THE AGRICULTURAL POTENTIAL IN ARID AND SEMI-ARID LANDS IN KENYA: A CASE OF MASONGALENI SETTLEMENT SCHEME

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Declaration

This thesis is my original work and has not been presented for a degree in any other university.

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" This thesis has been submitted for examination with my approval as University Supervisor"

DR. S. O. AKATCH.

Dedication

This work is dedicated to my Wife Lucy and my Daughter Veronica and to my parents, brothers, sisters and friends who contributed both financially and by words of motivation all through my academic work.

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Abstract

This study set out to analyze the agricultural potential in a newly settled Masongaleni Settlement Scheme being an example of an Arid and Semi-Arid land. The potentials here are the under-utilized rainfed, irrigated agriculture and livestock production particularly bee keeping. A comparison of selected rainfed crop yields from Masongaleni Settlement Scheme and similar ecological areas is used to identify the potentials of the scheme.

On the irrigated crops, the study compares the farmers' incomes from rainfed cash crops and the incomes that may be realised from selected irrigated crops. The irrigated crops earn the farmer much higher incomes as compared to the rainfed crops. The new improved bee keeping method is identified as untapped potential in the livestock sector. The study compares the new improved bee keeping method to the traditional method and finds that the new method is better.

The study identifies the major constraints to the tapping of these potentials. Opportunities, strategies and solutions to achieve sustainable development in Masongaleni settlement scheme are identified.

However, solutions to the above constraints are necessary if the potentials are to be fully tapped. In rainfed agriculture, buying of FITs by the farmers is recommended. The use of drought, pest and disease resistant crops is one of the solutions. Timely planting, weeding and harvesting are other

solutions. The solutions to irrigated agriculture are: application of appropriate pesticides, proper crop rotation, timely planting, weeding and harvesting. Growing low irrigation water requirement crops, tapping irrigation water from the various rivers in the scheme are viable solutions. On the livestock sector, AEOs should advise the farmers on the appropriate veterinary medicine. The farmers should also maintain land carrying capacity and rear small animals. The adoption of the new bee keeping method is recommended. Clearing of tsetse fly infested bushes and keeping tolerant animals is recommended. A well organised management of the proposed irrigation project is also recommended.

The study recommends an integration of rainfed, irrigated agriculture and livestock farming. The study recommends that future research be done to establish the cost of implementing the proposed irrigation project and how such a cost should be shared among the various agencies in the settlement scheme for its implementation.

Future research should be done to attain a tsetse fly eradication programme for Masongaleni Settlement Scheme and other parts of the country.

Data collection for the study was derived from both primary and secondary sources. The data was analyzed using descriptive method.

Abbreviations

FITs	Farm Implements and Tools.
AAK	Action Aid Kenya.
ET	Evapotranspiration.
GOK	Government of Kenya.
KARI	Kenya Agricultural Research Institute.
AMREF	Africa Medical Research Foundation.
CORPs	Community Own Resource Persons.
GDP	Gross Domestic Product.
AEOs	Agricultural Extension Officers.
AIs	Agricultural Inputs.
MOCSS	Ministry of Culture and Social Services.
DDCs	District Development Committees.
GVs	German Volunteers.
MACOSUD	Masongaleni Council For Sustainable Development.
FAO	Food and Agricultural Organization.
MIFCS	Masongaleni Irrigation Farmers Co-operative Society.
MOLRR&WD	Ministry of Land Reclamation, Regional and Water Development.
DCK	Denmark Company of Kenya.
TARDA	Tana and Athi Rivers Development Authority.
MOCD	Ministry of Co-operative Development.
KIP	Kibwezi Irrigation Project.
CINADO	Centre for International Agricultural Development Co-operation.

USAID	United States Agency for International Development.
IDRDU	Institute of Dry land Research Development and Utilization.
CHEK	Council for Human Ecology Kenya.
O & M	Operation and Maintenance.
ASALs	Arid and Semi-Arid Lands.
EIA	Environmental Impact Assessment.

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CHAPTER ONE

INTRODUCTION

1.1 Overview

ASAL areas are unsuitable for rainfed cultivation due to physical limitations such as aridity, poor soils and rough terrain.

According to the official Kenya Atlas of 1970,(p.28) the lands of Kenya are divided into six ecological zones based on rainfall and moisture indices. Zone 1 is the wettest and zone vi is the driest. The Arid and Semi-Arid Lands (ASALs) cover zones iv, v and vi with mean annual rainfall ranging between 200 and 800 millimetres and a moisture index of -57 and -30. Together the three zones in ASALs cover 473,000 km^2 as shown in table (1).

Table 1: Portion of land covered by ASALs in Kenya

Zone iv (Semi-arid)	5,8000km2	10%
Zone v (Arid)	284,1000km2	49%
Zone vi (Very arid)	131,000km2	23%
Total land area	473,000km2	82% of Kenya's total land area

Source: Official Kenya Atlas, 1970.

These three zones cover 82 per cent of Kenya's land area, plate (1). Masongaleni Settlement Scheme is found within the climatic conditions like those shown in table (1). Plate (1) shows an example of some of the very dry parts of ASALs with Masongaleni Settlement Scheme a case in point.

Plate (1). An example of a very dry part in Masongaleni Settlement Scheme

Source: Field survey, 1995.

Other defining characteristics of ASAL conditions include: highly variable and poorly distributed rainfall, scarcity of basic resources, a fragile ecosystem that is susceptible to degradation and lack of suitable infrastructure for development, plate (2). It portrays an example of a fragile ASAL area that is susceptible to soil erosion thus a degraded ecosystem.

Plate (2). An eroded and degraded land in Masongaleni Settlement Scheme

Source: Field survey, 1995.

From plate (2) it is evident that the ASAL areas in Kenya have ecological conditions that may be characterised generally as hot and dry with an evapotranspiration rate (ET) which is more than twice the available rainfall. The typical picture is that rainfall is between 250 and 1000 millimetres and an ET of 1500-2500 millimetres per year. Thus, Kenya's ASALs are characterized by severe natural resource limitations, rising population pressure and inadequate management of the existing resource base, which combined constitute the basic problem confronting the area and its people.

The majority of the ASALs' population are pastoralists

although the semi-pastoral and farming communities are becoming more important. Some of the new farmers are immigrants in recent opened irrigation and settlement schemes. Masongaleni Settlement Scheme is one of the examples of the recently established settlement schemes. Arising from what may be the world's highest population growth, increased migration from the overcrowded high and medium potential areas of the country to the less densely populated but lower potential ASALs is taxing the already limited carrying capacity of the land.

The population in ASAL areas subsists under the daunting and unpredictable conditions of poverty, famine and mortality, loss of livestock and drought (Pratt and Gwynne, 1977; Republic of Kenya, 1991).

Rangelands in ASALs yield multiple products besides being a source of meat and milk. They form the major watershed areas of Kenya, provide fuel-wood, and major habitats for wildlife (the basis of tourism in Kenya), and constitute a genetic store for most domestic plant and animal species (Farah, 1989). However, ASALs support over 25 percent of the total human population and about 50 percent of the livestock population.

The development of ASALs received low priority during the colonial period and during the first one and a half decades after independence. However, since the late 1970s, the development of ASALs received increasing attention in recognition of the important contributions ASAL areas can make to National Development.

The ASAL areas have considerable potential albeit at a higher cost than the rest of the country. At the same time, most of the rural poor people live in these areas, hence the need to improve their living conditions through increased productivity and creation of employment opportunities, Republic of Kenya, (1994-1996 National Development Plan).

According to the government of Kenya policy, the third development plan (1974-1978) was cognizant of the problems of the ASALs, but few programs were implemented during that period to rectify them. In contrast, the fourth Development Plan (1979-1983), which establishes poverty alleviation as its central objective, set forth a clearly articulated statement of the need to accord substantially greater emphasis to the development of the ASALs and recommends a set of action programs designed to achieve results.

Despite the efforts made to develop ASALs, numerous socio-economic, physical/environmental and technological constraints are characteristic of these areas. Physical/environmental constraints result from low, erratic and unevenly distributed rainfall, poor soil fertility, pests and diseases among others.

Social constraints result from the culture of the people relating to their tapping of the resources available. Also on the social constraints there are factors like high population growth rates among others. On the economic constraints, there are issues like lack of land tenure and low incomes associated with the people.

On the technological constraints, the 1979-1983 National Development Plan, states that previous research work has mainly concentrated on wetter areas and migrants from those areas often bring with them unsuitable technology to tap resources in arid lands.

From the experiences of implementation of area-based integrated development projects and the strategies spelt out in the sessional paper No.1 of 1986 on economic management for renewed growth, the sixth National Development Plan came up with what is now called second generation: strategies for ASALs' development.

The main objectives include making available the means of exploiting the important production potentials of ASAL resources thereby contributing significantly to income, employment and food security goals, reclaiming where damaged and protecting valuable and fragile natural environments, generating opportunities for improving the quality of life of present and future populations on a sustainable basis.

The explosive growth of the human population has resulted in increased pressure for land, with forests and semi-arid areas falling victim to human settlements and agricultural activities (Nation Newspaper, 2nd October, 1995). Additionally, the increasing problem of soil erosion and environmental degradation, the threat of desertification and negative consequences of such phenomena needs to be addressed.

However, Masongaleni Settlement scheme, an Arid and Semi

Arid zone just like other similar lands in the country possesses the same characteristics as other ASALs in Kenya. The research set out to identify and analyze the agricultural potentials that exist in the newly settled Masongaleni Settlement Scheme. The potentials here are the under-utilized crop and livestock production potentials.

Masongaleni settlement scheme is characterized by major constraints to crop and livestock production. These constraints include among others:

- Inadequate basic farm implements and tools and draught animal power.
- High incidence of human and livestock diseases such as Malaria, Trypanosomiasis and East Coast fever respectively.
- Inadequate agricultural extension services and
- Low, erratic and unevenly distributed rainfall.

The study therefore, set out to come up with opportunities and strategies for the scheme to tap these potentials and achieve sustainable development.

1.2 Statement of the Research Problem

Two-thirds of Kenya's land surface is Arid or Semi-Arid and 80% of the country's population live on only 18% of the economically high and medium potential land. The explosive growth of human and livestock population means that there is population pressure already being felt on the 18% high and medium potential land. This has resulted to increased demand

for land. This means an increasing number of people are moving into marginal areas. Forests and ASALs are falling victim to human settlements and agricultural activities (Nation Newspaper, 2nd October, 1995).

Previous research has mostly concentrated on the agricultural potentials of medium and high potential areas (wetter areas) of Kenya without proper documented research in the newly settled ASALs which are low potential areas.

Again, most of the research done in ASALs has looked at the agricultural potentials of these areas in general. There is need to identify agricultural resource potentials in these newly settled Arid and Semi-Arid Lands and see how these can be utilized for the ever increasing human and animal populations from the medium and high potential areas.

The research problem is therefore, to identify and analyze what agricultural potentials exist in the newly settled Masongaleni settlement scheme. The potentials here are the under-utilized crop and livestock production potentials.
After analyzing the agricultural potentials of Masongaleni Settlement Scheme, the study will identify the major constraints to the tapping of these potentials. The end result of the study is to come up with opportunities, strategies and solutions so that the scheme attained sustainable development.

1.3 The objectives of the Study

The study has a general objective; to identify and analyze

the agricultural potential of the newly settled Masongaleni settlement scheme.

The specific objectives are:

(i) To find out the major constraints to crop and livestock production in Masongaleni settlement scheme.

(ii) To come up with opportunities, strategies and solutions to attain sustainable development in Masongaleni Settlement Scheme.

1.4 The Significance of the Study

The study is very important because Masongaleni was recently settled (in 1992) and no proper documented research has been done in the Settlement Scheme especially on the agricultural potentials that may be tapped in the scheme.

Also, from experience gained from the research interviews, it was evidenced that no Environmental Impact Assessment (EIA) was done in Masongaleni before the GOK settled the farmers in the area. Therefore, this research would act as a model to planning agencies on what environmental impacts and development constraints would face the new settlers in their efforts to tap the agricultural potentials in such areas if a prior Environmental Impact Assessment was not done in similar settlement areas in future.

Lastly, there was need to study the agricultural resource potentiality in the scheme and see how these resources can be tapped to achieve sustainable development.

1.5 Assumptions of the study

The study assumes that:

(i) Inadequate farming implements, tools and lack of draught animal power are the major constraints to full utilization of crop production.

(ii) Tick and tsetse fly borne diseases are the major constraints to livestock production.

(iii) There exists a variety of under-utilized crop and livestock production potentials in Masongaleni Settlement Scheme that need to be fully tapped.

1.6 Structure of the Study

(i) Geographical scope

The research covered all the 8 blocks of Masongaleni settlement scheme which has an area of about 106 square kilometres. The project area is located East of Kibwezi Township in Kibwezi Division of Makueni District, Eastern Province of Kenya.

(ii) Main Statistical Research Coverage

The research set out to identify and analyze the agricultural potential in the newly settled Masongaleni Settlement Scheme. The major fields covered in this include:

- The existence of under-utilized crop and livestock production potentials.

- Major constraints to full utilization of crop and livestock production.
- Possible opportunities, strategies and solutions for the scheme to achieve sustainable development.

Chapter one gives an overview of ASALs. Chapter one also covers the research problem, study objectives, significance of the study, study assumptions, structure of the study, study methodology, scope and limitations of the study and operational definitions used in the study.

Chapter two contains the Literature Review of the study. The chapter highlights literature on the following sub-topics:

- ASALs conditions
- Economic potentials in ASALs
- The history of the development of ASALs in Kenya
- The main objectives of the Kenyan Government towards ASALs
- The constraints to the exploitation of the potentials in the ASALs
- The role of Agriculture in National development and some factors that may lead to agricultural success or failure and
- The strategies adopted and suggested by the GOK, the Israeli Government and other researchers to tap ASAL resources.

Chapter three provides the background information to Masongaleni settlement Scheme.

Chapter four is the data analysis, interpretation, summary of findings and solutions to the various constraints faced in

the tapping of the variety of agricultural potentials in Masongaleni Settlement Scheme.

Chapter five covers the conclusion and recommendations of the study.

1.7 Research Methodology

To answer the study objectives, the author together with the research assistants used the following data collection methods:

1.7.1 Sampling Procedures

Before the author and the research assistants proceeded to the field, they had first to establish how to collect data from Masongaleni Settlement Scheme. Masongaleni settlement scheme is divided into 8 main sub-divisions known as Blocks.

The research used simple random sampling method to pick the first household in each block to be interviewed and for questionnaire administration. Systematic sampling method was used to pick the next household to be interviewed in the same block. The same sampling procedure was used for the other 7 blocks in the scheme. A total of 80 households out of 2700 households in the scheme were interviewed. A total of 10 questionnaires were administered in each block.

(i) Primary Data Collection Method

The author and the research assistants used direct

observation in the field. Mettric, (1993: 172) suggests that observing operations in the field gives the researcher an opportunity to discuss with the farmers, what, why and how things are done, besides checking what one is told against what one sees. He adds that what farmers say and what they do may not necessarily coincide. They may sometimes report about the standard practice in the neighbourhood rather than what they themselves do. Observation of relevant human activities and the physical characteristics of the study area was therefore done.

