

**TOWARDS A LAND-USE STRATEGY FOR THE SMALL-HOLDER
SOUTH-WEST KANO IRRIGATION PROJECT, NYANZA PROVINCE, KENYA**

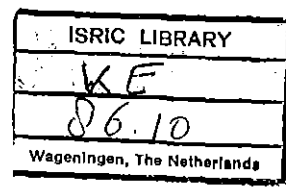
FINAL REPORT



MINISTRY OF AGRICULTURE AND LIVESTOCK DEVELOPMENT
AGRICULTURE ENGINEERING DIVISION
IRRIGATION AND DRAINAGE BRANCH

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TOWARDS A LAND-USE STRATEGY FOR THE SMALL-HOLDER
SOUTH-WEST KANO IRRIGATION PROJECT, NYANZA PROVINCE, KENYA

A STUDY PREPARED FOR THE PROVINCIAL IRRIGATION UNIT,
NYANZA PROVINCE

FINAL REPORT

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Aerial photograph 1979

INTRODUCTION

The Provincial Irrigation Unit (PIU) of the Nyanza Province has proposed a small-holder irrigation development in the South-West Kano area. The "overall" project area measures 7,800 ha, and a net area of about 1,100-1,300 ha is expected to be under irrigation in the next ten years. Compared to the actual acreage under small-holder irrigation in Nyanza Province (and in the country at large), the South West Kano Irrigation Project must be regarded as an important and ambitious undertaking. Also, for the first time, the Provincial Irrigation Unit (PIU)/District Agricultural Office (DAO) will engage itself in the introduction of irrigated agriculture in up-to-now rainfed cropped and grassland areas. The examples of spontaneous irrigation development in the Nyatini, Chiga and Alungo schemes clearly show the keen interest of the farmers of the area in irrigated rice production.

Within the South-West Kano project area two small-holder irrigation schemes exist already, namely: Obange and Nyatini. The Obange scheme has been in existence for about thirty years; the Nyatini scheme is a new (and fast) development since 1983. The schemes are almost equal in size and total about 350 ha. With 350 ha now under irrigation, another 750-950 ha of irrigated land is expected to be developed in the medium future. Those hectares have to be identified and brought into production by the farmers of the area. In selecting the new areas for irrigation development, the PIU/DAO has the task to assist the farmers. The PIU/DAO can only suggest future land use; the farmers themselves are the primary development agents. Consequently, the PIU/DAO must design a strategy which adopts the irrigated cropping as an integral component of a new, self-sustaining and balanced farming system, ensuring optimum use of the area's resources. The analysis of the current land use in the area must provide the elements for such a strategy. The study gives an inventory and analysis of the uses of the present landscape, as well as the consequences of the introduction of irrigated crop production (mainly rice) for these uses. This analysis results in guidelines for the adoption of irrigated cropping in a responsible and sensible way as described above.

Acknowledgement

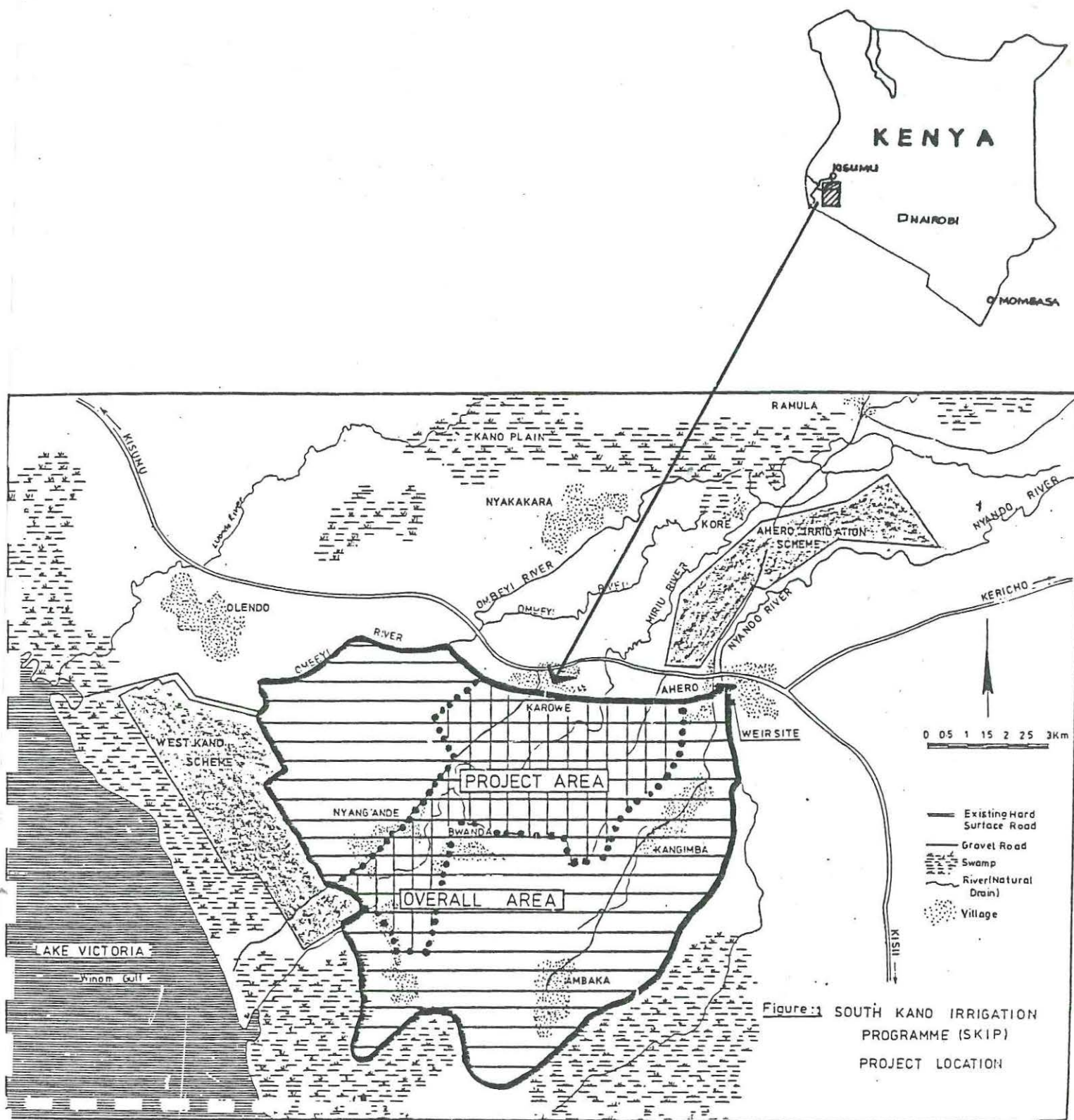
This study is carried out in close cooperation with the engineers and the officer in charge of the Provincial Irrigation Unit of Nyanza Province.

Mr Makau and Mr Opiyo worked on the interpretation of the aerial slides.

Special thanks for the enthusiastic assistance of Mr. S. Povel, the Provincial Irrigation Engineer of Nyanza Province and the extension officers who guided us around in the area.

Figure 1: Location of the South-West Kano project.

Source : Ministry of Agriculture and Livestock Development, 1986.



CHAPTER 1. SUMMARY AND RECOMMENDATIONS

Summary

The introduction of an irrigation system, will change the current land use and farming system. For example the irrigated area will take up the place of other landuse types, it may increase the total amount of farming labour, or may give a shift in the ratio of cash and subsistence farming. All these changes will give reactions in other activities of the farm household as labour division, firewood collection etc. In order to be able to advise the farmers in their future land use including the irrigated crop production, it is important for the PIU/DAO to obtain an insight in the current land uses and farming system, the socio-organic structure of the society in the area, and the economic feasibility of an increased irrigated (rice) area. The PIU/DAO, as the agent for this introduction, has to obtain an insight in the consequences of the selection of sites and of the main canal courses. A land-use strategy provides the PIU/DAO with knowledge about the functions of the different land-use types for the village communities. A strategy makes it possible for the PIU/DAO to react on possible future changes in due time, it offers them the possibility to stay one step ahead before the changes actually take place. Knowledge about the possible consequences of the introduction of irrigated crop production for the farming system prepares the PIU/DAO for the discussion with the farmers.

In the discussion with the farmers choices can be made, and a strategy towards the future farming system including irrigated crop production can be developed. For example if irrigated rice production (cash) will take the place of rainfed maize production (food), the self sustainability of the farm household will be influenced. (see chapter 4).

The opportunities and restrictions of the landscape and the norms and values of the individual and his/her society.

The land uses of an area are influenced by In a rural area as South-West Kano, the farmers use the landscape for the best, optimizing the opportunities offered by it and minimizing its restrictions. In order to gain knowledge of the land use and the farming system it is important to obtain an understanding of landscape and find answers to questions like:

- What are the landscape ecological dynamics, or in other words what are the relationships between geomorphology, hydrology, vegetation, soils and climates in the area?
- How do the farmers make use of these factors?
- In what way is this land use influenced by the cultural and social background of the farmers?
- Is it possible to define changes in land use or farming systems? What is the reason for these changes?

Chapter 3 of this report provides information on landscape ecological processes and the various land uses.

Besides insight in the landscape, it is important to become knowledgeable on irrigated crop production.

Chapter 4 gives the influence of irrigation on the landscape and its uses.

The general goal of this study is to introduce the irrigation system in such a way that the farm households have the opportunity to find a new sustainable balance in this farming system, it is important to safeguard food production, possibilities for firewood and water collection, sufficient land for grazing of livestock, space for the growth of building materials and the possibility for the farmer to spread risks of yield failures. At the same time improvement of the living standard of the population by raising the possibilities for cash-income of the farm household, through the introduction of a well functioning irrigation system, asks for a careful step by step planning of the introduction of the proposed South-West Kano project.

Option 2 (see Chapter 4) disturbs the existing farming system in a minimum way, and offer the opportunity for increased agricultural production. The various land-use types (irrigated land, rainfed cropped land, bush cover, village area and grazing), important for a sustainable farming system are in the proportion of 26 to 29 to 4 to 27 to 7 (rounded figures).

Table 6: Proportions of land-use types in option 2 given in rounded figures (based on the statistics of EcoSystems)

	ha/km ²
irrigated land	26
rainfed cropped land	29
including fallowing	
bush cover	4
village area	27
including 66% grazing	
grazing	7
rest	7

Approximately 26 ha/km² or 750 ha, based on the interpreted (inner) area by EcoSystems, can be developed for irrigated crop production in this first phase, which includes the rehabilitation of the existing schemes located in the project area. In this first phase a pilot study should be included.

Recommendations

1. The introduced irrigated crop production should be seen as an element in the farming system as a whole.
Which means the amount of land taken up by irrigation is in balance (and not in competition) with other landuses such as rainfed agriculture for food production, firewood collection, grazing, shelter and community life in the villages. It is important to note the uncultivated land still has its specific uses, e.g. firewood, water, building materials.
2. Before the irrigation and land-use plan can be designed more study has to be made on the following points:

- Studies of the existing schemes on land-use and farming system, with special attention to the balance between irrigated (rice) and rainfed (food) production, the firewood production and grazing areas; as well as on the economic viability of irrigated crop production.
 - An energy study, concentrating on firewood production. How much land is needed on household level for sufficient firewood production?
 - Study on the strategy of risk spreading in relation to yield failures within the farm household.
 - A study of the role and importance of livestock on aspects as traditional values, "farm ecology", diet and ratio livestock unit/grazing area.
 - Labour time on food processing, water collection, firewood collection.
3. The introduction of irrigation should take place in phases, starting with the reclamation of the seasonal and permanent swamps and their direct environment and the rehabilitation of the existing schemes. (Based on the figures of EcoSystems 26 ha/km² or 750 ha of the total "inner" area interpreted.)
4. In a pilot project the strategy has to be tested. All the members of the farming household have to be involved in this test, as the different members have different responsibilities.
5. Besides assistance to farmers in the introduction of irrigated crop production the following should be stimulated on
- energy production
 - drinking water
 - livestock improvement
 - small farmers mechanization.
- The cooperation between the PIU and the DAO provides a splendid opportunity for such an integrated approach.
6. The figures given by EcoSystems should be used with **great care**:
- some areas are flown and interpreted twice
 - the area interpreted is 74% of the total area flown.

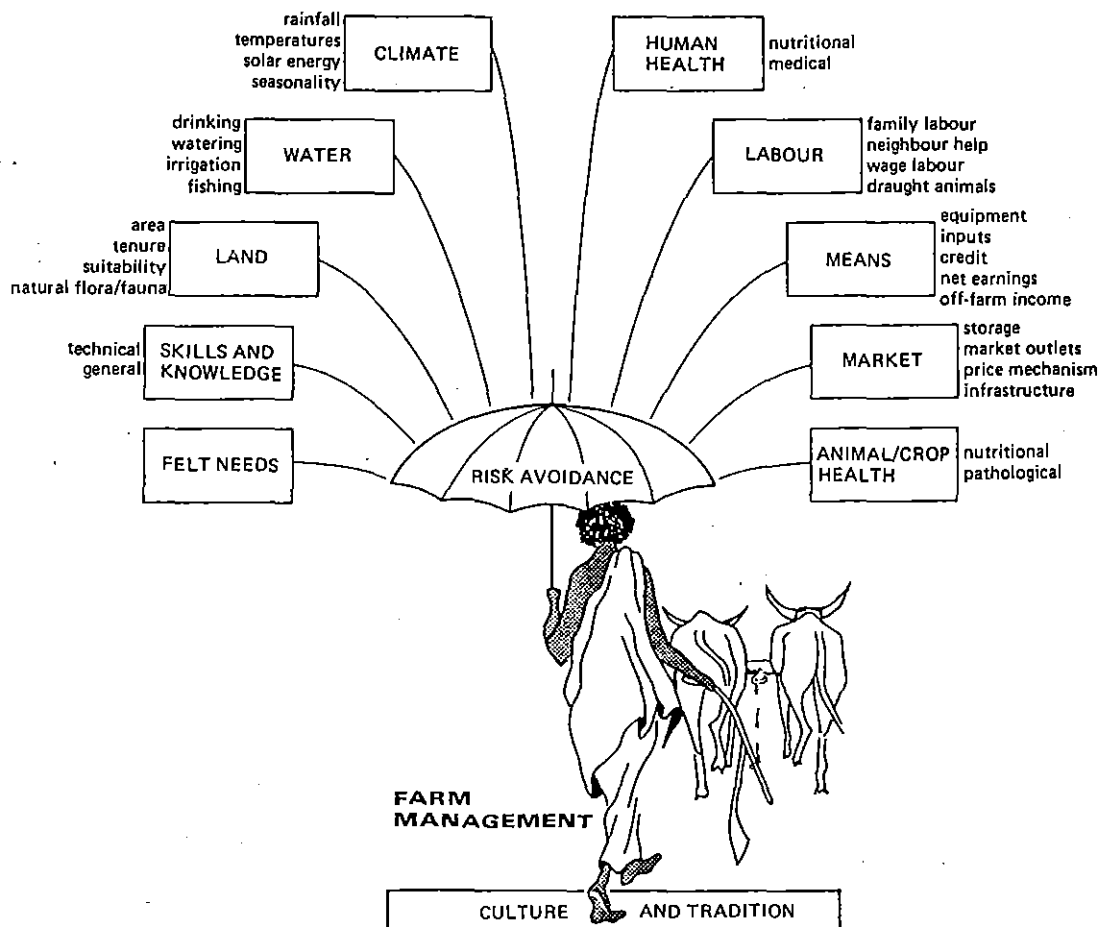
CHAPTER 2. TOWARDS A LAND-USE STRATEGY - WHY?

Technically speaking, the selection of sites suitable for irrigated cropping, may be based mainly on physical factors as topography, soil quality and the drainage condition. Especially in a small-holder irrigation project as this South West Kano project present land use and socio-cultural aspects give further restrictions. Moreover as the project area is densely populated.

The local population gradually developed through a process of trial and error land uses and a farming system that fit best with the ecology of the place and the norms and values of the society. The farming system is functioning as a whole, providing the households with food and cash income and spreading the risk of yield failures. All the farming factors interact, and any influence either from inside (e.g. norms, values, changes in climate etc.) or outside (e.g. national economy) tends to set off a chain-reaction, and the farm household has to find a new balance in its system.

Figure 2: The farm household's setting of resources, constraints, and values.

Source: Kortenhorst, 1980.



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The PIU/DAO have the responsibility to safeguard the interests of the communities. For example the functioning of a village community as a whole requires amongst others (communal) grazing areas. The individual land owner will not always have an interest in communal grazing areas, unlike the households headed by women or landless people for whom the communal grazing areas can play a vital role.

