.D.	Strongly acid	High bases	High	4.0 - 7.0	High
Sango Series	"Deep" Sand	N.D.	Strongly acid	Low bases	High	0.5 - 1.0	Low
Sesse Series	"Red" Loam	Deep	Extremly acid	Low bases	High	1.5 - 4.0	Low
	"Brown" Sandy Loam	Deep	Very strongly acid	Low bases	High	1.5 - 4.0	Low
Makole Series	Gravelly Loam	Deep	Slightly acid	Moderate	Low	1.0 - 1.5	Low
Bukora Series	Clay	N.D.	Strongly acid	Moderate	High	1.5 - 2.0	Medium
Tolero Series	Brashy Rock	Very Shallow	——	——	——	——	Low

3.2.3 Land Use

1) Classification of land use

(1) Data

Data on the present land use in this area exists in the form of 1:250,000 scale present land use maps produced in Japan on the basis of false colour enhanced Landsat satellite TM photographs taken in December, 1990.

Apart from this, MNR has been conducting a National Biomass Study since 1989 with the cooperation of Norway. Vegetation maps scale 1:50,000 covering the whole Uganda land area are due to be produced in the near future. But this Study terminates before the completion of the vegetation maps. To understand the current conditions of land use, it will be useful to have recourse to the results of the Biomass Study.

As for forests, members of the Study team have obtained a map giving the locations of forest reserves from the Forest Department, MNR, and have used it as reference material.

(2) Classifications of land use

Based on the above data the land in the area was classified into nine types for formulating land use plans. The characteristics of these classifications are described as follows.

a) Forest reserves

Most forest reserves are distributed over hilly land stretching for several tens of kilometres from the shores of the lake. The majority are tropical high forests. In the Study Area, there is about 240,000 ha of forest reserves, mostly in Mukono District.

The largest forest reserve is 30,000 ha Mabira Forest in Mukono District. Also, in Luwero District there is a planted forest of deciduous trees which form a spectacular forest zone.

b) Private forests

Forests other than forest reserves are classified as private forests. As with forest reserves, these are guaranteed continued use as forests and not agriculture. The forests along the shores of Lake Victoria consist predominantly of Piptademiastrum africanum and Albizia Spp. as well as providing a common stock of Antiaris toxicaria and Maesopsis eminii.

c) Forest/farm-grassland mosaic (FFGM)

The forest/farm-grassland mosaic (FFGM), mainly situated in the central part of the area, is broadly distributed in hilly zones. It is assumed that these used to be tropical forests, but now this zone has been turned into a mosaic of farm-grassland and forests, due to cultivation and felling for fuel timber.

Farms in the areas mainly cultivate crops such as bananas, cassava, and coffee, mixed with fruit trees, pulses, and maize, forming a mosaic of forest land interspersed with farm land, and making it difficult to classify this graphically from the satellite images. In this area, farm land is most generally found in the middle ranges of hilly slopes. The tops of hills mostly have

shallow earth layers and exposed laterite gravel, and because the soil also has low fertility, are mainly used as grazing land for livestock. The middle slopes of the hills have highly fertile soil as well as deep earth layers, thus they are commonly used for farming. The valleys at the foot of the hill slopes have even deeper earth layers, and usually feature dense woodland growth. Deposits of clay soil make drainage poor in many cases. Where drainage is good the land is used for farming.

d) Savanna/farm-grassland mosaic (densely wooded) (SFGM-DW)

SFGM-DW range from the center to the northern part of this area, because of the lower annual rainfall compared with lake regions. The area represents savanna grasslands and woods which have farmland superimposed in a mosaic fashion.

Trees in the savanna grasslands are mostly species resistant to drought, while the most predominant herbal plants are "elephant grass" (Pennisetum purpureum). Others such as Imperata cylindrica, Cymbopogon afronardus, and Chloris gayana are also seen.

Apart from these, Phoenix redinate and Acacia polyantha are also found in the valleys. The density of farms is less than that in FFGM and bananas and cassava are cultivated around the farms for personal consumption, though the conditions of cultivation are not that favorable. Conversely, the use of savanna grasslands for pasturing goats and cows is common.

Since in the north of Mukono annual rainfall is low and the earth layer is shallow, drought-resistant crops such as cotton, millet, and ground nuts are grown.

e) Savanna/farm-grassland mosaic (sparsely wooded) (SFGM-SW)

Savannah-type vegetation is even more notable in the north of Luwero District and the western part of Mpigi and Masaka Districts, as the annual rainfall is lower. Trees in the savanna plains are intermixed with cacti and the farm density becomes even more sparse. Meanwhile, due to poor rainfall some farms cannot cultivate bananas, by far the most common food crop in the area. On the other hand, in the cases where the use of pasturing livestock is not suitable, bare wild grass ground by excessive pasturing and soil erosion by rainfall have occasionally been caused.

f) Plantations

As one travels by road from Kampala eastwards, tea and sugar cane plantations stretch out between the boundary of Mukono and Jinja. The soil in this zone is the highest in fertility in Uganda, combined with favorable topography and climate. Under these natural conditions the plantations have been established.

Apart from these, there are large plantations of cacao in Mukono and tea in Mpigi.

g) Swamps

Cyperus papyrus covers the surface of most of the swamps in the area. Apart from breeding fish or building or handicraft materials, papyrus remains unexploited.

Other vegetation includes clusters of Leersia hexandia, Dryopteris striata, and Polygomun salicifolium.

Seasonal swamps, which for the most part only change to a swamps during the rainy season, often include areas of fertile soil, and farms commonly cultivate crops on a small scale. In the field study in Mukono District, farms were found that cultivate paddy field by direct sowing in dry fields, though only on a fragmentary scale. From the point of view of the natural environment and the protection of wildlife, due consideration should be given to the utilization of swamps.

h) Urban areas

Besides Entebbe, there are several towns in the area, mainly in the centers of each District. However, with the exception of the capital, Kampala, and Entebbe, which includes several government ministries or agencies, towns are extremely small.

i) Water areas

The largest body of water in the area is Lake Victoria. Three of the Districts (the exception being Luwero) include parts of Lake Victoria in their surface areas. Of these, Mukono District has the largest segment, about 9,200 km^2.

While Lake Victoria is a precious water resource which brings greenery and fertility to the surrounding areas and the countries downstream, in recent years a deterioration of water quality has become a problem, seen for example in the occurrence of water hyacinth caused by eutrophication.

Meanwhile, there is a flourishing fresh water fishery industry, with catches of tilapia and other fish.

Other water areas in the area include part of Lake Kyoga in the north of Luwero, and Lake Nabugabo in the east of Masaka.

2) Present land use

(1) Breakdown of land use types

Land use classifications for each county are shown in Table 3.2.3.1. Although statistic in Uganda do not include swamps in land area, the Study does include swamps, taking into consideration the wetland utilization plan. Thus the land area amounts to 25,091 km^2 excluding water areas. Forest reserves account for about 10% of the whole area. This proportion increases to about 16% if private forests are included.

The FFGM where farmland scattered in mosaic formation, accounts for about 25%, while the SFGM consisting of both densely and sparsely wooded areas takes up 43%. The swamps account for about 14% followed by plantations of tea, sugar cane, etc. about 3%.

Table 3.2.3.1 Present Land Use Classification by County

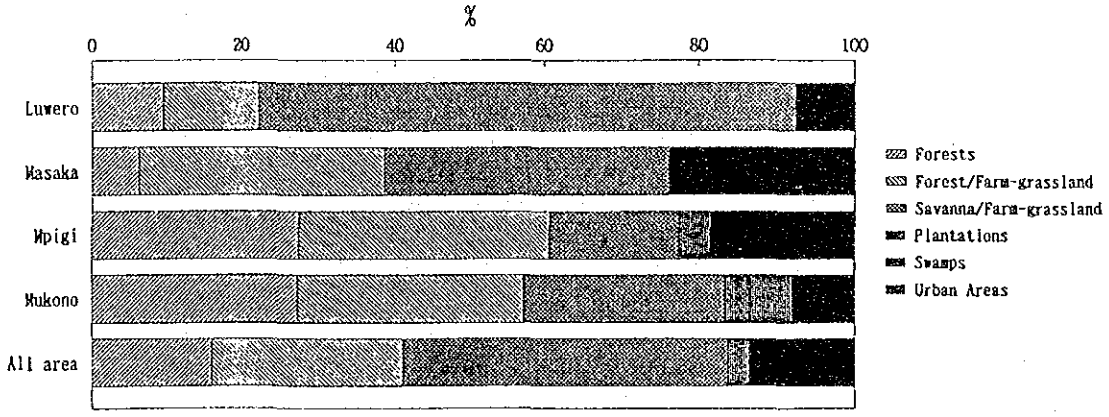
(sq.km)

DISTRICT COUNTY	Forest Reserves	Other Forests	Forest/Farm-grassland	Savanna/Farm-grassland (Tree:dense)	Savanna/Farm-grassland (Tree:scarce)	Planta-tions	Swamps	Urban Areas	Land Areas	Water Areas	Total	Grass-land	Farmland	Unused Areas (F/-G,S/F-G)
LUWERO														
BURULI	326.1			1,379.6	1,464.8	7.1	202.0	9.2	3,388.8	180.5	3,569.3	1,658.7	185.0	743.6
KATIKAMU	21.5	7.9	412.1	218.2	263.4	5.9	52.0		981.0		981.0	166.0	177.0	431.2
NAKASEKE	339.7	80.4	370.0	1,195.5	1,193.0		276.5		3,455.1		3,455.1	389.8	165.0	1,918.6
WABUSAANA	2.0	82.8	383.4	229.3	368.9	10.7	115.3		1,192.4		1,192.4	258.8	199.0	409.5
TOTAL	689.3	171.1	1,165.5	3,022.6	3,290.1	23.7	645.8	9.2	9,017.3	180.5	9,197.8	2,473.3	726.0	3,502.9
MASAKA									0.0					
BUKOMANSIMBI			314.9		126.2		131.3		572.4		572.4	213.6	305.0	
BUKOTO	209.8		714.8		784.7		419.8		2,129.1	1,082.9	3,212.0	705.3	657.0	
KALUNGU	9.9		354.7		145.2		283.7		793.5	38.0	831.5	450.0	132.0	
LWEMIYAGA	59.1		446.9		197.2		85.0		788.2		788.2	427.8	26.0	89.7
MASAKA MUN.	7.0		24.1		9.1		9.1	3.0	52.3		52.3	6.3	34.0	
MAWOGGOLA	75.9		47.3		944.1		462.4		1,529.7		1,529.7	850.9	260.0	
TOTAL	361.7		1,902.7		2,206.5		1,391.3	3.0	5,865.2	1,120.9	6,986.1	2,653.9	1,414.0	89.7
MPIGI									0.0			0.0		
BUSIRO	129.1	383.4	425.6	35.6		113.5	252.0		1,339.2	592.0	1,931.2	98.7	282.0	130.5
BUTAMBALA	92.8	95.3	144.7		43.1		40.9		416.8		416.8	88.6	97.0	
ENTEBBE MUN.			24.3			0.9	0.9	9.4	35.5	214.3	249.8	29.7	0.0	
GOMBA	166.5	20.2	581.6		620.7		294.3		1,683.3	6.6	1,689.9	783.3	148.0	122.0
KYADONDO	17.7	31.2	334.1	16.9	1.1	83.6	55.7	3.0	543.3	24.2	567.5	87.6	253.0	32.1
MAWOKOTA	253.3	241.2	197.0	7.0	139.9	7.3	303.7		1,149.4	273.4	1,422.8	87.8	292.0	
TOTAL	659.4	771.3	1,707.3	59.5	804.8	205.3	947.5	12.4	5,167.5	1,110.5	6,278.0	1,175.7	1,072.0	284.6
MUKONO														
BBALE	146.7		72.3	491.6	292.6		108.7		1,111.9	110.7	1,222.6	246.4	94.0	434.1
BUIKWE	192.2	258.8	216.6	242.9		267.1	60.3		1,247.7	227.6	1,475.3	234.2	637.0	
BUVUMA	98.8		187.1						285.9	7,866.7	8,152.6	32.6	32.0	85.1
MUKONO	170.5	318.5	307.5	61.8	1.0	108.6	43.4		1,011.3	994.9	2,006.2	179.3	309.0	
NAKIFUMA	103.1	66.3	352.6		121.7	64.8	133.6		842.1		842.1	93.3	379.0	
NTENJERU	10.5	21.2	363.1	44.1	57.7		45.7		542.3		542.3	69.5	352.0	
TOTAL	721.8	664.8	1,499.2	840.4	473.0	440.5	391.7	9.8	5,041.2	9,199.9	14,241.1	855.3	1,803.0	519.2
GRAND TOTAL	2,432.2	1,607.2	6,274.7	3,922.5	6,774.4	669.5	3,376.3	34.4	25,091.2	11,611.8	36,703.0	7,158.2	5,015.0	4,396.4

Source : Mesh Database in This Study

Note : Grass land area and Farmland area are estimated in livestock and farm management sector respectively.
Permanent swamps are included in Land areas.

Figure 3.2.3.1 Present Land Use Classification by District



Source: Mesh Database in this Study

In terms of Districts, Luwero comprises forest reserves and private forests combined, which occupy only about 10% of the land, while conversely the SFGM accounts for about 70% in total, reflecting the low annual rainfall. The savanna zone is widely distributed in the northern part, the FFGM is prevalent near the border with Mpigi in the south, taking up about 13% of the total. Swamps exist on the border with Mukono, while Sezibwa swamp ranges from north to south, occupying about 7% of the area.

Masaka, which has had forests felled as a result of mountain fires and population pressure, comprises only 6% of forests, or less than half of the proportion for the Study Area as a whole. At 32% the FFGM is greater than the national average. The tree density is lower than other District in the Study Area, and soil erosion by rain is problem. The proportion of SFGM is slightly lower than that for the area as a whole, but swamps take up 27%, or nearly twice the rate for the area as a whole. Swamps exist in areas adjoining Lake Victoria in the mid-west and east of the District.

The central part of Mpigi is much taken up with forests, accounting for about 29% of the total area of the District. On the other hand, the SFGM covers a mere 16%, mainly in the dry zone in the west. Swamps account for 19%, a little more than the ratio for the area as a whole, being spread over the whole District.

Forests are abundant in Mukono, including the national Mabira Forest (the largest forest reserve in the country). In all, forests account for about 27%. Sezibwa swamp, which, as mentioned above, lies on the border with Luwero. Apart from this, there are a few on the edge of Lake Victoria, and in all they occupy about 8%. What characterizes this District is its plantations, which account for about 8% of the area, being mainly distributed along the road from Kampala to Jinja in the east of the area. Land use on Buvuma Island in Lake Victoria is divided between FFGM and forest reserves.

(2) Estimate of unused land in mosaic areas

The present land use map prepared from Landsat images classifies the land mainly in terms of vegetation and does not identify farm lands, grasslands and unused lands involved in mosaic areas. According to the site survey, farm lands exist in FFGM, SFGM and Plantations, and grasslands exist in FFGM, SFGM and a part of wetland.

The area of unused lands in FFGM and SFGM was established by comparing the area of present land use map in LANDSAT images and that of farmland/grassland data based on farm management and livestock data. That area is object to the farm land development and grassland development in the land use plan.

Except in Luwero the counties which involve unused land in substantial square kilometres are Bbale in Mukono, Gomba in Mpigi, Lwemiyaga in Masaka and Buvuma islands in Mukono. All of them are located out of the lake Victoria crescent zone. Harsh climate, the distance from Kampala and other factors attribute to present land use patterns.

Counties within the Lake Victoria crescent zone have little unused land use ratio is high, have little available land for new farm land and grassland.