Observations involved ascertaining of the physical presence of certain items within the household, e.g animal and crop husbandry activities, the sheds, crops grown and tools used among others. Direct observation was conducted simultaneously along with interviews during field visits. Photography was also used as a method of collecting primary data.

(a) **Questionnaire Administration**

Questionnaire administration was used to collect primary data. This research tool employed standardized questionnaires with both closed and open ended questions. Both household and institutional guided questionnaires were used.

Informants were allowed to respond freely in open-ended questions. In guided and closed ended questions, the informants were confined to give specific alternative answers, eg. yes/no, for some questions. This enabled the author to generate specific information on some of the issues probed. Prewitt

(1975) points out that a structured questionnaire is important since it standardizes the stimulus presented to respondents. Guided and closed questionnaires were used for different categories of Officers. These included among others:

- The area Land Demarcation Officer,
- Agriculture and Livestock Development Officers.
- Kenya Agricultural Research Institute Officers.
- Environmental Officers.
- Officers from Action Aid Kenya (AAK) Kibwezi station.
- Small-holder irrigation individual projects neighbouring Masongaleni settlement scheme.
- The District Officer, Kibwezi and
- Water Officers

(b) **Field Survey**

A field survey of Masongaleni Settlement Scheme was used and this enabled the researchers have a general picture of the Scheme.

(c) **Informal Discussions**

Besides interviewing the small holder farmers, the data collected was enriched by holding oral discussions and informal interviews with extension officers and local leaders of Masongaleni settlement scheme. The discussions provided additional information on the agricultural potentials of Masongaleni settlement scheme.

(ii) **Secondary Data Collection Method**

Secondary method of data collection was also used by the author and the research assistants. This involved acquiring library and registry literature on Masongaleni settlement scheme. Crane and Angrosino (1984) and Bernard (1988) suggests that documentary information is indispensable in anthropological research especially in its formulation stages.

Library research provided background information to the subject matter of this study and Masongaleni settlement Scheme. The literature reviewed provided the author with information on how much has been done on the agricultural potential in Masongaleni Settlement Scheme. The Literature reviewed enabled the author to formulate the conceptual framework in Chapter Two of this study.

1.8 Limitations of the Study

Masongaleni Settlement Scheme is divided into 8 main divisions referred to as blocks. Due to differences in block sizes, some of the blocks (like block 2) are sub-divided further into small sub-divisions so that there is block 2A, 2B and 2C.

The researchers were only able to collect data from each major block using the 10 households sample size. This means that the sample size used was not based on the size of the major blocks.

If there was adequate time for the field research, those large blocks would have been given a higher sample size like 13

households. This is because as the size of the blocks increases, it is likely to portray peculiar potential characteristics that might require more time for a detailed analysis. To counter act such a limitation, the author used relevant secondary data.

Again it was not possible to get such population characteristics as mortality rate and population growth rates. This is because Masongaleni was recently settled (1992) and no much records have been complied for the Scheme. There was only one baseline survey done in Masongaleni Settlement Scheme by AAK in 1992 which did not cover those population characteristics. To counter act such a limitation, the author adopted a population growth rate of 3.3%. This rate was used by the MOLRR&WD in 1993 when the Ministry conducted research on water resources in the areas neighbouring Masongaleni Settlement Scheme.

1.9 Operational Definitions

1.9.1 **Crop water requirement:** According to FAO 1977, crop water requirement is defined as " the amount of water required to meet the water loss through evapotranspiration of a heavy crop growing in a large field under no restricting soil conditions, including soil water and fertility, achieving full production under a growing environment".

1.9.2 **Indigenous Knowledge.** Indigenous Knowledge is used in the study to mean technology which is based on experience. Indigenous knowledge is based on experience which is personal, particular, initiative, implicit, indecomposable and orally transmitted.

1.9.3 **Sustainable Development.** The study uses Habitat's definition of sustainable development. Sustainable Development here is used to mean, meeting the needs of the present generation without compromising the ability of future generations to meet their needs and meeting human needs implies recognising each person's right to a standard of living adequate for health and wellbeing, including adequate access to food, clothing, shelter, medical care and necessary social services as stated by the universal declaration of human rights.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

ASALs are areas which are unsuitable for rainfed cultivation due to physical limitations such as aridity and poor rough terrain, inadequate, erratic and unreliable rainfall. ASAL soil nutrient levels are low, structure is easily lost and erodibility is high. ASAL areas are prone to frequent and prolonged droughts. Even with the use of drought-resistant crops, arable agriculture in these regions remains vulnerable (Parkipuny, 1991).

According to an Arid and Semi-Arid Land pre-investment study of Kitui, Embu and Meru in 1979 by Ng'ethe et al, some ASAL areas are undergoing extremely high population growth rates. This is attributed to migration from high potential zones undergoing population pressure; internal movement within Arid and Semi-Arid areas due to the carrying capacities being reached or exceeded; establishment of settlement or irrigation schemes and subdivision of large scale farms. The demand for cultivation and grazing land contributes to illegal settlement (Squatting), one type of which is found on special reserves of state land and on the margins of game parks, on land owned by pastoral tribes and on large-scale ranches and farms in the ASALs. Migrants often apply technologies inappropriate to their

newly acquired land, leading to further deterioration of the fragile ecosystems. Land devastation, declining crop yields and deteriorating farm systems diminish the quality and quantity of food produced.

ASAL inhabitants live in dynamic and fluid environment which incorporates complex values, beliefs and adjustment mechanisms to stress conditions. People in ASALs view their economic functions as complementary to social ones since survival in such a harsh environment depends at least partially, on traditional social insurance systems.

According to the classification system used by the GOK, ASALs are comprised of:

Zone IV: Semi-arid with a moisture index of 30-42 and a mean annual rainfall generally between 500-800 millimetres .

Zone V: Arid, with a moisture index of 42-51 and mean annual rainfall usually between 300-500 millimetres.

Zone VI: Very arid, with a moisture index of 51 - 57 and a mean annual rainfall around 200-350 millimetres.

Zone IV contains 10 per cent of Kenya's total land mass; zone V 49 per cent; and zone VI, 23 per cent.

Republic of Kenya (1994-1996) National Development Plan states that the Arid and Semi-Arid Lands (ASALs) of Kenya make up over 80 per cent of the Country's total land surface and carry over 25 per cent of the total human population and slightly more than half of the livestock population.

2.2 Economic Potentials in ASALs

Rangelands in ASALs yield multiple products besides being a source of meat and milk. They form the major habitats for wildlife (the basis of tourism in Kenya) and constitute a genetic store for most domestic plant and animal species (Farah, 1989). The 1994-1996 National Development Plan states that ASALs have a considerable potential albeit at a higher cost than the rest of the country. Livestock is one of the economic potentials in ASALs. According to Farah, K.O (1989), the livestock sector in the Arid and Semi-Arid areas of Africa provides millions of dollars in foreign currency annually in the form of meat, milk, hides and breeding stock.

Kenya's economy is highly dependent on agriculture and over 90% of the country's rural labour force is dependent upon this sector for employment (Anker and Knowles, 1983). Approximately 30-40% of the country's Gross Domestic product (GDP) is generated from this sector as compared to 10-12% from manufacturing, 10% from commerce, and 13-15% from the government (Republic of Kenya, 1989 a).

The economic significance of agriculture in high, medium and low potential areas is indeed a common factor in the whole of sub-saharan Africa. Mcnamara (1991:7) observed that agriculture is absolutely essential today and will continue to be in foreseeable future to Sub-Saharan Africa's growth and development. It contributes 34% of GDP, 40% of exports and 70% of employment and it is the sector which the majority of

Africans depend on for their well-being and livelihood. At the same time most of the rural poor live in ASAL areas, hence the need to improve their living conditions through increased productivity and creation of employment opportunities.

2.3 The History of the Development of ASALs in Kenya

Throughout the colonial period, the development of the ASAL areas was given low priority, a situation that persisted during the first three post-independence Development Plan periods. However, by the late 1970s, the Government took a major evaluation of the potential that the ASAL areas could make to the National economy. From this evaluation, policy re-orientation gave recognition to the importance of these areas in National development and the need to accord them special attention considering that:

(i) They have substantial potential for development though at higher costs than the rest of the country;

(ii) Most of the poorer people live in these areas hence the need to improve their living conditions through increased productivity and creation of employment opportunities that would enable them to equitably share the benefits of development

(iii) The increasing problem of soil erosion and environmental degradation, the threat of desertification and the negative consequences of phenomena such as hunger and malnutrition which manifest themselves most severely in these areas

often calling for diversion of public resources to famine relief operations.

The first step in coming to terms with development of the ASAL areas was the implementation of the marginal lands pre-investment study project carried out in 1977 whose results were published in the 1979 policy paper entitled: The Arid and Semi-Arid Lands of Kenya - A frame work for implementation, programme planning and Evaluation. Since then, the ASALs' programme has dealt with integrated area development projects in Machakos, Kitui, Baringo and Turkana among other areas which have been met with varying degrees of success. From experience gained in implementing these area-based integrated development projects and in view of the new strategy emphasizing renewed growth as spelt out in sessional paper NO.1 of 1986, the approach to ASAL development requires restructuring hence the need for second generation strategies that will be implemented during the plan period.

(iv) Determining ways and means of effecting symbiotic exchange of resources and products between ASALs and the high potential areas. The new ASALs' strategy will focus attention on self-sustaining innovation and production activities in the small-scale dry-land farming, irrigated agriculture and pastoral sub-sectors. These in turn requires support through specific policies and investments in production of physical and social infrastructures which

will be necessary to overcome particular operational constraints in ASAL areas.

In the National development plan of 1978, an Inter-Ministerial task force began preparing a policy paper which set forth the GOK's objectives, strategy, general plans, and organization for implementing its ASALs Development program as called for in the fourth Development plan. The document, Arid and Semi-Arid Lands Development in Kenya: the framework for implementation, program planning, and evaluation (hereafter referred to as the ASALs Framework Document) was published in May 1979. It set forth four principle objectives:

(i) Development of Human resources, recognizing that the people of the ASALs are among the country's most disadvantaged;

(ii) Exploitation of productive potentials, recognizing that the output realized in ASAL areas of other countries (the middle East and North America) is far greater than that of Kenya's ASALs;

(iii) Conservation of Resources, recognized as a "fundamental objective of the program" and probably a pre-condition to realizing the production potentials of the land and

(iv) Integration with the National economy to redress the imbalance associated with past development investments which were concentrated in the higher potential areas.

2.4 The main Objectives of the Kenya Government towards ASALs

The main objectives of the Kenyan Government on ASALs as

per the Sessional Paper N0.1 of 1986 include among others: Making available the means of exploiting the important production potentials of ASAL resources, thereby contributing significantly to income, employment and food security, reclaiming where damaged and protecting valuable and fragile natural environments and generating opportunities for improving the quality of life of present and future populations on a sustainable basis.

2.5 Socio-Economic, Physical/Environmental and Technological Constraints in ASALs

The constraints to development of ASALs can be identified as socio-economic, physical/environmental and technological.

(i) Social constraints arise from the cultural aspects of the people which affect the tapping of ASAL resources negatively.

(ii) Economic constraints arise from low incomes with the majority of the ASALs' population. Other economic constraints are lack of security of land tenure among others.

(iii) Physical/environmental constraints result from low, erratic and unevenly distributed rainfall, poor soil fertility, pests and diseases. Under physical constraints there is also the issue of rough terrain among others.

(iv) Technological constraints arise from use of unsuitable technology by immigrants to exploit arid lands.

2.6 Factors Limiting Development of the Arid and Semi- Arid Lands

To achieve the objectives of the ASALs' programme, solutions to a number of serious limiting factors will have to be found. Before establishing a specific strategy of development, it is important to set forth the major constraints that must be overcome.

The environmental limits are the best known and the overriding constraint. Limited and erratic rainfall makes the present crop and animal production system marginal and risky in these areas at the present level of technology. The result is inadequate production to feed the population of the areas, creating a dependence on outside relief.

Scarce resources often result in conflict between groups or individuals for access to these resources. Given the limited land potential and water availability, these must be allocated in ways that encourage multiple use yet do not seriously reduce the productive capacity of any one activity.

Limited and unadapted technology is a severe constraint. Kenya's research programmes have generally focused on the high potential areas. The plant varieties, farming systems, water and conservation technologies needed for full production use of these areas have not been fully developed or adopted for Kenya.

This is a major limiting factor on production. Knowledge of Arid and Semi-Arid areas and of the nature of response to development in pastoral economies also limits development.

Population and migration constraints are serious because present land and water endowments and their distribution can not support increased population using present technologies. The problem is compounded by immigrants from higher potential areas who bring farm systems suitable for the areas they have left but which are potentially destructive to the environment in the Semi- Arid areas.

2.7 Different Strategies Applied by GOK to Tap ASAL Potentials

Strategies to overcome the Socio-Economic, Physical/ Environmental and Technological constraints in ASALs should be highlighted to overcome the various constraints experienced in ASALs. These are discussed as follows:

(i) Dryland Farming Systems Development

According to the Republic of Kenya 1989-1993 National Development plan, the leading activities in ASALs will hinge on the continued development and demonstration of low-cost outlays of technical packages through an accelerated Farming Systems Programme (FSP). This will involve farmers co-operating in on-farm trials and demonstrations and receiving free inputs and where justified, food aid in compensation for land and labour opportunity costs.

The improved packages will be widely demonstrated to generate on-going beneficiaries and demand at the local level. Promising or proven components will include agro-forestry species, new drought resistant maize and sorghum varieties, the latter grown on rationing mode for seed and drought period food reserve, grain legumes, root crops and oil seeds. Vertically integrated farming systems will be encouraged where they provide accelerated access to improved farm incomes. Oxen training and supply of ox-drawn equipment including ox-carts for farm-market access will be expanded.

Soil and water conservation methods such as terracing and water harvesting will be integrated within the improved farming systems. Enhanced vegetative cover in inter-cropping, relay cropping, agro-forestry and organic structure systems, improvement for water retention such as composting, the use of green manure and mulching will be encouraged. Pastoral Systems and development of livestock remains the most profitable way of utilising the extensive rangelands of ASALs. The viability of the pastoral and nomadic systems will be enhanced through improved disease control, range rehabilitation, production of supplementary feed and food crops using water harvesting techniques and various silvo-pastoral agro-forestry systems.

Pastoralists will be encouraged to match livestock numbers more closely to wet season and post-drought rangelands carrying capacities while reducing these numbers to match combined grazing, irrigated fodder and reserve feed supplies in the dry

season. The 1989-1993 National Development Plan in Kenya states that in so doing, the GOK will ensure that the role of livestock in the community, food security systems is strengthened and supplemented in several ways. These include reliable food cropping, improved cash returns from livestock sales reflecting higher animal quality, and access if all fails, to reliable famine relief and post-drought recovery programmes centred on state ranches and incorporating breeding stock entitlement and food-for work components.

(ii) **Promotion of Bee keeping**

Bee keeping is one of the strategies emphasized as a strategy to tap ASAL potentials. Bee keeping can increase incomes for the residents of ASAL areas who have little or no land or livestock. Recent experience indicates that modern bee keeping is particularly suited to women groups and lessons from traditional bee keepers are being carefully assimilated.