CHAPTER 3. INVENTORY AND ANALYSIS OF THE CURRENT LAND USE

3.1. Landscape

(see for more information on soils and climate appendix II)

The landscape with its opportunities and restrictions and the norms and values of the individual and his/her society influences the land uses of an area. In a rural area as South-West Kano, the farmers use the landscape for the best, optimizing the opportunities offered by it and minimizing its restrictions. In order to gain knowledge of the land use and the farming system it is important to obtain an understanding of landscape and find answers to questions like:

- What are the landscape ecological dynamics, or in other words what are the relationships between geomorphology, hydrology, vegetation, soils and climates in the area?
- How do the farmers make use of these factors?
- In what way is this land use influenced by the cultural and social background of the farmers?
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Climate

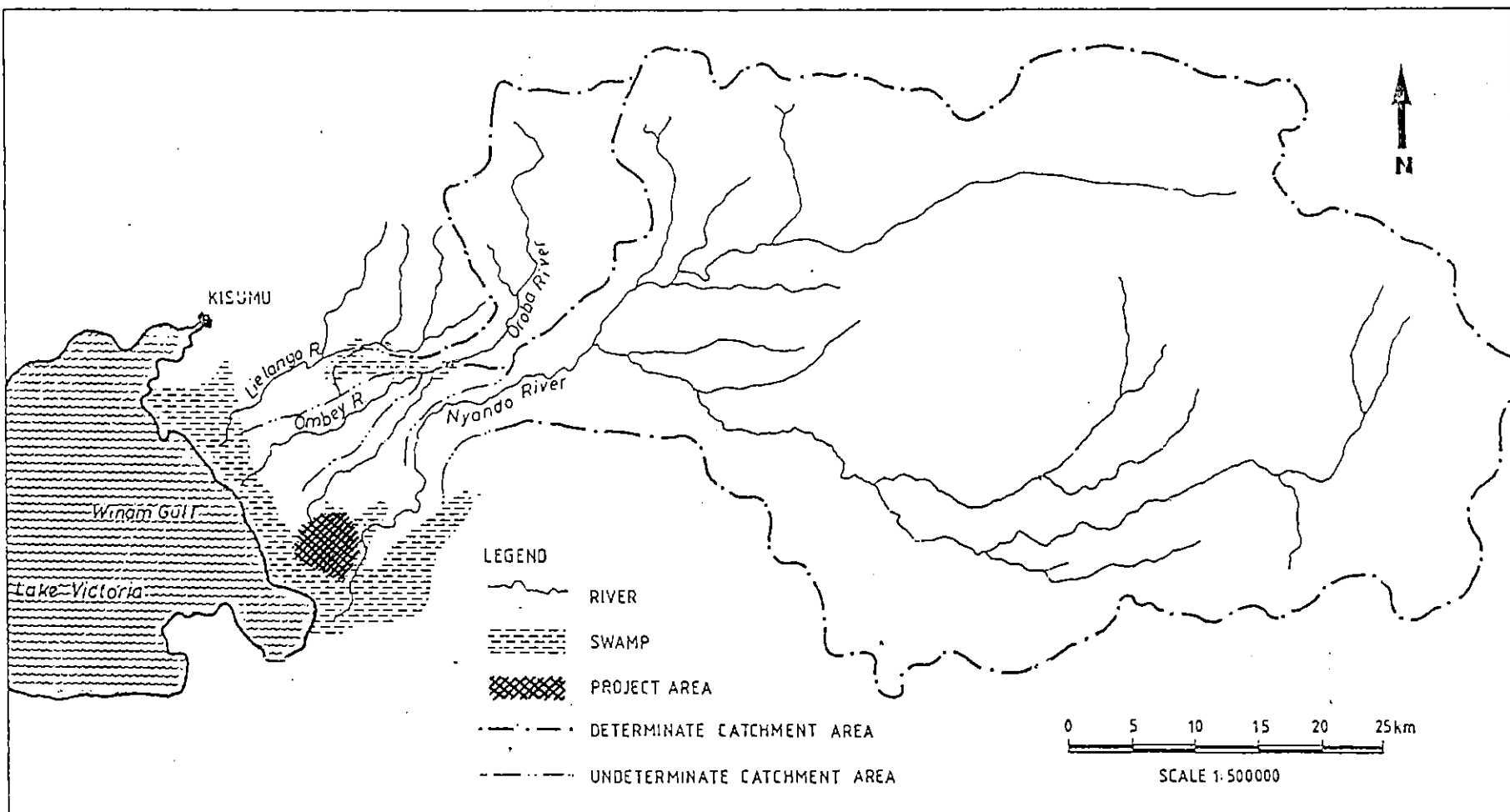
The climate of the Lake Victoria can be described as humid with moderate average temperatures. The annual precipitation is about 1,000 mm. There is no distinct dry season, rain can fall during every month of the year. There are two peak seasons of rainfall, from the middle of March to end of May, the so-called "long rains" and from the end of October to the middle of December, the so-called "short rains". Rainfall is erratic and inhomogeneous, resulting in heavy rain storms and periodic droughts. The average daily temperature is around 20-22 degrees Celcius throughout the year. Humidity is above 62 percent.

The climatic conditions are such that permanent rainfed agriculture in this area will meet high risks (one out of the three maize crops fails).

Geomorphology

The Kano plain is a pleistocene feature. The plain is more or less flat, with a east-north-east slope to the lake shore (from 1158 to 1135 m. above sealevel). This relatively low-lying land forms a distinct physiographic unit "walled" by surrounding highlands with faulted scarped edges. In the north the area is bordered by the Nyando Escarpment, in the south by the Nyabondo Plateau, in the east the area fingers out into the many valleys of the Tinderet Highlands and Lava Hills. The shore of Lake Victoria forms the western boundary.

Figure 3: Catchment of the Kano Plains
 Source : National Irrigation Board, 1981.



The water level fluctuated over the time, once the Kano plains was covered by the water of Lake Victoria. Due to different volcanic processes and drainage of the Kavirondo Gulf, the water level dropped and erosion and sedimentation processes took place interweaving lake and river sediments. The rivers coming from the surrounding hills and plateaus run through the area, and drain their water finally in Lake Victoria. They are still eroding and reworking the sediments. Serious floods occur frequently.

Although in the first instance the plains can be described as relatively flat; the micro relief of the plain is undulating, owing to minor ridges and levees, distributaries of rivers, marshes and lake beaches. In general the micro relief can be divided thus, in low-lying areas of permanent or seasonal swamps and in slightly higher lying areas of ridges and levees.

Soils

(see for soil map appendix II)

According to the mineralogical and physical features of the parent material most of the soils are characterized by a very high clay content (60-80 percent), a good nutrient status and a very low permeability. They are very sticky and plastic when wet, very hard when dry, two aspects that make land preparation difficult. In relation to the parent material the soils on the ridges contain slightly more loam. The soils of the southern permanent swamps near the lake shore are strongly saline and alkaline. They are difficult to reclaim and the soil characteristics would cause serious yield depressions. The high clay content of the majority of the soils combined with the relatively flat topography, causes water logging.

The classification legend gives irrigation status and suitability for main crops (appendix II). The majority of the soil types (units 9, 10 and 11) are well suited for rice cultivation (see soil map, appendix II).

Vegetation

Not much literature about the (original) vegetation can be found. The marshes around Lake Victoria are presently covered by Papyrus; the scattered swamps have a vegetation of reeds, sedges and grasses. The relatively higher lying ridges, with a slightly better soil permeability, have a vegetation of bushland and trees, characterized by *Acacia nilotica*, *Aloe* spp. and grasses with here and there an old ficus tree. Hedges of *Euphorbia terrucalli*, *Thevetia peruviana* and *Sisal* and scattered trees (*Cassia*, *Parkinsonia*, *Eucalyptus*, *Ficus*, *Spatodea* and *Lantana*) can be found around the compounds.

Occupation pattern

The landscape the first settlers found can probably be described as an area divided by ridges covered by bushland, and swamps and marshes covered by papyrus, reeds and sedges. The area was divided

by rivers with different a character; stable and meandering with levees, and braiding rivers still searching for their courses.

The people living presently in the project area and surroundings belong to the Luo tribe. A study in socio-organization structure of the area is ongoing. The results of this study will have to be incorporated by the PIU/DAO into the final strategy. This land-use study mainly looks at the way of living only. The information and field observations available in July/August 1986 within the PIU is used.

The Luo people invaded Nyanza some time in between 1490 and 1560. Luo society is patrilineal, so inheritance of property comes from the male side. The family or clan is made up of a man, his wife or wives, his sons and daughters, and if the sons are married, his sons' wives and his grandchildren, sometimes the clans are extended by other relatives. Landrights and landownership are organized via the clan. In a Luo homestead (dala), each wife is head of her own household and the leader of her domestic and economic activities. Under her are her children. She can not own the land she is cultivating, though her rights are most of the time respected by the family.

Originally the Luo were mainly nomadic pastoralists, who kept large herds of cattle. Even in the twentieth century some elders kept well over three thousand head of cattle each. The Luo drank and drink a great deal of milk. Only some one hundred year ago they began extensive cultivation of millet, potatoes, cassave and bananas. The Luo are fond of fish, the meat of cattle was eaten only during festival, ceremony, wedding or sacrifice. During the colonial period cash crops and maize were introduced. The increasing population density diminished the amount of cattle drastically, as well as the natural areas were the Luo hunted on wild animals for meat.

The combination of the topographical map scale 1:50,000 and the soil map scale 1:50,000 (page 13) clearly learns that occupation took place via the slightly higher lying ridges with sandy clay or loam soils with a moderate permeability (soil units 3, 4, 5, 6 and 8). They avoided the wet and swampy depressions with the impermeable soils (soil units 9, 10 and 11). The dalas (houses and compounds) and the roads are still situated on the ridges, because of this better soil characteristics and less problems with water logging. The younger developments as rural access roads, do not take the physical opportunities so much into consideration anymore. Field observations show that these newer roads are more often flooded than the older ones.

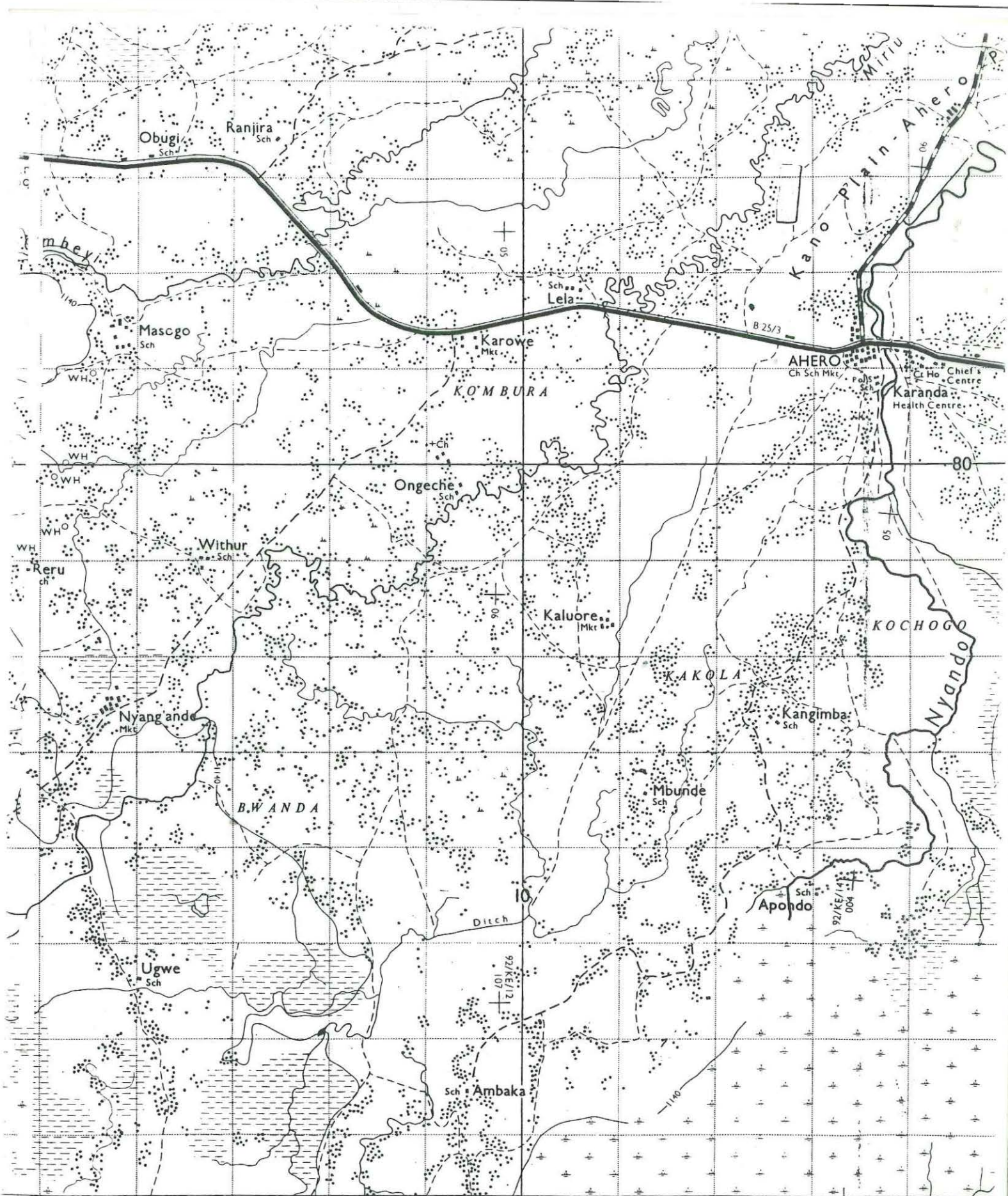
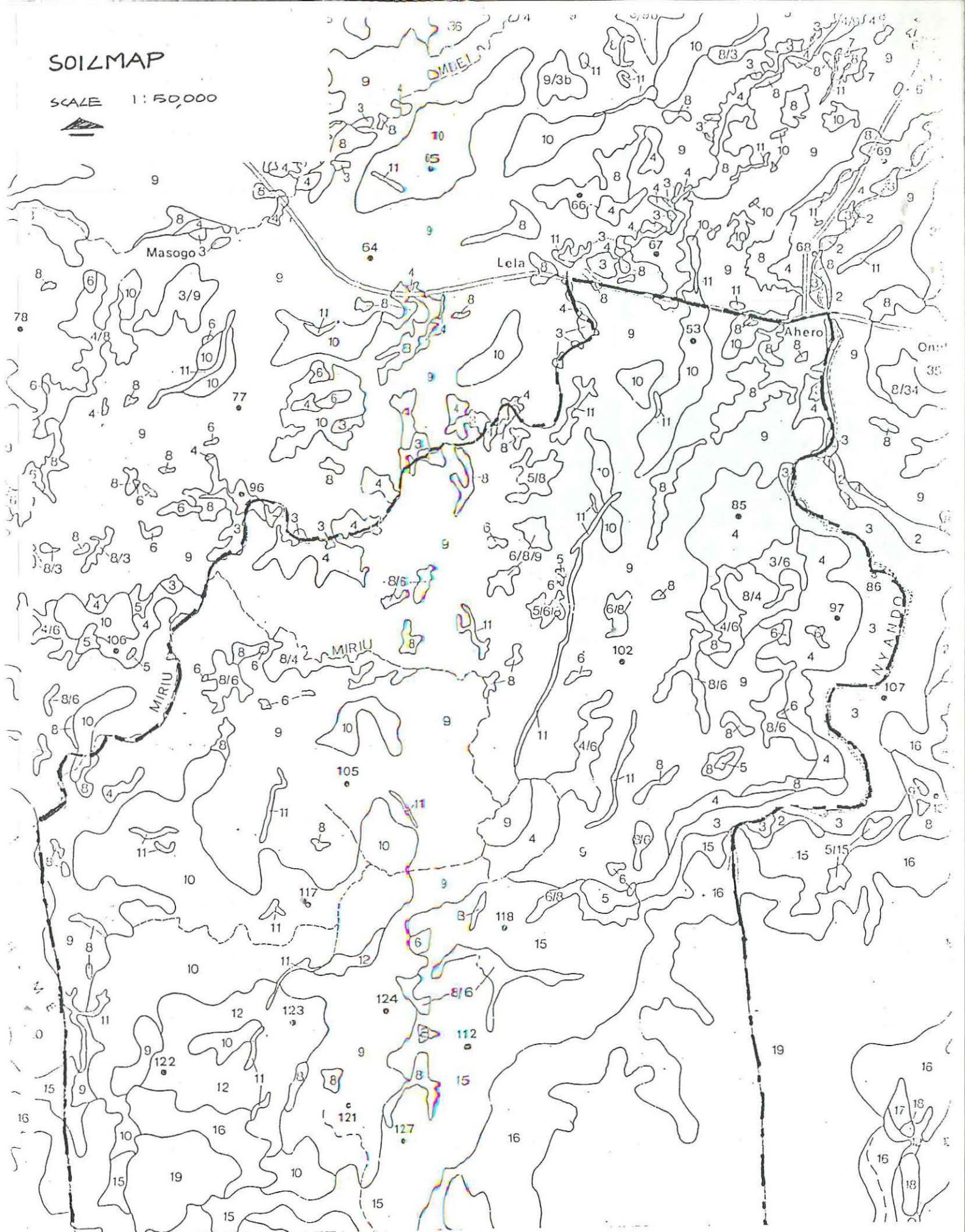