3.3 Cultivation, Agroeconomy and Farm Management

3.3.1 Cultivation

1) Cultivated crops

Due to favourable agro-climatic conditions for the production of tropical, subtropical and to a limited extent temperate crops, the Study Area has a wide range of crop species. The main food crops are food banana, cassava, sweet potato, maize and beans, as well as Irish potatoes, millet, sorghum, rice plants and peas (cowpeas, pigeonpeas and field peas). Other banana varieties include sweet and brewing bananas. With the exception of Irish potatoes, rice plants and peas, all of the above are grown in all districts in the Study Area. Maize, beans and Irish potatoes are boosting in compliance with domestic consumption, increase. The area under rice cultivation in the Study Area, although negligible at present, will increase under environmentally sensitive wetland development, in line with a steady climb in demand for rice.

Oil crops include groundnuts, soybeans, simsim and sunflower, which can be grown even in the relatively arid north of the Study Area.

Horticultural crops are an important source of cash for smaller farms. Appendix 2.3 indicates the range of fruits and vegetables, the bulk of which are grown near the home. Vegetables can even be cultivated on the fringes of wetlands, where the underground water level is low. Chilies, ginger, pineapple, passion fruit, mango, avocado and citrus fruits are grown for export, albeit in small quantities.

Traditional export crops include coffee, cotton, tea and cacao (the Ugandan rendition of cacao). Cotton is grown in the more arid north, other traditional export crops are grown around Lake Victoria where rainfall is heavy. Vanilla and cocoons are more recent exports. The former is found in areas of heavy rainfall near Lake Victoria, including parts of Mukono and Mpigi. Small-scale sericulture is undertaken by more progressive farmers in all districts within the Study Area. In 1993 some 1.7 tons of dried cocoons were exported to Japan for the first time.

Sugar is produced principally from sugarcane. Mukono District has the largest area under sugarcane in the Study Area, most of it in commercial plantations. Sugarcane for chewing is grown on a much smaller scale in all districts.

Crop yields, as shown in Table 6.2.3.1, are currently below standard international levels except in finger millet, sorghum, beans and tea. This is due to the lack of high-yield and superior pest-resistant and disease-resistant crops varieties, and of proper soil fertility management with chemical fertilizers, organic matter and soil erosion work. Both pest control and supervision of planting density are inadequate.

More details on cultivation techniques and problems associated with each crop type is given in the Appendix 2.3.

2) Cropping systems

The incidence of crop rotation is very low within the Study Area, as is single cropping. Mixed cropping predominates, as described below.

i) Nearly all crops are cultivated via mixed cropping.

ii) Banana is mixed with coffee, fruits, and food crops such as cassava, sweet potato and beans.

iii) Coffee is mixed with banana, Albizzia App., Ficus App., and other trees with wide crown growth providing shade. Cacao is often cultivated in the same way.

iv) Vanilla is mixed with bananas and coffee.

v) Fruits and vegetables are grown near homes. Vegetables are also grown on the fringes of wetlands.

vi) Passion fruit is cultivated via intercropping with pineapple and banana.

vii) In northern and eastern Uganda millet is cultivated after the cotton harvest. In the Study Area, however, priority is given to food crops such as beans, maize and sweet potato on account of the high population density. Cotton is planted after these.

viii) Most sugarcane and tea is single cropped in commercial plantations. Sugarcane for chewing is also grown on a much smaller scale.

3) Cultivation period

The Study Area lies right on the equator or near it, spreads over high lands approximately 1,100 to 1,500 metres above sea level, and its annual average temperature is normally low at 21C° to 22C°. Various kinds of crops, from tropical to temperate crops, are cultivated.

The overall average annual rainfall is 1,300 mm. The two rainy seasons are March through May and September through November. The area shows bimodal type rainfall. However, thunderstorms often come in dry seasons and rainfall is spread out through the year, except for the northern parts of Luwero and Mukono Districts, and northwestern part of Masaka and Mpigi Districts, where the dry seasons are long.

Temperature conditions are good enough to grow crops throughout the year and crops grow anytime with rain. In principle, most seeding and transplanting is done in the two rainy seasons as shown in Table 3.3.1.1. Each crop has a long period of seeding and transplanting, as a matter of course, a long period for harvesting. But people usually grow cotton only once a year. In addition, on the fringe of wet lands that hold a fair amount of water even in the dry seasons, people grow vegetables even in the seasons without much rain.

4) Conditions for using fertilizers and agrochemicals

Uganda imports all its fertilizers and agrochemicals. The conditions of their use are as follows.

a) Fertilizers

Artificial fertilizers currently used in Uganda consist of compound fertilizers which contain nitrogen, phosphoric acid and potassium; urea; calcium, ammonium and nitrate (CAN); single super phosphate (SSP); and triple super phosphate (TSP). Almost all of these artificial fertilizers are used on estate crops like teas and sugarcane and tobacco, and some are used for horticultural crops. Artificial fertilizers are seldom used for food crops, as the survey of farmers intentions revealed. People mainly use such organic matter as compost and poultry manure for horticultural crops and use crop residue as mulch materials for banana and coffee.

b) Pesticides and Fungicides

Uganda imports Fenitrothion, Dimethoate, Cypermethin, Deris, Actellic Dust, Dursban, and Orthrane pesticides. Cuprous Oxide, Dithane M45, and Salute are imported fungicides. Cotton cultivation uses Dimethoate, Deris, Cuprous Oxide, and Salute.

c) Herbicides

Herbicides used in Uganda are Ronstar 2 D, Tordon, Round up, Gesatop 500 FWC, Actril DS, Karmex, and Gramoxone. They are mainly used on estate crops like tea and sugarcane, where there is a shortage of labour.

Table 3.3.1.1 Growing Period of Main Crops in the Study Area

Crops	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Growin period (month)
Banana	◎	◎					◎	◎					
Cassava		○×	○×	○×	○×			○×	○×	○×	○×	×	6～12
Sweet Potato		○×	○×	○×	○×		×	○×	○×	○×	○×		6～7
Irish Potato			○	○		×	×	○	○		×	×	3
Yam	×	×	○	○				○×	○×				6
Maize			○	○		×	×		○	○		×	3～4
Millet			○	○			×	○×			×	×	4～5
Sorghum			○			×	×	○			×	×	4～5
Rice		○	△				○×	△				×	5
Beans			○	○	×	×			○	○	×	×	3
Groundnut			○				×						4
Soyabean			○	○		×	×		○	○		×	4～5
Fieldbean			○	○	×	×		○	○	×	×		2
Cowpea			○		×			○	○	×	×		1～2
Pigeonpea			○	○			×	○×				×	5～6
Simsim			○			×		○			×		4～4.5
Sunflower			○			×	×	○	○		×	×	3～4
Cotton						○					×	×	6～7
Onion			○	○		×	×	○				×	4～5
Tomato			○	△	×			○	○△	△	×	×	3～4
Cabbage		○	○△	○△×	×	×		○	○△	×	×	×	3
Cucumber			○	○	×	×		○	○	×	×		2
Eggplant		○	△	△	×	×		○	△	△	×	×	3
Chillies			○	○		×	×		○	○		×	3～4
Pineapple			○×	○				○	○×	○			18
Mulberry		×	○	○×		×		×	○	○×		×	4～5
Coffee	×		○	○					○	○	×	×	(36～60)
Tea		○	×	×	×			○×	×	×	×		
Cacao			○				×		○		×	×	
Vanilla		×	○	○				×	○	○			36
Sugarcane		×	○	○				○×	○				18
Mango	×	×	○	○			×	×	○	○			(5～6
Passionfruit			○	○×				○×	○				years)
Citrus	×	×	○	○			×	×	○	○			(18～20)

Source : Kawanda Agricultural Research Institute

Note : ○ Seeding △ Transplanting × Harvesting ◎ Main harvesting time

Number in the parentheses indicates a term to be harvested from transplanting

3.3.2 Agroeconomy and Farm Management

1) Agricultural structure

Agriculture is the key industry supporting the Ugandan economy.

Table 3.3.2.1 shows that farm households with agricultural land holdings of 2 ha or less account for over 75% of the farm households, and so one distinctive feature of agricultural industry in Uganda is the number of small-scale farm households.

Another feature is the number of subsistence-type farm households growing mainly food crops in the non-monetary economy, and production of cash crops such as coffee to pay for daily necessities and educational expenses.

Table 3.3.2.1 Ratio of Farmers by Farm Holding Size

District	Total %	<<1 ha %	1-2 ha %	2-5 ha %	5-10 ha %	10 ha<< %	Number of Households
Luwero	100	33.8	31.5	28.1	5.3	1.2	72,143
Masaka	100	49.2	28.2	15.8	4.2	2.5	163,051
Mpigi	100	50.0	30.5	12.5	4.3	2.7	147,837
Mukono	100	45.5	29.4	17.5	5.6	1.9	102,150
Total	100	45.9	29.7	17.3	4.9	2.2	485,181

Source: Uganda National Census of Agriculture and Livestock

Some farm households are further expanding by re-investing production revenue in fertilizers, agricultural chemicals, farm equipment and machinery for the following harvest. However, such managed farm households are still a minority.

Within the Study Area there are instances of efficient land use, for instance mixed cropping of coffee and/or cassava underneath banana plants, and double-cropping of maize followed by sweet potato or vegetables. However the FIS revealed large areas of land are used only in poor seasons of bad rains, which makes the total area under cultivation fluctuate. Generally the stages of agricultural development are as follows.

i) Self-sufficiency through subsistence food crop production
ii) Market distribution through the surplus production of subsistence food crops
iii) Market distribution to nearby towns through cash crops production
iv) Competitive market distribution through the introduction of crops transported to distant regions (including the international market)
v) Regionally apportioned planting to cultivate crops suited to each district

There are corresponding crops for each stage of agricultural development within the Study Area, for instance, maize at stage ii and coffee at stage iv. The area overall is shifting from stage ii to iii. In other words, it is a combination of subsistence and cash crops. In terms of cultivation technology and entrepreneurial skills, very few farm households practice rationalized production that makes full use of specialized technology for specific crops. Field survey results show that few farm households possess the business sense to re-invest capital into expanded production.

Table 3.3.2.2 Farmers Income by Farm Holding Size

Farm Holding Size	Agricultural			None Agr. Income 1,000 USHS	Total Net Income 1,000 USHS	Members of a Family (men)	Hired Labours (men)	Culti-vated Area (ha)
	Gross Income 1,000 USHS	Expen-diture 1,000 USHS	Net Income 1,000 USHS					
Small Size Under 2 ha	1,047	589	458	660	1,117	8.8	1.1	1.4
2.1-5.0 ha	2,981	1,921	1,060	349	1,409	11.4	1.7	3.5
5.1-10.0	5,589	3,182	2,717	1,739	4,456	16.1	3.9	8.1
10.1-20	7,387	4,149	3,238	926	4,164	14.8	5.3	15.9
20.1-30	10,959	7,403	3,556	358	3,915	16.0	5.5	27.2
30.1-70	13,700	8,168	5,532	4,367	9,899	13.5	12.1	55.2
Over 70 ha	27,721	14,220	13,500	1,357	14,858	17.9	30.1	88.6
Average	5,713	3,346	2,367	956	3,323	13.1	4.1	12.4

Source: FIS

Table 3.3.2.2 shows the FIS results concerning manpower, cropped area, agricultural income and expenditure by farm size. The average land holding of the surveyed farm households is 12 ha, which is six times larger than the average for the Study Area. Farmers with 2 ha or less account for only 15% of the all farmers surveyed. This number is small compared with other farm sizes in the sample, due to the request that the sample consist of representative farm households with marketed crops. Consequently, larger farms were selected because most farms of small-scale are subsistent.

The objective of this survey is the formulation of a farm management plan for average-size farms in the Study Area (generally being 2 ha). FIS figures give the average income of farms of this size as 1,118,000 USHS of which 458,000 USHS (agricultural) and 660,000 USHS (non-agricultural).

In the breakdown for non-agricultural income, many are buyers, traders and retailers of agricultural products, farming materials, and daily necessities. There are also traders, retail shop owners, and landlords, followed by those with income from processing factories, housing, and handicrafts and employees of organizations and government employees. In addition to the wages for people engaged in the processing and distribution of agricultural products such as coffee, wages account for a large portion of the operating costs of large farms, and so these farms provide employment for rural communities.

According to the Uganda National Household Budget Survey (1989–90), the monthly cost of living in a rural area is 36,500 USHS, and in an urban area 57,500 USHS. Of that, food expenses account for 23,495 USHS (64%) in a rural area, and 33,575 USHS (58%) in an urban area (see Table 3.3.2.3).

However, a large proportion of rural food expenses is spent on banana (matoke) and tubers instead of cereal or meat like urban dwellers. A considerable difference in dietary habits has emerged as urban demand shifts to cereals, meats and vegetables. In recent years horticultural produce of fruits and vegetables has risen in rural communities surrounding Kampala and Jinja, in response to the rising consumption. Horticultural products are heavy and bulky, and difficult to transport. Furthermore, since the storage of items such as tomatoes is difficult, horticultural produce with high commercial value are produced in the areas near cities or areas with advantageous geographical conditions for transport.

Table 3.3.2.3 Housing Expenditure in the Study Area (per household per month)

Description	Urbun		Rural		Central Uganda (Average)		Kampala	
	USHS	%	USHS	%	USHS	%	USHS	%
Banana/Tubers	6,490	11.28	7,285	19.97	7,102	17.18	6,637	11.07
Cereals/Bread	4,799	8.34	3,110	8.53	3,499	8.47	4,976	8.30
Meats/Poultry	3,269	5.68	2,130	5.84	2,392	5.79	3,438	5.73
Fishes	1,872	3.25	1,445	3.96	1,543	3.73	1,874	3.13
Milk/Eggs	3,059	5.32	1,211	3.32	1,637	3.96	3,292	5.49
Oil/Fat	1,000	1.74	416	1.14	551	1.33	1,039	1.73
Fruits/Vegetables	2,988	5.19	2,617	7.17	2,703	6.54	3,052	5.09
Beans	1,579	2.75	1,885	5.17	1,814	4.39	1,565	2.61
Sugar/Coffee/tea	2,982	5.18	1,142	3.13	1,566	3.79	3,034	5.07
Other Foods	415	0.73	331	0.91	351	0.85	417	0.70
Beverages	870	1.51	315	0.86	443	1.07	963	1.60
Alchohlic Beverages	2,544	4.42	988	2.65	1,331	3.22	2,780	4.64
Tobaco	471	0.82	348	0.95	378	0.91	503	0.84
Restaurants	1,237	2.15	292	0.80	510	1.23	1,424	2.37
Total of Food/Bever.	33,575	58.35	23,495	64.41	25,819	62.46	34,992	58.37
Clothing	3,534	6.14	2,091	5.73	2,423	5.86	3,701	6.17
Fuel/Power	7,125	12.38	2,401	6.58	3,489	8.44	7,492	12.50
Household Equipment	6,538	11.36	3,517	9.64	4,213	10.19	6,774	11.30
Transport	2,126	3.96	1,525	4.18	1,665	4.03	2,287	3.82
Health/Medicals	1,069	1.86	1,069	2.93	1,069	2.59	1,064	1.78
Education	2,265	3.94	1,174	3.22	1,426	3.45	2,291	3.82
Recreation/Culture	1,314	2.28	1,205	3.30	1,231	2.98	1,343	2.24
TOTAL	57,546	100.00	36,477	100.00	41,334	100.00	59,944	100.00

Source : MPED, Uganda National Household Budget Survey(1989-90)

2) Agricultural Zones

Crops are subject to the limitations imposed by natural conditions, such as climate and soil. In addition, differences in productivity arise depending on the level of cultivation technology, including the technology to overcome these conditions. Although crop yields differ by district according to technological level, the local character of farm management systems, which arises from societal factors, also cannot be ignored.