(iii) **Small-Scale Irrigation Development in ASALs**

There has been a long history of successful low-cost small-scale irrigation schemes in ASAL areas extending back to the pre-colonial era. However, in recent years, pre-occupation with the development of large scale irrigation schemes in the country has caused these past achievements to be ignored. The 1989-1993 National Development Plan states that, when new schemes are proposed for the ASAL areas , the basic approach will be to

adopt accessible irrigation technology to the needs of smaller units. New irrigation Schemes of this kind, rehabilitation of older ones and improved maintenance of irrigation works will be accorded high priority.

The 1989-1993 National Development Plan again states that more efficient use of water for agricultural production in ASAL areas will be secured by water harvesting techniques of all kinds in areas far from river basins. The higher rainfall portions in Arid areas will adopt the development of various water conservation structures especially the integrated network of drains and small dams constructed through food-for-work and Harambee labour to provide high pay-off supplementary irrigation water.

In the lower rainfall areas, new techniques including the triangular and trapezoidal bands often referred to as the Kitui Ridges will be applied where appropriate. The same National Development Plan (1989-1993) states that even where potential is known to exit, ground water resources have so far not been utilised to any significant extent in the ASAL areas. Technology is already available for the economic delivery of water to plants which make effective use of the restricted supply of ground water in the form of drip irrigation.

(iv) **Institutional Arrangements for ASAL Planning & Management**

Since the initiation of the ASAL programme in 1979, activities in these areas have been co-ordinated by the

Rural Planning Department of the Ministry of Planing and National Development. Over time, the Rural Planning Department has evolved as the focal point for the planning and co-ordination of the programmes in ASALs. This evolution has been further extended within the context of the District Focus for Rural Development strategy.

2.7.1 Strategies applied by Israel to Tap Potentials in ASALs: A case study of Negev (Israel)

Negev is one of the largest desert areas in Israel. Through the Jewish National Fund, the Israeli Government has adopted a variety of strategies to fight the desert conditions in Negev. These strategies are discussed below.

(i) **Afforestation Programmes**

The role of afforestation in Semi-Arid zones in Negev is not a fundamental factor in redeeming the desert and checking its further invasion into fertile land. Long term research and development in desert ecology in Israel has shown that by proper management, the process of desertification can not only be halted, but can be reserved. Planting trees in desert lands has some major aims and same for all countries. These are to:

(a) Provide some greenery and shade near settlements for recreation and livestock.

(b) Establish shelter belts around settlements, industrial

plants, agricultural crops and grazing fields to provide protection against hot winds and dust storms.

(c) Protect the soil and roads against water and wind.

(d) Provide fuel wood, charcoal and other minor products.

The only available land in which to expand Israeli agricultural base and disperse the population, thereby easing the pressure on the central part of the country lies in the desert. Making the Negev an attractive, more productive region has been given high priority officially. Thus the creation of a pleasing visual contrast to the barren dry landscape as well as the creation of a health ecological system is of utmost importance.

Planting in a Semi-Arid zone for instance, in order to push the desert back as far as possible, trees and bushes are now being planted in the Northern parts of Negev (200 millimetres of rainfall) creating overtime a new scenery. The most effective planting method in these areas is based on the principle of catching run off and of a small number of trees per unit area. Habitat (1990) states that capturing the run off water which may account for up to 60 percent of the total precipitation also reduces soil erosion and preserves agricultural lands.

(ii) **Development of Water Sources**

Development of water sources in Arid zones has been viewed as an integral part of land development (Habitat 1990). Simply put, the more water, the more land can be developed for

agricultural use and the creation of pleasant environments. The existing conventional water sources in Israel are few, so non-conventional sources are being developed in the following ways:

(a) Dams for catchment of run off water.

(b) Dams for enrichment of the existing aquifer by stopping the flood water flow and letting it seep into the ground for sub sequent pumping.

(iii) **Waste waters**

In Israel the most effective use of recycled waste waters that can not be put to agricultural use is for the planting of groves and parks. About 200 hectares of parks and groves are currently being irrigated with recycled waste waters (Habitat, 1990). Brackish water, saline water containing (1000-2000 parts per million (pmm) at times even more) can be used. The soluble salts are being used for irrigation purposes, either for salt tolerant agricultural crops or for planting trees and establishing recreational spots mainly in the Negev Highlands and the Avava valley.

(iv) **Savannization**

According to Habitat (1990), Jewish National Fund unveiled plans for a new strategy to reverse the trend of desertification. Savannization is a process that involves creation of a relatively high productive eco-system within the low productive desert to raise the value of otherwise barren

land. In the process of savannization, the few shrubs and soil crust associated with the desert are replaced by trees and grasses. This process is practised in Negev and it can only be developed by implementing water harvesting techniques in which water run-off is utilized to supplement scarce rain water. Savannization techniques in the Negev desert include:

(a) Agro-technical activities for run off harvesting

(b) Soil conservation activities.

(c) Tree planting.

(d) Increasing the productivity of plants and animals in the desert.

2.7.2 Other Strategies suggested by Researchers

The most important ASAL land-use problem is how to conserve water and soil for livestock and secondarily crop production. According to Kiriro et al (1991), development experts now recognise that traditional societies copped poor soils and shortage of water by adopting agricultural practices which emphasized people moving over large areas to utilise the little water available. People also used the vegetation which was produced by the scattered rain for their livestock. Although experts have for a long time ignored the knowledge which the people developed to cope with the scattered rainfall, they are now finding that such traditional knowledge is not only useful but also important if the Semi-Arid areas are to be developed. Already new institutions are being set up in different parts of

the world to tap such knowledge and incorporate it into other formal research activities.

Kiriro, A. et al (1991), states that one of the most important traditional agricultural techniques was slash-and-burn. The authors state that a farmer came to an area which was not farmed and cut the existing bush but made sure some of the fruit and construction trees were left standing. This was a way of preserving the environment.

2.7.3 Agriculture as a Potential in ASALs and its Role in National Development

Agriculture forms the backbone of the rural economy. As a result, it has a major role to play not only in rural development but even in the overall National objective of economic growth and development (Akungo 1980). This also implies that there are no clear cut roles of agriculture in the rural areas as opposed to those in the national context. The major roles of agriculture in the rural and national development are:

(i) To provide food to the rural population. This is important in giving nutritional ingredients which are important for good health.

(ii) The provision of income earning opportunities through the growth and sale of farm produce. This goes along way in helping to alleviate poverty which is a central theme in Kenya's 1979/1983 Development plan.

(iii) Agricultural growth, i.e higher production and improved marketing efficiency may lead to the improvement of the balance of payments especially with regard to exported cash crops. This is important in a national context.

(iv) Agriculture provides raw materials for industrial processes, for example, cotton fibres for making clothes.

(v) Agriculture provides food to those in the non-agricultural sectors of the economy whether in the rural or urban areas. Agriculture has a major role to play not only in rural development but also in national development. Agriculture is the main-stay of Kenya's economy, contributing 26 per cent of the National Gross Domestic Product (GDP). The small holder farmers contribute over 75 percent of the country's total value of agricultural output using only 60 per cent of arable land (GOK, 1993).

The agricultural share of wage employment is about 18 per cent but considering self-employment, over 70 per cent of the country's labour force is engaged in agricultural activities.

The question is not over the importance of these roles in development, but rather the issue is over the ability of the government and the people of Masongaleni to tap the potentials in Masongaleni Settlement Scheme, mostly in the agricultural sector to effectively play the above outlined roles. Thus the study addresses the existence of a variety of agricultural potentials in Masongaleni Settlement Scheme and finding ways and

means through which these potentials could be tapped in order to achieve sustainable development.

2.7.4 The Factors that may Lead to the Success and Failure in Agriculture

Several factors have contributed to agrarian development in Kenya in this century. Among these are land reform, introduction of high value crops and use of farm inputs (Hunt, 1984; Livingstone, 1981).

Although not widely recognized, availability of appropriate tools and equipment has played a key role in this transition. There is considerable evidence to suggest that sustainable improvements in agricultural output by small holders has been achieved through improved availability of appropriate tools and equipment. For example, in a study carried out by Mortimore and Wellard in Machakos District, it was observed that adoption of the ox-plough in combination with other agricultural practices has enabled local small holders to increase their output by 500 percent between 1910 and 1980 (Mortimore et al, 1991). The authors further note that the time required for weeding can be reduced by 95 per cent through the use of appropriate equipment.

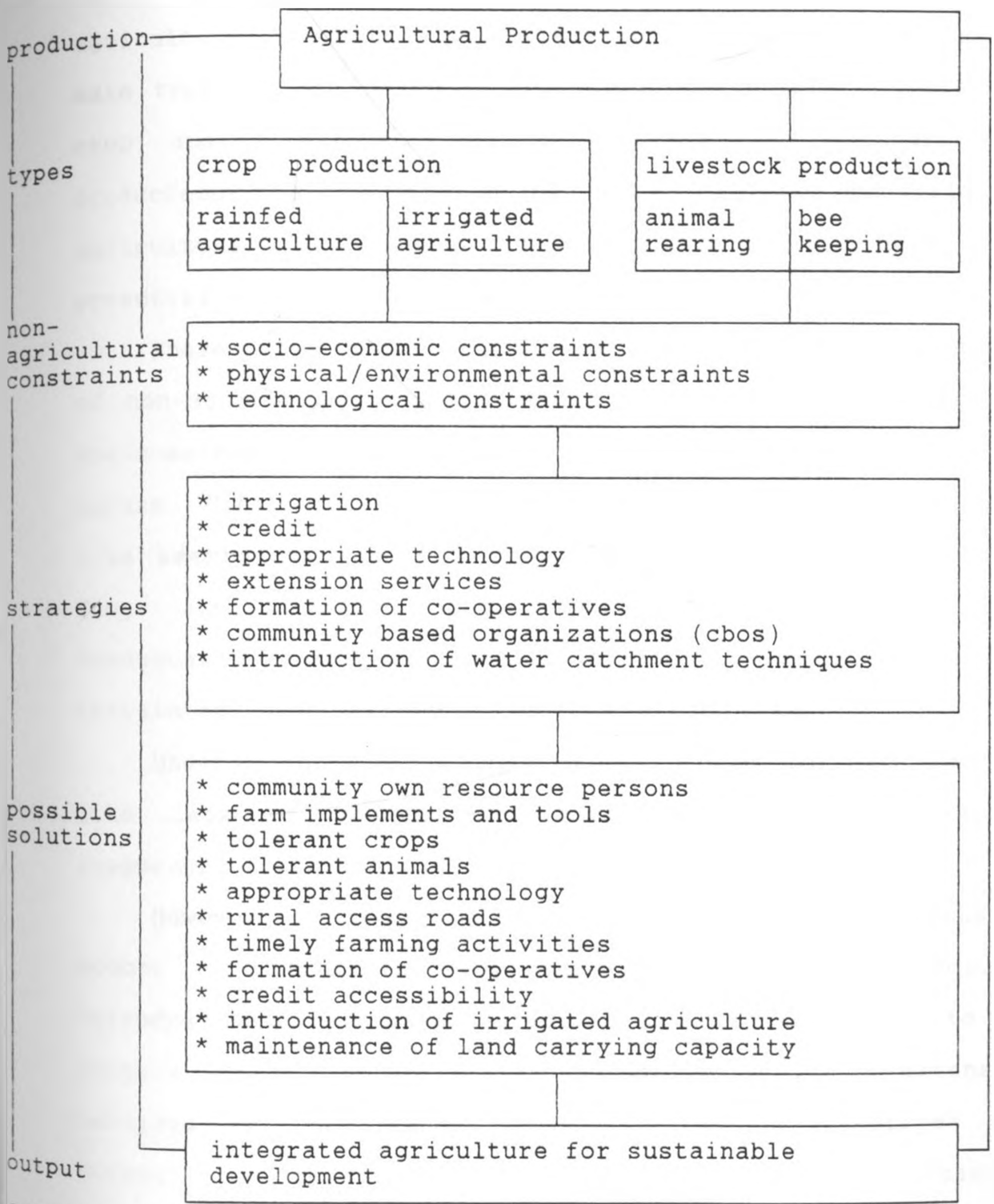
On the other hand, unavailability of appropriate tools and equipment constitutes a major constraint in agricultural production. The most basic farm implements and tools required by the small holders in Kenya are "Jembes", fork-"Jembes",

Shovels, rakes, traditional hoes, Wheel-barrows and ox-ploughs. However, many farmers do not have adequate supply of these. A recent study in Embu District found out that there was an inadequate supply of ploughs and as a result many farmers were unable to plant at the optimum time just as the rains were starting (Skinner, 1993). Many farmers had to wait until a plough was available before they could plough and plant their crops. A delay of 10 days in planting can lead to a 52 per cent reduction in yield.

Research has also shown that the use of draught animal power can reduce the time needed to cultivate a farm by over 60 per cent compared to cultivation by hand and generally the more mechanized, the higher output per unit acre of land under agricultural activity (GOk, 1986; Ministry of agriculture, 1992: 19).

In order to raise productivity, Kenyan farmers need to have access to basic tools and farm implements. In addition, there are many other simple tools and equipment which can improve performance of farmers such as rotary planters, weeders, scarifiers and simple motor powered equipment. The utilization of these is still very low among small-scale farmers in Kenya. With some training and/or demonstration, existing tools could also be put to more and better use, for example, ploughs could be used much more widely for weeding if crops are planted in lines.

Fig(1) A Conceptual Framework For Agricultural Potential in ASALs



Source: Own derivation.

The conceptual framework in Fig (1) tries to show agricultural production potentials in ASAL zones. There are 2 main types of agricultural production potentials. These are crop and livestock production potentials. Under crop production, there is a potential in both rainfed and irrigated agriculture while under livestock production, there is a potential in both animal rearing and bee keeping.

These potentials have not been fully tapped due to a number of non-agricultural constraints. These constraints are of socio-economic, physical/environmental and technological in nature. Under socio-economic constraints there are such factors like small land sizes, lack of land tenure and low incomes. Under environmental factors there are such factors like inadequate, erratic and unreliable rainfall, poor soils, rough terrain and high incidence of pests and diseases.

Under technological constraints, there are such factors like lack of modern appropriate technology or use of inappropriate technology in agriculture.

However, to tap this agricultural potential in ASALs, a number of strategies may be pursued. These include: introduction of irrigated agriculture, accessing credit to the farmers, use of appropriate technology, provision of extension services to the farmers, formation of co-operatives and formation of Community Based Organizations (CBOs). Possible solutions to fully tap the agricultural potential in ASALs may include among others:

- Provision of CORPs to the farmers
- Buying FITs by the farmers themselves.
- Growing and raising of drought, pest and disease resistant crops and animals respectively.
- Timely planting, weeding and harvesting of the farmers crops.
- Use of appropriate modern or traditional technology.
- Introduction of irrigation agriculture .
- Formation of farmers co-operatives and Community Based Organizations.
- Accessibility to agricultural development credit and
- Maintenance of land carrying capacity.

The output is to have an integrated agriculture in ASALs. This would result to employment, increased incomes, high standards of living and sustainable development. The various strategies are to be applied by various actors in different zones in ASALs.