Figure 4: Combination of soil and topographic map scale 1:50,000, showing the occupation pattern.
(for legend see appendix 2)

SOILMAP

SCALE 1:50,000

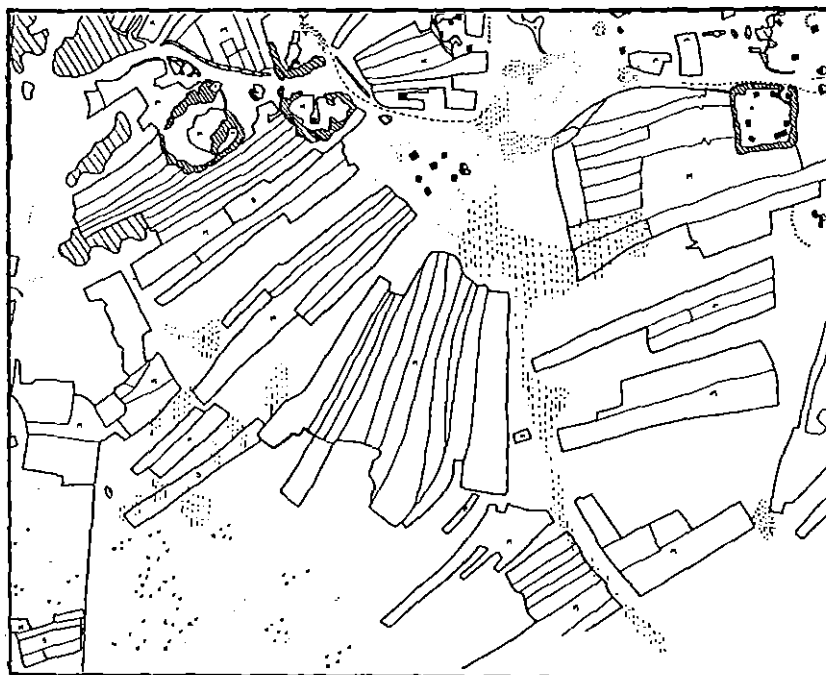


APPROXIMATE BOUNDARY OF THE PROPOSED
SOUTH-WEST KANO PROJECT

SOURCE : MINISTRY OF WATERDEVELOPMENT , 1982

The soil characteristics of the ridges allows the growth of trees and bush, and thus providing the settlers with fuelwood, building materials and shade, as well as these ridges are more suitable for the cultivation of rainfed crops like maize and sorghum. The land has been divided into long strips, from the ridges into the swamps. Each strip belongs to one family or clan.

Figure 5: Illustration of parceling pattern



3.2 Current land use

Land-use types

Field observations and the interpretation of the aerial slides scale 1:5,000 give an impression of the land uses in the area. Map 1 (scale 1:15,000) is the result of this interpretation and gives the spatial lay-out of the current land use. The major land-use types are villages (including houses, compounds, woodlots, windows, grazing, paths etc.), rainfed agriculture (maize), irrigated agriculture (rice), major roads, herbaceous cover and swamps. EcoSystems made a statistic analysis of the land-use types in the area (scale 1:5,000), resulting in a table with the percentage coverage of the land uses. The following table gives ha/km or percentage per land-use type, the indication ## gives a total amount. The statistics are carried out on a total of 112 samples (=slides).

Tabel 1: Simple averages of block data. (see appendix III).
Source : EcoSystems, 1986.

COUNT (number of samples)		112.00			
R1A	Rice - tilled land	3.37	SLA	Sugarcane	0.26
R2A	Rice - growing	5.11	OTA	Other Crops	0.36
R3A	Rice - harvested	0.39			
R4A	Rice - fallow	2.85	TOTRAINFED	Total Rainfed Crops	28.93
TOTALRICE	Rice - total	11.73	BFA	Bare Fields	0.22
M1A	Maize - harvested	1.88	FFA	Fallow Fields	12.22
M2A	Maize - growing	26.44	FDA	Field Dividers	0.32
TOTALMAIZE	Maize - total	28.31	BUA	Bunds	0.82
HCN	House Compound - ##	42.15	CDA	Canals and Ditches	0.21
HCA	House Compound - ha	6.14	HEA	Hedges	1.08
STN	Stock Compound - ##	8.13	WRA	Windrows	1.96
STA	Stock Compound - ha	0.24	ACA	Access	2.94
OCN	Other Compounds - ##	0.91	WLN	Woodlots - ##	1.43
OCA	Other Compounds - ha	1.09	WLA	Woodlots - ha	0.25
TOTALCOMP	Total Compounds	51.19	HHA	Grassland	20.80
MRN	Modern Roofs - ##	58.38	BCA	Bush Cover	3.56
MRA	Modern Roofs - ha	0.67	TCA	Tree Cover	1.69
UCN	Roofs - U.Cnstr - ##	0.31	SMA	Swamps	3.43
UCA	Roofs - U.Cnstr - ha	0.01	OWA	Open Water	0.51
TRN	Trad. Roofs - ##	138.80	XXA	Miscellaneous	0.05
TRA	Trad. Roofs - ha	1.02			

Land uses

Map 2 gives a cross-section of the different land-use types based on the interpretation of the slides on a scale 1:2,000.

The following gives the uses by the population of the different land-use types.

The permanent or seasonal marshes, being the smaller depressions and the swamp along the shore of Victoria Lake provides the population with grasses and Papyrus for roofing and tatching. During the dry periods these areas are used as a grazing area and a water source. Some of these permanent and seasonal swamps are reclaimed and used for rice cultivation. Irrigation water comes from minor streams and the main drains of the Ahero Irrigation Scheme. In some places the edges of these swamps are drained and maize and sugar cane is grown. The interpretation of the aerial slides scale 1:2,000 shows the bad drainage condition of these areas (see map 2) in juni 1986. The marsh land along the lake has soil characteristics (the soils are very saline and alkaline) which makes this area unsuitable for even rice cultivation. Along the borders of the marsh sugar cane and bananas are grown.

On the edges of the ridges along the villages the land is intensively used for rainfed cultivation. Sorghum, maize and beans are grown as food crops, often intercropped with cotton as a cash crop. Together with subsistence farming, livestock keeping is a traditional occupation of most of the Luo people. Approximately 20% of the overall project area is under grassland. Areas under bush cover and land left fallow function as grazing as well. If the areas under bush cover and the land left fallow are added to this percentage, 36% the total project area is used for grazing.

As mentioned earlier the swamps are used for grazing as well, however, it is not very easy to estimate the extent in which the swamp is used. The fact that the swamps are used especially in the dryer periods, gives this land use type a vital role in the survival of the cattle.

In 1979 sugar cane was an important crop in this area, now it is largely taken over by rice (see aerial photographs of 1979 and the slides of 1986). One of the reasons behind this change in land use was the increasing cost of transportation to the sugar factories. Recently, a new jaggery in Ahero was built and a sugar cane factory at West Kano Irrigation Scheme is planned. This might influence the amount of sugarcane grown in the area again.

Water, a basic source for survival is collected from rivers, drains or even the swamps. In some areas shallow wells are built, very few households catch the water running from the roofs.

Although the land-use map (map 1) visualizes the different land-use types in the area. The statistical analysis of EcoSystems gives an idea of percentages of coverage of the land-use types. The relationships and ratio between the different land-use types or landscape features for the farm household can not be extracted out of this information.

In order to obtain a better understanding of these these relationships and functions, on a farm household level, a detailed landscape analysis has been carried out on a scale 1:2,000 (map). A representative area has been chosen, with a large variety in landscape features, covering the land-use types used by a community (clan or village).

3.4. Farming system

The farm household is an important unit in this rural area, providing its members with food, water, shelter and cash income. How this provision of these basic needs takes place, or in other words what are the functions of the land-use types or the landscape features for the household, is described in the analysis of the farming system.

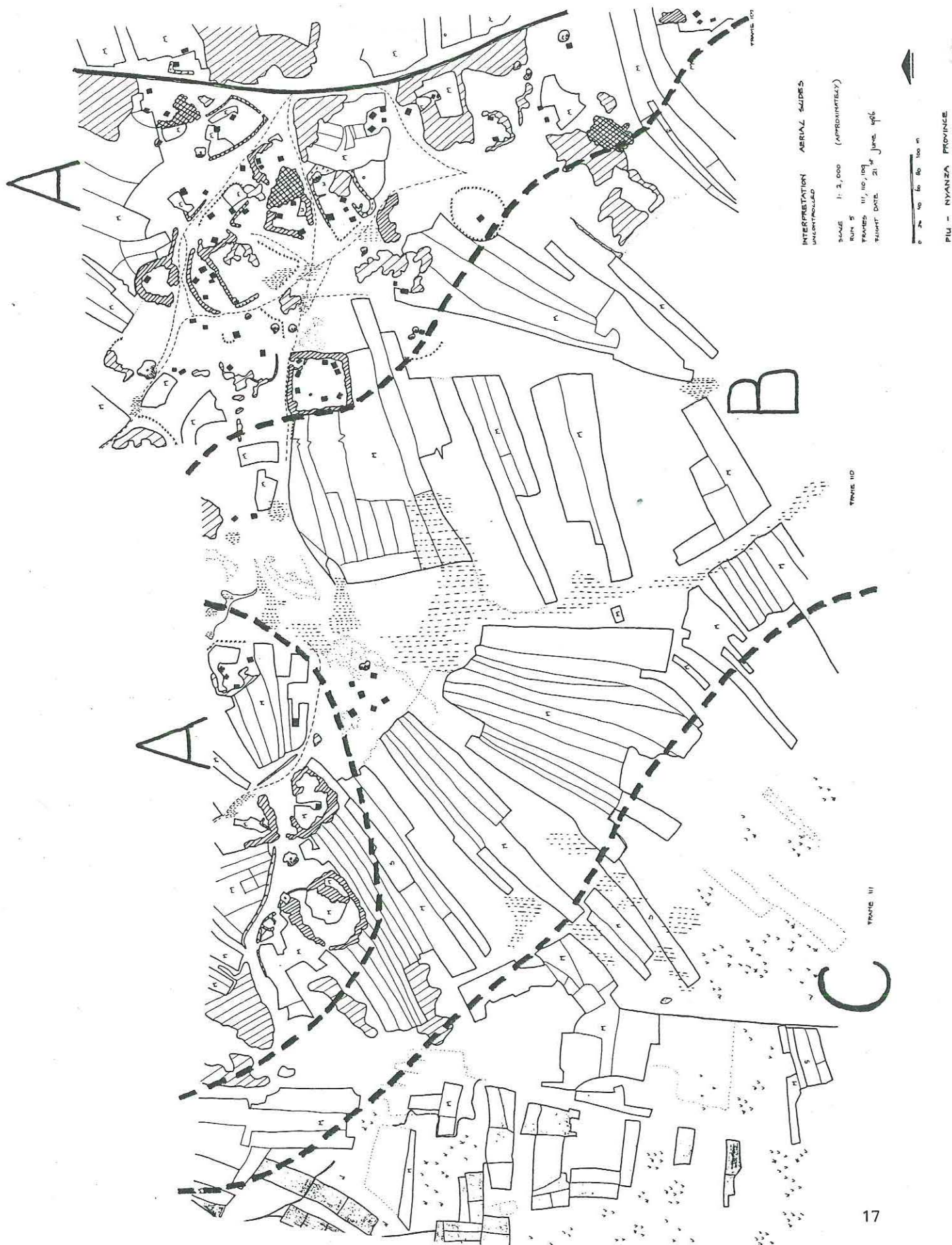
The analysis aims at a community level or "village ecology" and at the individual household. Though the household is the heart of the farming system, the information available does not allow an analysis of the different farming systems; for example the systems for the rich and the ones for the landless people.

Map 2 shows the detailed landscape analysis of the cross-section from approximately Akamba upto Obange Irrigation Scheme.

The detailed landscape analysis shows the relationships between the physical conditions and the use the people make of these conditions.

Three major landscape types, each with its own characteristics and functions can be distinguished, namely (see figure 6).

Figure 6: Interpretation of aerial slides
(interpreted on scale 1:2,000).

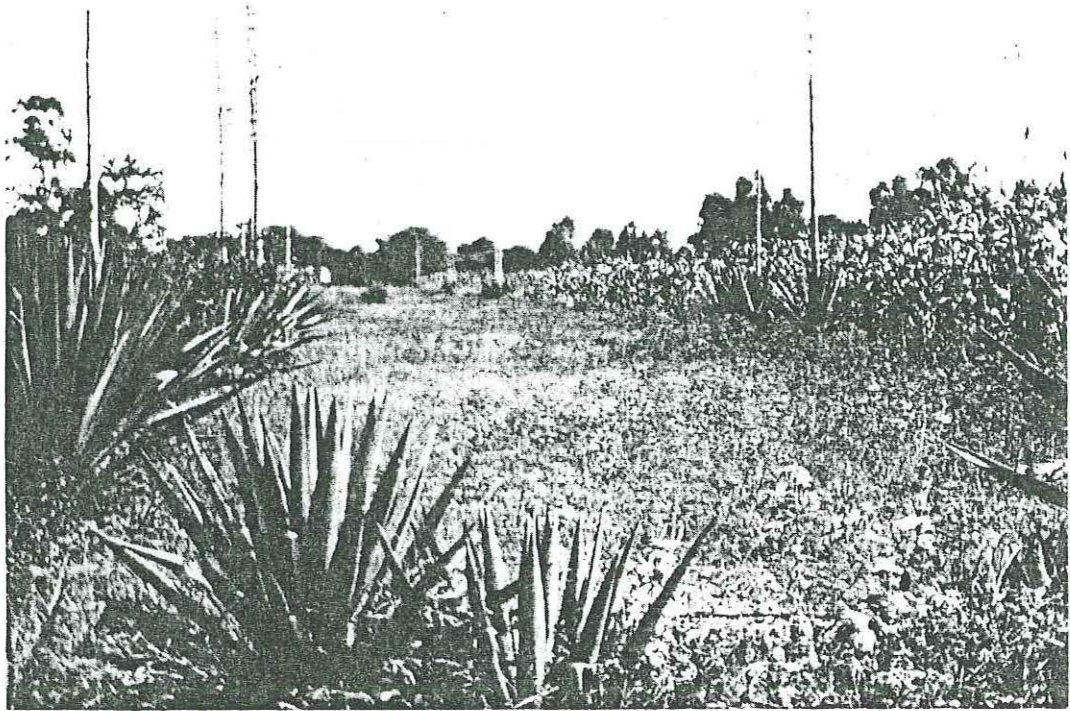




Village



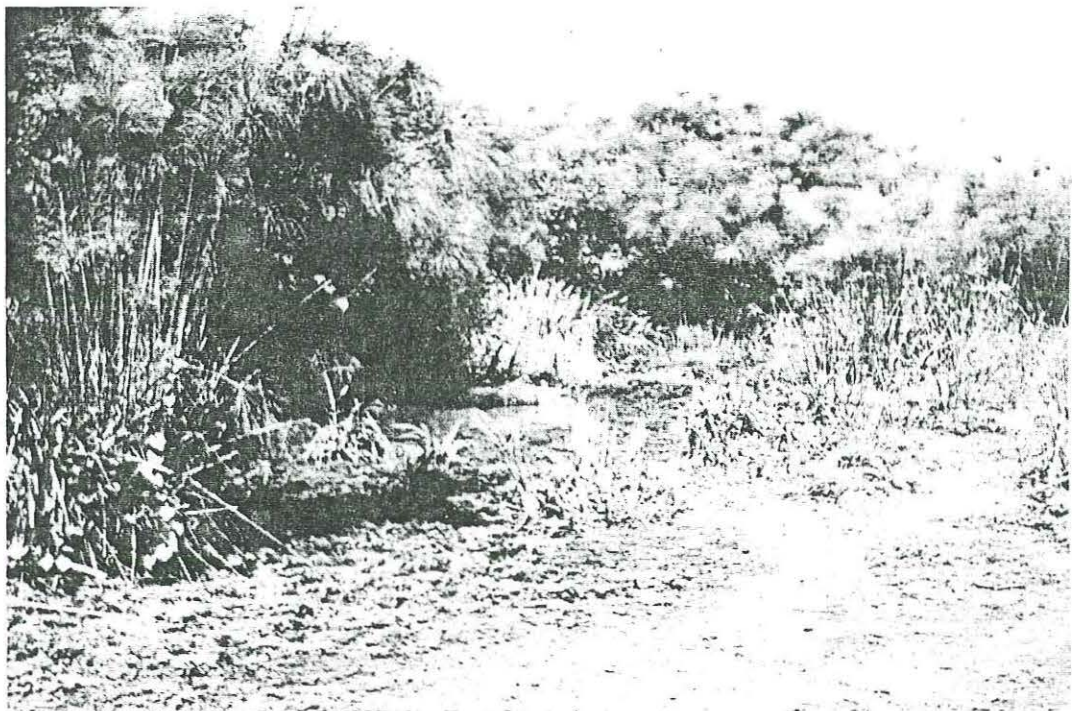
Windrow/living fence



Rainfed agriculture



Cattle/grazing on maizestalks



Marsh



Small holder rice scheme



Small holder rice scheme

-A: the "village" area: on the slightly, relatively higher and drier areas the farm houses encircled by windrows and hedges, the woodlots and the roads can be found. In the landscape these areas clearly feature. Particularly on these soil types, with their better drainage conditions and lighter texture the higher up growing vegetation can establish itself.