There is a method of agricultural zoning whereby crop selection is tailored to natural conditions (the crop is referred to as an indicated crop). For example, coffee and cotton are indicated crops in 'Production Zones and Targets' (1992–1995, MAAIF). According to the report, the Study Area is divided into two zones: the Intensive Banana Coffee Lake Shore System Zone and the Banana Millet Cotton System Zone in the northern parts of Luwero and Mukono. In this Study, the area is divided into two zones according to natural conditions: the Lake Shore region, called the Lake Victoria Crescent Zone (Zone I), and the Inland Zone (Zone II) (Figure 3.3.2.1).

Next, in order to determine the limitations imposed by societal conditions, such as the food demand structure and distribution system, Zone I and Zone II are each divided into three sub-zones according to crop and livestock distribution, as shown in Figure 3.3.2.2, and Table 3.3.2.4.

a) Zone Ia has a relatively large number of estate plantations. Farm products requiring processing, such as vanilla, cacao, and tea, have been introduced by many small-scale farmers. Agricultural support systems, from primary processing to distribution and export, are being established through the use of private capital. The development of commercial farming from subsistence agriculture is also progressing. Specialization through the introduction of horticultural products can also be observed in this zone.

b) There is no difference in weather and geographical conditions between Zones-1b and 1a, and Zone Ib is also making progress in the introduction of horticultural crops. However, as far as distribution is concerned, there is little production directed toward processing and exporting. In terms of the stages of agricultural development outlined in Section 1) of 3.3.2, this zone is in transition between stages ii) to iii).

c) Conditions in Zone Ic differ from elsewhere in Zone I, especially climatic conditions fall in the middle of the range of Zone Ia, Zone Ib and Zone II. These form slightly different crop production conditions from other Zone I areas. Nevertheless, Zone Ic also has some advantageous geographical conditions. In spite of its other disadvantages the crops produced here are virtually the same as in Zone Ib.

d) Geographic and natural conditions, such as climate and soil in Zone IIa differ greatly from Zone I. Except for large-scale livestock farmers, the farmers in this zone have no choice of cash crops other than coffee and vegetable. They are therefore at a disadvantage. The crops selected here are similar to those of Zone Ic.

e) In Zone IIb both natural and geographic conditions differ from Zone I, and crops are quite different, for instance cotton and oranges.

f) While Zone IIc has the same natural and geographic conditions as Zone IIb, land use centers on livestock grazing by local communities and nomadic tribes. The production style is livestock-based.

As mentioned above, Zone IIa, for instance, has adopted coffee production, even if it is a crop not suited to its natural conditions, simply because it has no other choice of cash crops. There are also some areas that grow few tubers, a stable food, because there is little demand for it, even if natural conditions are suitable.

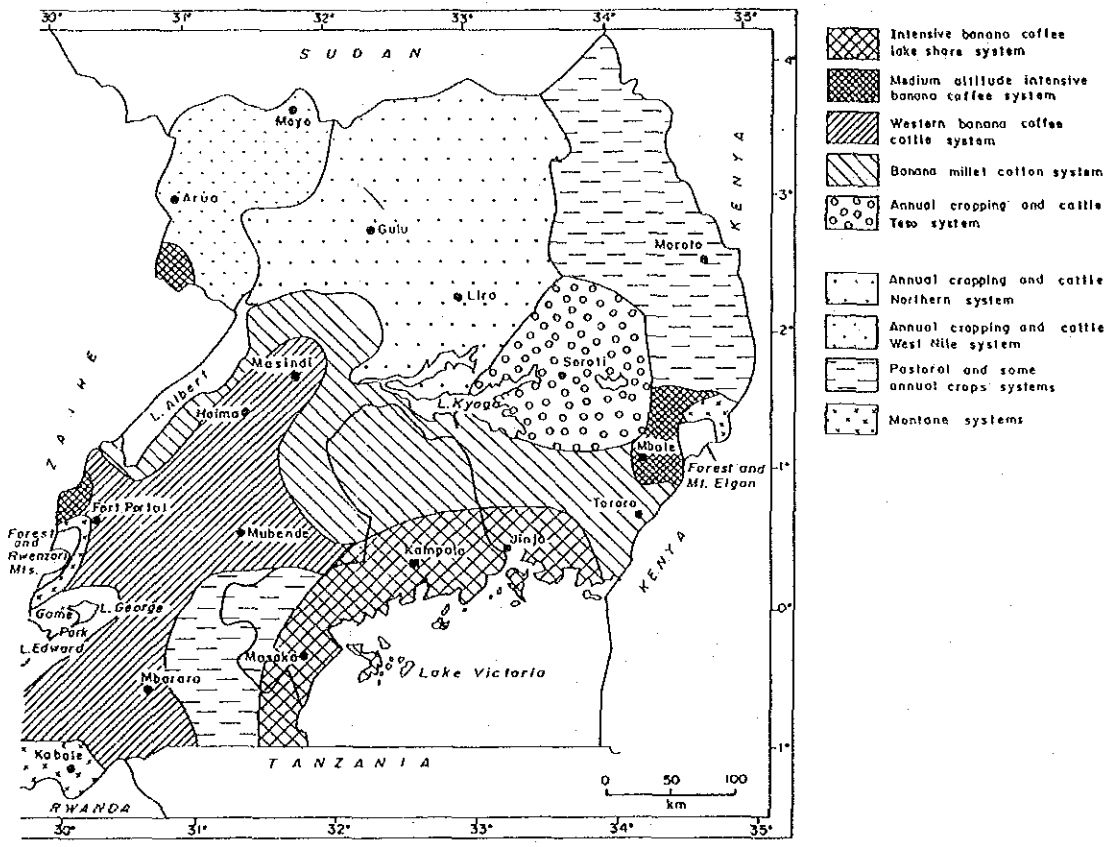
Table 3.3.2.4 Planted Crops by Farming Zone

++ Plenty, + Some

Item	Zone I			Zone II		
	Ia	Ib	Ic	IIa	IIb	IIc
Banana	++	++	++	+	+	++
Maize+Sorghum	++	++	++	+	++	++
Cassava+Potato	++	++	++	++	+	++
Beans+s.beans	++	++	++	+	+	++
Vegetable	++	++	++			+
Pineapple	++	++	++			+
Passion fruit	++	++	++			
Rice	+					
Cacao	++	+				
Vanilla	+	+				
Sunflower	+	+				
Coffee	++	++	+			+
Sugarcane	++	+	++			+
G/Nut+simsim	++	+	++	++		++
Local fruit	++	++	++	++		
F/Millet				++	+	+
Orange				+		
Cotton						++
Cattle(milk)	+	+	++	++	++	
Cattle(beef)	+	+	++	++	++	
Goat&Sheep	+	+	+	+	+	
Poultry	++	+	++	++	+	
Eggs	+	+	+	+	+	
Pig	++	++	++	+	+	+

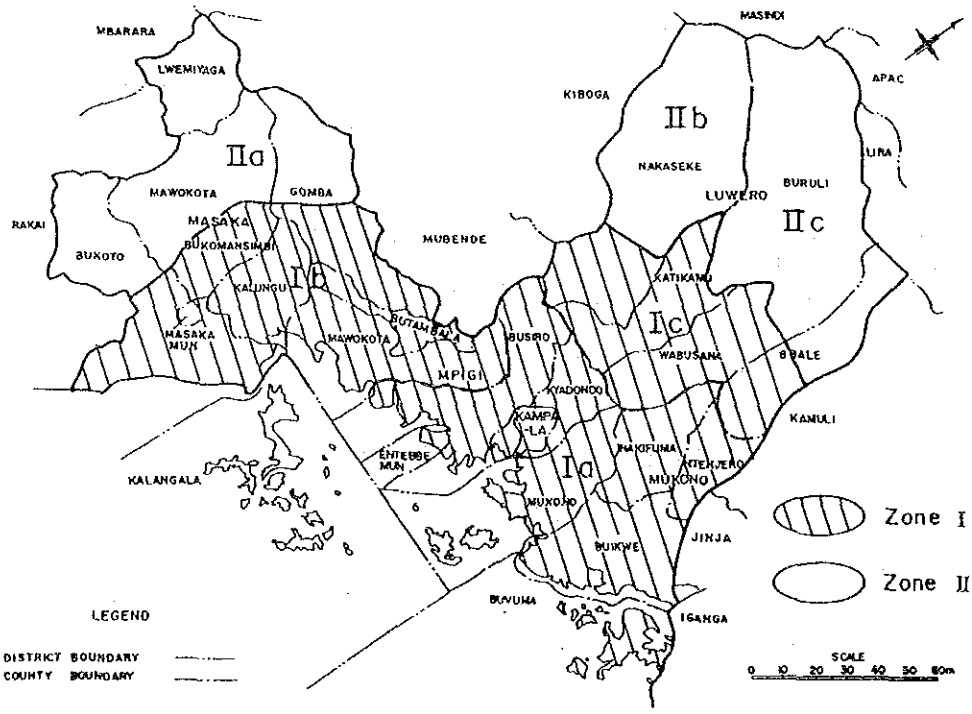
Source : FIS

Figure 3.3.2.1 Farming Systems in Uganda



Sorce : Production Zones and Target 1992-1995 by MAAIF

Figure 3.3.2.2 Agricultural Farming Zones



3) Existing Farm Management Types

(1) Outline of Farm Management

a) Table 3.3.2.5 shows the seven current farm management types. Each type is run by on average 3.5 head of family labour and 1.3 head of employees, drawn from around ten family members. Of a total farm household income of 1.12 million USHS, of which 460,000 USHS is from agricultural and 660,000 USHS from non-agricultural sources.

b) Most farmers cultivate such crops as banana(matoke), maize, beans, oil crops, mainly for self-consumption. The household income depends on the surplus of food crops and livestock products which can be sold, and the production of cash crops.

c) There are considerable differences in the kinds of cash crops cultivated in Zone I and Zone II. In Zone I, besides coffee, sugarcane, and tea, diverse horticultural crops have been added as new cash crops. This is thought that agricultural production aimed at urban consumers is developing in areas with convenient transportation systems near cities such as Kampala and Jinja. In Zone II, many farms grow cotton and peanuts and raise livestock.

d) Many farmers do not use fertilizers, agricultural chemicals or farm machinery. Consequently, land productivity is poor, the household produces no surplus, and there is little potential for re-investment.

e) Table 3.3.2.5 shows existing combinations of farming patterns. These are explained in further detail in the section below.

Table 3.3.2.5 Present Farm Management Types

Item		No. of Worker men	Size of Farm ha	Gross Income ,000USHS	Production Cost ,000USHS	Net Income ,000USHS	Total of Farmer ,000	Main Crop /Livestock
Type 1	Coffee +Banana	3.3 hired 0.3	2.74	1,381	481	900	144.8	Coffee Banana Tubers Beans +livestock
	Coffee +Banana +Vanilla	3.0 1.0	1.30	924	296	628	1.0	Coffee Banana Tubers Vanila +livestock
Type 2	Other cash crops +Banana	4.5 1.3	3.00	2,276	1,027	1,249	10.4	Coffee Banana Tubers Vanila or tea
Type 3	Horticulture	5.2 1.9	1.55	2,025	886	1,139	29.2	Banana Beans Vegitable Fruits +livestock
Type 4	Cereals Oil crops	5.2 1.4	3.13	1,729	964	765	19.4	Banana Tubers Beans Oil crops Cereals +livestock
Type 5	Cotton Oil crops	5.2 1.1	2.73	1,721	968	753	5.0	Banana Tubers Oil crops Cotton +livestock
Type 6	Banana Tubers	4.5 1.5	2.40	1,247	816	431		Banana Tubers Beans +livestock D.Cattle
Type 7	Dairy Cattle	4.4 1.2					5.1	Banana Tubers Cereals
	Beef Cattle	4.4 1.2					0.6	B.Cattle Banana Tubers Cereals
	Other Livestock	3.3 0.3	2.10	1,480	571	909	0.2	Poultry Banana Tubers

Source : FIS

(2) Farm Management Types

a) The income of type No. 1, farms that mainly produce coffee and bananas, is stable. Production costs are low and, in particular, wages and expenses for agricultural chemicals and machinery and equipment have been kept low. This indicates that crops are suited to natural conditions, such as weather and soil, that socioeconomic conditions such as distribution are also established, and that farming skills are also firmly rooted. However, as mentioned in section 3.3.1, Cultivation, there is little effort to improve cultivation technology through soil productivity control or introduction of new breeds. Both land and labour productivity are declining. These are issues to be addressed in improving productivity and rationalizing management.

b) The number of farms which belong to type No. 2 is increasing, through traders, into new products such as tea, sugarcane, cacao, vanilla, to replace coffee, since in recent years the world market price of coffee has remained low and the profitability of type No. 1 is declining. However, market prices fluctuate considerably, and both the cultivation technology and farming skills of small farmers have yet to establish, and so there is a great difference in output between farmers who have succeeded in this business and those who have not.

Coffee accounts for 95% of Uganda's agricultural exports. Specializing in one product is highly vulnerable to price fluctuations in the world market. Therefore, the diversification of export products (via Type No. 2) has become an important policy. It is possible to develop rural processing industries for these crops.

c) Type No. 3 produces horticultural products in areas surrounding cities. However, in this type of farming, some farmers are improving productivity by investing capital in seeds and fertilizers, while others practice extensive farming. Since crops are greatly affected by the weather, price fluctuations during good and poor harvests are also great, and the recovery of production investment is a major issue in farm management. Therefore, as previously mentioned, a large number of farmers (56%) still take a passive stance towards investment in fertilizers and other such expenses.

Since this type involves products whose demand will expand with the growth of cities, there is a need to steadily increase it in response also to future changes in national dietary habits.

d) Type No. 4 is based on cereals, which are also subject to rising urban demand. In developed countries, farm management of cereal cultivation is firmly established using large farm machinery, and of the farmers targeted by the FIS, those with farms of 30 ha or more in size also practice the same type of management. Furthermore, even some small-scale farmers have switched over from conventional plantain and tuber cultivation to cereal cultivation.

As mentioned in 6.2.2 Production Targets, only about 24% of cereal demand is met within the Study Area. Because this presents a market advantage for suppliers, it is believed that the production drive of farmers is heightening.

e) Although cotton production has fallen to one tenth of the pre-civil war volume, Type No. 5 is a management type which includes the highest hopes for a revival of cotton production in Uganda, where rainfall is low. However, there are some issues to be addressed. Firstly, many primary processing plants were destroyed in the civil war, and this is a great problem for producers and market distribution. Secondly, the commercial value of cotton will decline greatly if the quality of the raw material is poor. Thirdly, production costs such as agricultural chemicals are high compared to other crops. Consequently, if the market price declines, the burden on the farmer is considerable. It is important that these issues be resolved in order to establish a stable production system, and they are being studied in various projects.

f) The farmers in Type No. 6, mainly plantain and tuber growing farmers, have not made the transition from traditional farming. However, many wish to expand their farms in the future, and so this is a type to be added with new land and new crops such as paddy.

g) Type No. 7, centering on livestock, is a traditional pattern to be expanded further. There are diverse farming types, from large-scale farms of 1,000 ha to small-scale livestock and crop cultivation combination type farms of a few hectares. These farms cultivate plantains, tubers, and pulses as subsistence crops and raise cattle, goats, sheep, hogs, and chickens as commercial farm products. Farmers use their land not only to cultivate crops but to raise dual-purpose cattle. A few farmers specialize in hogs and chickens.