CHAPTER THREE

BACKGROUND INFORMATION ON MASONGALENI SETTLEMENT SCHEME

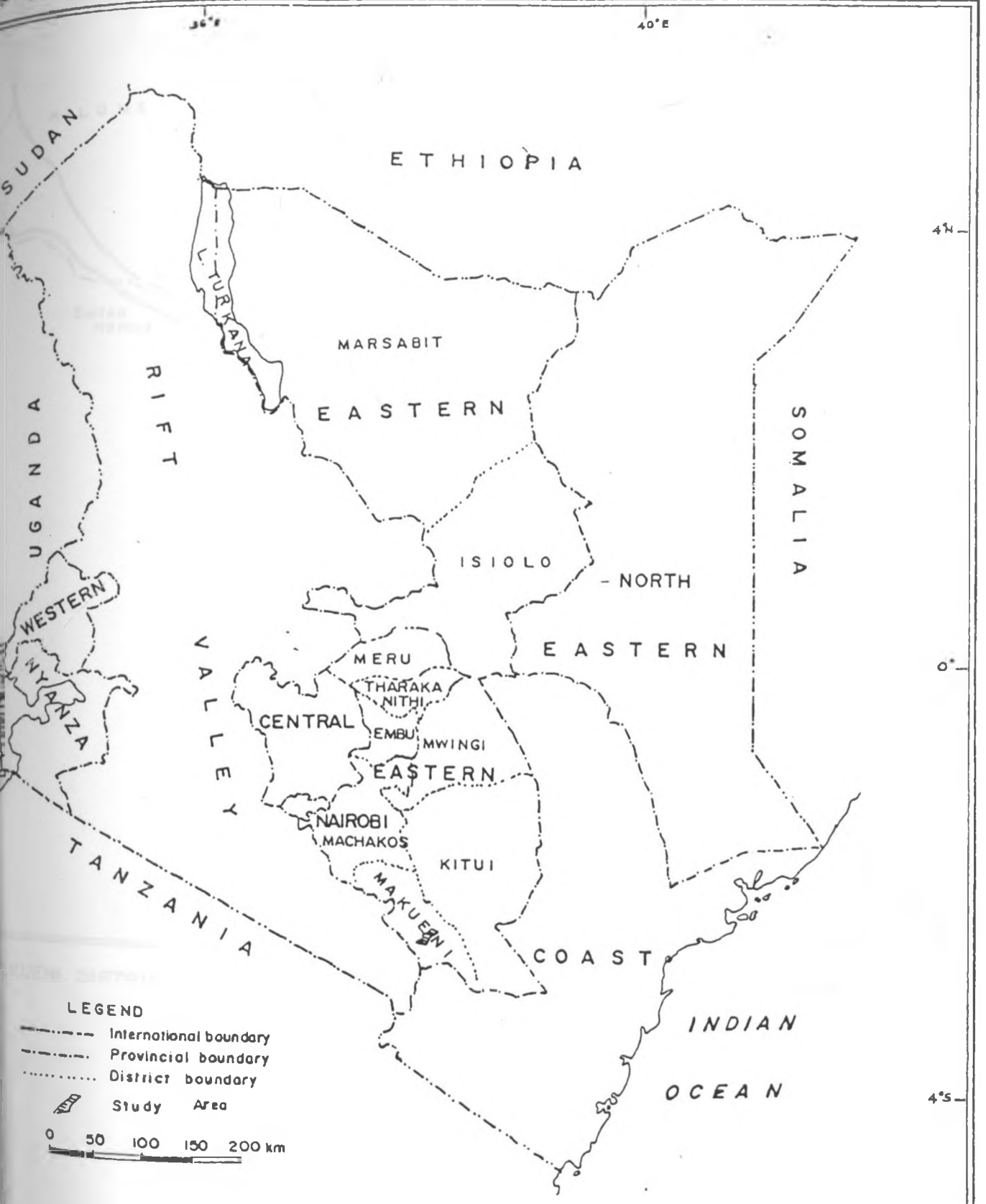
3.1 Introduction

This chapter covers the physical, socio-cultural and economic characteristics of Masongaleni Settlement Scheme.

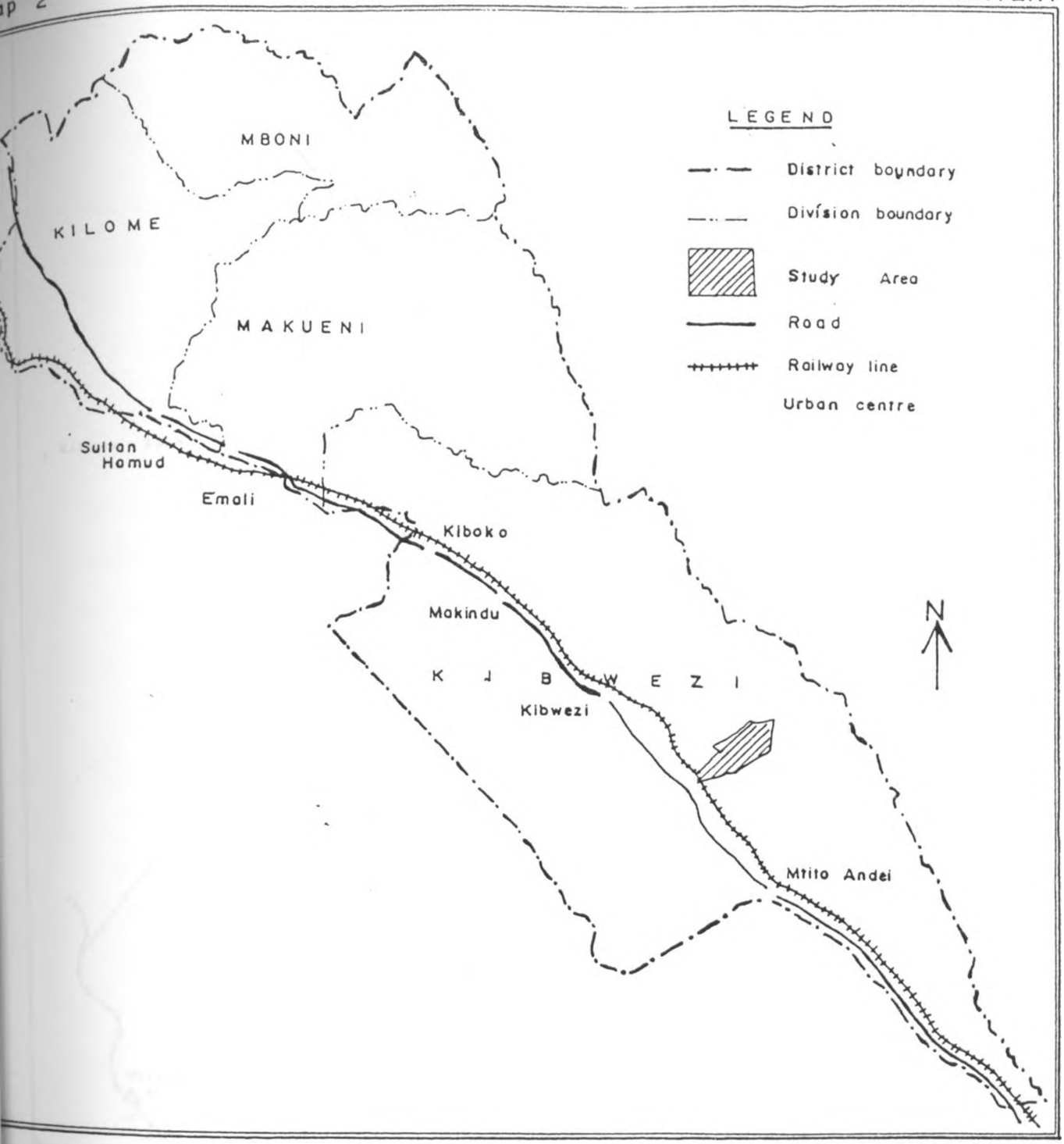
3.2 Location of Masongaleni Settlement Scheme

Masongaleni settlement scheme whose area is about 106 square kilometres is located East of Kibwezi township in Kibwezi Division of Makueni District, Eastern Province of Kenya. Access is through the Nairobi-Mombasa tarmac road which runs close to Masongaleni Settlement Scheme about 200 kilometres south of Nairobi City.

LOCATION OF MASONGALENI SETTLEMENT SCHEME IN NATIONAL CONTEXT

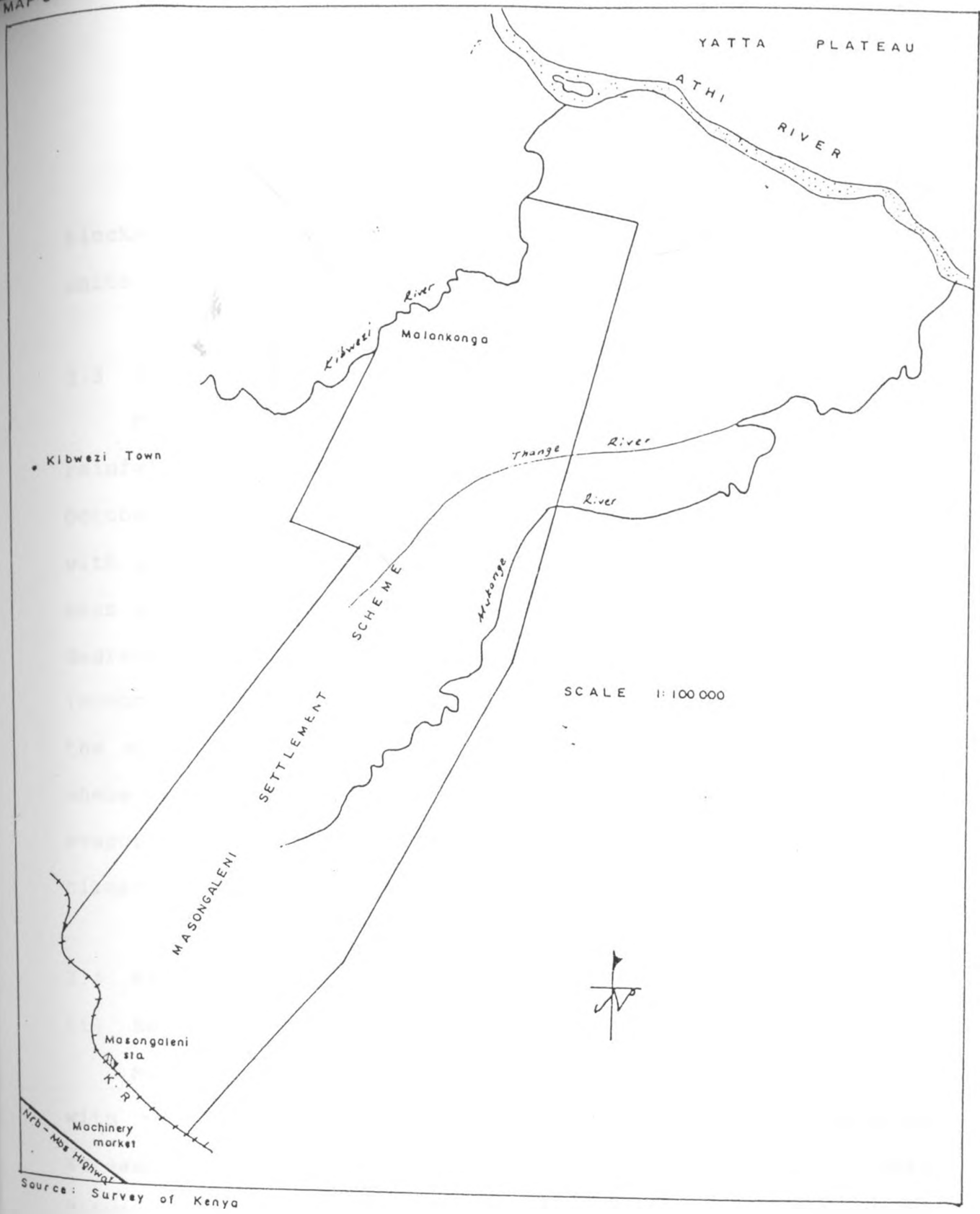


ap 2 THE LOCATION OF MASONGALENI SETTLEMENT SCHEME IN REGIONAL CONTEXT



AKUENI DISTRICT Showing the location of Masongaleni Settlement Scheme

MAP 3



Source: Survey of Kenya

Masongaleni Settlement Scheme is divided into 8 main blocks. These 8 blocks are further sub-divided into smaller units giving a total of 18 smaller blocks.

3.3 Climate

Masongaleni is generally a semi-arid zone with a bi-modal rainfall pattern, February to May being the long rains and October to December the short rains. Rainfall is not abundant with a mean annual precipitation of about 631 millimetres. The mean annual temperatures of Masongaleni Settlement Scheme is 26 degrees centigrade. This temperature is termed as warm (sombrock et al 1972). The mean annual potential evaporation of the area is calculated as: E=2422-0.358h (wordhead, 1968), where h is the altitude in metres and E is the potential evaporation in millimetres. This area falls in the agro-climatic zone described as semi-arid.

3.4 Relief and Drainage

(i) Relief

Masongaleni Settlement Scheme is generally of low relief with the thickly bushed, sandy plains bisected by numerous streams. The configuration of a number of low ridges between kibwezi and Athi river is influenced by the north-south strike of the Basement system gneisses, hornblende gneisses and sillimanite gneisses are observed as hills remnant on a peneplain in the southern part of Masongaleni Settlement Scheme.

Elevations range between 610 metres and 915 metres above mean sea level. Most of Masongaleni Settlement Scheme is covered by quaternary red-brown sandy soils overlying undifferentiated basement system rocks. Recent olivine basalt volcanic cover a section near Kibwezi town as a result of extrusion of lava-flows from volcanic vents to the west, forming a plateau. Generally Masongaleni settlement scheme is a continuation of a gently undulating landscape falling from North West to South East. Immediately after the scheme's boundary at river Athi, the landscape rises as one approaches the Yatta plateau on the Eastern side of the scheme. Figure (3) is on the cross sections of Masongaleni Settlement Scheme. Cross section (1) is drawn from point (A) i.e Umanyi spring to point (B) i.e. Block (7) in Masongaleni Settlement Scheme. Cross section (2) is drawn from point (B) i.e. from Block (7) in Masongaleni Settlement Scheme to point (C) i.e. River Athi. Points A, B and C are on the relief and drainage map (4).

(ii) Drainage

(a) Surface Water Potential

Masongaleni Settlement Scheme is drained by Thange, Kibwezi and Mukange rivers. Mukange river is perennial. Umanyi spring and River Athi are located outside the scheme but can be used as other sources of water for Masongaleni Settlement Scheme.

Thange river has a maximum flow of 0.65 cubic metres per second, mean flow of 0.35 cubic metres per second and a minimum

of about 0.23 cubic metres per second. However, the safe yield from the river would be about 0.23 cubic metres per second.

Kibwezi river: The information concerning the kibwezi river flows is based upon 25 years of record at gauging station within the university of Nairobi Dryland Farming Station. The minimum flow recorded was 0.151 cubic metres/second and the maximum flow is almost 25 cubic metres/second. If the water in this river is tapped just by the use of a big dam below " KWA KYAI" irrigation project, the water is able to irrigate Block 3 and 4.

River Athi: At the upstream of the river just above the Kibwezi river confluence, there has been greater than 1,000 cubic metres per second. If this water is tapped through construction of a subsurface dam, it can be used to irrigate the whole of block (1) and (2), plate (3). It shows the possible portion of river Athi where a sub-surface dam may be constructed to tap irrigation water for irrigated agriculture for block (1) and (2) in Masongaleni Settlement Scheme.

plate (3). A suitable point along Athi river where irrigation water from sub-surface dam may be tapped from.