-B: the "maize" area: this area is the transition zone from the higher ridges to the depression. The soil texture makes the land better workable, the better drainage condition allows the growth of food and other rainfed field crops. Important food crops are sorghum, maize and to some extent cow peas of which tender leaves are cooked and consumed as vegetable locally known as Alot-boo. Beans and green-grams are cultivated but not extensively. The food crops are commonly intercropped: maize/sorghum/cow peas/beans/cotton and green-grams. Cotton is usually planted between maize or sorghum at the end of season and remains as pure stand after the crop is harvested. Some farmers intercrop upto four crops, but three crop intercropping is more frequently practiced (Ministry of Agriculture, 1980). Often the wetter and heavier soils at the edge of the depressions are planted with maize as well, thus spreading the risk of yield failures (in a very dry year one still has some harvest from this lower areas, in a extremely wet year there is still a yield from the higher lying areas). Some pure stand of sugar cane can be found as well.

-C: the "swamp" area: the very wet areas covered by permanent or seasonal swamps, sometimes reclaimed by the farmers for irrigated rice cultivation.

The information available now (literature and verbal information obtained during the field studies) clarifies that men, women and children (for as far they are not attending school) all have their role in the farm household. Casual labour is hired when needed and cash is available. It is stated several times that the work on the farm is carried out by men and women in a complementary way, whereby the men take up the heavier tasks, like clearing and ploughing, and the women the lighter but more labour intensive tasks, like weeding and harvesting. The head of the family acts as a coordinator and manager.

Within the extended family, each women with her children forms a matrifocal unit:

- the women have usufructuary rights on their own plots,
- the women take care of their own children, (a woman cannot afford to have her granary exhausted before the next harvest, she would have failed as a wife and gained the contempt of her co-wives).

The workload of women has increased over the years due to male migration, schooling of children and a general depreciation of manual work.

In the following tables the landscape types with the specific features and their uses are summerized as well as the users groups or the groups putting most labour time in these functions.

AREA A:

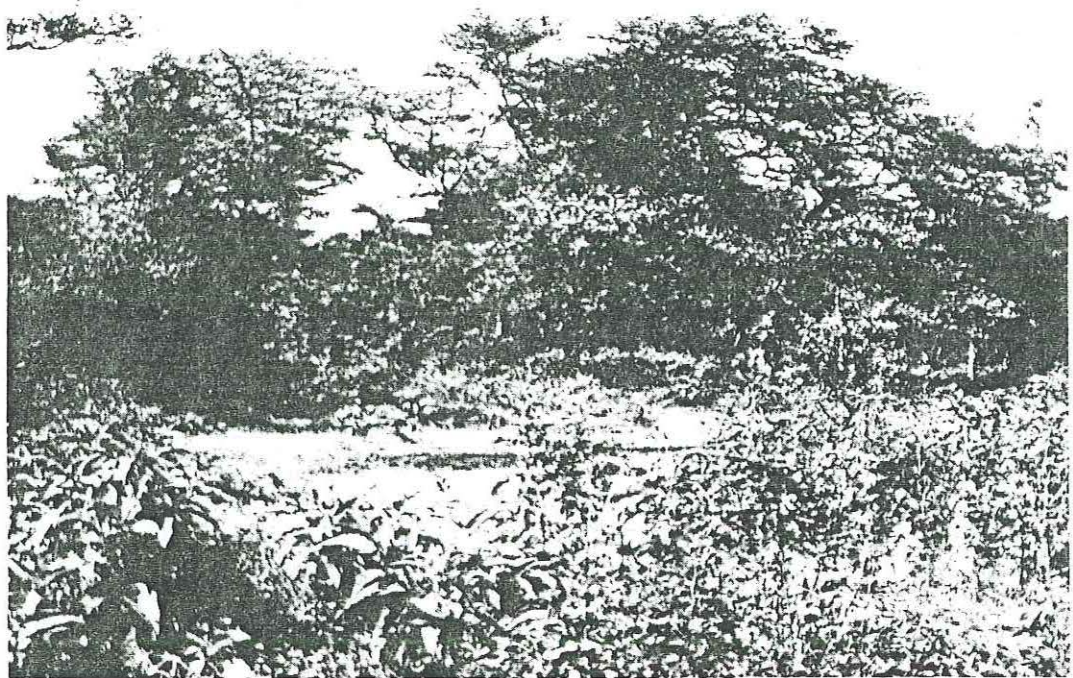
landscape features	functions	users group/labour
houses	shelter	family
major routes	communication	community
rainfed agriculture (maize, sorghum, beans)	subsistence crops	women/
(cotton)	cash crop	men
fallow	cattle grazing	family
	soil quality recovery	
hedges	protection, privacy	family
windrows	building material, cash (firewood)	men (women)
woodlots	building material, cash (firewood)	men (women)
bush cover	communal cattle grazing firewood	family women
grassland	communal cattle grazing	family
scattered trees	shade, fruits, pods	community/
	religion, building material, firewood.	family

AREA B:

landscape features	functions	users group/labour
rainfed agriculture (maize, sorghum, beans)	subsistence	women/
(cotton, sugar cane)	cash	men
grassland	cattle grazing	family
bush cover	cattle grazing firewood	family women
fallow land	grazing	family
	soil quality recovery	
shallow wells		women

AREA C:

landscape features	functions	users group/labour
papyrus swamps	roof tatching	men?
marsh	water source	women
open water	grasses for roof tatching	men?
herbarious cover	(grazing)	family
fallow land	grazing	family
open water	water source	women



Bush cover (fuelwood/grazing)



Village (fuelwood collection)



Water collection

3.5. Summary and conclusions

The land of the project area is intensively used. Every land-use type has its own function for the farm household. Even areas presently not cultivated, still have a specific and important role in the farming system as a whole. Bush land provides the community with firewood and some building materials; the land is used for grazing; herbs etc. are gathered for medical purposes. Land left fallow is used as a grazing area; it helps the soil quality to be improved. The cattle droppings increase the fertility of the soil.

Different groups (women, men, children, older people etc.) have different responsibilities and therefore use different parts of landscape. Besides agricultural activities the women are responsible for the housekeeping, including child care, water and firewood collection. The men take care of the building and maintenance of the houses. In the discussions with the farmers about the introduction of irrigated crop production this aspect should be taken into account.

The use of the land is not fixed.

Over the ages due to a growing population the extent of the grazing land has been decreasing steadily. Although the herds kept by the Luo have been reduced drastically, livestock still is an important element in the farming system. (As draft animals, for a more balanced diet and for the manure). The herds graze at communally used grassland, which is most of the times land that is left fallow and bush land. The need for land is increasing fast. The reduction of the amount of livestock heads is a relatively slow process. These two factors can result easily in a overgrazing of the area.

Another important ongoing process is the reduction of the availability in firewood.

Verbal information gathered during the field visit indicates a serious firewood shortage in the area. The natural vegetation is the major source for firewood, exceptionally Eucalyptus trees are planted for this purpose.

The women are confronted with this problem, as they are the ones responsible for the collection of the wood and the preparation of the food.

The physical conditions of the landscape give the basis for the technical possibilities for irrigation.

Areas suitable for rice irrigation are indicated on the soil classification legend in appendix II. As a matter of fact, the ongoing study on the interpretation of aerial photographs will provide the PIU/DAO with much more detailed information. The interpretation of the aerial slides scale 1:5,000 (reduced to 1:15,000), see map 1, combined with the information gained out of the detailed analysis of the aerial slides scale 1:2,000 indicates that the major area which has the best potentialities for irrigated rice cultivation will be the depressions, presently swamp or marsh land and their direct surroundings, presently under maize, bush cover or used as grazing. This leaves out the present village areas, which are situated on the ridges with more permeable soils.

CHAPTER 4. INFLUENCE OF IRRIGATION ON THE LAND USE AND FARM HOUSEHOLD

4.1. Introduction

In the foregoing landscape analysis the landscape ecology of the area and how people make use of it, are discussed.

In this chapter emphasis is paid to rice cultivation under irrigation, although the farmers may decide to irrigate their maize or any other crop they prefer. For the time being it is to be expected that the farmers will put the irrigated area under rice, as this a technique and cultivation they became familiar with. Besides, the soil characteristics are such that often rice is the only suitable crop. An evaluation combined with the landscape analysis forms the basis for the discussion on options for the introduction of irrigated crop production in South-West Kano.

4.2. Evaluation of studies on existing rice schemes

Some existing rice schemes in the project area or in the vicinity of the area have been studied by Ministry of Agriculture. The studies on the Kore, Obange and Nyatini Rice Scheme are evaluated on the following aspects:

- the land uses and the priorities given to them,
- the landscape ecology in relation to the introduction of irrigated rice,
- the farming system,
- the role of women, in relation to labour division.

Kore Scheme

Most of the work in the Kore Scheme is done by women, because of their responsibility for food /children and they outnumber men (a polygamous society).

The following table shows the divisions of labour according to the Kore women. As the information source (only women) is rather one sided, this table has to be compared with labour division tables in other schemes.

Table 2: Division of labour according to the Kore women
Source : Povel-Speleers, 1982 (adjusted)

Activity	women	men	children
Clearing	x	xx	
Ploughing (oxen)		xx	x
Land preparation (hand digging)	xx	x	x
Transplanting	xx	x	xx
Irrigation	xx	xx	
Weeding	xx	xx	xx
Bird-scaring	x	x	xx
Harvesting	x	xx	
Threshing	xx		
Winnowing	xx		
Shelling	xx		

x also done by --- xx largely done by

An important conclusion drawn in this evaluation is the general shortage of labour:

- the women can not cope with the work
- they pay the children for their labour
- they hire labour (more women than men)
- they recruit labour from the neighbourhood
- they do not seem to use their rice fields to full capacity as they give priority to their food crops, especially sorghum and maize. The rice cultivation starts after the food crops have been taken care of.

In addition to the agricultural work, women also have the responsibility of fetching water, collecting firewood, food processing, cleaning, washing, cooking and taking care of the children.

In an unpublished labour utilization survey carried out by J. Dibbets and F.Povel-Speleers in 1983 under twelve families, the following figures give an indication of time spent per family on off-farm activities and on livestock.

Off-farm activities:

- off-farm labour 7 hours weekly average
- marketing and trading 4.5 hours weekly average
- divers (meetings, harambee, helping of relatives, fishing, not including funerals) 1.5 hours weekly average

Male 53.8 percent
Female 46.1 percent
Children 0 percent.

Livestock:

- herding 36.5 hours weekly average
- milking 4.3 hours weekly average

Male 24.8 percent
 Female 8.2 percent
 Children 7.9 (at 0.5 manhour).

The average labour time spent on one hectare of rice 2,500 hours, and an average farm site is 0.4 ha.

Obange Scheme

The Obange Rice Scheme (implemented 1950) is located in the South-West Kano Irrigation Project area. The total income from all farm activities in 1979 was approximately Ksh. 2640. Rice accounted for 41 percent of this. The farmers in this area spend much of their income (18-20 percent) on casual labour. In Obange Scheme 70 percent of the rice yield used to be sold, the rest is used partly for payment of casual labour and for food (Ministry of Agriculture, 1979).

Inhabitants of the area lived mainly by subsistence farming and livestock keeping. An average family consists of 10 members, 7 of these actually lived on the compound. The average farmer owns 3.6 ha of land. Of this 2.1 ha are located outside and 1.4 ha inside the scheme area. In 1979 an average farmer cultivated 0.9 ha plot of rice and approximately 1.3 ha of food crops mixed with cotton.

In Obange livestock keeping is still an important element in the farming pattern, in between the rice yields (one per year) the fields are used for grazing. Table 3 shows the average number of cattle per farmstead and the percentage of farmers having them.

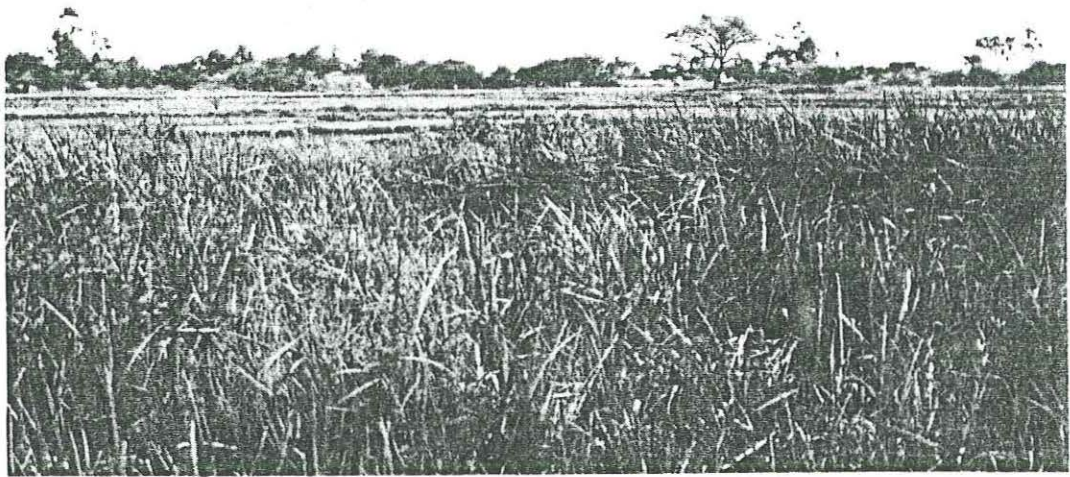
Table 3: Livestock

Source : Ministry of Agriculture, 1980.

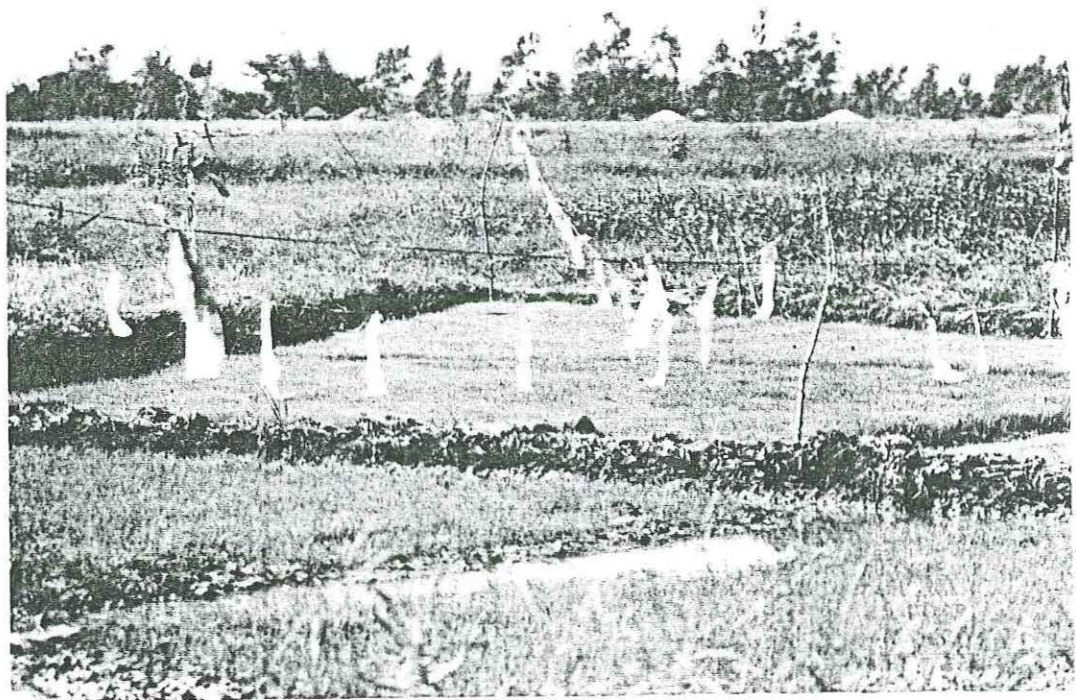
	oxen	bulls	cows	heifers	calves	sheep	goats
av. head per farmstead	2.0	1.5	3.6	1.8	2.0	3.4	2.5
% of farmstead owning	50%	53%	83%	57%	67%	57%	47%

In the Obange study it is stated that "The farmers are in favour of irrigation development in the region but only if it does not entail large scale uprooting of homesteads to give way to schemes". Problems indicated by the farmers concerning rice cultivation were:

- occasional flooding of the rice fields
- water deficit owing to low stream flows and in some parts of the scheme due to uneven levelling.