(3) Advanced farmers

The investigation covered farmers considered to be at an advanced level in each farm management type. An analysis revealed the reasons for their success and future issues as given below.

a) The principal crops grown by advanced farmers are still banana, potato and coffee, since these are the staple foods of the region and thus serve as cash crops. Since bananas and cassava are costly to transport due to their size and weight, they are shipped to urban areas only when the market price justifies the expense. When the market price is low, harvesting and distribution are cut back accordingly.

b) Coffee is increasingly popular as a cash crop for shipping outside the Study Area. Primary processing is carried out in rural villages, where the processed coffee can also be stored temporarily if necessary. As it can readily be transported long distances, coffee has become a common crop in many areas.

c) With changes in dietary habits, consumption of vegetables, fruits and meats is rising. The FIS found an increasing number of farmers growing vegetables such as tomato and cabbage on the outskirts of cities, especially larger ones like Kampala. However vegetable market prices can vary considerably, making this form of farming rather unstable. Initial costs -- fertilizers, chemicals and seedlings -- are high. And despite the need for proper cultivation management, of the 80 farm households interviewed only 50% spent money on fertilizers, 20% on chemicals,

and 30% on seedling renewal. When market prices fall profits suffer, which in turn puts the farmer off subsequent plantings.

d) Fruits such as passion fruit and pineapple, which are spreading through the region, involve the same problems as vegetables. Producers should be given training in farm management techniques. Many fruit farmers run into trouble because it takes several years from the initial investment in fruit trees before the first profits are actually made. Thus finance is an important issue for the future.

Recently the government has begun examining the export potential of products like vanilla and flowers. This has led directly to an increase in the number of 'advanced' farmers. With more money to invest in agricultural production, and more money for exporters and other private sector concerns, agricultural technology is gradually improving.

e) Larger farms plant more crops with continuity, which provide greater stability in farm management. Domestic demand for perennial varieties such as banana and coffee, and annual crops such as grains, beans and oil plants, is rising steadily and such produce is guaranteed to sell well.

Larger farms also tend to make more use of newer cultivation techniques to boost production efficiency and facilitate distribution. For instance, mixed rotation cropping will be used if enough labour is available, and single cropping if not.

4) Toward stability in rural areas

The following problems must be addressed to ensure the steady expansion of the agricultural industry in rural areas.

(1) Transportation

The lack of transportation for farmers prevents organized collection and transportation of goods in bulk. Traders have to visit each farm or garden in turn. This situation is a major obstacle to the growth of the agricultural produce industry. Goods are carried around farms by workers with bags, and taken outside farms chiefly by bicycle, in small lots. Traders are unable to ascertain the source, timing or quantity of deliveries, and thus unwilling to guarantee steady purchasing.

Only the trader visiting a particular farm or garden in his or her pick-up truck knows the type and quantity of produce available there. This gives them the advantage in negotiations over price and quality.

Were farm produce to be openly traded at markets, farmers with better quality goods would be able to negotiate from a position of strength and reap the financial benefits accordingly.

(2) Quality

Farmers struggle valiantly to cope with drought and disease, but make little attempt beyond this to improve quality or boost production levels. Buyers, especially export traders, are not interested in cash crops grown without attention to quality. Exporters in Kampala complain of deficiencies in three areas: bulk collection, quality, and stable shipping volume.

(3) Extension and new cultivation techniques

Five areas need to be addressed in order to improve both quality and production levels:

i) introduction of new, superior crop varieties
ii) application of fertilization and disease & pest control techniques
iii) use of green manure crops and organic material
iv) application of suitable cropping systems which sustain soil fertility, and
v) enhance soil improvement.

Extension organizations will be central to this process, and these need to be furnished with adequate means of transport to give individual extension workers proper access to farmers. At the moment, extension work in remote areas is severely restricted: workers are given motorbikes but not enough fuel for long distances, for instance.

3.4 Livestock

3.4.1 Animal Husbandry

Livestock is said to occupy 13 percent of all agricultural production in Uganda (National Agricultural Research Strategy and Plan). But in the Study Area where coffee and food crops have a high share, livestock product share is estimated to be 6%, a little below the national average. In the Study Area, beef cattle is popular taking advantage of natural inland grasslands. On the other hand, near the cities, more small and medium sized dairy farms are starting to appear. Furthermore, it is known that almost all farmers raise some domestic animals for self-consumption purposes. Taking this into account, promoting livestock is important in terms of agricultural development of local farmers and also of nutrition levels.

Popular domestic animals are cows, goats, sheep, pigs, and chickens. Husbandry systems vary considerably by the type of animal and area.

1) Animal population

Since much of the statistical data studied in the past differs considerably with respect to the number of animals, holding sizes and number of households, it was decided to look at a variety of data. Four kinds of data are available regarding animal numbers in each district:

i) MAAIF, National Census of Agriculture and Livestock (1990–91);
ii) MAAIF, EEC/WFP, agricultural Sector Survey 1986–1987;
iii) District Veterinary Office, yearly report to MAAIF; and
iv) Information collected from the District Veterinary Offices in this Study.

The census is thought to be the most reliable, although data is not detailed by district and the census study itself employs a survey method that emphasizes crops, so there may be problems with the sampling for the livestock census. Given that most beef cattle graze on public grasslands and considering nomadism, this would lead to a big error in the number of cattle.

A comparison was made of the four documents and it was decided to use data i) above for small and medium size domestic animals (goats, sheep, pigs, and chickens) which are raised in small numbers. Data iii) was used for cattle as it contains more precise data about local conditions, since the district office is involved in animal improvement and sanitation and has close contacts with farmers.

Data iv) was used for all types of domestic animals raised. Table 3.4.1.1 shows numbers of each animal in each District (see Appendix 2.4). According to the table, cattle hold a big share in the areas, totaling 667 thousand. Most are beef cattle, i.e. indigenous cattle such as Zebu and Ankole. The improved milk cattle, mainly Freisian, account for only 2%.

Table 3.4.1.1 Population and Type of Animal

Item	Population of Animal					Type of Animal			Remarks
	Luwero	Masaka	Mpigi	Mukono	Total	Indig-enous %	Exotic %	Im-proved %	
Cattle	234,400	240,417	110,737	81,294	666,848				
Beef	232,675	239,505	107,571	75,307	655,058	100	—	—	Zebu Ankole
Dairy	1,725	912	3,166	5,987	11,790	—	—	100	Friesians
Goats	43,800	115,400	58,900	148,800	366,900	100	—	—	Small East Africa
Sheep	3,100	11,800	10,900	50,400	76,200	100	—	—	Fat tailed breeds
Pigs	37,700	27,600	44,200	77,100	186,600	99	1	—	Landrace, Indigenous
Chicken	345,700	389,200	672,200	362,100	1,769,200	85	—	15	Broilers (8%) Layers (7%)

Notes: 1. Total cattle by District is from Appendix, considering Census Data accuracy. Heads of goats, sheep, pigs and chicken are from National Census of Agriculture and livestock (1990–91).

2. Types of Animals are based on information from District veterinary officers

2) Animal husbandry type

(1) Cattle

There is a big difference in cattle raising between the area around Lake Victoria, where farms dominate, and the inland area of savanna grass land. Around Lake Victoria, beef cattle and dairy cattle are kept on a small scale, being fed by cut grass, tethered, or on small pasture lands. In contrast, in the inland part of the country, cattle are raised on large-scale ranches or on free ranges.

The latter includes nomadic husbandry, in which people seasonally move around with the cattle. Cattle husbandry can be broadly divided into the raising of beef cattle primarily for beef production and the raising of dairy cattle primarily for the purpose of dairy production.

The former consists of free ranges which utilize public lands (national, local and lands for nomadic use) and individually managed ranches, while the latter consists of paddocking, in which dairy cattle are mainly raised in improved grassland areas, and zero-grazing in which

dairy cattle are mainly kept in one area and feed from improved grassland areas and agricultural by-products are brought and fed to them.

The number of cattle of each district by husbandry type with the average cattle holdings and the number of farmers are shown in Appendix 2.4. According to this, the number of dairy cattle is small (about 1.8%), but they are concentrated in Mpigi and Mukono. This demonstrates the fact that dairy farming aims at supplying milk to rural towns and neighboring villages. On the other hand, beef ranching, especially on huge ranches, is common in Luwero and Masaka Districts, mainly covered with savanna grasslands. The characteristics by husbandry type are described as below.

Although beef and dairy cattle are classified by breed, except for large-scale ranches, milk is taken from even from beef cattle, with 80% of the milk production within the region coming from beef cattle.

a) Free ranges

These are divided into small-scale grazers who combine crop cultivation with the rearing of small numbers of beef cattle (from one to ten head of cattle), and large-scale grazers who specialize in raising large numbers of beef cattle. The latter include many nomadic herdsmen, who seasonally move beyond district boundaries seeking grass and water. Herdsmen of both types graze animals on public lands and natural communal grasslands, also feeding goats and sheep in many cases. This brings many undesirable outcomes such as trespassing into established ranches, spreading of contagious diseases through crowding at certain drinking places during dry seasons, and bringing about soil erosion by overgrazing. The Uganda government is trying to encourage nomadic herdsmen to settle down by establishing ranches.

b) Ranches

There are two types of ranches: government-supported ranches established in the 1960's in units of five square miles (about 1,200 hectares), and others that are privately owned. Both types of ranches are usually fenced making boundaries clear. Facilities of water supply and disease control had been installed on most ranches but these facilities have deteriorated in many cases, and are in urgent need of repair.

c) Paddocking

While paddocking generally consists of raising foreign and mixed breed dairy cattle on ranches having improved grassland on a scale of around 18 head of cattle, there are some areas which manage upwards of 100 head of cattle. Grazing forms the mainstay of paddocking, although concentrated fodder is often provided through the use and purchase of feed grass. Milking is primarily done by hand, and milking on large-scale operations is done by hired labour.

d) Zero grazing

This is an indoor style of rearing dairy cattle on a small scale, mostly one to three cattle. Fodder is grown, cut and carried to the animal mixed with such crop residue as banana peels and sweet potato vines. In zero-grazing, domestic raising of livestock is well managed and the accident rate is low. Attempts to encourage this type is being made with aid from such NGO projects as the YMCA with the aim of improving the nutrition and income levels of small-scale farmers.

(2) Goats and Sheep

Goats and sheep are raised for meat. Occasionally 100 to 200 goats and sheep will graze together with cattle, but generally they are tethered near farm houses on a small scale. According to MAAIF's National Census, 367,000 goats and 76,000 sheep are raised in the Study Area, of which 87% of goats and almost all sheep are raised in numbers less than ten.

Goats have traditionally been left out to graze on natural grasslands. The accident rate for kid goats is high at around 50%, and their size are small due to in adequate improvements in the health and condition of the breeds.

(3) Pigs

Almost 100% of the more than 186,000 pigs are raised locally on a small scale of ten head or less by farmers who are primarily crop farmers, and the pigs are often allowed to roam freely on the farm plots. While they are raised on grass and crop by-products, the pigs are also sometimes given surplus cassava and sweet potatoes.

(4) Poultry

85% of the poultry are indigenous kept on free range system. They are housed at night and left out during the day to roam freely in search for food around the farm plot. They are kept mainly for meat and a few eggs if any in excess of their brooding capacity. The 15% include exotic breeds of the two types, layers (for eggs) and broilers (for meat). There are kept indoor mainly by the deep-litter system and fed on commercially prepared feeds.

(5) Beekeeping

Beekeeping in Uganda began in the 1960's. Although it is estimated that total nationwide output could potentially reach 1000–1200 tons per year, FAO put 1991 production record at only 230 tons, of which 100 tons was consumed domestically.

Within the Study Area even the more enterprising farmers make bee houses by the traditional method of curling banana leaves in a cylinder and hanging in a cool place in the shade of a tree. Honey has to be extracted by destroying the bee house, which is highly inefficient.

Since the bee houses are left unattended, the bees have known to desert their home if sources of honey run out or the lack of water during the dry season.

The government, aware of the high nutrient content of honey, is encouraging and providing training in order to raise farm incomes. Due to the lack of equipment and experience however yields are still low.

Within the Study Area the supply of honey from tree flowers is excellent all year round, and there is considerable potential to develop beekeeping in combination with pollination of crops and other plants.

3.4.2 Grasslands

1) Ecosystematic classification of natural grasslands

Most beef cattle, goats, and sheep are grazed on natural grasslands. Dairy cattle are raised on improved pastures and supplemented by commercially manufactured fodder.

As shown in Figure 3.4.2.1, Ugandan natural grasslands are categorized into seven zones according to the dominant grass in each ecosystem. There are three grassland zones in the Study Area, Pennisetum purpureum grassland, Dry hyperrhenia grassland and Themeda triandra grassland.

a) Pennisetum purpureum grassland:

This area receives rainfall of above 1,000 millimeters per year. Intensive agriculture of annual and perennial crops is common in the areas close to Lake Victoria.

b) Dry hyparrhenia grassland:

Here rainfall is moderate and the dry seasons are well marked. The vegetation is grassland with scattered trees. It supports few perennial crops. Includes the northern parts of Luwero and Mukono Districts.

c) Themeda triandra grassland:

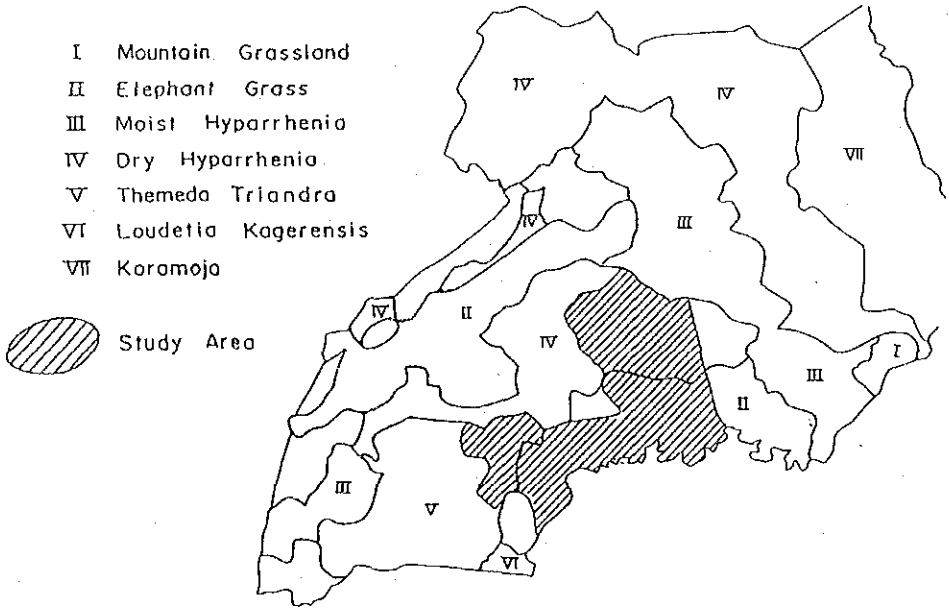
Rainfall is low, with pronounced dry periods during which bush burning is frequent. It is associated with Acacia trees. Covers the north-west of Masaka District.

2) Grasslands productivity

Grass from natural grasslands, seldom cut for hay and silage, is instead used for pastures. Grass yield depends on rainfall as well as on whether leguminous plants are mixed in with the grass or not, thereby making it difficult to determine accurately. Grass without leguminous plants is estimated to produce 5,000 to 8,000 kg of dry matter per hectare per year, and with leguminous plants at 7,000 to 9,000 kg per hectare per year.

Most pastures are poorly established and managed due to the shortage and high cost of pasture seeds, fertilizers, labour, as well as a lack of mechanisation.

Figure 3.4.2.1. Natural Grassland Types in Uganda according to Dominant Grasses



3) Area of grassland

At present there is no reliable data on the area of grasslands used regarding herbivorous livestock species. Instead, the area was estimated from livestock numbers and grass production volumes as follows:

i) The total grass requirement is derived from the number of cattle, goats and sheep multiplied by grass consumption by each.

ii) Annual grass yield per hectare is obtained taking grass usage rate into consideration for each natural grass type.

iii) Natural grassland area is estimated from the total grass requirement divided by annual grass yield.

Appendix 2.4 gives the estimates thus obtained for each Sub-county. From these the total grassland area within the Study Area was estimated at 715,000 ha.