Source: Field survey, 1995.

Umanyi Spring: This spring has a minimum water flow of 0.64 cubic metres per second. This is equivalent to 1,529.6 cubic metres per day. The maximum flow of the river is 0.176 cubic metres per second. If the water of the river is tapped using a canal, then it can be used to irrigate Block 5, 6, 7 and 8 through gravitational irrigation. The rest of the water can be used for domestic purposes.

(b) Ground Water Potential

Ground water in Masongaleni Settlement Scheme may be described as low to medium considering the impervious nature of

the crystalline metamorphic rocks found in the area and the low rainfall experienced.

Ground water occurrence in such geological terrain is usually restricted to fractured and faulted zones within the rocks. These zones of broken rock may create sufficient storage for water especially where they extend deep into the ground.

Some ground water will also occur where the basement rocks are deeply weathered and at the contact of these crystalline metamorphic rocks and the overlying Chyulu volcanic where the latter occur. Shallow ground water may occur within the sands of dry river bends or along old and buried river channels where some base flow takes place.

Borehole and shallow well sites may be selected by using a combination of hydrogeological methods and results of a geological field study supplemented with geographical data collected in the field.

Table (2) represents a list of 11 boreholes. These boreholes/ shallow wells are found in Masongaleni settlement scheme and the neighbouring areas. The current total water yield per day from all those boreholes, the cost of each borehole and the total cost is shown.

Table 2: Borehole/shallow wells' characteristics:

B.H No	R.T	Dep(M)	Dia	W S. L	W R. L	Y (M^3/D)	Cost of B.H(kshs).
33	BM	122	4	13	-	38.4	634,300
73	BM	95	4	16	11	108	520,900
C34	BM	78	45	-	1. 3	52.4	449,500
C35	BM	122	45	-	13	52.4	634,300
C1004	BM	173	45	85	76	54.6	848,500
C1005	BM	58	5	46	46	32.7	365,500
C1006	BM	148	45	61	61	58.7	743,500
5054	BM	26.5	-	9.5	7	60.48	151,900
5088	BM	22	-	-	-	60.48	133,000
C1241	BM	148	45	15	10	272.9	289,900
C1242	VBM	28	45	-	15	13.1	158,200
Total						791.06	4,929,500

Source: MOLRR&WD.

Note:
M in table (2) = Metres.
Dia = Diameter
Dep = Depth
BM = Basement.
WRL = Water Rest Level

WSL = Water Struck Level
VBM = Volcanic Basement.
B.H = Bore Hole
Ft = Feet
RT = Rock Type
Y(M^3/D)= Yield in Cubic Metres per day.

Table (2) shows that the boreholes' total water yield per day is 791.06 cubic metres. The total cost of drilling, lining and even putting up a pump in all those boreholes is kshs.4,929,500. The cost of each borehole is arrived at by using the following figures:

(i) Borehole siting fee = kshs. 10,000

(ii) Application fee to drill/dig the borehole =kshs.600

(iii) To drill 1 metre deep using a drilling machine= kshs. 4200.

(iv) To dig manually 1 foot deep = kshs. 1273

(v) Using a GOK electric pump= kshs.111,300

(vii) Using a Company electric pump= kshs. 145,750

(viii) Using a hand pump= kshs.30,000

Those boreholes with a depth of 28 metres and below may be dug manually because it is possible to do it according to the field research conducted on shallow wells' drilling. Such boreholes\shallow wells should use hand pumps since it is viable economically to use such. The farmers should as far as possible buy the electric pumps from GOK for boreholes above 93 feet deep. It is cheaper to buy the pumps from GOK than from the private sector which is expensive.

That recommendation is viable because it promotes

employment to the local community. It also minimise costs of drilling the boreholes/shallow wells. If a shallow well is done manually, the community may be involved in the digging of the borehole thus minimising the costs of providing the shallow wells/boreholes. There is a great potential for ground water in Masongaleni as it is noted in table (2). The table indicates that the water yield does not depend on the depth or diameter of the boreholes. As noted in the table, some boreholes with less depths yield more water than even some with a greater depth.

(c) **Hydrogeology of Masongaleni Settlement Scheme.**

The hydrogeology of Masongaleni Settlement Scheme is intimately dependent upon the nature of the basement rocks. Depending on the type of rock, the degree of jointing, fracturing and weathering, varied hydrogeological conditions certainly exist in Masongaleni Settlement Scheme, with sufficient amounts of ground water occurring within the intensively jointed, fractured and/or weathered basement rocks. In addition, the amount and frequency of precipitation is also a significant parameter in influencing ground water occurrence.

(d) **Aquifers in the Basement Rocks**

The crystalline rocks of the basement complex that form the sub-surface in Masongaleni Settlement Scheme are relatively impermeable and in their fresh state form poor aquifers. However, where these rocks have been fractured and jointed, and

where weathering has occurred, the breakdown of the minerals that form the rock may lead to the formation of conditions favourable to the storage of ground water.

Water wells in basement areas in the Scheme are known for their large variation in water yields, principally reflecting the presence or absence of the conditions described above. This is quite often demonstrated by the normally wide variation in water yields recorded at boreholes drilled at short distances from each other. Due to this large variation in water yields, it is imperative to accurately locate borehole sites to take advantage of either faulting or weathering of the basement rocks. Optimum locations can usually be found using aerial photographic interpretation field verification of the geological conditions, followed by surface geophysical measurements.

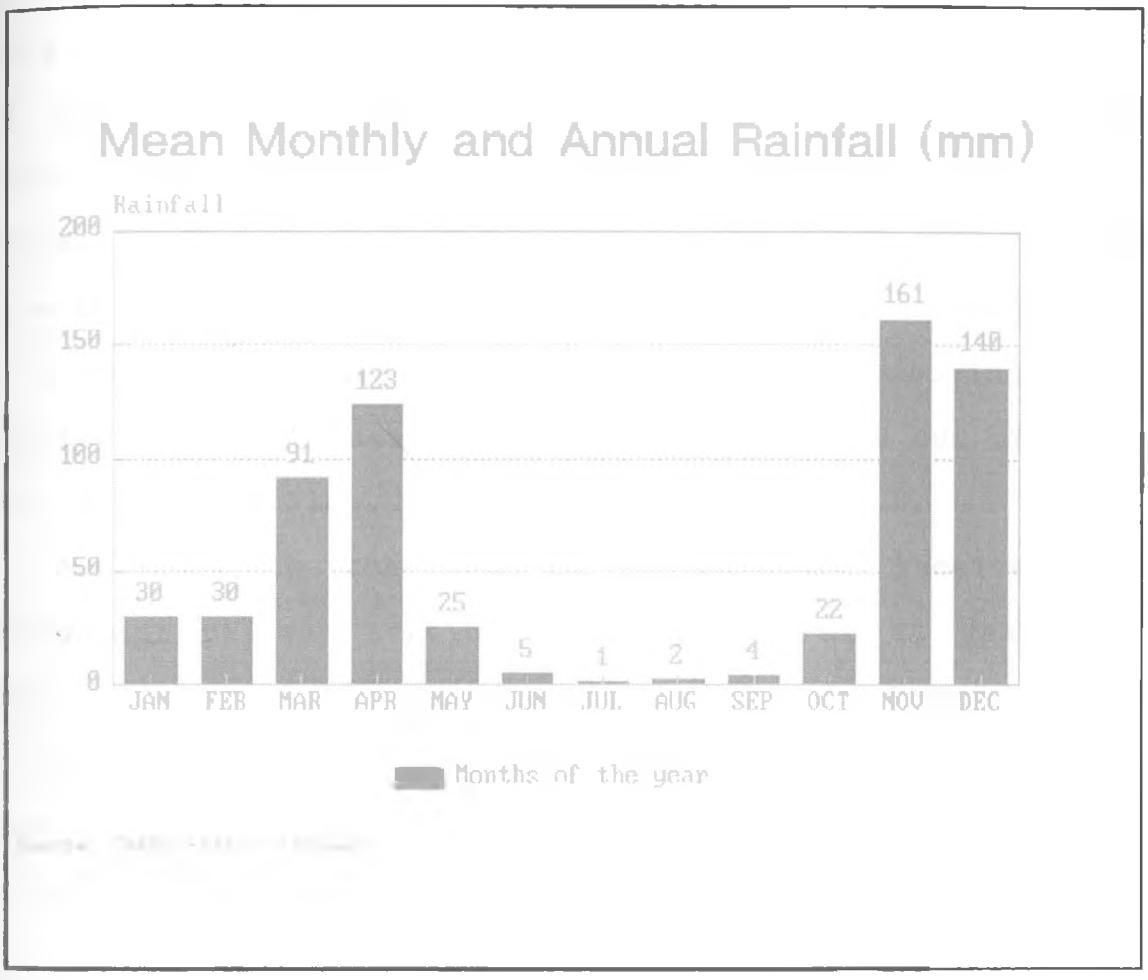
(e) **Water Quality from the Ground**

Some boreholes in parts of Masongaleni Settlement Scheme have encountered saline water most probably due to the high evaporation rates in the area. However, deeper aquifers and indeed shallow ones can be expected to be less saline as long as there is sufficient percolation and water does not stagnate.

(f) **Rain Water Potential and Mean Annual Rainfall**

The mean annual rainfall of the area is about 640 millimetres and its distribution may be described as two seasons with long rains occurring in March-May and short rains in October-December.

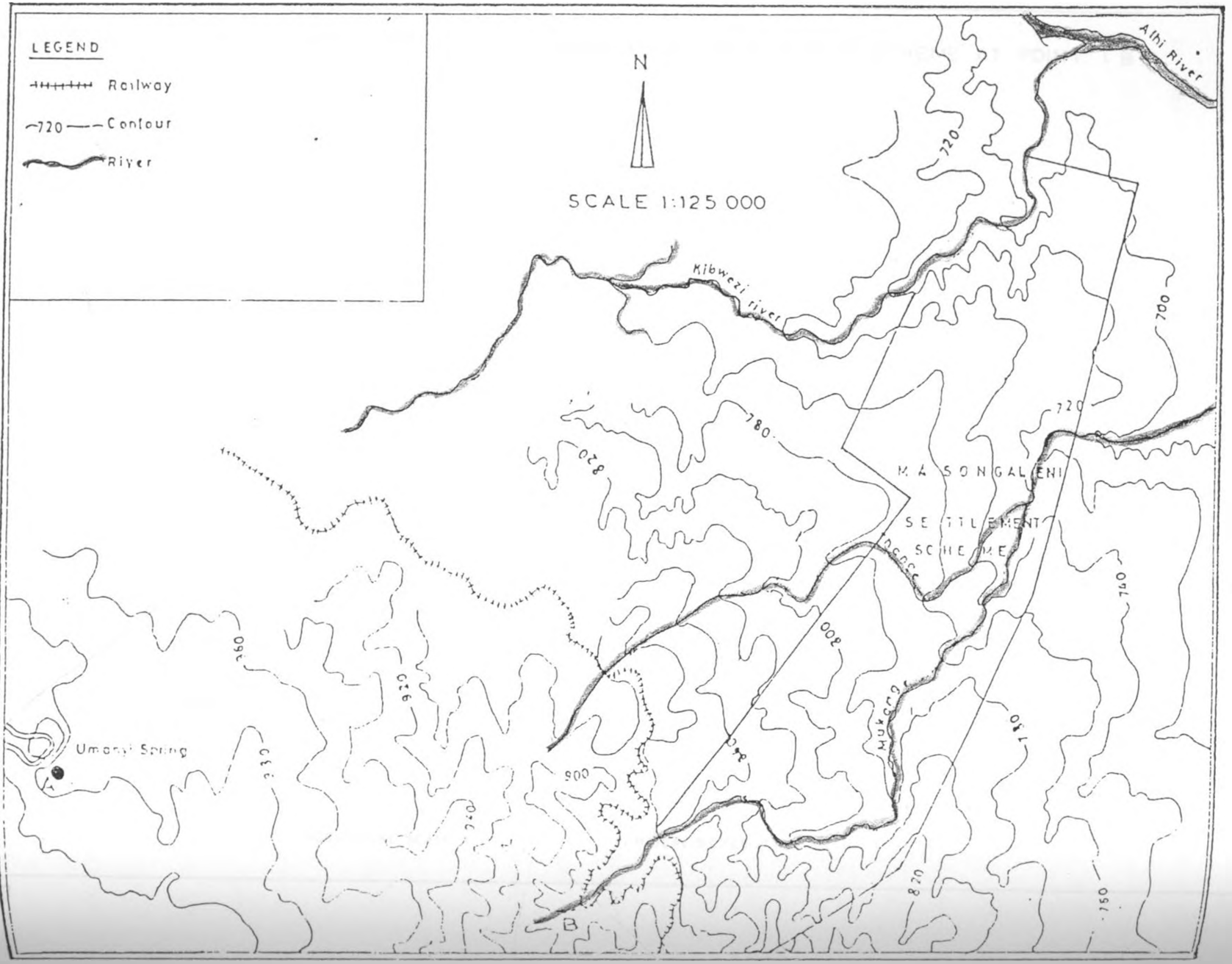
Figure (2). Mean Monthly and Annual Rainfall in (mm)



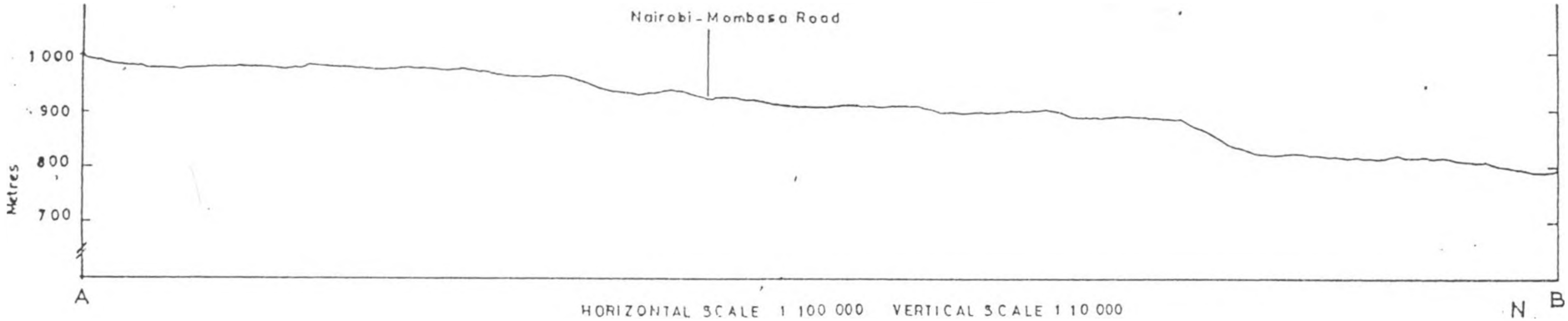
The rainy seasons, March-May and October-December contribute 37% and 50% of the mean annual rainfall respectively, while dry period contributes 11% for January/February and 2% for the June/ September period. November receives the highest amount of rainfall while July experiences the least amount of rainfall. The chances of having a good crop during the long rains is 2 out of 10 seasons and during the short rains is 4 out of 10 seasons. Likewise, the probability of receiving a fair crop is 4 out of 10 seasons for long rains and 6 out of 10 for short rains Aqua Plan, (1992).