Small holder rice scheme Nyatini



Small holder rice scheme Nyatini (nursery)



Small holder rice scheme Nyatini



Small holder rice scheme Nyatini

Nyatini

The Nyatini scheme area (+ 200 ha) is part of the proposed South-West Kano Scheme as well. The proposed development started in 1983 at the initiative of the farmers, using the drainwater of the Ahero Scheme. Upto 1983 the area was known as a sugar cane area. The extension of the area under rice cultivation is a continuous process, provided water is available. The major recommendations in this study were related to organization of the distribution of the water; the maintenance of the distribution system, and the rearrangement of the water inlets.

Communal use of land is known by 15 percent of the informants of this study. They claim the land is used for schooling, a fish pond for the Kosida womengroup and for the Ombaka vegetable project. Verbal information during the field visit in July 1986 indicated grazing as a communal land-use type as well. 15 percent of the informants mentioned that special grazing areas are found around the homestead and at the edges of the rice plots. Livestock is kept for milk, meat and as draft animal.

Reasons for low yields mentioned by the farmers is stated in the following table.

Table 4: Reasons for low-yield.

Source : Ministry for Agriculture and Livestock Development, 1986.

Reasons for low yield	% informant
no good seeds	75%
poor nursery	69%
late transplanting	75%
bad weeding	81%
pests	94%
disease	94%
bad use fertilizer	75%
bad water regulation	94%

35 % of the informants drain the field before harvesting.

4.3. What can we learn from this evaluation?

First of all the studies do not pay much attention to the farming system as a whole, and the landscape ecology. The studies concern different topics, so comparison of the individual studies is not very well possible.

Still some observations may be made:

- rice is a cash crop. For example in Obange Scheme 41 percent of the farm income comes from the sales of rice. (59 percent from other sources).
- farmers give priority to their food crops. In the Obange study it is stated that farmers lived mainly, in the period of thirty years of rice growing, on subsistence crops and livestock. Verbal information during the field visits supports the importance of livestock and subsistence farming for the farm house-

hold.

- special grazings are found around homesteads and the edges of the rice plots, some of it is communally used.
- rice cultivation is very labour intensive (+ 2000 hours/ha - 3000 hours/ha).
- the rice fields are not used to their full capacity due to labour shortage. In the discussions between the farmers and the PIU an optimal plotsize should be calculated, taking into account labour availability and the labour intensity of rice cultivation.
- the technical constraints for rice cultivation in the present schemes concern:
 - organization and management of water regulation
 - water deficits due to low stream flows and uneven leveling
 - occasional flooding.

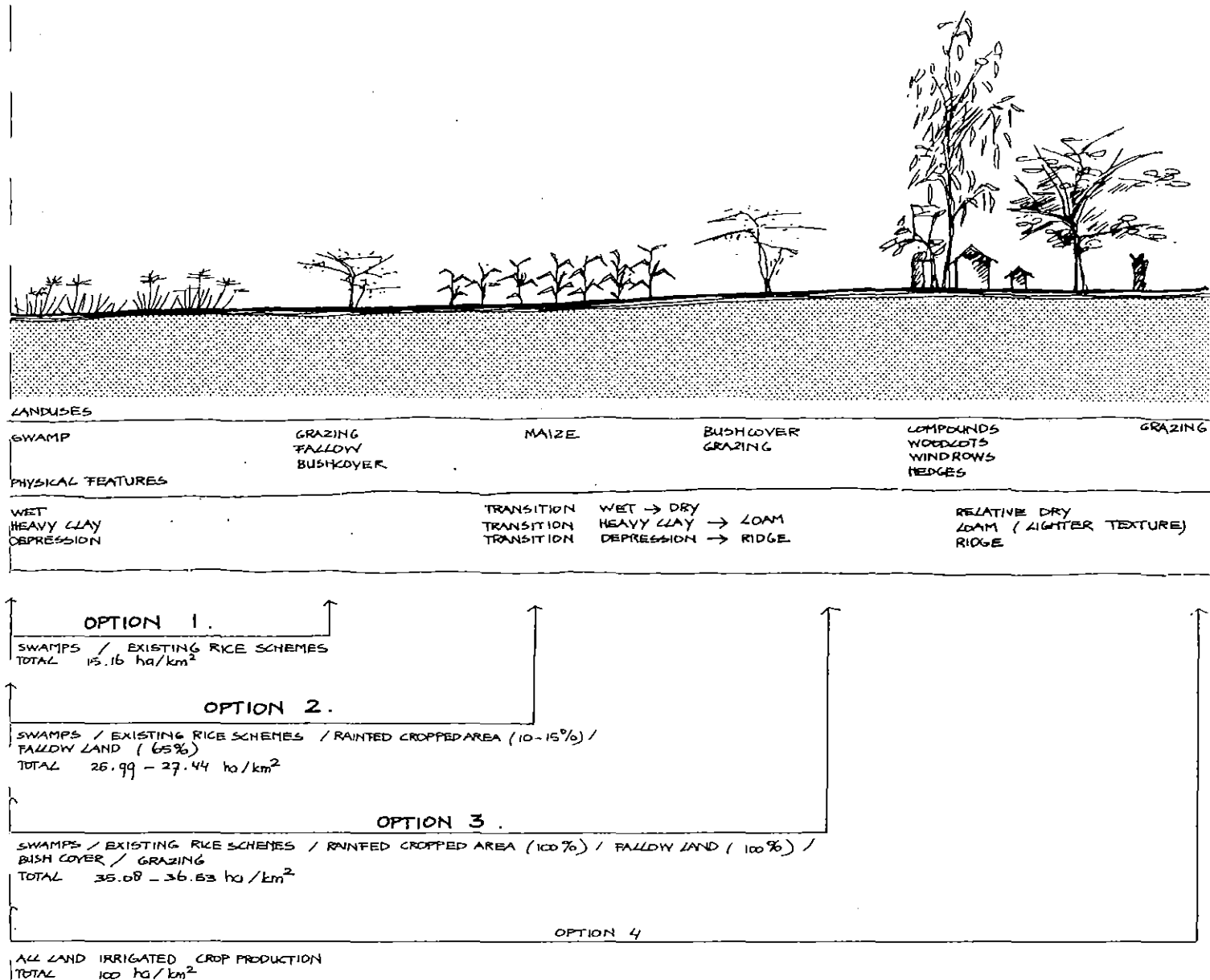
4.4. Consequences of irrigated rice cultivation on land utilization and farm household

The opening up of land for irrigation, means a replacement of one land-use type for the other. The consequences of this change in land use depends very much on the actual functions of the landscape feature being replaced. The cultivation of irrigated rice does not allow many other uses on the same piece of land, thus in effect restricts the areas brought under rice cultivation to a monoculture area. For example trees and shrubs near rice fields are not popular as they attract birds, and give shade.

Generally, green gram is widely used as "follow-up" crop in rice cultivation and in many countries rice culture is combined with fish cultures. However, these practices are not yet introduced in the Kano Plains.

In this paragraph 4 options for the introduction of irrigated crop production and the consequences for the land use as a whole, are discussed.

Figure 7: Cross-section of the landscape of South-West Kano, illustrating four options of introducing irrigated crop production



In the following discussion each extra option adds replaced land-use types to the foregoing option. So the consequences of for example option 3, include the consequences of options 1 and 2.

In the options the figures used are based on the statistics of EcoSystems. The number data used by EcoSystems are converted to ha/km² (or percentage) or to numbers/km².

The PIU/DAO expect a net area to be under irrigation of 1100-1300 ha in the coming years.

Conversion from ha/km² to ha can be made by multiplying with 0.256 km² and 112 (the amount of slides) but that will not cover the total project area, for the following reasons:

1. only an inner interpretation per slide (=0.256 km²) is made which covers 74% of the total slide
2. in one flight line or run the slides 1:20,000 hardly overlap but the flight lines themselves do. So many slides cover the same area.

The total flown covers approximately 81.6 km² (see appendix III). Parts of the Ahero and West-Kano Rice Scheme, and the marsh land around Lake Victoria are included in the area flown by EcoSystems. A correct use of the data of EcoSystems is ha/km² or percentages. This will give a ratio between different land uses rather than net areas.

	percent or ha/km ²	ha total interpreted area	total area flown (81,6 km ²)
swamps	3.43	98	280
total rice	11.73	336	957
total rainfed crops	28.93	829	2361
rainfed crop (wet)	2.89-4.34	83-124	236-354
10-15% of total r.f.			
rainfed crop (dry)	24.59-26.04	705-747	2007-2125
85-90% of total r.f.			
fallow land	12.22	350	997
65% of fallow	7.94	228	648
35% of fallow	4.28	123	349
bush cover	3.56	102	291
grassland total	20.80	596	1697
33%	6.93	197	565
66% in village area	13.72	393	1120
compound	10.17	291	830
hedges	1.08	31	88
windrows	1.96	56	160
woodlots	0.25	7	20
village area total	27.18	779	2218
miscellaneous	0.05		4
open water	0.51	15	42
<u>left out are:</u>			
field dividers	0.32	bunds	0.82
canals and ditches	0.21	access	2.94
sugar cane	0.26	other crops	0.36
bare fields	0.22		

Option 1:

In option 1; the marshes and fallow land in the depressions will be replaced by rice culture. The functions fulfilled by this landscape features (grasses and reeds used for roof thatching and grazing) will reduce. The papyrus marshes and swamps south of the project area are too difficult to reclaim and are for this reason not taken into account. It can be expected that these swamps will provide for the time being the farmers with the necessary building materials.

Part of the depressions are also used as grazing land, thus the rice cultivation will replace some of the grazing area of the people. In Obange, in between two rice yields, the land is used for grazing. It is difficult to compare the grass production of the swamps with the production of the off-season rice land and thus difficult to estimate the consequences of the disappearance of the swamps in relation to grazing land.

The depressions act as a water reservoir, especially in very dry years they play a vital role in the survival of the cattle. The swamps function not only as a water source for cattle and human beings, they regulate the hydrology of the area as well; they act as a sponge. Drains and canals will certainly influence this characteristic. It is difficult though to estimate the extent of this influence. Flood irrigation will keep quite some water in the depressions, and thus fulfill a similar function as the swamps in the hydrological cycle, but irrigation of maize for example will drain much more water out of the area.

Some of the swamps are already brought under rice cultivation. According to the statistics of EcoSystems land taken up by swamps and marches and land presently under rice cultivation accounts for respectively 3.43 ha/km² and 11.73 ha/km², in total 15.16 ha/km².

Option 2:

In option 2; the area directly surrounding the depressions covered with subsistence crops, grazing and fallow land and some bush cover will be replaced. Replacement of the rainfed food crops situated in the lower lying and wetter areas means that in very dry years no crops can be expected from the rainfed areas. This enhances the risk of a crop failure, unless during those years the farmers use the irrigation system for the cultivation of food crops. The fallow land as well as the areas with bush cover are used for grazing, replacement of these features by rice will reduce the total land presently used for grazing. As well as the source for firewood will reduce. Already in the present situation firewood shortage exists, reduction of the existing firewood source will further increase the need for firewood.

According to the statistics of EcoSystems, the land taken up by rainfed crops accounts 28.93 ha/km², no distinctions are made between rainfed crops in the relative wetter zones and those in the dryer ones. The analysis on a scale of 1:2,000 and the field visits give the indication that approximately 10-15 percent of the total rainfed cropped area is located in the wetter areas. Thus an area

of 2.89-4.34 ha/km² of the total rainfed cropped area will be replaced by irrigation. This year, though, the rainfall has been extremely well, so the estimation is very rough and concerns only this specific year.

Relatively a large amount of the total fallow land can be found in the zone surrounding the depressions, field visits and the detailed analyses justify an estimation of approximately 65 percent of the total fallow land (the fallow land is 12.22 ha/km², thus 7.94 ha/km² will be replaced by rice in this option). The percentage of bushcover is very low in this relatively wet area (some Balanites can be found here), and difficult to estimate.

The total area replaced by irrigation in option 2 will be 10.83-12.28 ha/km². Option 1 covers 15.16 ha/km². Option 1 and 2 together shows the situation whereby 25.99-27.44 ha/km² of the overall area are brought under irrigation.

Option 3:

In option 3 the rest of the rainfed cropped area and the fallow land, most of the bushcover and a substantial part of the grazings will be taken up by irrigation. The replacement of the rainfed crops will replace the subsistence food crops and the intercropped cash crops. In Obange Scheme the farm households lived on the foodcrops, replacement of these crops will make the farm households very much depending on the income of the rice production. The region as a whole will not longer be self sufficient in their food production.

Most of the bush cover is situated in this area; bush vegetation and irrigation, especially rice are not compatible. So the firewood source for the farm household will be very limited.

General information, concerning the whole of Kenya, indicates that 80 percent of energy demand in the rural areas is supplied by firewood. Verbal information indicates that a firewood shortage exist in the project area. The fallow land and the grazings make it presently possible to keep livestock. Livestock keeping will become very difficult when option 3 will be implemented.

The farming system as a whole will be disturbed in a serious way as this area will disappear.

The total land taken up by irrigation in option 3 will be 24.59-2.04 ha/km² for food crop area, plus 3.56 ha/km² for bush cover, plus 4.28 ha/km² for fallow land, 6.93 ha/km² for grassland) 35.08-36.53 ha/km² plus the land taken up in option 1 and 2.

Option 4:

In option 4 all the land in the project area is taken up by irrigation. House and compounds with all the functions as shelter, grazing land, building materials, firewood and other tree products, roads etc. will be replaced by a monoculture with a monofunction.

CHAPTER 5. PROPOSED LAND-USE STRATEGY

5.1. Proposed strategy

The proposed strategy is based on the following:

1. a phased planning of the proposed South-West Kano project
2. the encouragement of the programmes on energy, drinking water and livestock improvement parallel and integrated with the South-West Kano project.

In order to introduce the irrigation system in such a way that the farm households have the opportunity to find a new sustainable balance in this farming system, it is important to safeguard food production, possibilities for firewood and water collection, sufficient land for grazing of livestock, space for the growth of building materials and the possibility for the farmer to spread risks of yield failures. At the same time improvement of the living standard of the population by raising the possibilities for cash-income of the farm household, through the introduction of a well functioning irrigation system, asks for a careful step by step planning of the introduction of the proposed South-West Kano project.

The difficulty to obtain sufficient labour in the existing rice schemes (Kore, Nyatini and Obage) also justify a step by step approach. It can be expected that the introduction of large areas of labour intensive irrigated crops cannot immediately be used in an optimum way. The encouragement of the initiation of programmes on energy and drinking water, thus saving time on firewood and water collection may reduce the labour shortage. Less hired labour will be needed (a relative large part of the income is spent on hired labour) and the area under rice may be used in a more efficient way. Besides programmes on energy, drinking water and livestock an other option may be the introduction of small-scale farm mechanization.

It can be expected that with the introduction of the irrigation scheme the land used for grazing will reduce. Livestock still plays an important role in the life of the Luo people. PIU/DAO may encourage a programme on livestock improvement in order to react in time on this reduction of the grazing area. Overgrazing of the areas left, can cause serious soil erosion problems in the near future, which in its turn means a reduction of one of the major resources of the area.

5.2. Proposed phases

Phase 1.

It is proposed to start with the further development of the relatively low lying areas, as discussed in options 1 and 2.

This option 2 disturbs the existing farming system in a minimum way, and offer the opportunity for increased agricultural production. The various land-use types (irrigated land, rainfed cropped land, bush cover, village area and grazing), important for a sustainable farming system are in the proportion of 26 to 29 to 4

to 27 to 7 (rounded figures).