3.4.3 Livestock Breeding and Sanitation

1) Organization

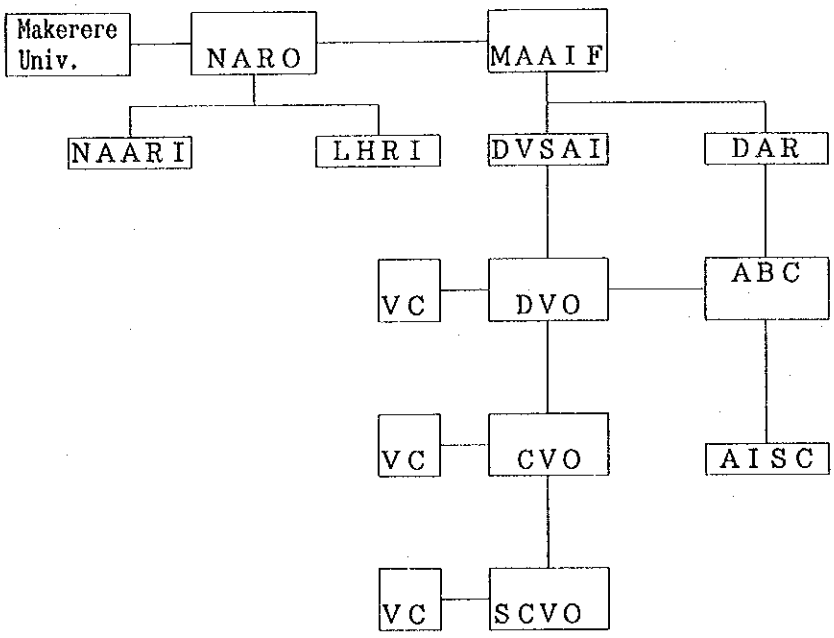
Main issues for promoting livestock, besides improving feeding methods, are improving indigenous breeds which are low in productivity and sanitation mainly to protect animals from the many contagious diseases common in the tropics. There are three organizational lines involved in this field (see Figure 3.4.3.1).

a) The first is livestock production testing and research. As well as Makerere University this includes the Animal Health Research Centre (AHRC) and the Uganda Trypanosomiasis Research Organization (UTRO). AHRC is to presently restoring the Entebbe farm and Masaka testing facilities with the assistance of GTZ and ODA. Experimental and research capability has improved considerably over the last few years. In the future AHRC is be merged with UTRO into a Livestock Health Research Institute (LHRI) under NARO. NAARI also carries out research into livestock production.

b) The second is livestock sanitation. The MAAIF Department of Veterinary Service and Animal Industry (DVSAI) is at the top. District Veterinary Office (DVO)—County Veterinary Office (CVO)—Sub-county Veterinary Offices (SCVO) form a vertical line arrangement. Some of the latter two are Veterinary Centres (VC), responsible for inoculation and treatment of illnesses.

c) The third is livestock improvement. Under the MAAIF Directorate of Animal Resources (DAR), the Artificial Breeding Centre (ABC) distributes frozen semen through DVO to Artificial Insemination Sub-Centres (AISC), working to improve cattle breeds through artificial insemination

Figure 3.4.3.1 Organization Chart of Animal Breeding and Veterinary



2) Livestock sanitation

Although accurate herd numbers are unavailable around the period of civil war, it is estimated that cattle numbers fell by half in Luwero and Masaka, two districts that saw the heaviest fighting. Recovery after the war (i.e. from 1986) has been slow.

One of the major reasons is delays involved in rehabilitation work on livestock hygiene facilities destroyed in the war. Once thriving centres for animal health, VCs, are now severely limited by the lack of equipment and means of transport, and unable to control strongly virulent diseases affecting various types of animals.

A variety of projects to stimulate livestock farming are being carried out throughout the country under the umbrella of the IDA-funded Livestock Service Project (1991 - 95). Given the size and scope of the Project, however, funds for restoration of VCs are virtually unavailable. (Livestock diseases and remedies, the Livestock Service Project are described in Appendix 2.4.)

3) Livestock breeding

There are two ways to improve cattle breeds: introduction of foreign breeds and artificial insemination. Cross-breeds with Freisians, Jersey, Guernsey and Ayrshire already account for 4% of total cattle numbers.

Insemination is still 95% reliant on natural methods. Some of the large ranches improve breeds using their own bulls, but smaller farmers usually just use the nearest bulls available.

VC veterinarians and AISC experts are supplied with frozen bull semen for artificial insemination from ABC through DVO.

The ABC, established in the 1960's to tackle domestic breed improvement, no longer produces semen after its facilities were deteriorated during the civil war. Presently there is no bull and all frozen semen is imported. The uncertainty of this setup (for instance, should the semen supply be cut off) has prevented the livestock improvement program from regaining its earlier momentum.

3.4.4 Livestock Production and Consumption

1) Production

Production levels of beef, milk, goat meat, mutton, pork, chicken and egg in the Study Area were calculated for each county, by multiplying the number of animals by average output per head. The output of cattle per head was estimated from husbandry standard of cattle, while outputs for other animals were obtained from the FAO Production Yearbook 1991.

2) Consumption

Consumption of animal produce in the Study Area for each county is based on consumption per capita from the FAO Yearbook multiplied by population, taking into account differences in consumption per capita between rural areas and cities such as Kampala.

3) Balance of supply and demand

Table 3.4.4.1 sets out these calculations in terms of supply and demand for meat (beef, lamb, chicken, pork and goat), milk and eggs within the Study Area. It indicates that surpluses of meat (2,100 tons, or 8% of total production) and milk (6,900 tons or 9%) go outside the Study Area, to Kampala and Jinja.

Table 3.4.4.1 Production and Consumption of Livestock Products

Item	Production	Consumption	Balance	(Reference) Consumption of Kampala
(Meat)	ton	ton	ton	ton
Beef	15,754	12,427	3,327	4,772
Goat Meat & Mutton	1,967	3,930	-1,963	1,696
Pork	8,396	5,835	2,561	859
Chicken	2,707	4,547	-1,840	1,556
Total	28,824	26,739	2,085	8,833
(Milk)	76,527	69,586	6,941	34,980
(Eggs)	1,416	2,450	-1,034	1,394

Source : Estimate of the Study Team

3.5 Processing and Distribution

3.5.1 Processing

1) Outlook for processing of agricultural produce

The principal agricultural items processed in Uganda are coffee, cotton, tobacco and tea, which are then exported.

In coffee processing, the ratio of cooperatives to individual processing agents is estimated to be 55:45 in terms of the number of hullers. Cotton is processed by cooperatives, while tea is processed by public companies and individual processors. Tobacco is under a BAT monopoly. Maize flour and cassava flour are processed in each district by individual processing agents.

Coffee (kiboko) is dried on farms then sold as fair average quality (FAQ) after being hulled. Cotton seed is dried and sorted on the farms, and then processed and sold as lint. Tea is sold as "made tea" after the green leaves have been processed.

Problems related to these facilities include:

i) inconsistent or low quality of raw materials due to technology on farms
ii) restrictions on produce collection due to underdeveloped roads
iii) reduced processing equipment capacity due to age and difficulty in obtaining spare parts
iv) irregular power supply.

Livestock produce is traded in markets after being slaughtered in few local slaughter houses with refrigeration equipment or slaughter slabs which have no refrigeration equipment. In most cases, livestock is slaughtered directly by butchers using simple facilities near the local market. Because there are no refrigeration facilities, the dressed carcasses are not stored long, and this causes losses as the meat goes bad. The development of slaughtering facilities and refrigeration equipment for storing dressed carcasses will become increasingly important, since meat consumption is expected to rise in future.

Milk processing facilities managed by the Dairy Corporation (established in 1967 with government funding) are to be found in Kampala, Entebbe and Mbale, where fresh milk is pasteurized, packed and sold. Yoghurt, ice cream, cheese and butter are also produced in Entebbe. Milk is also sold to other milk collection centres with refrigeration facilities and retail outlets, but there are no pasteurizing facilities, which makes it difficult to control the quality of fresh milk.

The main agricultural processing facilities such as for coffee, cotton, tea, fruits, meats in the Study Area are listed in Table 3.5.1.1.

Table 3.5.1.1 The Number of Main Processing Facilities

The name of facilities		LUWERO	MASAKA	MPIGI	MUKONO	Total
Coffee	Private	14	39	43	50	146
	Cooperative	5	9	25	19	58
	Public					
	Total	19	48	68	69	204
Tea	Private		3		4	7
	Cooperative					
	Public				3	3
	Total		3		7	10
Cotton	Private					
	Cooperative	1				1
	Public					
	Total	1				1
Fruits	Private					
	Cooperative		1			1
	Public					
	Total		1			1
Slaughter House	Private					
	Cooperative					
	Public		1	1	1	3
	Total		1	1	1	3

Source : Data of DAO, DCO and DVO

2) Typical processing facilities

Of the many processing facilities studied, four typical facilities are described below for coffee, cotton, meat and milk.

(1) Coffee processing facility

Location: Mukono county, Mukono district

Organization: Nakayago Growers Cooperative Society

This processing facility comprises a hulling factory for coffee (kiboko) produced mainly by the 1,500-member cooperative society. Annual production was 1,358 tons in 1992, and the main purchasers were CMB and other exporters.

Seventy percent of the kiboko is purchased from cooperative members, and the remainder from non-member farmers or traders. The purchase price is 290 USHS/kg for goods brought to the factory by the farmer, and 280 USHS/kg if collected from the farms. The sale price to CMB and other exporters is 628,500 USHS/ton for Grade 1.

The main facilities consist of a factory and two warehouses, which were built in 1974 and 1975 using society funds. The main problems are:

i) undeveloped feeder roads making access impossible to some areas for the society's trucks

ii) high workers' wages

iii) poor quality of kiboko produced without expensive fertilizers or agricultural chemicals.

(2) Cotton processing facility

Location: Katikamu county, Luwero district

Organization: East Mengo Union

This facility is run by 14 workers and 3 managers. Lint production was 585 bales in the seven-month period of operation from December 1991 to June 1992, and the lint was sold to LMB and private traders.

Seed cotton is bought not only from cooperative societies in Luwero, but also from Mukono. Purchase prices are 300 USHS/kg for AR and 170 USHS/kg for BR. The sale price ranges from 1,382 USHS/kg to 1,531 USHS/kg for AR. Cotton seed is also sold to oil processors.

The main problems are:

i) irregular power supply

ii) parts difficult to obtain for the old machinery

iii) high transportation costs

(3) Slaughter house

Location: Masaka town, Masaka district

Organization: Masaka Butchers Association

This slaughter house is used to slaughter and butcher livestock (cattle, goats and sheep) brought in by traders and butchers. It is affiliated to Masaka Town Council, and employs ten slaughter men.

The slaughter charges are 2,500 USHS for one cow. On average, eight cows are processed on a weekday and 15 to 20 on a Saturday. Fewer goats and sheep are processed than cattle.

The main facilities are a livestock processing building (with outdoor slaughter yard) and a livestock tethering building. The former comprises four butchering rooms, a refrigeration room, a hot water supply facility and an office. The animals are slaughtered in the outside slaughter yard, then after bloodletting, they are hung on hooks and cut up into dressed carcasses in the butchering room before being stored in the refrigeration room. However, the refrigeration room and the hot water boiler are in a state of disrepair.

(4) Milk collection centre

Location: Mukono district

Organization: Nubuka Dairy Association

This centre is affiliated to the Nubuka Dairy Association, set up in 1989 with aid from UNDP and FAO. The purpose of the centre is to bring milk from farms to market, and it has 600 participating farmers. Between 600 and 1,200 liters of milk are output daily. The milk is stored in a 3,000 liter cooler. Some 300 tons is sold to consumers annually. Milk is purchased from the farms for 300 USHS/liter, and the farmers take the milk to the centre by bicycle. The milk is then sold for 370 USHS/liter if the customers bring their own containers. Recently, milk has started to be sold in sachets at 230 USHS/500cc.

3.5.2 Distribution

The main farm products produced and distributed in the Study Area are coffee, cotton, grain and others such as bananas, root crops, fruits and vegetables. Milk, meat and eggs should also be included as main livestock products. These are sold to markets inside the Study Area and in Kampala and Jinja through distribution organizations.

1) Distribution of farm and livestock produce

(1) Coffee

In 1990, coffee production in the Study Area reached 170,000 tons. The coffee (kiboko) is processed (hulled) by cooperative societies or cooperative unions and private processors through local dealers after harvesting and drying by farmers. The processed coffee is then bought by CMB, UNEX and private exporters and is exported from the ports of Mombasa in Kenya and Dar es Salaam in Tanzania after being graded by CPSU.

Coffee exports were monopolized by CMB after it was first set up, but now by UNEX and other private exporters are also involved: between October 1991 and September 1992 the breakdown was 84% CMB, 12% UNEX and 4% private traders. However, in October 1992—March 1993 this changed to 29% for CMB, 9% for UNEX and 62% for private exporters, reflecting the growing participation of private exporters following the legalization of private sector companies for coffee exports in 1992 (see Table 3.5.2.1).

CMB is a coffee marketing board set up with government funding in 1969. It has now lost its original monopoly on the purchase, export and sale of coffee, under the government policy of free competition. UNEX was set up to represent the district cooperative unions (Bugisu, Busoga, Masaka and Banyakole Kweterana) in coffee exports.

Table 3.5.2.1 Quantity and Shipping Share of Coffee Export

Period	C M B		UNEX		Private Trader		Total	
	Quantity	Share	Quantity	Share	Quantity	Share	Quantity	Share
	(ton)	(%)	(ton)	(%)	(ton)	(%)	(ton)	(%)
Oct.1991 ~ Sep.1992	102,083	84	14,457	12	5,358	4	121,898	100
Oct.1992 ~ Mar.1993	29,732	29	9,104	9	64,183	62	103,019	100

Source : UCDA Annual Report, Data of CMB

(2) Cotton

In 1990, 940 tons of cotton was produced in the Study Area. Seed cotton is harvested and dried by the farmers, graded into categories, and stored by cooperative societies. It is then processed into lint by the cooperative societies and marketed to domestic textile factories as cotton lint. The cotton seeds produced during lint processing are sold as seeds for future cotton production, and the remainder sold to oil and soap factories for processing into edible oils and soap. Cotton seed cake is sold to animal feed manufacturing companies as fodder for livestock.

LMB is a lint marketing board set up with government funding in 1947 for purchasing and selling (exporting) lint cotton and cotton seed. At present, it still holds a monopoly on the export of lint cotton, exporting 7,820 tons in 1991.

(3) Grain

In 1990, 69,000 tons of grain was produced in the Study Area. Grain is harvested and dried by the farmers, then marketed to local and urban markets through i) cooperatives, ii) parastatals (PMB, F&B, UGMC), and iii) private traders. These are the three main types of distributor, excluding in-house consumption by the farmers. Grain is also exported from the ports of Mombasa and Dar es Salaam, as with coffee and cotton.

The export of grain was monopolized by PMB up to 1987, but PMB lost its monopoly in 1988 when the government privatized the market, and F&B and private traders now also handle exports. Shares of exports of maize in 1990 were 49% for PMB, 24% for F&B and 27% for private traders. Thus PMB still controls about half of all grain exports (see Table 3.5.2.2).

Table 3.5.2.2 Quantity and Shipping Share of Grain Export, (in 1990)

Item	P M B		F & B		Private trader		Total	
	Quantity	share	Quantity	share	Quantity	share	Quantity	share
	(ton)	(%)	(ton)	(%)	(ton)	(%)	(ton)	(%)
Maize	12,992	49	6,425	24	7,316	27	26,733	100
Beans	1,081	12	1,980	21	6,217	67	9,278	100

Source : Report of Master Plan for the Grain Marketing Sector

Although there is no officially published data on domestic distribution volumes (with the exception of the main distributors), the DANIDA survey estimates that 48% of maize is distributed domestically. Based on this figure, in 1990 PMB handled 11%, F&B 2%, UGMC 4% and the other 83%. The majority of the other distributors are thought to be private traders, who dominate the domestic distribution of grain (see Table 3.5.2.3).