According to the records of rainfall received from Masongaleni railway station for a period of 64 years, the average rainfall for Masongaleni Settlement Scheme is 631 millimetres/annum. Using this data, then the possible amount of water that can be harvested from one square metre of iron sheet roofed house is 0.631 cubic metres.

MASONGALENI SETTLEMENT SCHEME-RELIEF AND DRAINAGE

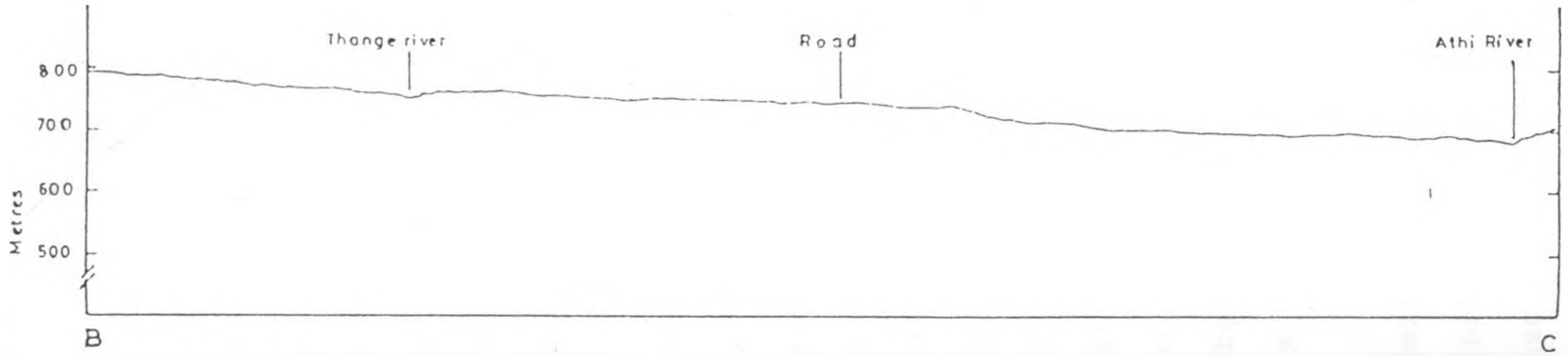


A CROSS SECTION FROM UMANYI SPRING (A) TO MASONGALENI SETTLEMENT SCHEME AT POINT (B)



HORIZONTAL SCALE 1 100 000 VERTICAL SCALE 1 10 000

A CROSS SECTION FROM MASONGALENI SETTLEMENT SCHEME AT POINT (B) TO ATHI RIVER (C)



HORIZONTAL SCALE 1: VERTICAL SCALE 1

Fig. 3

3.5 Geology

Geology is important to study because it provides the parent material of an area. Geology also influences the productive potential of the soils. Geology and soil types of an area are responsible for the spatial diversity of land use and therefore they are important in agricultural production and development.

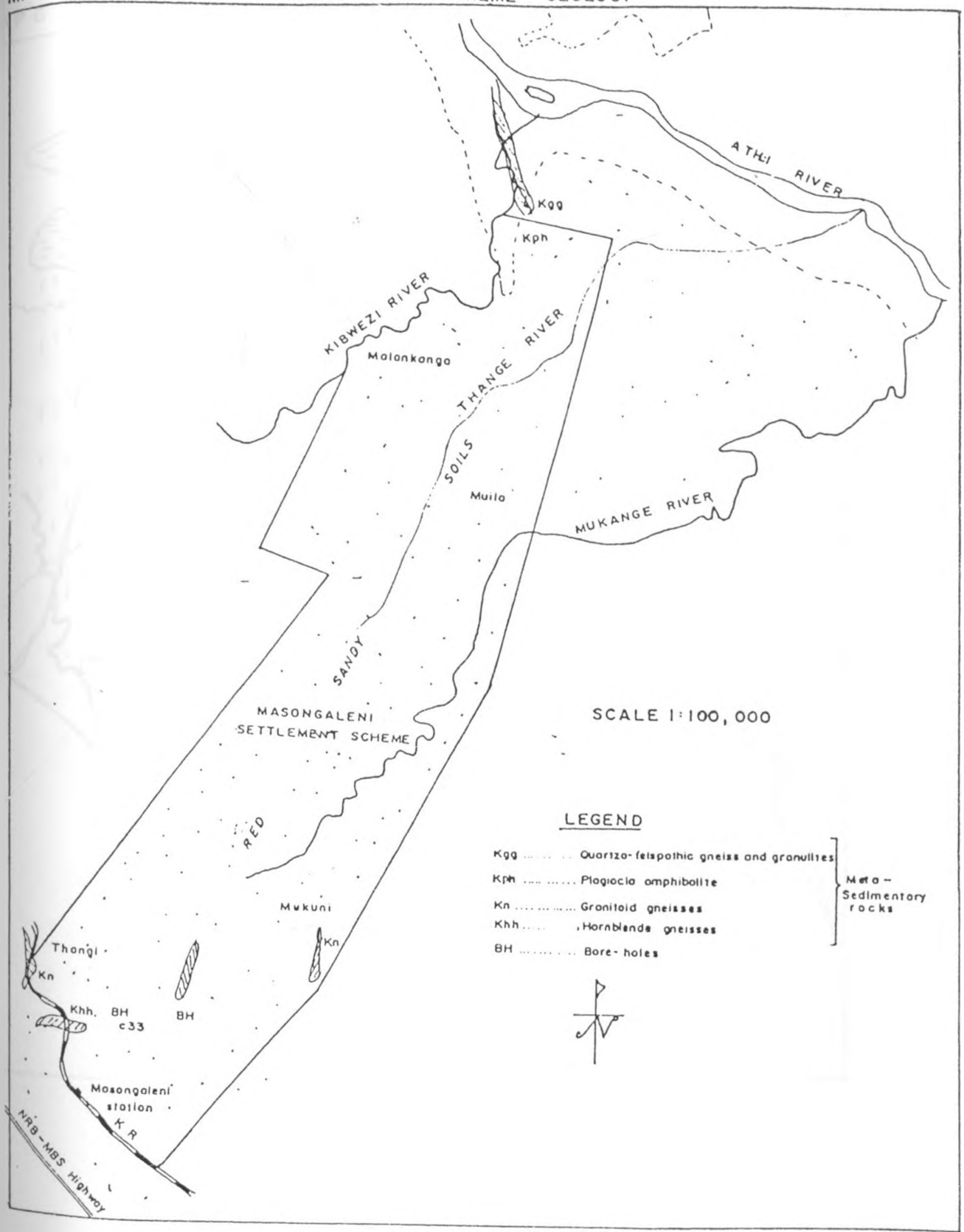
Geologically, Masongaleni Settlement Scheme is underlain by rocks of the Basement system. These are metamorphic rocks of Precambrian age. They are overlain in some parts of the area by volcanic lava which emanated from the Chyulu hills South West of Masongaleni Settlement Scheme (Baseline survey, AAK 1993). Apart from the Chyulu Hills and the area near Yatta plateau, the underlying geology is basement system rocks. These are rocks of Archean age. The pre-cambrian rocks were originally of sedimentary origin but have since been metamorphosed into different rock types depending on the degree of metamorphism.

Biotite, hornblende-biotite, hornblende, biotite-garnet and sillimanite gneisses and schists are the most common rock types in Masongeleni Settlement Scheme. These rocks are usually inter-bedded and they show distinct textural grades, with a complex mineral composition, geological map (5).

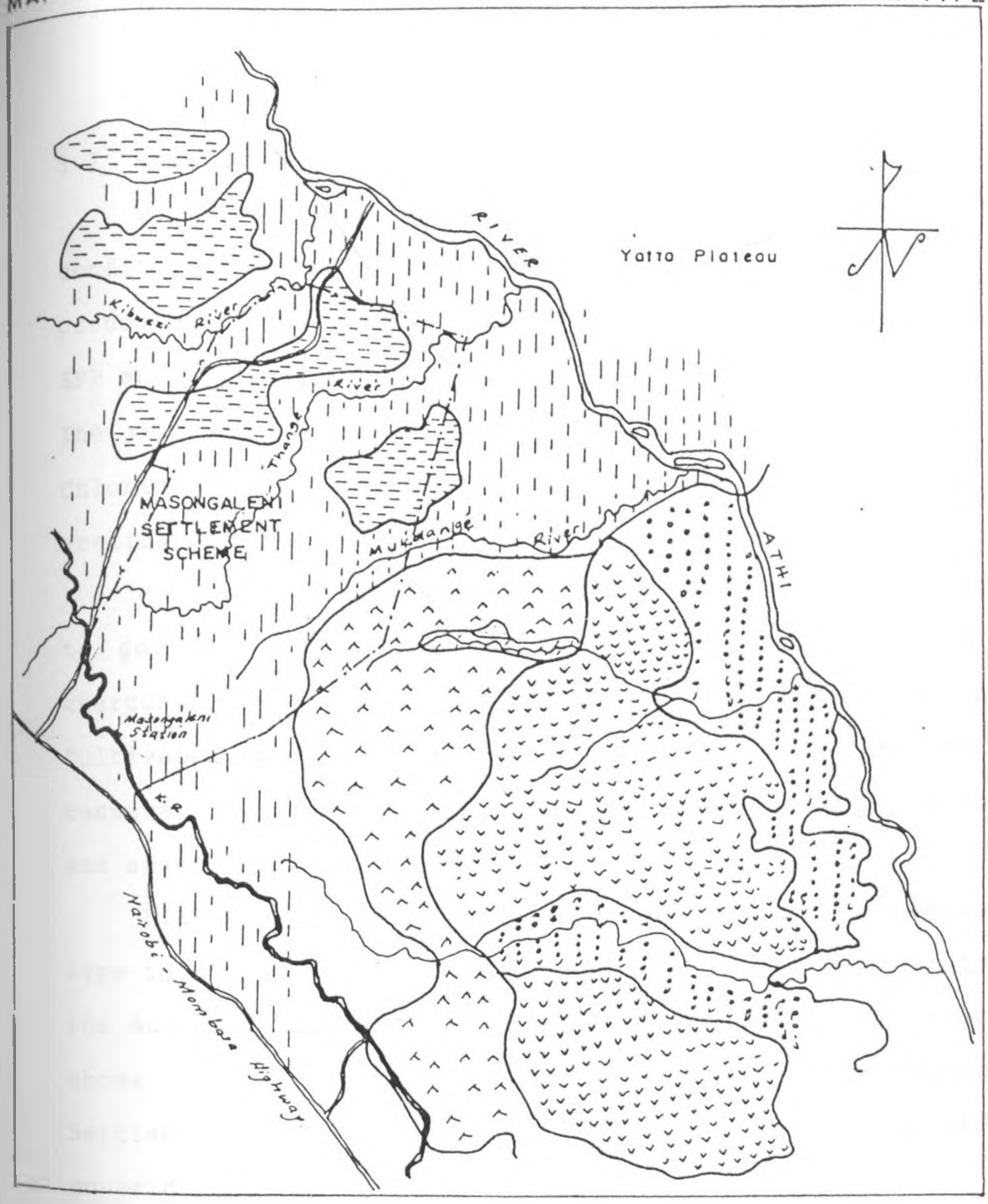
3.6 Soils: Soil Characteristics

Soils in Masongaleni Settlement Scheme are developed on gneisses rich in ferro-magnesian minerals. In most of

Masongaleni Settlement Scheme, the soils are well drained, moderately deep to deep, dark red to dark reddish brown, friable to firm, sandy clay to clay over quartz gravel, map (6).


ATHI RIVER
Kgg
Kph
KIBWEZI RIVER
Malonkonga
THANGE RIVER
SOILS
Muilo
MUKANGE RIVER
SANDY
MASONGALENI
SETTLEMENT SCHEME
RED
Mukuni
Kn
Thongi
Kn
Khh.
BH
c33
BH
Masongaleni
station
K R
NRB - MBS Highway
SCALE 1:100,000
LEGEND
Kgg ..... Quartzo-felspathic gneiss and granulites
Kph ..... Plagioclase amphibolite
Kn ..... Granitoid gneisses
Khh ..... Hornblende gneisses
BH ..... Bore-holes
Meta-Sedimentary rocks

MAP 6 MASONGALENI SETTLEMENT SCHEME - MAJOR SOIL TYPES



SCALE 1' 250,000

LEGEND

1. Soils developed on gneisses rich in ferromagnesian minerals.

well drained, moderately deep to deep, dark red to dark reddish brown, friable to firm, sandy clay to clay, over quartz gravel

2. Soils developed on gneisses rich in ferromagnesian minerals

well drained, very deep, light brown to strong brown, very friable clay

well drained, deep to very deep, dark red, friable to firm, sandy to clay

Source: NARL (Kenya Soil Survey

3.7 Vegetation

Vegetation is affected by the relief and climatic conditions of an area. Masongaleni Settlement Scheme is predominantly scrubland. Commiphora species, grewia SPP, Boscia SPP and several acacia species are the common woody components. The very big trees are baobab. Most common grasses include Chloris Roxyburghiana, Eragrotis Superba, Cehehns cilianis and arstida species.

Many of the common tree and grass species are becoming rare to get due to uncontrolled clearing of the vegetation for charcoal burning and to get land for farming (growing of crops). Cultivated crops include among others: maize, millet, sorghum, cassava, cow-peas, beans, pigeon peas, green grams, castor oil and sweet potatoes, map (7).

Plates (4) and (5). Plate (4) shows the common vegetation type in Masongaleni Settlement Scheme. This vegetation type is the Acacia species, an indication of an arid land. Plate (5) shows the very common big Baobab tree species in Masongaleni Settlement Scheme. The Baobab trees are also an indication of an arid land.