Table 6: Proportions of land-use types in option 2 given in rounded figures (based on the statistics of EcoSystems)

	ha/km ²
irrigated land	26
rainfed cropped land including fallowing	29
bush cover	4
village area	27
including 66% grazing	
grazing	7
rest	7

Approximately 26 ha/km² or 750 ha, based on the interpreted (inner) area by EcoSystems, can be developed for irrigated crop production in this first phase, which includes the rehabilitation of the existing schemes located in the project area. In this first phase a pilot study should be included.

Phase 2.

On a midterm (5 years after the start of the implementation of phase 1) this first phase has to be evaluated. This evaluation should focus on the influence of the irrigated crop production on the farming system and the land use.

Based on this evaluation new choices have to be made and a strategy for the second phase can be developed.

5.3. Pilot study

The proposed land-use strategy and phasing has to be discussed and tested with the farmers. It is advisable that PIU/DAO select with the farmers a pilot area; a permanent or seasonal swamp (partly reclaimed for rice cultivation) with the surrounding rainfed cultivated area and villages (so areas A, B and C, see figure 6, are included in this pilot project).

As men and women have different responsibilities and make use of different landuse features, men and women should participate in this pilot study.

To make the farmers familiar with the approach used by the PIU/DAO, the following steps may be undertaken.

1. A photomosaic of the pilot area can be made based on the aerial slides. (1:20,000).
2. Four transparant overlays, showing the four options discussed, can cover one by one the mosaic. The consequences of the different options can be discussed with every one involved (farmers,

PIU/DAO).

3. In order to make the step easier from a two dimensional photo-mosaic with an overlay to the three dimensional reality. It is suggested to do a rough and preliminary alignment of the, in the future, irrigated area. During this preliminary survey the optional course of the canals can be indicated by pilons. This course can be discussed with the farmers in the field, and where necessary adjusted.
4. The final alignment survey will be the last step before the implementation of the canals and canal structures.
5. During the course of this pilot study the interest amongst farmers for parallel programmes on drinkwater, wood (building/fire), small-scale farm mechanization and livestock improvement can be studied.
6. The experience with this pilot study will be of a great help for further implementation of the strategy proposed.

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APPENDIX

APPENDIX I: METHOD AND RESEARCH QUESTIONS

Research questions

Land use is influenced by the opportunities and restrictions of the landscape and the norms and values of the individual and his/her society. In a rural area as South-West Kano, the farmers use the landscape for the best, optimizing the opportunities offered by the area and minimizing the restrictions. In order to gain knowledge of the land use and the farming system it is important to get an understanding of landscape as a whole and find answers to questions like:

- What are the landscape ecological dynamics, or in other words, what are the relationships between relief, soil, water and climate?
- How do the farmers make use of these physical factors?
- In what way is this land-use influenced by the cultural and social background of the farmers?
- Is it possible to define changes in land-use or farming systems? What is the reason for these changes?

Method

In order to find answers to the first two questions it is important to obtain an understanding about the landscape forming factors. The landscape forming factors can be divided in the following elements:

- the physical, the inanimate natural factors, being parent material in the form of geology, the shape and form of the land in the form of the geomorphology and topography, climate hydrology and the soils;
- the bio-physical factors, i.e. vegetation and animals;
- the human element, showing in land-uses.

All these elements are interrelated to each other and subject to a continuous change; for example, the soil type depends very much on the parent material, but over the ages the soil characteristics change under the influence of climate, vegetation and biological activities. Moreover, the agricultural activities as plowing, adding manure changes the top soil. Some of these changes take place in a relatively slow process like geological processes; others, especially those related to human activities, may change rather drastically and relatively quickly.

The physical and bio-physical elements are largely determined by physical laws, the human element by norms and values and planning decisions which are depending on the individual, and on his/hers social and cultural environment.

The landscape as it appears to us, can be seen as an reflection of the integration of the various elements and the forming processes. For example a change in vegetation or land-use often reacts on a change in soil characteristics or the hydrological situation; erosion indicates an imbalance between the land-use and the natural environment. Studies of the landscape in the field and from aerial photographs will provide a lot of information: literature studies and analysis of maps will complement them.

In this land-use study, roughly the following steps are taken, in an iterative process and not in a fixed sequence:

- An analysis of the current land-use is made using aerial slides, flown in June 1986 on a scale 1:40,000 and 1:20,000. The slides are flown by Eco Systems Nairobi. The slides are projected vertically and enlarged to a scale 1:5,000 and 1:2,000. The analysis on a scale 1:5,000 is made to give an impression of the spatial dimensions of the land-use types and the changes in the land-use by comparing the situation of 1986 to the one in 1979. The analysis on the scale 1:2,000 shows the land-use on a village level, covering a cross-section of the different land-use types.
- A field survey provided detailed information, necessary to control the interpretation of the slides. A cross-section is made through the whole study area, using the aerial slides 1:20,000 projected and enlarged to a scale 1:2,000 (see map 2). Extension workers of the Ministry of Agriculture together with the farmers provided the verbal information.
- An analysis of the soil maps and literature in combination with the topographical map (via overlays) clearly showed the interrelationships between land-use and soil types. Further literature studies made clear the relationships between the geological and topographical features.
- An analysis of the detailed maps of the aerial slides, combined with literature and verbal and visual information gathered during the field trips gave inside in the farming system as a whole.
- The analysis carried out by EcoSystems in Nairobi provided information about the statistics of the land uses.

An important study on the potentials of the land for the land-use type irrigated agriculture, mainly rice, will be carried out by Kenyan Soil Survey. The comparison between the current land uses and the area suitable for irrigated rice growing can only be carried out when all the information available, including the social studies. The results have the social studies should show the changes the society is undergoing and thus influencing decisions taken by farmers. On the basis of the information gathered, the policy within the PIU/DAO and the needs expressed by the farmers, the goals of the South West Kano Project have to be set. The farmers finally will decide how much land will be put under irrigation, but the PIU/DAO have the responsibility to put the rice cultivation into the context of the farming system and landscape ecology.

An important step in the land-use planning process is the discussion of the landuse strategy with the parties involved, the strategy has to be illustrated by a detailed pilot study. This will make the strategy less abstract and offers the farmers the opportunity to react in a much more effective way. The results of the discussion have to be incorporated in the strategy, often the farmers have a lot of detailed information gathered over years of a process of trial and error in coping with this environment.

APPENDIX 11: PHYSICAL DATA OF THE KANO PLAINS

Climate

The climate of Lake Victoria area is humid combined with moderate mean temperatures.

The average annual percipitation is about 1,150 m. The average annual precipitation is about 1,000 mm - 1,260 mm. At the escarpment surrounding the plains annual precipitation increases upto 1,800 mm. In general there are two rainy seasons in this region; a long rainy season from the middle of March to the end of May, the "long rains" and a short rainy season from the end of October to the middle of December the "short rains". Rainstorms are of a convective nature. Therefore, the spatial distribution of precipitation is very inhomogeneous and erratic.

During the months November upto April there is a prevailing South-West wind over the Kano Plains, whereas for the rest of Kenia North-East winds tend to blow.

table 1: Average mean montly temperature, sunshine, radiation, humidity and windspeed at Ahero Iirigation and Research station.
source: National Irrigation Board, 1981.

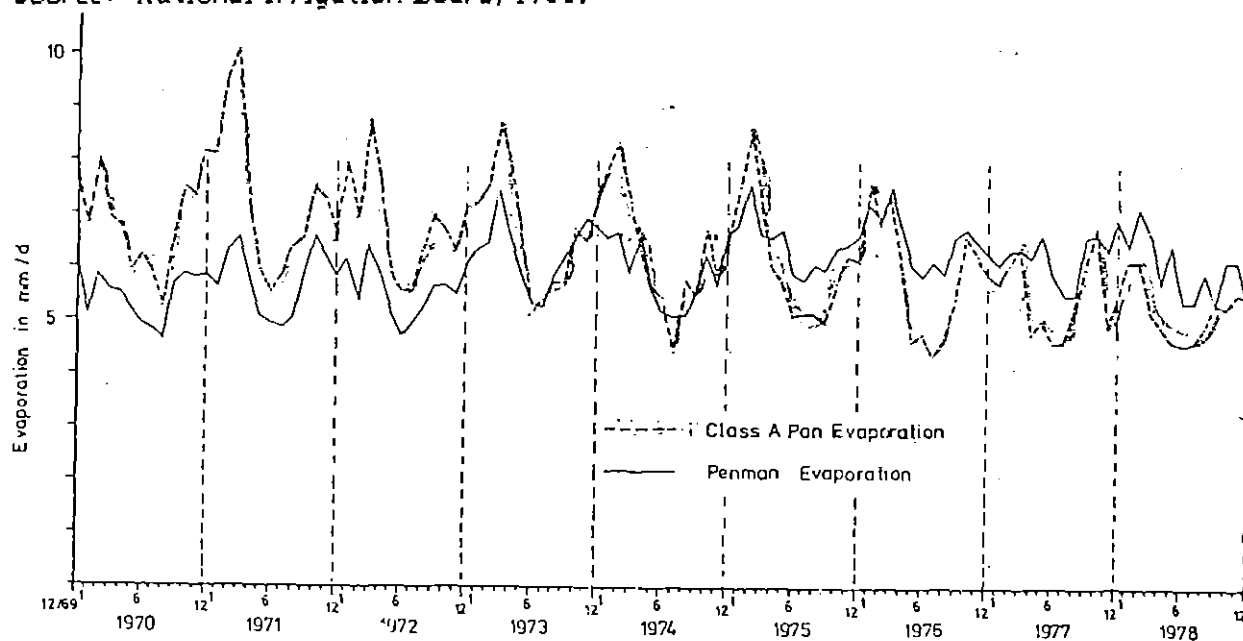
Reference Period:	Jan. - Apr. 1970 - 79; May - Dec. 1970 - 79											
Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Kind of Value	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Temperature [C°]	21.9	22.3	22.7	22.2	21.6	20.9	20.7	20.9	21.2	22.2	21.8	21.7
Sunshine hours	8.4	8.3	7.7	7.2	7.1	7.0	6.6	6.6	6.8	7.3	7.1	8.3
Radiation [cal/cm²]	616	633	624	598	587	554	543	550	584	608	577	625
Humidity [%]	67	68	63	74	73	76	76	73	65	62	64	67
Wind Speed [km/h]	5.6	5.7	5.4	5.1	4.5	4.5	4.2	4.6	5.1	4.5	9.0	5.3

The highest mean temperature can be expected in March, and the lowest in July, respectively 22.7 C and 20.7 C. For growth of the crops it is of interest to note that the maximum figures for radiation, sunshine hours and temperatures occur from December to March.

Highest evaporation values are observed from December to March, coinciding with highest sunshine and radiation.

figure 1: Class A Pan and Penman evaporation at Ahero Irrigation and research station.

source: National Irrigation Board, 1981.



Soils

In this report information about soils is based on the literature available, most of these studies are carried out on a scale 1:50,000 and thus deal with a regional scale. Kenya Soil Survey will carry out a more detailed study for the specific project area.

The Kano plains are situated at an altitude of 1,135 m. at the shore of Lake Victoria to a level of about 1,158 m. During the pleistocene period they were covered by Lake Victoria to about 1,220 m. silt and clay sediments were laid during this time, and were partially reworked by subsequent fluvial activity.

According to the mineralogical and physical features of the parent material, all soils, except those in units 10 and 6 (see legend tabel) are characterized by a very high clay content (60-80 percent), a good nutrient status and a very low permeability. They are very sticky and plastic when wet, very hard when dry, two aspects that make land preparation very difficult. 70 percent of the soils are very deep (more than 2 m.), without a groundwater table in the first 2 m.

The soils in the project area of the Sout-West Kano Project are shown in the part of the soil map compiled by Ministry of Waterdevelopment, 1982 and Dacosta, 1969.

Table 2: Soil characteristics, classification, extent and suitability for irrigation.
Source: National Irrigation Board, 1981.

Map unit	Soil characteristics	Classification	Extent		Suitability for irrigation	
			ha	per cent	Class (1)	Subclass (2)
1	Dark brown or very dark grayish brown, imperfectly drained, cracking, heavy clay	Udic Pellustert very fine, montmorillonitic, isohyperthermic	374	15.7	2	2h
2	Very dark, gray or black, poorly drained, cracking, heavy clay	Udic Pellustert family as above	896	37.6	2	2hf
3	Very dark gray or black, very poorly drained, cracking heavy clay of seasonal swamps	Hydric Pelludert family as above	414	17.3	2	2hf
4	Very dark gray, very poorly drained, cracking heavy clay, with sodic-saline subsoil, of seasonal swamps	Hydric Pelludert family as above sodic-saline phase	103	4.3	4	4hfa
5	Very dark gray, very poorly drained, cracking heavy clay overlying coarser, sodic-saline material at 100 - 200 cm depth, of seasonal swamps	Hydric Pelludert very fine over loamy or sandy, montmorillonitic, isohyperthermic sodic - saline phase	216	9.1	4	4hfa
6	Very dark gray, sodic - saline, medium to heavy clay of permanent swamps	Sodic - Saline Hydroquent fine to very fine	265	11.1	5	
7	Very dark gray or black, poorly drained, cracking, heavy clay overlying coarser and calcic material at 50 - 100 cm depth	Udic Pellustert very fine over loamy, montmorillonitic over carbonatic, isohyperthermic	38	1.6	2	2hfw
8	Dark brown or very dark grayish brown, imperfectly drained, cracking heavy clay overlying coarser material at 50 - 120 cm depth	Udic Pellustert very fine over loamy, montmorillonitic isohyperthermic	20	0.8	2	2hw
9	Very dark gray, poorly drained, cracking heavy clay overlying stratified silt and sand at 80 - 120 cm depth	Udic Pellustert very fine over sandy, montmorillonitic, isohyperthermic	9	0.4	2	2hw
10	Dark brown, moderately well-drained, light to medium clay overlying heavy clay at 50 - 100 cm depth	Vertic Ustifluent fine, montmorillonitic, isohyperthermic	50	2.1	4	2hw

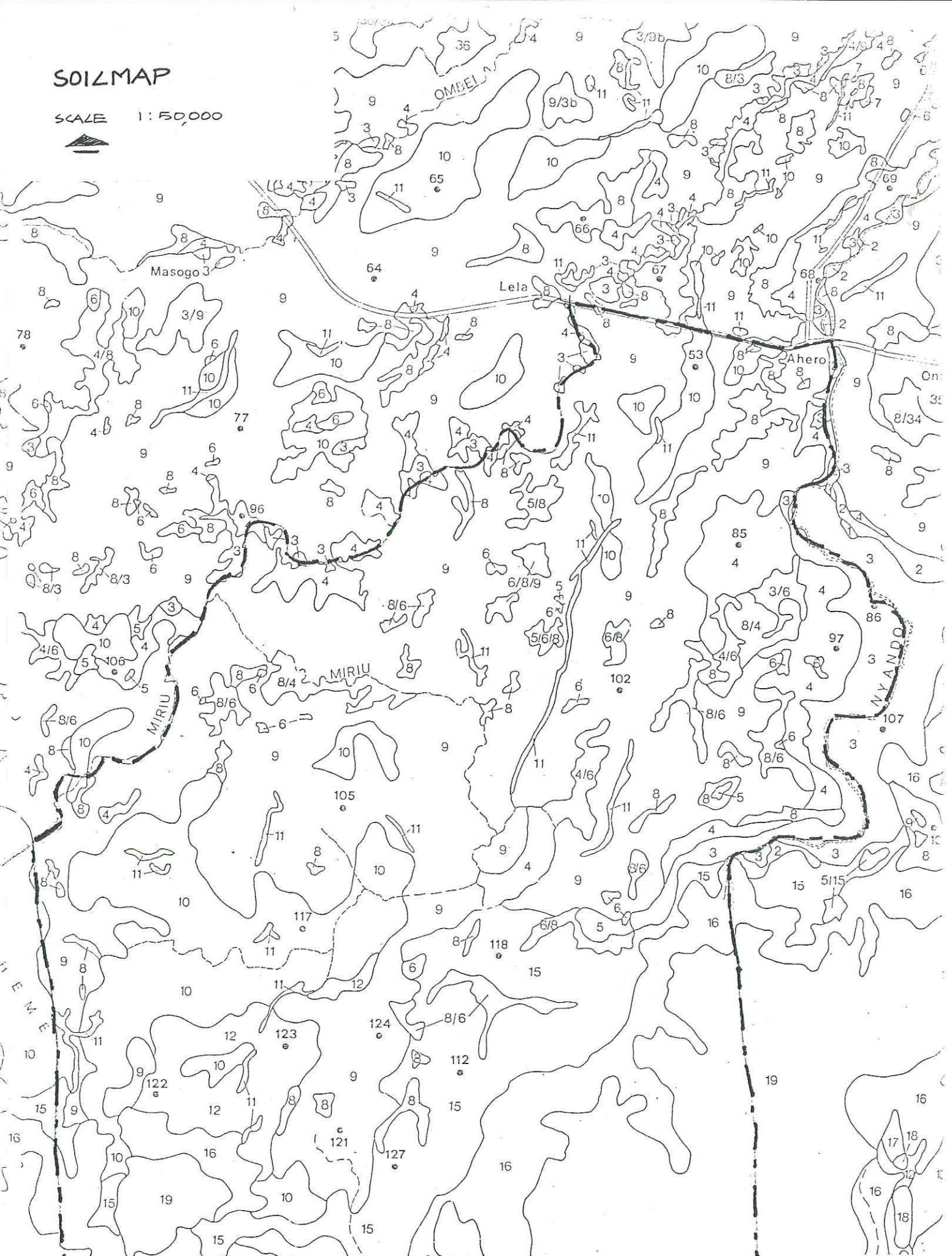
Source: Results of the Soil Survey carried out within the framework of the present feasibility study.