Table 3.5.2.3 Domestic Distribution of Main Grain (in 1990)

Item		Unit	Maize	Beans
Estimated quantity of grain marketed		(ton)	280,300	110,900
PMB	Quantity	(ton)	31,791	5,849
	Share	(%)	11	5
F&B	Quantity	(ton)	5,665	3,261
	Share	(%)	2	3
UGMC	Quantity	(ton)	10,403	1,603
	Share	(%)	4	2
Others	Quantity	(ton)	232,441	100,187
	Share	(%)	83	90

Source : Report of Master plan for the Grain Marketig Sector

The main constraints in the distribution and selling of grain are:

i) Too few collection points in rural areas, leading to low collection levels
ii) Fluctuations in market price
iii) High grain losses to insects and rotting
iv) High transportation and packaging costs
v) High interest rates on bank loans

Further details are given in Appendix 2.5.

(4) Other agricultural produce

Tea and sugarcane are mostly produced on large-scale farms (estates) and distributed from these estates. Bananas (matoke), root crops (Irish potatoes, cassava, etc.), fruit and vegetables are generally sold to rural and urban markets through private traders. For rural markets, goods are sometimes purchased directly from the farmer by market retailers. No union has been organized as for coffee, cotton and grains, so produce is sold to traders by negotiation.

(5) Milk

It is estimated that 44% of milk produced in Uganda (437,000 tons in 1991) is consumed in-house by farmers, while the remainder is sold to neighbors or through traders to rural and urban markets and to the Dairy Corporation (DC), which has processing facilities for pasteurization and packing.

The majority of milk produced in the Study Area, excluding that consumed by farmers, is sold directly to neighbors or through small traders to local town markets. In towns in Luwero, Masaka, and Mukono there are also milk collection centres run by cooperative societies, where milk collected from nearby farms is refrigerated before being sold to consumers. However none of the milk is pasteurized, which increases losses. The shortage of refrigeration facilities limits the volume of milk that can be stored for long periods. The inadequate milk transportation system (including the poor network of rural roads and means of transportation) also limit the volume of milk reaching the market.

Within the Study Area, there is one milk collection centre in Luwero two in Masaka and three in Mukono.

(6) Meat and eggs

The main livestock reared in Uganda are cattle, goats, sheep, pigs and poultry. In 1991, 188,000 tons of meat was produced from these sources, all of which was consumed domestically. Almost the same type of animals are reared in the Study Area. Cattle, goats and sheep are purchased by traders or butchers through livestock markets, then sold in rural and urban markets after being butchered at the slaughter houses. Major traders in Kampala purchase from livestock markets as well in large volumes directly from the ranchers and communities located far from the livestock markets, and sell in Kampala and Jinja. Small-scale butchers are also known to purchase livestock directly from the farms for subsequent resale. Pigs, poultry and eggs are sold directly to the markets through traders.

There are six livestock markets in Luwero, eight in Masaka, two in Mpigi, and one in Mukono. Cattle, goat and sheep markets are held once a month. A study in Masaka found the sale price to be 70,000 to 100,000 USHS/head for cattle, 10,000 to 15,000 USHS/head for goats, and 8,000 to 10,000 USHS/head for sheep, (prices settled by negotiation). Trading prices in each district are not published in newspapers or elsewhere, as is the case with farm produce. Therefore, farmers have no guidelines on prices and may be selling below the market price for their livestock.

Since more livestock are likely to be bred in future to meet rising meat consumption, livestock markets will have to be distributed more rationally, and information on livestock trading will have to be published, as is the case with grain.

2) Storage of farm produce

Agricultural produce currently grown and stored in the Study Area includes coffee, cotton and grain. These are stored in separate storage facilities at the farms and distribution stages as outlined below.

(1) Storage at farms

Agricultural produce stored at farms includes coffee, cotton and grain. After harvesting, these are put into sacks and stored in storehouses or inside the family farmhouse. However, problems with storage on the farm include damage from insects and rodents, rotting due to mold, theft and inadequate storage space.

For low-volume, short-term storage of farm produce, the goods are often stored inside the family farmhouse for convenience and to prevent theft. Grain is stored for longer periods, while harvested grain is usually shelled, threshed and winnowed before being sacked and stored. However, sometimes it is stored after being dried without shelling, threshing and winnowing in order to reduce the damage caused by insects when stored for a long time.

Storehouses on farms usually have walls of woven branches daubed on both sides with mud, standing on a raised floor with a roof of thatched grass. These storehouses last 6 to 8 years at most. In the farms that were visited during the field study, some storehouses let in rainwater, and walls appeared to be in danger of collapsing. This is likely to cause severe losses due to rotting grain, rodents and insects.

Harvested farm produce, with the exception of that for in-house consumption, is stored on the farm until sold to traders and elsewhere, though the exact period of storage depends on the farm. According to the FAO survey, 60% of farms sell their grain within 1 to 2 months of harvesting, while 22% of farms store their grain until prices rise just before the following harvest before selling. About 80% of farms sell their grain within four months of harvesting due to:

i) urgent need for cash
ii) damage from insects, rodents and mold
iii) lack of proper storage facilities.

Coffee and cotton are not stored for long, but sold to cooperative societies and local traders soon after harvesting and drying.

As shown in Table 3.5.2.4, storage losses in farms that hold their produce for three months are 1.6% for maize, 2.1% for sorghum, 1.5% for beans, and 1.7% for ground nuts. When stored for six months, the losses are 5.7% for maize, 6% for sorghum, and 5.6% for peas. When stored for nine months, the losses rise to 12.8% for maize, 11.8% for beans and 13.1% for peas.

Thus, the longer the storage time, the greater the losses due to insects, mold and rodents. Yet few farms use insecticide to counteract such damage. Because of the high cost of such insecticides, most farmers prefer to sell the grain before the damage becomes too great, regardless of market price.

Table 3.5.2.4 Losses of Main Crops by Storage

Crop	Field drying in Storage (%)	Harvesting, Shelling Threshing, Winnowing Losses (%)	Main Loss Agents in Storage Damage	Mean Weight Loss (%) by Length of Storage		
				3 months	6 months	9 months
Millet	7.5 Birds/Shatter	4.7	Rodents	N.A	N.A	N.A
Maize	12.5 Birds/Mammals	4.9	Insects, Rodents	1.6	5.7	12.8
Sorghum	6.8 Birds	4.5	Insects	2.1	6.1	N.A
Beans	6.3 Birds/Rat	3.5	Insects, Moulding	1.5	5.6	11.8
Peas	7.5 Birds/Rat	3.8	Insects, Rodents	N.A	5.9	13.1
Groundnuts	8.0 Rodents/Mammals	1.5	Insects, Moulding	1.7	N.A	N.A
Simsim	4.5 Shatter	5.8	Insects	N.A	N.A	N.A
Cassava Chips	15 Rodents/Moles	8-15 Poor Transport	Insects	N.A	N.A	N.A
Sweet Potatoes	13 Rodents/Moles	4-7 Poor Transport	Insects	N.A	N.A	N.A
Banana	4-6 Hailstone Nematodes	20-25 Poor Transport				

Source : Technical report of the post harvest loss prevention project
Note : N.A = Not available

(2) Storage at the distribution stage

For storage at the distribution stage, each of the distribution organizations (cooperative societies, private traders, PMB, CMB, LMB, etc.) have their own storage facilities.

a) Storage of coffee and cotton

Cooperative society storage facilities mainly hold coffee, cotton and other export crops; there are few facilities for grain. The Luwero Triangle Rehabilitation Project, centered around Mpigi and Luwero, where great damage was sustained during the civil war, is currently renovating its storage facilities. In Mpigi, thirty new storage facilities have been built by UCA/SCC, while in Mukono, UCA is planning three new storage facilities.

Cotton is processed by the cooperative unions and then either sold to domestic traders or bought by LMB for export. Prior to export, it is stored in domestic facilities owned by LMB in Totoro, Iganga and Mbale, or in foreign export bases at Mombasa (Kenya) and Dar es Salaam (Tanzania).

b) Storage of grain

The distribution of grain is mainly undertaken by private traders, PMB, F&B and UGMC. While private traders in the districts mainly concentrate on short-term storage and therefore have only small storage facilities, the major private traders in Kampala and Jinja either own or lease large warehouses and are thus able to store greater quantities of grain. F&B owns 36 warehouses of up to 500 tons used as collection centres for grain in the production regions, as well as a warehouse in Kampala, with a total capacity of 15,000 tons. UGMC has wheat warehouses in Kampala and Jinja with a total capacity of 13,000 tons, and grain warehouses with a total capacity of 7,000 tons. DANIDA is planning to construct a 6,000 ton grain storage facility in Jinja.

Storage facilities owned by PMB are listed in Table 3.5.2.5.

Table 3.5.2.5 Main Storage Facilities of PMB

Depot	Storage Type	Storage Capacity	Main Machinery	Year of Construction	Year of Latest Rehabilitation
		ton			
Jinja	silo	20,000	Cleaner Dryer	1991	
Nalukolongo	Warehouse	18,000	Cleaner	1976	1988
Tororo	//	18,000	Cleaner	1976	1989
Kasese	//	6,000	Cleaner	1976	1989
Kyazanga	//	3,000	Cleaner Dryer	1990	
Gulu	//	※ 6,000	Cleaner	1976	

Source: Master Plan for the Grain Marketing Sector

Note: * Represents not usable capacity

3) Surplus of agricultural and livestock produce

(1) Agricultural produce

Excluding consumption by the farm households themselves, surplus agricultural and livestock produce from farms is sold to consumers through distribution organizations such as traders. No information is published on surplus produce in the districts surveyed and thus the actual statistics are not known. Figures are therefore based on DAO information on yield and planted area by county. Table 3.5.2.6 shows the surplus by country calculated from national per capita consumption estimates.

The figures show that, except for a few counties, all districts have surpluses of plantains and tubers, the principal foods of the Ugandan people. Masaka district in particular produces a large surplus. However, there are shortages of cereals such as maize in all districts overall (except in a very few counties), and thus although cereals are distributed within individual counties, probably very little cereal is sent outside. Approximately 40% of the counties produce surpluses of pulses (e.g. beans) and oilseeds (e.g. ground nuts). Mpigi has a surplus of vegetables and Masaka of fruits and vegetables.

(2) Livestock produce

The surplus of livestock produce was estimated from the number of livestock in each county (see Section 3.4.1). The surplus is the balance between production and consumption, estimated from the population and consumption per capita.

According to the figures shown in Table 3.5.2.7, 40% of the counties have a milk surplus. However, excluding milk sold to Kampala by farmers in nearby suburbs, almost all of the surpluses are believed to be consumed by neighboring counties with shortages. Like milk, 40% of the counties produce a surplus of beef, and these surpluses are both consumed by neighboring counties with shortages and sold as live cattle to large consumption areas like Kampala. There are shortages of goats, sheep, chicken meat and eggs in all districts, and almost all supplies are thought to be consumed only in the original county of production. Approximately 60% of the counties have a surplus of pork, but this is either consumed by the breeders themselves as a substitute for beef or sold to nearby countries. Thus very little pork is sold to other areas of consumption like Kampala.

Table 3.5.2.6 Surplus of Main Agricultural Products

District	County	Bana-/Tube-	Banana	Tubers	Cereals	Pulses	Oilseeds	Vegetables	Fruits
Luwero	Bamunanika	+ +		+ +		+		+	+
	Buruli	+ +		+ + +		+	+		
	Katikamu	+		+ +				+	
	Nakaseke	+ +		+ +		+		+	+
Masaka	Bukoto	+ +	+	+				+	+ +
	Bukomansimbi	+ + +	+ + +	+		+	+	+	+
	Kalutanga	+ + +	+ + +	+ +				+	+
	Lwemiyaga	+	+	+	+	+	+	+	+
	Nawagola	+ +	+	+				+	+
Mpigi	Busiro			+				+	
	Butambara	+	+	+		+		+	
	Gomba			+		+	+	+	
	Kyadondo			+				+	
	Mawokota	+ +	+	+ +		+		+	
Mukono	Bbale			+			+		
	Buikwe		+						
	Buvuma	+	+			+	+		
	Mukono	+	+						
	Nakifuma	+		+					
	Ntenjeru	+	+	+			+		+

Noes : + : Under 25,000ton
+ + : 25,000~50,000ton
+ + + : over 50,000ton

Table 3.5.2.7 Surplus of Main Livestock Products

District	County	Milk	Meat				Egg
			Beef	Goat/Mutton	Pork	Chicken	
Luwero	Bamunanika	+	+	+	+	+	+
	Buruli	+ + +	+ + +	+	+	+	+
	Katikamu						
	Nakaseke	+ +	+ + +		+		
Masaka	Bukoto			+			
	Bukomansimbi				+		
	Kalutanga		+	+			
	Lwemiyaga	+ + +	+	+		+	
	Mawokota	+ + +	+ +	+			
Mpigi	Busiro				+	+	+
	Butambara					+	+
	Gomba	+ + +	+ +	+		+	+
	Kyadondo						
	Mawokota						
Mukono	Bbale	+ + +	+ +				
	Buikwe				+		
	Buvuma	+					
	Mukono				+		
	Nakifuma				+		
	Ntenjeru				+		

Explanatory Notes : + : under 1,500ton
+ + : 1,500~3,000ton
+ + + : over 3,000ton

3.6 Agricultural Support

3.6.1 Research

Agricultural research in Uganda was placed under the aegis of the National Agricultural Research Organization (NARO) in December 1992. Up till then there had been lack of coordination among the various research organizations, which were under the jurisdiction of different Ministries. Before July 1991 the Ministry of Agriculture and Ministry of Animal Industry and Livestock were separate entities. In addition forestry research was carried out by the Ministry of Energy, Mines and Environment Protection. NARO, a semi-autonomous body, was formed in an attempt to rectify these problems.

NARO proposed a massive restructuring of agricultural research organizations, as shown in Table 3.6.1.1. (March, 1993)

Of the organizations shown in Table 3.6.1.1, Kawanda Agricultural Research Institute (KARI) and Namulonge Agricultural and Animal Production Research Institute (NAARI) are located in the Study Area. KARI conducts research into perennial cash and food crops such as coffee, banana, cacao and horticulture, farming systems, soil and crop protection, the introduction of plants, as well as quarantine services, while NAARI conducts research on annual industrial and food crops such as yam, sweet potato, beans and maize, as well as crop and livestock management systems and pastures.

The two agricultural research institutes is considerably restricted by:

i) Inadequate research facilities and lack of operating funds
ii) Lack of basic infrastructure such as water, electricity and communication
iii) Poor salary structure and inadequate career development and training opportunities for scientists
iv) Poor contact between Ugandan, regional and international research institutions, and underdeveloped relationships with universities, extension services, farmers and the private sector.

NARO has recently been involved in institutional restructuring, budget allocation and the fixing of national research priorities with financial support from IDA. Funding is inadequate however, and research still insufficient.

IDA also is assisting with fisheries research, and USAID with forestry research and human resource development via a "Manpower for Agricultural Development" Project. EEC and UNDP are assisting with research on crop production and GTZ with livestock research.