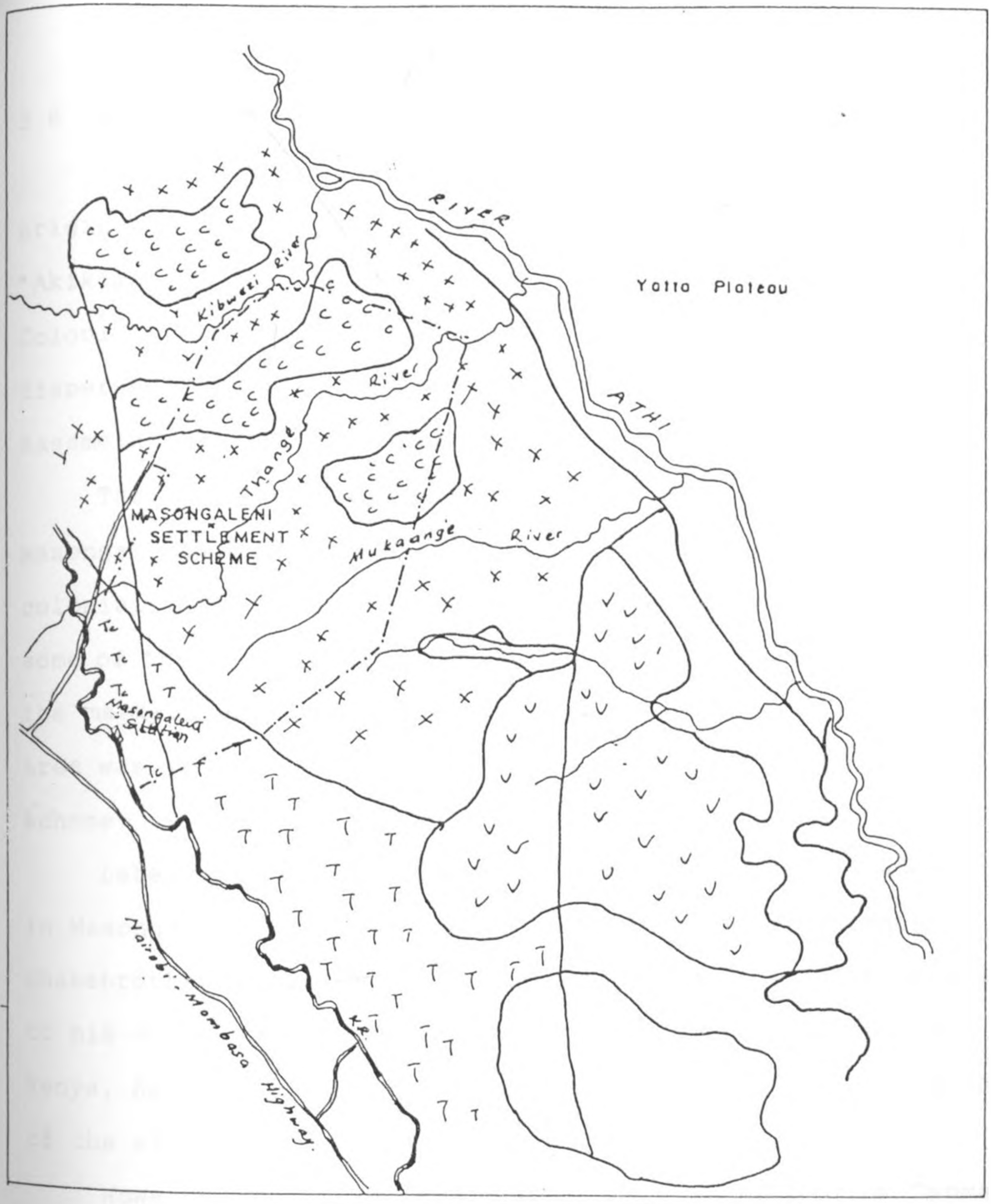
plate (4). Acacia. A common tree species in Masongaleni Settlement Scheme

Source: Field survey, 1995.

plate (5). Baobab tree species. The big common tree species in Masongaleni Settlement Scheme

Source: Field survey, 1995.

MAP 7 MASONGALENI SETTLEMENT SCHEME – VEGETATION TYPES



SCALE 1:250,000

LEGEND

Grewia tallax variant

Boscia angustifolia variant

Grewia tallax variant (2)

Source: NARL (Kenya Soil Survey)

3.8 Historical background

The present day Masongaleni settlement scheme was originally settled by indigenous Kamba people referred to as "Akikumbulyu" as early as 1934. In 1938, the then British Colonial Government evicted the indigenous Kamba people and they dispersed to squat in such areas like kinyambu, Kasayani, Kasemeini, Kevanda and Masonga.

The word " Masongaleni" is derived from the word " Masonga", that means a dwelling place for squatters. When the colonial Government evicted people from Masongaleni in 1938, some of them went to squat in the then small railway station and the market centre acquired the name Masonga. The surrounding area was given the name Masongaleni, now Masongaleni settlement scheme.

Later, an Asian by the name shakebrother bought some land in Masongaleni and established an expansive sisal plantation. Shakebrother handed over the management of the sisal plantation to his son Rashid. Unfortunately, on his flight from India to Kenya, Rashid died in a plane crash. This saw the closing down of the sisal plantation.

However, later on a European farm by the name Denmark Company of Kenya (DCK) was established in Masongaleni. The agricultural crops grown in the farm by then were: sisal, pepper, sunflowers, rose flowers among other horticultural crops. These crops were grown with abstraction of irrigation water from Thange and Kibwezi rivers. Due to lack of market

abroad for the company's agricultural products, the company closed down. The government of Kenya bought the land and until its settlement in 1992, Masongaleni has been a game reserve.

In 1992, through a presidential directive, squatters from the slopes of Chyulu hills, Kasayani and Kalembwani were allocated land in Masongaleni.

3.9 Socio-Economic and Institutional Characteristics

According to a baseline survey carried out by AAK in Masongaleni Settlement scheme in 1993, the scheme had a population of about 9245 people by the same year. According to the survey the scheme had 2700 households. The average number of families per block was about 150 people.

(i) Total Population

According to a study done on Kikumbulyu Water supply in 1983 by the MOLRR&WD in the areas neighbouring Masongaleni Settlement Scheme, a population growth rate of 3.3% was used. The author uses this rate to calculate the current total population for Masongaleni settlement scheme.

Using that population growth rate, then:

In 1993 Masongaleni Settlement Scheme had a population of 9,245 people. The current population is arrived at by saying:

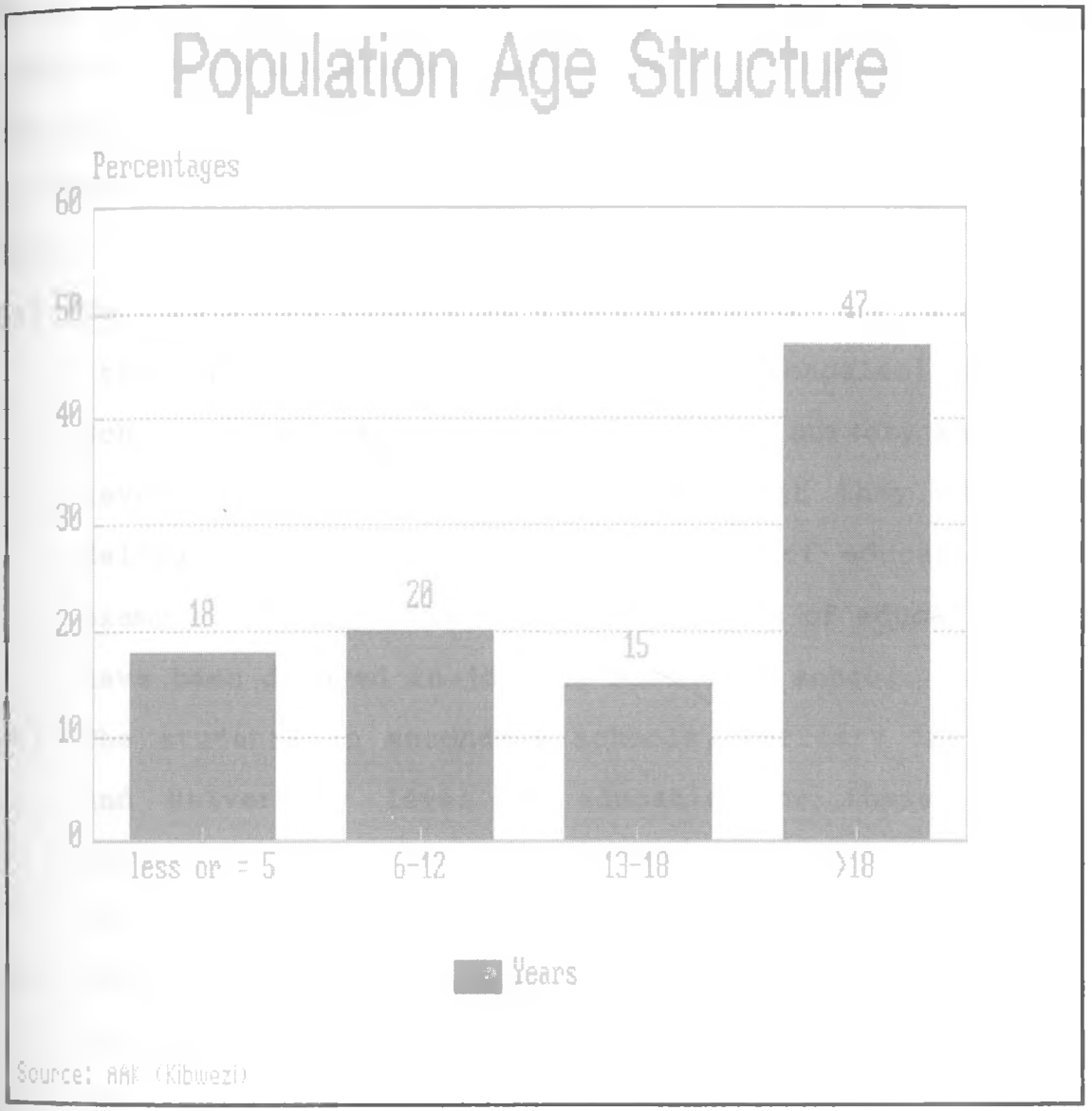
$Pn = Po(1+r\%)n$

Therefore, the current population = $9245(1+3.3)/100)3$

$= 9,245(1+0.033)3$

$= 9,245(1.1023029) = 10190$ people.

Figure (4). Population Age Structure



According to the study, over 90 per cent of the school going children in Masongaleni settlement scheme are in nursery and primary levels of education. From the population cohorts in the population age structure above, a number of implications can be deduced and the following facts need to be born in mind. That:

(a) The hasty and unexpected resettlement of the people from their previous places of origin to Masongaleni Settlement Scheme disrupted the children/pupils in nursery and primary levels of education. This means that they might have delayed in going to the next levels of education. For example, those pupils in primary levels of education might have been delayed in joining secondary school.

(b) The students in secondary schools, tertiary institutions and University level of education or those who were supposed to join these institutions might have abandoned the idea because of the disruption.

(c) There is need to plan for not only education facilities for this youthful population but also for other facilities for the same category of population in Masongaleni settlement scheme.

(d) There is need to raise the farmers' incomes in the settlement scheme so that they may send their children in future to secondary, tertiary institutions and university level of education.

(e) There is need for the GOK to consider such implications so that in future such problems may be avoided.

(iii) **Population Migrations**

Masongaleni settlement scheme is composed of a population of squatters mainly from Chyulu hills, Kalembwani and Kasayani all of them in Makueni District. A small proportion of the people in Masongaleni Settlement Scheme consists of a minority group of people who have come from other parts of the country and have bought land in the scheme.

The data collected from the field reveals that a total of 5,696 people (69%) of the total population migrated (place of origin before settling in Masongaleni) from the slopes of Chyulu hills. On the other hand, a total of 2,558 people (27%) of the total population migrated from Kasayani while 387 people(4%) of the population migrated from Kalembwani.

(iv) **A comparison between Chyulu Hills and Masongaleni Settlement Scheme**

It is very important for this study to compare the two places of origin. This is because, the ways of socialization the people experienced in their original places in terms of farming systems, values and beliefs among others, will very much affect the exploitation of the land resources in the new settlement area (Masongaleni settlement scheme). The author compares Masongaleni settlement scheme with Chyulu hills only,

because Kasayani and Kalembwani have the same agro-ecological zone like that of Masongaleni settlement scheme,(agro-ecological zone 5). The author compares Masongaleni settlement scheme with Chyulu hills because 69% of the settlers in Masongaleni settlement scheme originated from Chyulu hills.

Masongaleni settlement scheme is within agro-ecological zone LM5 while Chyulu hills is found within a variety of agro-ecological zones i.e UM4, UM3-4, LH4, LH3-4.

Masongaleni settlement scheme has an annual average rainfall of about 631 millimetres while the annual average rainfall for Chyulu hills is about 1000 millimetres.

Masongaleni settlement scheme being an example of an ASAL is capable of supporting the growth of such drought resistant crops like Katumani composite B, Sorghum, Millet, Cow-peas, Cotton, Sisal, Pigeon-peas, Green-grams etc while Chyulu hills being an example of a medium potential zone is able to support the growth of such crops as Bananas, Potatoes, Arrow roots, local traditional maize, and to some extent coffee.

However, looking at the above comparison, resettling of people from the medium potential area to an ASAL has a lot of implications to the new settlers in Masongaleni settlement scheme. The following are some of the important facts that need to be noted. That:

(a) The new settlers will take some time before they adjust to the new agro-ecological zone.

(b) The new settlers are likely to use inappropriate

technologies in farming. For example, the use of inappropriate seeds like the local traditional maize seeds instead of Katumani maize. Use of inappropriate tools and farming systems is likely to happen in Masongaleni settlement scheme. This leads to low agricultural yields and hence under-utilization of the agricultural potentials in the settlement scheme.

(c) The new settlers needs a lot of education and sensitization on the importance of adopting very fast to the new agro-ecological zone so as to fully tap the agricultural potentials of the settlement scheme.

(v) **Land Tenure**

A study of the land tenure system of an area is important in assessing the feasibilities not only in agricultural development but also any other development project. All the land in Masongaleni settlement scheme is Government land. The land has been demarcated and letters of allotment have been issued to the settlers. The average land size allocated to each settler is 8 acres. The settlers have not been issued with title deeds and they do not know when they will be issued with the title deeds. Therefore, land tenure was found to be a critical issue in Masongaleni Settlement Scheme. The settlers are supposed to pay kshs.600 per acre to the Ministry of lands and settlement.

During the field survey, the area's Land Demarcation

Officer said that the settlers can get their title deeds as soon as they pay all their land dues to the Ministry of lands and Settlement. They are supposed to pay these dues to the Ministry's Headquarters (Ardhi House) in Nairobi.

The area's land demarcation Officer recalled that there was to be an office that was to be established in Kibwezi, the Divisional Headquarters. This office would facilitate easy payment of the settlers' land dues. This would mean short travelling distance to the Divisional office. When interviewed on the issue of paying these dues, some of the constraints the settlers expressed were:

- Unreliable and irregular sources of income from the agricultural produce.
- Far and inaccessible land dues' paying office. The inaccessibility was said to be in terms of travelling costs, all the way to Nairobi.
- There has not been a follow up from the Government on the payment of these land dues. This led to reluctance by the settlers in paying these dues even when some of them had the money.

One common view from the interviewed settlers was that the land size allocated to them was small compared to an average household size of 8.

Therefore, the 8 acres allocated to the settlers is small compared to the farmers' activities that they would be willing to perform on their land. These activities include mainly

arable farming and livestock keeping. In the livestock sector there is a variety of animals that the farmers wished to keep for the different benefits they would get from them. For example, they would wish to keep cattle to obtain milk, bride wealth and plough their farms. Goats would provide milk, meat, bride wealth and sell to get incomes to meet their household requirements. They would keep sheep to get meat and sell to get incomes to meet household requirements. They would also wish to keep poultry to meet such requirements as provision of eggs, meat and for sale sell to meet most of the household's miscellaneous needs. It is the same piece of land that the farmers may wish to practise bee keeping.

To raise the farmers' incomes and general standards of living, the farmers need to apply such agricultural practices like integrating rainfed agriculture and irrigated agriculture with livestock farming. Irrigated agriculture enables multiple cropping, intensive use of land, growing of high value crops which yield cash incomes thus contributing to employment and income generation. Also to raise their incomes, the farmers need to apply such farming practices like soil and water conservation among other methods.

(vi) **Land Potentiality**

The factors which determine the potential of land in an area are its climate, topography and soils. The climate of Masongaleni Settlement Scheme is generally hot with a mean

annual rainfall of about 631 millimetres per annum. This climate can support only a limited number of crops especially the drought resistant crops like Katumani composite B, sorghum, green grams, millet, pigeon peas and cow-peas, etc.