- (1) Suitability class - 1 - highly suitable
2 - moderately suitable
4 - restricted suitability (only for rice)
5 - unsuitable pending further study

- (2) Subclasses are symbolized by lower case letters indicating some limitations -
h - very fine texture (reduces permeability, porosity and soil workability)
f - surface waterlogging hazard
w - watertable rising hazard
a - sodic and/or saline hazard

SOILMAP

SCALE 1:50,000



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SOIL CLASSIFICATION LEGEND

MAP UNIT (SOIL TYPES)	SOIL CHARACTERISTICS SOILS PREDOMINANTLY OF ALLUVIAL OR LAKE ORIGIN (BASAL PLAINS)	IRRIGATION STATUS AND SUITABILITY FOR MAIN CROPS
1	Dark brown, intermixed coarse textured (sandy clay loam to loamy sand) river bank levees, freely drained.	Suited to sugar cane but topographic limitations.
2	Dark brown, varying textures (clay loam to sandy loams) often topsoils truncated; confined commonly to river banks with uneven relief.	Unsuitable.
3	Dark brown, variable, slightly fine textured (sandy clay to light clays) river levees with moderate permeability.	Suitable for sugar and cotton.
4	Dark brownish sandy clays to light clays moderately permeable underlain by dark greyish, poorly permeable light or medium clays.	Suitable for sugar and cotton.
5	Dark brown stratified coarser textured (sandy clay loam to loamy sands) infertile, older levees with free drainage.	Fairly suitable for sugar but better for settlement.
6	Dark brownish moderately permeable, slightly saline mixed, medium fine textured (sandy clay loam to light clay) older levees.	Fairly suitable for sugar and cotton but better for settlement.
7	Dark brownish, finer textured, saline-alkaline older levees.	Unsuitable - Grazing or settlement.
8	Very dark brown lighter clay overlying below (about 25 cms.) very dark poorly drained medium or heavy clays.	Fairly suitable for sugar, cotton and rice.
9	Very dark greyish, poorly drained, impermeable, cracking, medium or heavy clays. i) Material developed from and underlain by clay and ash. (Kibigori clays).	Well suited for rice. Fair for sugar and cotton.
10	Very dark grey or black, very poorly drained, cracking, heavy clay receiving drainage. ii) Developed from interbedded clay-volcanic ash beds (Aristos clay).	Suitable for rice only.
11	As above (phase of S.10) appears as old meander channels or ponds.	Drainage channels or level off for rice.
12	Very dark grey, very poorly drained, saline-alkaline, medium or heavy cracking clays of swamp fringes.	Suited for rice by reclaiming.
13	Very dark grey medium or heavy cracking clay overlying below 90 cms. coarser textured material.	Suitable to rice, cotton but topographic limitations.
15	Infilled deltaic deposits of swamp fringes; very dark brown friable, variable, mixed, finer textured, overlying older clays at depth.	Suitable for sugar and cotton.
16	Very dark greyish or black medium or heavy cracking clays of seasonal swamps.	Suited for rice by reclaiming.
17	Dark brownish somewhat saline-alkaline sandy clays to light clays of lake beaches.	Better for settlement. With subsistence crops.
18	Dark brown, saline-alkaline sandy clay loam to loamy sands of lake beaches.	Unsuitable - Settlement only.
19	Very dark grey or black clays of permanent swamps.	Unsuitable - Requires extensive reclamation.

b = undulating 2 - 6% slopes.
c = 6 - 13% or more slopes.

Soil Unit 1 - Miriu sandy loam

This soil is dark brown very locally sorted deposition of fast moving streams, occurring as river bank levees. The profile has complex layers of stratified, mixed and varied textured material with a predominance of sand often speckled with quartz fragments. The textures commonly range from sandy clay to sandy loams with interspersed lenses of clay and silt. The soil has good physical properties, soft to friable consistency, free internal drainage and unimpeded rooting system. Being in proximity to rivers, the subsoil may be mottled but with reddish or yellow colours. The profile has acid reaction mean pH 5.5 slightly increasing with depth. The CEC is generally low but wide range (6 - 25 me %) occurs depending on the clay content of the horizons. The basic nutrients (K, Ca, Mg including P) tend to be low or marginal possibility due to leaching effect, but the organic matter in the surface horizon is adequate (mean 2.5% carbon).

U.S.D.A. Classification: Miriu sandy loam falls into Andic or in the Typic (absence of finer layers) Tropofluvent subgroup of Entisols.

U.S.B.R. Classification: Class 2, Subclass $2s_{p1}$.

Soil Unit 2 - Complex of non-arable fluvial soils

This unit is a complex of varied textured soil occurring locally along stream banks. It represents minor eroded phases of various soils (characterized by truncated shelves of wide range of remnant soil material including gravel, rubble or mudstone).

U.S.B.R. Classification: Class 6, Subclass $6s_{x5P2}$

Soil Unit 3 - Miriu sandy clay

This soil like Miriu sandy loam is dark brown locally sorted deposition of contemporary streams. It is found along banks of streams releasing moderately slow loam. The profile is varied, mixed and stratified, finer than Unit 1; the textures commonly are sandy clays or loams with intermittent layers of sand or clay accretions. The soil has generally friable consistency and moderate permeability which diminishes slightly at depth depending on the clay content. The clay fractions commonly show montmorillonite, illite and kaolinite in the proportion of 2:1:1. The soil reaction is slightly acid to neutral increasing slightly at depth. The basic nutrients (Ca, Mg, K including P) are adequate, but the organic matter content is marginal perhaps because it is intensively cultivated.

U.S.D.A. Classification: The soil unit falls in the Andic Tropofluvent subgroup Entisols.

U.S.B.R. Classification: Class 2, Subclass $2s_{P1r1}$

Soil Unit 4 - Ombei clay loam

This is dark brown to greyish finer textured flood deposition of contemporary streams with a predominance of alluvial clay. The top-soil textures to a depth of 45-60 cm are mixed and variable, commonly loamy textured with friable consistency and moderate permeability. The subsoil is very dark greyish older deposition, mostly light to medium clays often with thin sandy lenses. The subsoil permeability is slow degenerating with depth. The clay fractions is composed dominantly of montmorillonite with some illite and kaolinite. The profile has neutral reaction which tends to become mildly alkaline with depth. The major nutrients (Ca, Mg, K and P) are adequate but nitrogen content is low.

U.S.D.A. Classification: It falls in the Aquic Tropofluvent subgroup of Entisol.

U.S.B.R. Classification: Class 3, Subclass $3s_{h2P1r1}$

Units 5 - Nyalunya sandy loam

The Nyalunya sandy loam has a coarse varied textured profile commonly with sandy loam or sandy clay loam horizons and intermittent finer lenses. The soil has moderately rapid permeability decreasing slightly at depth depending on the subsoil clay and sodium content. The topsoil has acid reaction (mean pH 5.2) becoming neutral or slightly alkaline below. The major nutrients including P and N are low presumably due to free internal drainage. The soil is non-saline but some concentrations of lime and alkali tend to be encountered at depth.

U.S.D.A. Classification: It is Typic Troorthent subgroup of Entisols.

U.S.B.R. Classification: Class 4P, Subclass 4Ps_{x3}

Units 6 - Awach sandy clay

The Awach sandy clay like the Nyalunya sandy loam has a varied and mixed textured profile without discernable order of horizons; the textures being commonly sandy clays or clay loams. The profile has moderate permeability which diminishes slowly at depth. The topsoil reaction is neutral becoming slightly alkaline in the subsoil depending on the impermeable clay layers. The subsoil clay layers have invariably significant level of salt content, i.e. ECe more than 4 mmhos/cm. Carbonate concretions and gypsum are also often encountered at depth. The nutrient content is adequate with exceptionally high reserve of P and K but nitrogen content is low.

U.S.D.A. Classification: It is a Halic Troorthent subgroup of Entisols.

U.S.B.R. Classification: Class 3, Subclass 3s_{h2o1r1}

Soil Unit 7 - Alendu silty clay

This is dark brownish finer textured old deposition of streams or lake, occurring as levees within the basal clay areas.

The profile textures are commonly light clays incorporating appreciable amount of silt particularly in the surface layer (silty clays).

Occasionally heavy clay layers are found at depth. The topsoil clay contains montmorillonite, illite and kaolinite in the proportion of 2:1:1 but in the subsoil montmorillonite predominates. The profile has slightly acid reaction becoming alkaline at depth. The subsoil below 30 cm has significant level of alkali (ESP 15%) and salt content ECe 4 mmhos/cm; lime and gypsum are also encountered at depth. The nutrient reserve is adequate with exceptionally high content of P and K but nitrogen content is low.

U.S.D.A. Classification: It falls in the Halic-Andic Troorthent subgroup of Entisols.

U.S.B.R. Classification: Class 4R, Subclass 4Rs_{h2p2e3}

Soil Unit 8 - Ahero clay loam

This soil has a very dark brown to greyish brown shallow (20 - 30 cm) clay loam or light clay topsoil overlain by silty or sandy veneer. The topsoil consistency is slightly friable with moderate permeability. The subsoil is very dark grey medium or heavy clay occasionally with lighter horizons and having slow to very slow permeability. Due to higher montmorillonitic clay content the subsoil commonly shows cracks, slickensides or weak prismatic structures. The pH is neutral throughout the profile sometimes increasing to mildly alkaline at depth. The basic nutrients are adequate with rather high amount of P but nitrogen content is marginal.

U.S.D.A. Classification: It falls in the Vertic Troorthent subgroup of Entisols.

U.S.B.R. Classification: Class 3, Subclass 3s_{h2p2}

Soil Unit 9 - Kano clay

This is very dark grey or black clay, often with a very shallow surface cover of very dark brown or greyish recent origin. Although no textural distinction exists between the topsoil and subsoil, the latter is generally slightly heavier with mean content of silt 18% and clay 70%; the clay fraction being composed of 60% montmorillonite with remainder illite and kaolinite in equal proportions. When dry the soil has loose surface mulch consisting of discrete very hard granular or blocky aggregates dominantly less than 5 mm in diameter; accounting for good surface tilth. The subsoil is distinctly blotched in deeper layers. When dry the soil is also characterized by deep vertical cracks about 2 - 5 cm wide and having rust mottling as high in the profile as the surface horizon, often taking the shape of root channel rusting; whilst most sub-surface horizons have strong blocky structures with dense fabric and hard to extremely hard consistence when dry. The profile permeability is slow to negligible and once the cracks close water, losses due to percolation are very slight. Topsoils tend to be acid to neutral in reaction but the subsoil is generally alkaline with mean exchangeable sodium of 13%; the highly significant level of alkali is encountered around 70 cm depth. A noteworthy feature of the subsurface horizons is the invariable presence of root galleries, comprising of a profusion of mats of broken fine dead roots. This may be considered a horizon of root frustration as rarely do any healthy roots appear below this layer, presumably due to alkali and montmorillonitic clay content. Within the modal profile carbonate concretions appear about 100 cm depth; free lime and gypsum clusters were encountered at depth in some profiles. There are adequate levels of nutrients including P, K and S but nitrogen content is marginal.

U.S.D.A. Classification: This soil falls in the Typic Pellustert subgroup of Vertisols sometimes integrating towards Chromic Pellustert.

U.S.B.R. Classification: Class 3, Subclass $3s_{h_2p_2r_1}$

Soil Unit 10 - Nyamware clay

This is very dark grey or black heavy cracking clay. In terms of texture no obvious distinction exists between topsoil and subsoil. Mean content of silt is 13% whilst clay is 75%. The clay is predominantly montmorillonite with some illite and kaolinite. In dry season the surface has characteristic undulating micro-relief resulting from tussocky puff formation, which may have been initiated by worms during rains. The tussocks measuring about 10 x 10 cm are prominently mottled and are very dark brownish in colour; the depressions between the tussocks show deep cracks 2 to 10 cm wide. The profile structure and consistency closely resembles to those of Kano clay. The topsoil is slightly acid to neutral in reaction but the subsoil at an average depth of 60 cm becomes alkaline with mean ESP 16% increasing to some depth. The subsoil is invariable calcareous, containing about 2% calcium carbonate concretions and lime, which occur below 90 cm depth. The profile though exceedingly heavy textured, dense and impermeable, is non-saline throughout. There seems to be rather high organic matter content in the soil presumably due to its basin status, with the topsoil having an average content of about 5%. The nutrient reserve is adequate.

U.S.D.A. Classification: The soil falls in the Typic Pellustert subgroup of Vertisols.

U.S.B.R. Classification: Class 4R, Subclass $4Rs_{h_2p_2r_1e_3}$

Soil Unit 11 - Nyamware clay

This unit is a more depressed soil "phase" of Unit 10, occurring as meander channels, ponds or wells in areas of basal clays. Due to its lower lying status the soil is flooded and in receipt of drainage for longer periods than Unit 10. This soil occurs very locally as narrow strips or channels. Soil 11 could serve as drainage channels for irrigation or infilled with surrounding clay for rise irrigation.

U.S.B.R. Classification: Class 4R, Subclass $4Rs_{h_2p_2e_3}$

Soil Unit 12 - Bwanda clay

This is very dark greyish mottled clay commonly spread with a thin insipient sandy or silty veneer with some organic trash. The sub-surface below 10 - 20 cm is very dark grey or black heavy clay with average content of clay 70% and silt 19%. The clay is dominantly montmorillonite with some illite and kaolinite and average CEC of 53 me%. The profile though morphologically resembling the Nyamware and the Kano clays has more strong coarse, blocky structure, sometimes compounded into prisms, and often with pronounced slickensides. It is characterised by deep vertical cracks. The profile has strong alkaline reaction sometimes even in the surface layer, with more than 15% ESP in all sub-surface horizons; it invariably has one or more sub-layers with significant level of salt content (more than 4 mmhos/cm). The subsoil is calcareous averaging 1 to 2% carbonate and gypsum crust occur at depth. The high levels of alkali, salt and lime in the profile is possibly due to seasonal accumulation of products by fluctuating rise of swamp waters and their concentration by process of evaporation and precipitation.

U.S.D.A. Classification: It is a Sodic Pellustert subgroup of Vertisols.

U.S.B.R. Classification: Class 4R, Subclass 4Rs_{h₂P₂e₃}

Soil Unit 13 - Nyalla clay

This is localised very dark greyish cracking clay underlain at variable depth around 80-90 cm by dark grey - brown older stream deposition of mixed and varied textures, commonly sandy clay loam to sandy loam, including sometimes fragments of mudstone. The upper profile has slow to very slow permeability but the subsoil owing to coarse accretion has moderate to slightly rapid infiltration. The clay mineralogy indicates the predominance of montmorillonite with small amounts of illite and kaolinite; the proportion of illite tends to further decrease at depth whilst the other two increase proportionally. The soil has neutral reaction throughout the profile but the horizon immediately above the coarse material at times shows some alkali accumulation. In the upper profile the CEC averages more than 30 me% whilst at depth it averages 21% or less. The nutrient levels including the organic matter content of the soil appears adequate.

U.S.D.A. Classification: It is a Thapto-Arentic Pellustert subgroup of Vertisols.