Table 3.6.1.1 Restructuring Plan of Agricultural Research Organizations

No	Name of Organization	Mandate
	{Institute}	
1	Serere Agricultural and Animal Production Research Institute	Retained
2	Livestock Health Research Institute Tororo, formerly UTRO (Uganda Trypanosomiasis Research Organization)	Retained
3	Kawanda Agricultural Research Institute (KARI)	Retained
4	Namulonge Agricultural and Animal Production Research Institute	Retained
5	Fisheries Research Institute Jinja	Retained
6	Animal Health Research Institute Entebbe	Merged to 2
7	Nakawa Forestry Research Institute	Moved to 8
8	Forestry Research Institute Kifu	Established
9	Food Science and Technology Research Institute	Established
10	Agricultural Engineering and Appropriate Technology Institute	Established
	{Station}	
11	Kalengeyere Agricultural Research Station	Retained
12	Buginyanya Research Station	Closed
13	Kotido Agricultural Research Station	Established
14	Ngetta Research Station	Retained
15	Kituza Research Station	Closed
16	Rwebitaba Tea Research Station	Retained
17	Kigumba Research Station	Closed
18	Kajjansi Agricultural Research Station	Retained

Source: Agricultural Research Strategy & Plan Vol. 1 and Inquiries to MAAIF as of March 1993

3.6.2 Extension

Agricultural extension work is the responsibility of several organizations.

1) District Offices

In the 38 districts the District Agricultural Office (DAO) and District Veterinary Office (DVO) come under the purview of the Ministry of Agriculture, Animal Industry and Fisheries, while extension officers coordinate the preparation and implementation of extension plans in each field as well as in other areas within the respective Districts.

2) District Farm Institutes (DFI)

DFIs are located in only 16 districts (42%). As a whole country the aim of DFIs is to train extension officers and farmers. Each DFI has a demonstration farm. There are only 2 DFIs in the Study Area, in Masaka and Mukono.

3) University and Agricultural colleges

Agricultural education is the responsibility of Makerere university and five Agricultural Colleges and Institutes. Bukalasa Agricultural College (in the Study Area) has Certificate and Diploma agricultural courses.

The Department of Agricultural Extension Education was established in 1989 at the Faculty of Agriculture and Forestry, Makerere University in order to produce extension officers at MAAIF and agricultural teachers in agricultural colleges and high schools. It also provides in-service training for senior extension staffs and agriculture instructors at agricultural colleges and high schools. Its charter is to provide:

i) Undergraduate courses, e.g., Introductory Agricultural Extension, Rural Sociology, Programme Planning & Evaluation, Extension Methods, Visual Aids, Research Methods, Agricultural Communication, Agricultural Administration, Curriculum Development & Training Methods, Adult Education, Social Research Methods.
ii) Hands-on experience at Kabanyolo Farm
iii) Courses for post-graduate degrees in Extension/Education
iv) In-service training courses, e.g. Program development and Evaluation, Leadership principles, Adult learning principles, Extension methods.

Agricultural extension suffered badly with the devastation of facilities and economic chaos in the political turmoil of the 1970s, which hit small farmers particularly hard. Unlike research which is administered overall by NARO, different types of extension activities are supervised by MAAIF, MNR, MOTI. The lack of overall coordination has a pronounced effect on efficiency, with Ministries sometimes duplicating one another.

The key issues affecting agricultural extension are as follows.

i) Lack of staff (one worker to some 2,000 farmers, 364 farmers in case of Japan)

ii) Lack of equipment

iii) Lack of regular training in extension delivery and new technology

iv) Underdeveloped links with research

v) Lack of transport and allowances

vi) Low level of working morale and motivation due to low salaries

vii) Unbalanced distribution of workers due to lack of accommodation.

The following items have been raised in the "Agricultural Extension Planning" announced in December 1990 as policies for improving these problem areas.

i) A unified approach, whereby parallel services would be minimized as much as possible at the individual farm level

ii) Use of farmer groups, agricultural societies and leaders of regional agriculture in day-to-day operation

iii) Provision of technical support by Subject Matter Specialists, the Department of Cooperatives and Forestry and Makerere University

iv) Developing stronger ties between research and extension

v) Establishment of national extension information centres at District Farm Institutes, rehabilitation and establishment of new DFIs

vi) Provision of worker accommodation

vii) Support for women's activities

viii) Promotion of living improvement Programme.

Access to farmers is hindered by the general state of rural roadways and the lack of transport facilities such as bicycles and motorbikes. Currently foreign aid is being directed toward extension in three main areas:

i) "The Agricultural Development Project" has been running under the supervision of IDA and IFAD in six districts to the north and east since 1986. In addition, "The Southwest Regional Agricultural Rehabilitation Project", based on the ADP, has been underway in four south-eastern districts since 1988. Using experience gained from both of these "The Agricultural Extension Project" is to be implemented in 16 districts from 1993.

ii) The EEC is operating "The Farming System Support Program" in 16 districts (including the entire Study Area), chiefly on coffee crops.

iii) 'The Development of the Horticultural Industry' is underway in nine districts (including part of the Study Area) under UNDP and FAO.

3.6.3 Farmers' Organization

1) Cooperatives

At the end of 1992 there were 5,737 village-level cooperatives (Primary Societies) across the country. Sixty-three percent were formed chiefly for purchasing and processing of traditional exports coffee and cotton, and the remainder are involved in dairy products, livestock production, transport, leather goods, purchasing of consumer goods, handicrafts, credit savings and fishing. Table 3.6.3.1 shows the number of cooperative by category operating within the Study Area. Most have a director, an accounts section and an executive committee. Roughly 70% of these are paid employees, and the remainder volunteers.

Uganda has 36 district cooperative unions, seven within the Study Area. Most primary societies belong to a district union, which are designed to utilize economy of scale.

At the national level are five bodies: the Cooperative Bank Ltd., the Uganda Cooperative Transport Union Ltd. (UCTU), Uganda Cooperative Insurance Ltd. (UCI), Uganda Cooperative Savings and Credit Ltd. (UCSCU) and the Uganda Wholesale Cooperative Union Ltd. The Bank, established in 1961 to provide support for cooperatives, lends mainly to small-scale farmers. The Transport Union is designed to meet transport requirements of cooperatives. The Uganda Cooperative Central Union Ltd. (UCCU) was set up at the same time to oversee purchasing of farm materials such as fertilizers, chemicals and tools as well as machinery and parts for coffee and cotton factories. However on October 13 1993 it went bankrupt with outstanding debts of 1.37 billion USHS.

At the top, overseeing the entire cooperative structure and acting as a general spokesman, is the Uganda Cooperative Alliance (UCA). This body is responsible for coordinating foreign aid with plans and programs at the cooperative level, as well as training personnel. The Union Export Services (UNEX) has been established under UCA to promote coffee exports on behalf of four District Unions (Bugisu, Busoga, Masaka and Banyakole Kweterana) and now handles 20% of the total export volume. This is one aspect of government market deregulation policy, whereby cooperatives are now allowed to engage directly in coffee exporting, previously the exclusive domain of the Coffee Marketing Board. The effect on farmers and the industry in general has been extremely pleasing. It is expected that the expertise developed in UNEX will be extended to other produce. Figure 3.6.3.1 shows the relationship between cooperatives and the various bodies mentioned above.

Current efforts to boost exports and domestic demand through cooperatives are hampered by a lack of crop finance and by inefficient and inexperienced management. These can be traced to three root problems:

i) the Ugandan people have been prevented by the colonial administration from acquiring merchandising skills

ii) the cooperatives themselves are lacking in motivation to improve their capacity for administration and management

iii) some cooperatives have strayed from their original mandate, even being used to pursue tribal disputes

Table 3.6.3.1 Number of Primary Societies by Category

Item	Luwero	Masaka	Mpigi	Mukono	Total	Uganda
1 Agricultural Marketing	123	207	187	170	687	3,635
2 Saving & Credit	5	38	7	11	61	503
3 Multipurpose	13	13	22	23	71	410
4 Consumer	13	2	15	18	48	249
5 Transport	8	6	18	7	39	266
6 Live Stock	14	5	4	2	25	187
7 Hides & Skins	1	3	3	2	9	69
8 Farming	1	2	1	5	9	118
9 Fishing		3	4	4	11	65
10 Beekeeping					0	4
11 Dairy		4	3	3	10	27
12 Enguli (Distilleries)				4	4	25
13 Milling			1	1	1	17
14 Carpentry		1	4	1	6	17
15 Handicraft			2	1	3	16
16 Housing			2		2	10
17 Engineering					0	17
18 Brick		1			1	6
19 Charcoal					0	2
20 Poultry		1			1	12
21 Mining				1	1	13
22 Cottage Industry		1	7	1	9	36
23 Processing		7	1	6	14	20
24 Horticulture Crops			1		1	13
Total	178	294	282	259	1,013	5,737
Number of Membership	32,680	42,828	41,001	21,139		
Number of Farmer	72,143	63,051	47,837	102,150		
Participant Ratio %	45	68	86	21		

Source: Ministry of Trade and Industry

Note: As of December, 1992

The situation worsened considerably under the Amin administration and ensuing civil war, which saw the destruction of a large number of cooperative facilities such as warehouses. In addition to their own shortcomings, cooperatives had to operate under extremely difficult external conditions such as rising prices and interest rates, lack of liquid funds in the financial sector, and competition from the private sector. September 1991 saw the promulgation of the new Cooperative Societies Statute, legislation covering financial and other terms and conditions for establishing cooperatives, as well as strict guidelines for operation. The Statute is designed to increase the autonomy of cooperatives and reduce the level of government intervention.

Cooperatives are supported at the national level by MOTI. The Ministry runs Cooperative Offices in each district to create, register and supervise cooperatives and to provide assistance, training and advice. However the offices are largely inoperative due to the lack of funds.

Cooperatives in Uganda are supported principally by the two agencies: USAID and SIDA through SCC. USAID is sponsoring the seven-year Cooperative Agricultural and Agribusiness Support Project (CAAS). The project, scheduled to run from February 11, 1988 to September 30, 1994, is focused on five key issues:

i) policy development and planning skills
ii) support for agrobusiness
iii) financial auditing and management
iv) education and training
v) funding for Primary Societies.

The UCA/SCC Cooperative Development Programme under SIDA supports market expansion, financing and housewife unions. Of the six districts in the Programme, only East Mengo Union is in the Study Area.

2) Uganda National Farmers' Association (UNFA)

UNFA became operational in January 1992 following a meeting of farmers from 38 districts of Uganda at Mukono District Farm Institute to discuss the status of food and agriculture in Uganda. UNFA is registered in the MIA as a Non-Government Organization working to redress Agriculture issues. The principal goal is to work together as a team on agricultural problems and to promote farmer incomes and consequently make Uganda rich.

UNFA is aiming at production increases, especially exports of farm produce, by setting objectives as follows.

i) To unite and harness all farmers' organizations, all individuals and entities engaged in agro-related industry together under UNFA.
ii) To establish a common front and forum for all agro-related associations and organizations and to promote, encourage, coordinate and safeguard their activities and interests within and outside Uganda. Further, to act as a representative body

conveying their needs, requirements and proposals to government departments, other domestic bodies and international organizations.

iii) To form, establish and provide a single united organ of all such agro-related organization and/or individuals with the knowledge, authority and capacity to represent and make binding resolutions regarding the industry.

iv) To develop, maintain and promote a National Farmers Network to ensure effective participation by farmers, peasants, workers and all others at all levels in the field.

v) To provide facilities for training Ugandans either locally or abroad and to invite foreign skilled personnel so that Ugandans may acquire greater expertise in the agriculture industry.

vi) To establish an agricultural bank in Uganda to lobby for reasonable terms of credit for the agro industry.

Membership is registered at the district branch office. Full membership entitles one to voting rights, while part membership, through a related organization with similar aims and objectives, does not. There are also life membership and honorary membership categories.

UNFA has only just got underway at the present point in time. Hopefully it will be a real boost to development, by acting as a national organisation for farmers run by farmers themselves.

3) Women's and youth groups

(1) Women's groups

Women's groups are divided into two categories: those registered as primary cooperative societies and the remaining non-registered groups. Table 3.6.3.2 shows the number of women's groups and their membership in Study Area. Those groups are active in fields such as agriculture weaving, handicrafts, and poultry. Table 3.6.3.3 lists the activities of women's groups in the Study Area.

i) Financial assistance form the Uganda Cooperative Bank through the Women's Cooperative Activities Programme (WOCAP)

ii) Financial assistance based on support by the Swedish International Development Agency (SIDA) and Danish International Development Agency through the National Council of Women

iii) Matching Grant Facilities based on support by the United States of America International Development Agency

While district associations are facilitating the organization of women, efforts should be made to actively promote women's cooperative societies in the future because of their comparatively higher level of activity than other associations.

Table 3.6.3.2 Number of Women's Groups and Members

Item	Luwero		Masaka		Mpigi		Mukono	
	No	Members	No	Members	No	Members	No	Members
Registered	1	32	6	2,400	13	570	10	na
Unregistered	27	135	3	na	na	na	15	na

Source: DCO, Annual Reports, 1991
Interviews with DCOs

Note: na = information not available

Table 3.6.3.3 Activities of Women's Groups (including multiple answers)

Item	Luwero	Masaka	Mpigi	Mukono
Agriculture	13	1	7	5
Crop	1		2	
Handicrafts	7	1	10	
Animal Husbandry	2	1		3
Poultry	4	1	3	7
Horticulture	1			
Music	1			
Bee keeping	1			
Produce buying		1		
Nursery School		1		
Saving & Credit		2	1	
Bricks and Tile making		1		4
Enguli manufacture		1		
Multipurpose			1	
Bread Making				1

Source: 1991 Annual Reports from District Cooperative Officers, and
Interviews with District Cooperative Officers

(2) Youth groups

District agriculture offices are in charge of fostering youth groups under the Young Farmers of Uganda Programme (YFU). Table 3.6.3.4 shows the number of Youth group and their membership in the Study Area at the end of 1991. The main aim of the programme is to give special attention to agricultural training of young rural people between 10 and 25 years old. Activities are both agriculture and non agriculture oriented, including growing of horticultural crops, poultry rearing, brick making, handicrafts, and the distribution and selling of agricultural products. YFU is dependent on the government for funds, as well as assistance from FAO for a seminar on youth in Uganda. The government, however, is unable to provide enough assistance for the YFU programme due to the tight financial situation.

Table 3.6.3.4 Number of Youth Groups and Members

Luwero		Masaka		Mpigi		Mukono	
No	Members	No	Members	No	Members	No	Members
10	120	12	279	15	120	76	3,030

Source: Young Farmers of Uganda Programme, Department of Agriculture

3.6.4 Farm Financing

Generally, farmers who want to improve the living conditions and management of their farms strive to increase their incomes through measures such as expanding farm management scale and improving productivity through the use of fertilizers and agricultural chemicals. In order to do this, it is necessary to purchase the materials of production, such as land and farm machinery, implements, and facilities, and to invest capital in areas such as land improvement. However, farmers who do not have much capital accumulation must use loans.

The types and forms of loan projects in Uganda and the roles they fulfill were summarized as part of the study of utilization of capital for farm improvement in the Study Area.

1) Forms of loans
   i) System financing through bank loans (handled by the Uganda Co-operative Bank (Co-operative Bank), the Uganda Commercial Bank (UCB), etc.)
   ii) Financing that uses the funds of aid institutions as a source of capital (loaned through cooperatives)
   iii) Through mutual aid societies or mutual financing associations
   iv) Loans between individuals or groups (utilization of personal financing provided by traders or villages)

In the case of i) system financing, The Bank of Uganda procures national government funds and international aid funds to use in the financing system. The Co-operative Bank and UCB lend this money to users.

The Co-operative Bank provides two financing systems: the Co-operative Credit Scheme (CCS) lends production funds to farmers (especially small-scale farmers) while the Crop Finance Project lends plant and equipment funds and operating funds required by brokers or processors. The UCB also provides financing systems for large commercial farmers, such as the Rural Farmer's Scheme.

Both financing systems, are functioning but inadequate, and the systems have been reworked via frequent evaluations. Subsequently, a new effort to make the systems functional was undertaken in 1988, through the South West Region Agricultural Rehabilitation Project (SWRARP). The Study Area is not covered in SWRARP. Leading figures in extension offices, cooperatives, and other institutions are keen to see a similar project.

2) CCS and SWRARP's farm financing

(1) Borrowers
   i) Cooperative societies, farmers' groups, women's groups, youth groups
   ii) Groups or members of groups registered with Credit-Subcomponents (CS)

(2) Objectives
   i) To help increase production and productivity
   ii) To increase farmer incomes and create employment opportunities
   iii) To upgrade the farming skills and management abilities of group members

(3) Projects components
   i) Selection of loan target groups
   ii) Guidance and instruction in management skills
   iii) Repair and production of farm tools
   iv) Establishment of lending agencies in the region
   iv) Lending, supervision and promotion of saving

(4) Financing target items
   i) Production of agricultural, livestock, and aqua products
   ii) Processing and distribution of farm produce
   iii) Purchase and sale of farming materials
   iv) Production and sale of handicrafts and craft works contributing to farm production

(5) Types of financing
   i) Farm operating funds to groups and individuals
   ii) Farm development funds to commercial farmers
   iii) Agricultural land development funds to groups

iv) Activation loans to small farmers and women

(6) Obligatory guarantees

All members shall agree to joint liability on guarantees prior to the starting of any funding (Although collateral is set aside to guarantee the amount of funds deposited with the cooperative bank, some form of incentives should be given to those members within the group who return the funds such as permitting further borrowing for those who pay back while not offering any such services for those who do not repay their loans, since such guarantees do not offset the initial amount of funds.)

(7) Perpetuation of financing projects

Implement a majority of the loans (raise the repayment rate, and improve the efficiency of the administrative work of loan institutions.)

Fundamentally, this project must cover all expenses, including expenses associated with the loan institution, with the profit earned from interest on loans. However, it is expected that it will take 10 - 20 years for this to be possible.

(8) Types of loan and their credit lines

i) Group loans

Financing for projects executed by groups

An institution is established to foster the project through the CS, for a minimum of six months before the financing begins.

ii) Individual loans

The loan application is made by the individual, through the group to which the individual belongs, and the purpose of the loan shall agree with the activity contents of the group

iii) Commercial loans

Maximum of 12 months, 41% per annum interest rate (variable: determined by The Bank of Uganda)

iv) Development loans

Maximum of 24 months, 37% per annum interest rate (variable: determined by The Bank of Uganda)

v) Credit lines are established as follows for each case according to the loan's purpose.

Cultivation	USHS 500,000
Distribution	1,000,000
Processing	1,500,000
Livestock breeding	1,500,000
Fishery	1,500,000
Craft work production	500,000
Craft work materials	500,000
Farm machinery & tools	3,000,000

(9) Financing target region and implementation institution

i) The SWRARP implements a pilot project in three districts, monitors its progress, then expands it to other districts if it appears to be proceeding satisfactorily

ii) Lending institutions include the Bank of Uganda, MAAIF, MCCM, Cooperative Bank, NGO (cooperates in training) and Cooperative Unions.

(10) Additional conditions required to financed groups or individuals

a) Individuals shall reside in the activity sphere of the group they belong to, shall pay their group entrance fee and possess a minimum of one share of stock, shall be at least 18 years old and of good character, shall be able to contribute to group activities, shall agree to deposit money in the group's savings account, shall agree to joint liability on guarantee, shall participate in training courses for CS implements, and shall monitor other members and cooperate in repaying loans.

b) Groups shall have group unity, organization, leadership, and future prospects, and shall deposit in savings a minimum of 10% of the amount of the loan requested.

c) Particulars requested are: repayment conditions (time limit, interest rate, payment in installments), property as collateral, and signatures of the relevant people (lender, CS, SWRARP manager, borrower, group representative(s), group founder, district loan committee chairperson).

d) To encourage saving, members applying for loans must deposit savings into the Co-operative Bank account of the group to which they belong, with the initial deposit of the loan being 20%.

e) Individual deposits and withdrawals of savings and loans are recorded in personal passbooks issued by the Credit Sub-sector Management Unit (CSMU) to each person. This is also the same in the case of groups. However, concerning the credit line, for business operation funds it is 20%, and for development funds it is 30%.

Agricultural financing in rural areas, as revealed by FIS is summarized in Table 3.6.4.1. Of the 316 farms surveyed, approximately 20%, or 71 farmers, have loans. The breakdown is: small-scale farms-20%, medium-scale farms-30%, large-scale farms-50%. However, looking at the amounts borrowed by loan period, it can be said that many large-scale farm businesses utilize long-term loans and are investing to rationalize their business management.

Most small-scale farmers utilize medium or long-term loans. In particular, five out of ten farmers use short-term loans of about six months, repaying the loan from the profit on the sale of produce and using the loans as farm management funds for each planting.

Interest is 20% for public loans and about 40% for private loans. However, as Appendix 2.3.2. indicates, interest rates are not fixed. An increase or a decrease is negotiated through discussions between the borrower and the lender. There is not much difference in the interest rate according to the loan period, and a 40% interest rate is paid even for long-term loans. The burden on the farmer is considerable.

The survey covered farmers who sell produce typical of the region, and found that a comparatively high rate of 20% of farmers use loans. The average income of a farm borrowing funds is USHS 2,815,000, which is high compared to the total average for all farms (USHS 2,367,000) indicated in Table 3.3.2.2. Thus it can be said that loans are having a positive effect on farmer incomes.

Table 3.6.4.1 Amount of Loans and Number of Farmers

	Amount of Loans (000USH)			Number of Farmers				
	Long term	Medium term	Short term	Long term	Mediu term	Short term	Total	
							Farmer	Ratio%
Under 2ha	7,034	15,404	4,650	1	4	5	10	14
2.1-10.0 ha	16,510	22,000	2,375	10	3	10	23	32
10.1 ha <	314,060	187,150	34,519	15	12	11	38	54
total	337,604	224,554	41,544	26	19	26	71	100

Source : FIS

3.7 Irrigation & Drainage and Agricultural & Livestock Infrastructures

There are ten large-scale irrigation projects throughout the country. All are government-supported projects started between the late 1960's and the 1970's, with the exception of the Olweny Swamp Rice Irrigation Project which began in 1993. More than half suffered during the civil unrest in the 1980's, becoming run-down or derelict.

Irrigation is rare in the Study Area at present, and usually on a small scale, operated by individual farmers. Facilities are poor. All the farmers who were visited during the field survey emphasized the need for irrigation. In terms of agricultural infrastructure, farm roads and ditches for soil protection are common on farms, but only at the bare minimum required level, having been built through necessity as farms expanded rather than in any systematic way.

3.7.1 Irrigation and Drainage

There are no large-scale irrigation projects in the Study Area, only small individual set-ups, of which many are still being developed. None of these are complete. Drainage facilities for the most part consist of contour ditches on sloping land. These are thought to be for soil protection and water harvesting rather than drainage.

1) Existing farms

(1) Hilly land

All individual farms with irrigation projects draw water from wetlands on or near their land. The water head between source and crop fields is generally no more than 30 m, and all farms require pumps.

Some typical examples are as follows.

a) J.H. Floriculture Growers Uganda Ltd.

This farm cultivates mainly flowers and food crops. Irrigation at present consists of a steel water tower; there are no pumps or pipes, and water has to be transported by tractor.

b) Mr. Kizza's Farm

This farmer cultivates horticultural produce. He is involved in the FAO Small-Scale Irrigation Pilot Scheme, and he has five small reservoirs on low ground on his own land, collecting water from inside the fields. His pump has broken down and irrigation water has to be transported by tractor.

c) Mr. Ssalongo's Farm

This farmer grows mainly pineapples in addition to vegetables and food crops. Two sites of this farm are being dredged as prospective water sources. There are also earth canals running to all points of the fields. The farmers hopes to extract water with portable pumps

from the two dredged water supply sites and feed these to a water tank on high ground, from where the water will be used for sprinkler irrigation.

(2) Wetlands

Farming in wetlands is either at tributaries or the extreme upper reaches of the wetland, and is limited to places where natural drainage can be readily achieved by manually digging small drainage ditches. Some examples of irrigation and drainage in wetlands found in the field survey are presented below.

a) Mr. Matovu's Farm

This farmer cultivates horticultural crops. He is also involved in the FAO Small-Scale Irrigation Pilot Scheme, and has concrete intake and diversions completed recently.

Furrows made in the field form an irrigation system. The furrows, between five and 10 m long, divide up the fields for the cultivation of a variety of crops.

b) Others

There are three other cases of irrigation and drainage in wetlands within the Study Area. All are small rice farms operated individually on reclaimed land. The irrigation and drainage facilities are very basic, using flood water retained in levees surrounding the fields. Irrigation depends on natural water level changes in the wetland, and thus the crop condition varies with the climate, an unstable form of farm management. The farmers all stress the importance of water control.

2) Related projects

a) FAO Small-Scale Irrigation Pilot Scheme

This project, begun in November 1991 with the aim of demonstration and extension of small-scale irrigation, is currently being implemented at five farms, and including three of the Districts in the Study Area (the exception being Masaka).

Participating farms are selected by FAO from local farmers requests lodged at District Offices. FAO support project is centered on technical extension. For example if a farmer chooses pump irrigation, the farmer himself has to purchase the principal equipment such as pumps and pipes, and then receives technical assistance with installation from FAO.

b) Kibimba Rice Project

This is located in the center of Iganga District, bordering on the Study Area to the east, adjacent to the road running between Kampala and Tororo. It was formed between 1971 and 1973 with assistance from China, and is currently managed by a government-affiliated corporation.

The Kibimba project guarantees irrigation water by creating a dam in the upper reaches of the wetland. The earth-fill dam is 4.5m high, 1,500m long and 3m wide at the crest, while the capacity of the reservoir is 3,000,000 m^3.

Other facilities include a manual intake gate, a spill way, a main canal, irrigation canals and drainage canals, as well as a drainage pump station (equipped with two pumps) and farm roads. Directly downstream of the dam, paddy fields stretch out over 532 ha in a rectangular shape.

Large numbers of Chinese agricultural machines were brought in for the project, most of which have now broken down and out of order.

Apart from this, cultivation practice has become harder with the aging of irrigation canals and partial subsidence of fields, so that currently only about 150 ha of the original 532 ha is being cultivated with low yield more or less 1.0 ton/ha, far below the target.

The project is characterized by mechanized large-scale paddy rice cultivation, which requires large paddy plots, high techniques of rice cultivation, maintenance of facilities and machines. However, insufficient acquisition of recurrent cost together with lack of spare parts of machines has hindered the proper management and maintenance resulting in the recession of the cultivation.

From the fact of this it should be noted that the following principles to be observed for the development of paddy field in Uganda.

i) Paddy cultivation should be practiced based on by labour hand in principle.
ii) Small paddy plots are allowed, and irrigation and drainage facilities are to be simple in structure and for operation.
iii) Farmers association is to be formed for the cooperative facility management and maintenance.

3) Need for irrigation and drainage

In the Study Area steps need to be taken to diversify crops and improve quality, as well as to increase crop cultivation area in order to expand and develop agriculture in line with the expanding population and economy. However, increases in cultivation area are limited by environmental conservation, current land use and land ownership. At the same time, the many wetlands in the Study Area could be used as sources of water for irrigation to reduce the influence of the climate and boost yields, diversify crops and stabilize yields. The field survey indicates that farmers are well aware of the need for irrigation, particularly after the extended droughts of the last two years, while the FIS results also reveal a strong desire for the development of irrigation facilities, especially in Mpigi District.

4) Relevant natural conditions

(1) Soils in wetlands

When utilizing wetlands, information regarding topography, hydrology, weather as well as concerning the soil itself is necessary. In particular, it is necessary to know whether the soil is

latently acidic or vitriolic or whether there are any peat deposits in the area. It is said that acid sulfate soils are found in coastal areas, and also inland at high elevations. Chenery (1954) and J.F. Harrop (1960) reported acid sulfate soils around the Kigezi peaty soil belt in Kabale District at an elevation of 1, 800 meters. According to these reports acid sulfate soils occur when papyrus swamps drain and soil dries, generating sulfuric acid via the oxidation of sulfur-containing materials (see Table A2.7.1.1).

Wetlands within the Study Area with potential as paddy field were surveyed to determine the existence of peaty or potentially acid sulfate soils.

As Table A2.7.1.2 shows, peaty soils were not found even in areas of papyrus vegetation. Soil samples dried out slowly over a period of one week showed lower pH values than wet soil. However strong acidity ranging from 2 to 4 in pH value was not observed.

The pH of clayey sub-soils at sites MP-2 and MP-3 showed a fairly acidic 4.5 and 4.6 after dried, as with Kyambala soil where the ground water level is low, and drying process is in progress pH values at in wetlands. Under these conditions, it is necessary to circumvent bringing lower soils to the surface because potential acid sulfate soil requires extensive lime treatment to correct soil acidity before it can be used as farmland. The cost associated with such treatment renders the soil unfeasible.

(2) Bearing capacity

Bearing capacity was investigated for five wetlands with potential for paddy field development using a portable cone penetrometre. The observations (given in Table A2.7.1.3 and Figure A2.7.1.1) will be used in both construction design and basic data for farm management. All readings were taken near the center of the wetland. The depth at which bearing capacity rapidly rises varied considerably between sites, ranging from 50 cm to 4 metres. This illustrates the change from high humus topsoil through to the sandy lower strata. Bearing capacity at NAR-2, LW-3 and SEZ-2 was low down to a depth of 1 m. Cultivation would not be easy with the underground water level at its present depth. Any plans for soil dressing and drainage channel construction to improve bearing capacity would be subject to environmental and economic feasibility assessments. In addition, irrigation works would require special reinforcement to prevent the collapse of unlined channels and uneven subsidence of structures.

(3) Water quality

Water quality surveys were conducted at 24 potential paddy development sites to determine the suitability of swamp water for both paddy fields in wetlands and irrigation schemes in nearby areas. Japanese agricultural water quality standards were adopted for paddy fields, and FAO-based standards (temperature, electrical conductivity (EC) and dissolved oxygen (DO), pH) for dry field irrigation.

Heavy metal content and other such readings were not taken, since there are few pollutant sources nearby and no reason to suspect pollution of this kind. It was decided to use the harsher of the two sets of standards.

	Paddy field	upland field
EC (μs/cm)	<300	<700
DO (ppm)	5<	-
pH	6.0-7.5	6.5-8.4

As shown in Table A2.7.1.4, EC registered above 300 us/cm at one site, while DO was 5 ppm or below at 15 of 28 sites observed. pH readings were 6.0 or less at only one of the six sites where observations were taken. The sole EC reading of 460 μs/cm was an exception, the result of waste water entering the river as it passes through urban areas on its way to the wetlands. At all other sites, the water was found to be safe for irrigation purposes, with no danger of salt damage.

There appeared to be some sort of link between DO level and temperature: water with extremely low DO of 1 ppm or less was consistently found to be 21 C or below (see Figure A2.7.1.2). Much of this low-temperature water is spring water from underground, where microbiological processes decompose organic matter, consuming DO in the process. DO levels over 5 ppm are often found in both properly defined waterways and huge sheet-like expanses of surface water co-existing in many wetlands. If the water were collected and directed towards fields in irrigation channels, the DO level would rise through interaction with the atmosphere. Thus, even low-DO spring water could be used her irrigation.

pH readings were taken at six sites, of which only one was unsuitable at 4.3. This is believed to be a localized phenomenon, caused by the production of organic acid through resolution underground. It was concluded that wetland water quality poses no problems for general irrigation use. However more detailed water quality surveys should be carried out in the relevant wetlands before embarking on specific projects.

(4) Intake rate

Intake rate, an indicator of soil seepage, was investigated with respect to irrigation methods.

a) Observation sites: two farms (3 sites) currently under cultivation

Kizza's farm: above a slope facing a wetlands area; blackish soil mixed with miscellaneous matter such as grass roots

Upper Matovu's farm: gentle slopes leading out of wetland; brown soil just recently plowed

Lower Matovu's farm: mouse-grey soil within wetlands; fine, hardening particles