U.S.B.R. Classification: Class 3s, Subclass 3s_{h₂P₂r₁}

Soil Unit 15 - Kakola clay loam

This is very dark brownish deltaic flood deposition of streams, occurring along swamp fringes on the lower reaches of the plain. The surface textures are commonly clay loam to light clays, sometimes with stratified sandy lenses or pockets. The clay content below the sub-surface tends to increase with depth and is distinctly mottled. In localised areas of intilled stream courses, aggraded sandy or silty accretion is commonly found in the profile. The subsoil at variable depth below about 60 cm is very dark grey, somewhat gleid heavy clay of old swamp origin. The upper profile has friable consistency, moderate permeability and unimpeded rooting system. The strongly mottled and blotched subsoil, has slow permeability becoming negligible at depth. The pH of the soil is slightly acid to neutral increasing slightly with depth. The CEC appears moderately high due to the heavy montmorillonitic clay content ranging between 40-70 me%. The nutrient reserve is adequate with well incorporated organic matter in the topsoil (mean 4.8%).

U.S.D.A. Classification: It is an Aeris Tropaequent subgroup of Entisols.

U.S.B.R. Classification: Class 3, Subclass 3s_{h₂P₂}

Soil Unit 16 - Kawino clay

These are very poorly drained, very dark cracking clays of seasonal swamps. The horizon textures are commonly medium to heavy clays becoming blotched at depth. The soil towards the higher fringes may have minor pockets of shallow lighter textured surface horizon. Where old streams have crossed these areas, the subsoil may also have lighter textured horizons; these areas could be considered as phases of Kawino clay, but they are of mixed and of very limited extent for mapping. The soil has notably slow to negligible permeability and being waterlogged for considerable periods, is prominently mottled almost to the surface. The profile has very firm, very sticky and plastic consistency with generally blocky structure, sometimes with weak insipient prisms. Some subsoils are sub-angular blocky with lenticular pressure peds and click-sides movement. The soil when dry during brief spells, has self "mulching" surface and wide cracks in the upper profile but the deep subsoil is invariable moist almost throughout the year. The soil are non-saline/alkaline with low ECE's and ESP. The soil reaction is slightly acid to neutral, though localised higher level of alkali may be encountered in the surface owing to seasonal flood accumulation. The CEC's averages more than 30 me% and the basic nutrient appear adequate. The organic matter content is satisfactory (5% organic matter), though not in fully decomposed form.

U.S.D.A. Classification: It falls in Hydric Pellustert' subgroup of Vertisols.

U.S.B.R. Classification: Class 3, Subclass 3 sd_{h2p2f2}

Soil Unit 17 - Nduru silty clay

This is dark brownish or greyish brown finer textured deposition of lake, occurring as raised beaches. The profile is variable without discernable order of horizons; the surface textures are commonly silty clay, clay loam or light clay, whilst the subsoil tends to be more clayey in composition, interspersed with sandy lenses. The upper profile has slightly friable consistency and moderate permeability, while the subsoil has generally slow permeability and firm consistency depending on textural composition. The soil shows distinct mottling below 30 cm depth. The structures are weak to moderate, medium blocky or sub-angular blocky. The profiles is strongly alkaline with average of more than 10% ESP which increases with depth, with significant level of alkali occurring as high 20-30 cm; the subsoil below 30 cm is also saline (ECE more than 4 mmhos/cm). The pH is surprisingly high ranging between 8-10. The available nutrients Ca, Mg, K, P and S appear adequate but organic matter is marginal. The subsoils are invariably calcareous with abundant carbonate concretions and lime occurring as high as 30 cm depth; gypsum crusts also occur at depth.

U.S.D.A. Classification: It falls in the Halic Troporthent subgroup of Entisols.

U.S.B.R. Classification: Class 6, Subclass 6s_{h2p2r5a5e3}

Soil Unit 18 - Nduru sandy clay loam

This is dark brownish locally sorted coarser textured deposition of lake occurring as raised beaches. The profile textures are variable but commonly range between sandy clay and sandy loam interspersed with lenses or pockets of clay or silt. The soils are characterised by moderately free drainage, but the external drainage, in particular in the vicinity of the lake, is subject to lateral water table with the subsoil showing distinct mottles at varying depths. The profile consistency is friable and the structure is normally weak sub-angular blocky. The soils are strongly saline with significant levels ($\text{ECe } 4 \text{ mmhos/cm}$) occurring throughout the profiles sampled. When dry, the surface is characterised by whitish salt crust formation. The saturation percentage for these soils is low averaging about 30%; a factor unfavourable for growth of most plants. The soils are also strongly alkaline with pH range of 8-9 and ESP of more than 15 me% throughout the profile. The nutrient reserve appears adequate with outstandingly high levels of P but low amounts of organic matter. The subsoils are invariably calcareous and some gypsum commonly occurs at depth.

U.S.D.A. Classification: It falls in the Halic Trophotent subgroup of Entisols.

U.S.B.R. Classification: Class 6, Subclass 6s
 $P_2 r_5^a s_5 e_3$

Soil Unit 20 - Kibos sandy clay

This is dark brownish locally sorted flood deposition of streams incorporating coarse hill wash accumulation. The soil is found below the colluvial apron representing flood plain of infilled old marshes and abandoned river courses. The profiles are mixed and variable textured without a discernable order of horizons commonly ranging between sandy clay loam to light clays interspersed with accretions of feldspartic and quartz sand and gravel. The upper profile has commonly friable consistency, granular or sub-angular blocky structure with moderate permeability. The soil has acidic reaction becoming neutral at depth. The CEC fluctuates depending on textural horizons ranging between 12-30 me%. The nutrient content appears adequate with fair amount of organic matter content in the surface (2.4% carbon).

U.S.D.A. Classification: It falls in the Andic Tropofluvent subgroup of Entisols.

U.S.B.R. Classification: Class 2, Subclass 2s
 P_1

3. PHOTO INTERPRETATION PROCEDURES

Each colour diapositive was projected downwards onto a desk top dot-grid at a *10 enlargement to give an interpretation scale of 1:2,000. The dot-grid consisted of 18 * 12 cells each of 2 centimetres square and each containing two randomly located dots of 1.5mm diameter. Only the inner 16 * 10 cells containing $16 * 10 * 2 = 320$ dots were interpreted.

Data from the inner interpretation area were entered directly onto data sheets (Table 1). The first four variables hold the flight line, frame number, block and area. Block was coded as "A" or "B", or "X" if the photograph fell outside of the blocks. Area remains to be coded, but will eventually define sub-areas of the two blocks.

The area of a land cover class was measured simply by counting the number of dots covered by it; for example the number of dots covered by rice paddies with growing rice, or the number of dots covered by maize fields, or the number of dots covered by woodlots. Each of the 320 dots was assigned to one land cover class, so all areas add up to 100%. In contrast, numbers were simple counts of the number of objects (e.g. modern roofs) within the inner interpretation area.

4. DATA PROCESSING

All data sheets were carefully checked (e.g. dots added up to 320) before entering into a data base file using the dBase3 programmes. The records in the file were the exact equivalents of the data sheets. After entry, all data were listed and checked against the individual data sheets before being converted to Hectares/Km² or Numbers/Km².

Area variables were converted to Hectares/Km² by dividing the number of dots by 3.2 (dots/320*100). All area measurements thus show the percent cover on the sample photograph in hectares per square kilometre.

Number data were converted to density (Numbers/Km²) by dividing by 0.256, the area (in square kilometres) of the inner interpretation area at a scale of 1:20,000.

Ha/Km² and No/Km² can be converted to total hectares and total numbers by multiplying by 0.256.

5. BLOCK AVERAGES

Table 1 shows simple averages for each block, and for the points lying outside the two blocks. 4 summary variables have also been created showing total rice (R1+R2+R3+R4), total maize (M1+M2), total rainfed crops (M1+M2+S1+OT) and total compounds (HCN+STN+OCN).

6. DATA BASE FILE

All data, as Ha/Km² and No/Km², are contained in a single dBase3 file called KANO.DBF. The structure of the file is given in Table 2. The two variables TRANSECT and FRAME identify the individual 1:20,000 scale diapositive in the photo file holders, while COUNT is a control variable needed by dBase3 if the TOTAL command is to be used. All data are listed in Table 3.

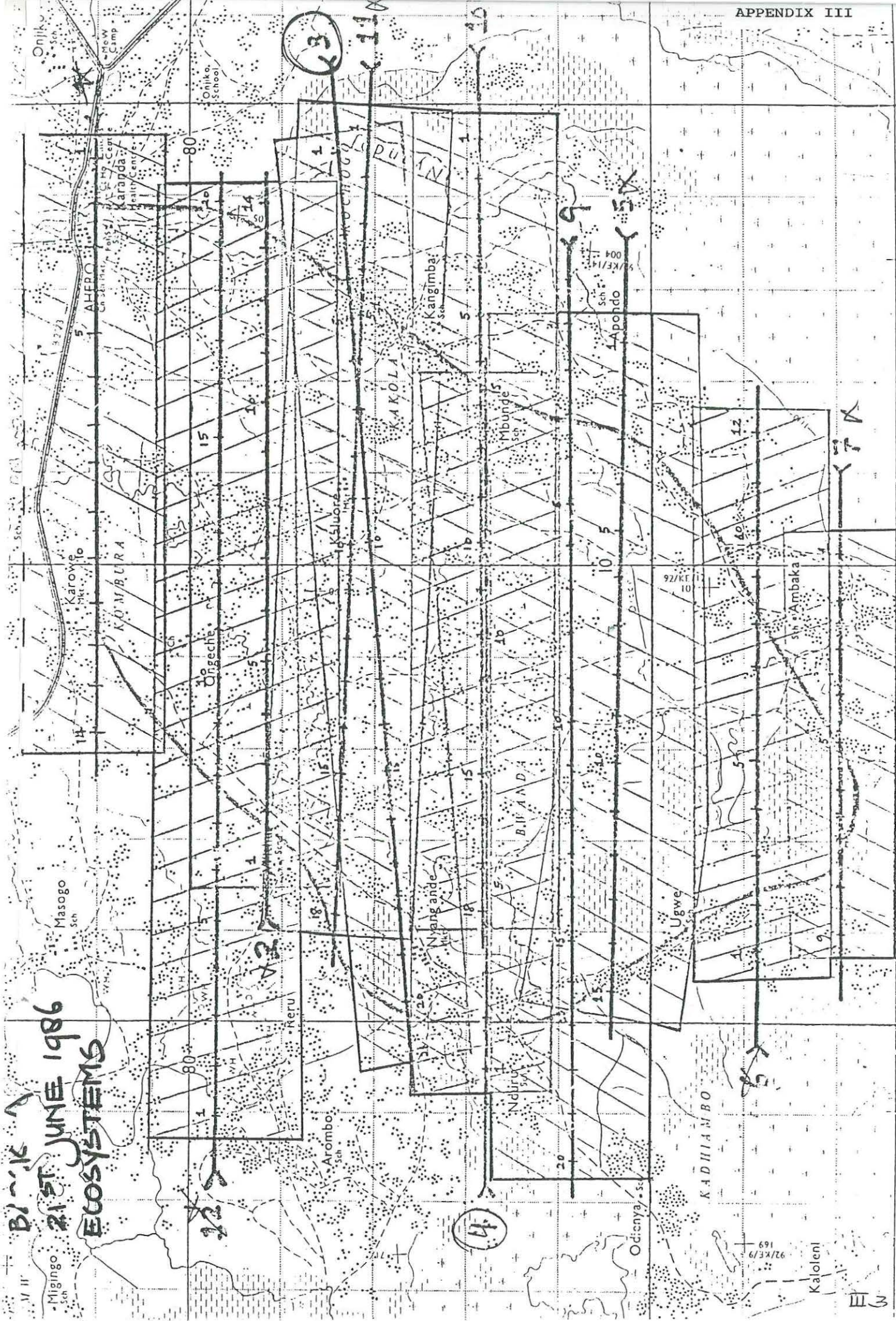
NOTES: (a) There are too many fields in the file to make a dBase2 file.

(b) The diskette containing the data file also holds this report.

Table 1: Simple Averages of Block Data

		BLOCK A	BLOCK B	OUTSIDE
COUNT	(number of samples)	112.00	37.00	67.00
R1A	Rice - tilled land	3.37	2.76	0.52
R2A	Rice - growing	5.11	2.45	0.21
R3A	Rice - harvested	0.39	1.49	0.32
R4A	Rice - fallow	2.85	0.84	0.34
TOTALRICE	Rice - total	11.73	7.53	1.39
MLA	Maize - harvested	1.88	0.24	2.46
M2A	Maize - growing	26.44	15.02	36.43
TOTALMAIZE	Maize - total	28.31	15.26	38.89
SLA	Sugarcane	0.26	21.56	3.49
OTA	Other Crops	0.36	0.60	1.04
TOTRAINFED	Total Rainfed Crops	28.93	37.42	43.43
BFA	Bare Fields	0.22	1.05	0.40
FFA	Fallow Fields	12.22	10.28	7.73
FDA	Field Dividers	0.32	0.39	0.35
BUA	Bunds	0.82	0.77	0.10
CDA	Canals and Ditches	0.21	0.53	0.42
HCN	House Compound - ##	42.15	18.18	54.75
HCA	House Compound - ha	6.14	2.58	7.65
STN	Stock Compound - ##	8.13	3.17	8.75
STA	Stock Compound - ha	0.24	0.08	0.28
OCN	Other Compounds - ##	0.91	0.11	0.93
OCA	Other Compounds - ha	1.09	0.16	0.57
TOTALCOMP	Total Compounds	51.19	21.46	64.44
MRN	Modern Roofs - ##	58.38	12.58	53.76
MRA	Modern Roofs - ha	0.67	0.15	0.67
UCN	Roofs - U.Cnstr - ##	0.31	0.00	4.79
UCA	Roofs - U.Cnstr - ha	0.01	0.00	0.03
TRN	Trad. Roofs - ##	138.80	55.81	195.42
TRA	Trad. Roofs - ha	1.02	0.51	1.74
HEA	Hedges	1.08	0.95	1.08
WRA	Windrows	1.96	0.25	1.67
ACA	Access	2.94	3.41	5.55
WLN	Woodlots - ##	1.43	0.74	2.28
WLA	Woodlots - ha	0.25	0.25	0.47
HHA	Grassland	20.80	14.51	18.69
BCA	Bush Cover	3.56	1.91	2.98
TCA	Tree Cover	1.69	0.53	2.35
SMA	Swamps	3.43	16.75	2.29
OWA	Open Water	0.51	0.35	0.59
XXA	Miscellaneous	0.05	0.00	0.09

BLANK
21st JUNE 1986
ECOSYSTEMS



4. TERMS OF REFERENCE FOR LANDUSE PLANNEROBJECTIVES

1. To provide a strategy to enable the PIU/DAO to propose and implement an ecologically sound landuse/landscape development plan for the South West Kano Irrigation Project area.
2. To assist and train the PIU in the preparation of the necessary documentation, essential for the landuse planning of the South West Kano area.

DUTIES

Under the responsibility of the Provincial Irrigation Unit Nyanza Province:

1. To study available reports, maps and (aerial) photographs concerning the S.W. Kano area.
2. To conduct field visits to the project area for orientation and observations. The PIU will provide guidance and transport.
3. To describe the area in the ecological context, and to inventorize and document the various landuse/landscape elements in order to create an understanding of the ecological processes and balance of the area.
4. To supervise the landuse interpretation (on the basis of aerial photographs -slides- taken in June 1986) to be undertaken by ECO-Systems Ltd., Nairobi. This to ensure an optimum professional liaison between the PIU and the firm.
5. In collaboration with the Irrigation and Drainage Branch of MALD (IDB) to assist in securing the most recent aerial stereoscopic photographs and to liaise with the Kenya Soil Survey (KSS) for their -soil and suitability- interpretation. The IDB to provide letter(s) of introduction and transport.
6. To discuss and explain the principles of analysing maps, results from photo-interpretation and other documentation to enable the formulation of needs, objectives and strategy of landuse planning.
7. To draft a report containing:
 - a. Practical guidance to develop a strategy for landuse planning of the S.W. Kano Project area;
 - b. A landuse analysis of available (by July 23th) documentation of the S.W. Kano area;
 - c. A proposed landuse development strategy for the S.W. Kano area, particularly indicating ways to find and weigh (rank) priorities in the context of smallholder irrigation development, taking into consideration the (subsistence) needs of the smallholders and an optimal use (and conservation) of physical resources;
 - d. An inventory of additional data to be collected and items that need further investigation to enable a better formulation of the landuse development strategy, together with an indication how they fit into this strategy.

CONTRACT PERIOD

Proposed is a period of three and a half weeks. Work will have to be done in Kisumu as well as in Nairobi, and it is estimated that about half of the working time will be spend in Kisumu.

WORKING RELATIONS

Responsible to the Oi/c through the PIE of the PIU Nyanza Province. Assistance from IDB through the teamleader SSIDP.

Source : PIU, 1986