(vii) **Existing Agricultural Situation**

Rainfed agriculture is one of the sectors whose full potential has not been tapped. Rainfed agriculture involves cultivation of crops including maize, millet, sorghum, cassava, cow-peas, beans, castor oil, green grams, pigeon peas, etc.

The cultivation of these crops forms part of the economic base of Masongaleni Settlement Scheme. For example, the surpluses realised in all the above mentioned crops apart from castor oil, are sold to get cash for purchasing domestic items and for paying fees for their children in school. Irrigated agriculture under small holdings could also form another part of the economic base of Masongaleni Settlement Scheme. According to a hydrogeological and geophysical survey by Aqua plan commissioned by AAK in Masongaleni Settlement Scheme in 1992, it was established that the total land available in the scheme was 2,700 x 8 = 21,600 acres. Aqua plan consultants assumed that only half of this land would be available for irrigation use.

Therefore, land available for irrigation would be 21,600/2 = 10,800 acres. Assuming half of this 10,800 acres would be

under irrigation at any given time, then land being irrigated at any given time would be 5,400 acres.

Depending on the data collected from the small-holder irrigated agriculture in the area neighbouring Masongaleni Settlement Scheme, irrigated agriculture in Masongaleni Settlement Scheme may include the following crops:

- Okra
- Karella
- Doodhee Turia
- Tinda
- Egg Plant (Brinjals)
- Chillies
- Tomatoes
- Guar

Potential irrigation water sources are Kibwezi, Thange and Athi rivers. Umanyi Springs and the perennial Mukange river are other sources of irrigation water.

Irrigated agriculture would involve the growing of high value crops namely horticultural crops like vegetables. According to Kangangi, G.M. (1982), the production methods for these crops are labour intensive and generates employment opportunities. It allows multiple cropping that encourages intensified agricultural land use. According to the research done by aqua plan on behalf of AAK on irrigated agriculture in the area neighbouring Masongaleni Settlement Scheme, one hectare of irrigated horticultural field is equivalent to 1000 man days per

season. If the four rivers together with Umanyi spring were tapped for irrigation purposes, then assuming that each farmer irrigated a minimum of 2 acres, then all the work force in Masongaleni Settlement Scheme will fully be employed in the irrigated agriculture.

By tapping irrigation water from the mentioned sources, then there is a potential of having small scale irrigation project for each farmer in Masongaleni Settlement Scheme. The success of such small scale irrigated projects would require an organization of the following:

- Grouping together of the farmers to share a common source of water supply and other services which leads to solving of many organizational problems so that the supply of irrigation water can increase individual small farm incomes in such areas.
- Organization of input and credit, marketing and extension services necessary to relate to the scheme to the full range of development needs of the people of Masongaleni. It is advisable to have an integration of rainfed agriculture, small scale irrigated agriculture and livestock farming.

The supplemental irrigation water is expected to achieve worthwhile response through the horticultural production which require less land and gives higher potential returns to both unit of land and labour thus creating employment in agricultural production. The growing of high value crops which yield cash

incomes is expected to contribute to employment, income generation and equity distribution of these incomes which constitute rural development.

Kibwezi, an important local market opens the scheme to the main urban areas of Nairobi,Mombasa, Nakuru, Eldoret, Kisumu and Mtito-Andei if the small scale irrigated agriculture is implemented in Masongaleni Settlement Scheme.

However, a number of constraints are likely to be experienced in the enhancement of the small-scale irrigated agriculture in Masongaleni Settlement Scheme. These are:

(a) Operating irrigation equipment

(b) Organizing necessary inputs and satisfactory market outlets

(c) Obtaining market information.

If the farmers are to be involved in an expanded development programme, they require specific assistance in the above matters and in financing their enterprise. An attempt to leave the farmers on their own may lead to the failure of the irrigation systems as was noted in Karatina in Nyeri. This is because there would be limited experience in irrigation developments in Masongaleni settlement scheme where such irrigation systems have not been done before. Therefore, institutions for setting of socio-economic organizations for the management of capital, input supply, provision of extension services in skills of production methods, marketing and organization of management and production needs to be developed for the purpose. Despite the creation of a sense of owner

operator, the extent to which the Government can let the farmers alone has to be well established if the irrigated agriculture has to transform the living standards of the farmers and at the same time repaying the capital investment on the project.

(viii) Rainfall and Crop Water requirement of Irrigated Agriculture

According to the data collected from the small-holder irrigation projects by Aqua plan, the average rainfall is about 239 millimetres for the months of March-May and 339 millimetres for the months of October-December.

The yearly rainfall distribution shows clear peak in October -December and March-May. The highest irrigation water requirements are in January-February and June-September. The mean potential evapotranspiration (EO) is about 2,162 millimetres. It should be noted that some of the horticultural crops may be grown as rainfed crops.

(ix) Season of Production of the Irrigated Agriculture

Most of the irrigated agricultural crops have good prices throughout the year. The small-scale farmers produce these crops all the year round. During September-October-November, production is low because farmers concentrate on rainfed food crops. These crops may be sold locally or exported to outside countries. The highest demand for export crops is between November and May, while that for local market is during dry

months, June-July-August and December-January. Nairobi and Mombasa are the major local markets for a variety of crops produced in Masongaleni settlement scheme and its environs. This is by virtue of the high population in these areas. The other relatively important markets are Kisumu, Kisii, Nakuru, Eldoret, Kitale and Meru.

(x) Sources of Incomes

The study assessed the population's economic status by collecting data on the major sources of income.

Table (3) represents the respondents sources of income.

Table 3: Sources of income

Sources of income	Respondents	Percentage
Agriculture	37	46.3
Charcoal burning	31	38.7
Business	6	7.5
Formal employment	6	7.5
Totals	80	100

Source: Field survey, 1995.

Table (3) indicates that agriculture is the main source of income in Masongaleni Settlement Scheme accounting for 46.3 per cent while charcoal burning accounts for 38.7 per cent. Other sources of income are: business and formal employment both accounting for 7.5 per cent.

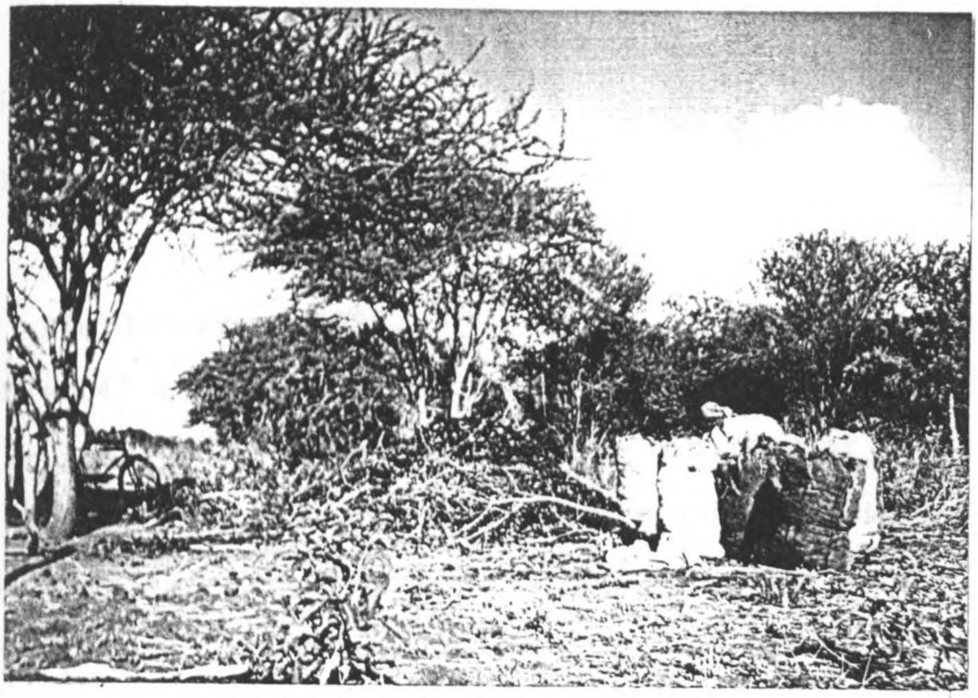
According to the study, charcoal burning is ranked number two in the list of sources of income. Charcoal burning has led to high levels of deforestation. This activity has led to lack of building poles and wood fuel, soil erosion, low crop yields and environmental degradation in the scheme. This therefore, needs some quick action to avoid any further environmental degradation, plates (6) and (7).

These two plates show that farmers in Masongaleni Settlement Scheme depend to a large extent on charcoal burning as the second most important source of income.

plate (6). A man and his family participating in charcoal burning in Masongaleni Settlement Scheme

Source: Field survey, 1995.

plate (7). A woman packing charcoal in sacks in Masongaleni Settlement Scheme



Source: Field survey, 1995

Other sectors contributing to the enrichment of the economic base of Masongaleni Settlement Scheme are shop keeping, bicycle repair and formal employment especially in the teaching profession.

Table 4: Income patterns.

Income pattern	Respondents	Percentage
Regular	12	15
Irregular	68	85
Totals	80	100

Source: Field survey, 1995.

Table (4) shows that 85% of the population interviewed had irregular sources of income while 15% had regular sources of income. The irregular sources of income includes among others Charcoal burning. The regular sources of income on the other hand includes formal employment like teaching etc.

A representation of the various ranges of incomes per month and the number of frequencies and percentages of the respondents in those income ranges (in Kshs) is shown in table (5).

Table 5: Income Ranges

Income range	Respondents	percentage
less than 1000	2	2.5
1000-1100	3	3.8
1101-1200	4	5
1201-1300	64	80
1301-1400	5	6.3
over 1400	2	2.5
Total	80	100

Source: Field survey, 1995.

From the above figures, the average household income per month can be calculated. This can be achieved by using the following formula.

1000 x 2 = 2000

1050 x 3 = 3150

1150.50 x 4 = 4602

1250.50 x 64 = 80032

1250.50 x 5 = 6752.50

1400 x 2 = 2800

Total = 99336.50

99336.50/80 = Ksh.1242

The average household income per month for the scheme is Kshs. 1,242. This is low compared to the uses the farmers would wish to put the money to. The farmers would wish to perform a number of activities using this little income. They use the

income to take their children to school and for subsistence purposes such as provision of food, clothing and shelter.

(xi) **Expenditure Patterns**

Table (6) represents the frequencies and percentages of the various major uses to which the respondents incomes are put to.

Table 6: Income Expenditure patterns

Uses	Respondents	Percentage
Subsistence	23	28.7
Medical care	20	25
Education of children	19	23.8
Purchase of livestock	18	22.5
Totals	80	100

Source: Field survey, 1995.

According to table (6), subsistence takes the highest percentage of income for the households. Subsistence here would include such things like purchase of basic household items like clothing, salt, fats, paraffin, among other items. Medical care takes the second position in the list. Education of children and purchase of livestock takes the third and fourth positions respectively.

If each of these uses took a portion of the household's average income equivalent to their percentages as shown in table (7), then the following would be the breakdown of the various incomes spent on the various uses per month.

Table 7: Household's portion of incomes(Incomes in Kshs)

Uses	%age of Income spent	Income spent
Subsistence	28.7%	356.40
Medical care	25%	310.50
Education of children	23.8%	295.60
Purchase of livestock	22.5%	279.45
Total	100%	1242.00

Source: Field survey, 1995.

Table (7) indicates that the respondents only invest in the purchase of livestock like buying poultry, goats, sheep and cattle. It shows that the settlers do not plough back some of their incomes to their businesses like shop-keeping and bicycle repairing.

Table (8) represents the various responses from the sampled households on the strategies to achieve higher sustainable incomes in future.

Table 8: Strategies to achieve Sustainable Income

Strategies	Respondents	Percentage
Better agricultural production	54	67.5
Buy livestock	18	22.5
Engage in business	3	3.75
No answer	5	6.25
Totals	80	100

Source: Field survey, 1995.

Table (8) indicates that the farmers would like to practise better crop and animal husbandry. This would involve improvement in crop production techniques which would include:

- using the right crop production inputs like appropriate seeds, fertilizers, farm implements and tools.

This would also involve such crop production practices like early planting and weeding, proper crop harvesting and storage among others.

On animal husbandry, the farmers need to raise tolerant animals such as goats, sheep and the zebu/Boran type of cattle. The livestock should be purchased from the surrounding area because the livestock here is resistant to the environmental hazards.

(xii) **Livestock Keeping**

Livestock keeping is one of the economic activities in Masongaleni Settlement Scheme. The common animals kept are: sheep, goats, poultry and a few number of cattle and donkeys. According to the study, virtually all the settlers' livestock died following their settlement in Masongaleni Settlement Scheme in 1992. The settlers had very few animals with them during the field survey compared to the time they were settling in Masongaleni. The livestock was affected by tsetse fly and tick borne diseases. The most affected of the animals was cattle. However, the farmers have tried to raise goats, sheep and poultry which according to the study are more tolerant to the environmental factors such as pests, diseases and drought. According to the study, these animals are kept for several purposes:

(a) As a means of capital investment.

(b) Sell to get money for household needs such as buying food, clothing, shelter and sending children to school etc.

(c) For home consumption especially poultry, goats and sheep. The products for home consumption from these animals are: milk, meat and eggs.

(d) To pay dowry.

Bee keeping though practised in a low proportion as far as part of the livestock practices carried out in the scheme is concerned is also another economic base of Masongaleni Settlement Scheme. Data analysis indicates that, 31.5 percent

of the settlers keep bees while 61.3 do not keep bees. In the areas surrounding Masongaleni Settlement Scheme there are about 30 women groups and a good number of individual families practise bee keeping. The women groups and private individuals/families have adopted a relatively better bee keeping technique compared to the traditional bee keeping technique.

(xiii) **Fish Potential**

Masongaleni settlement scheme has a potential for fishing. Currently, small scale fishing is taking place in the 3 main rivers. These rivers are: Athi, Kibwezi and Thange. Umanyi spring is about 19 kilometres from the scheme, so in terms of distance, it is not accessible for fishing to the people of Masongaleni. Though there are no records of the fishing activities along the three rivers, there is a potential for a variety of fish. Once the proposed dams are constructed there may be a great potential of fish as a source of protein and incomes for the people of Masongaleni. Fishing in the scheme is mostly done during the dry season and therefore it is regarded as a secondary activity from the other economic activities within the scheme. However, it is important to sensitize the local community (mostly the kamba people) on the importance of fish as a source of protein to the household.

(xiv) **Housing**

The quality of life in the rural areas can not be improved without improvement in the quality of houses in these areas. Shelter is a basic human need and any development must take this into account. The provision of decent housing for the rural people is therefore a necessity for rural development

In Masongaleni Settlement Scheme, most of the housing structures are of low quality, made of grass thatched roofs and mud built walls. The main quality of housing structures in the scheme is a function of the low incomes of most people. Unless the incomes are raised, the quality of houses will remain low and this implies low quality of life.

Thus housing in Masongaleni Settlement Scheme is related to agricultural development in the sense that, it is through improving agriculture that more incomes can be earned to provide good quality housing and raise the people's standards of living, plate (8). It portrays the quality of housing which is found in most parts of Masongaleni Settlement Scheme.

plate (8). The common housing status in Masongaleni Settlement Scheme

Source: Field survey, 1995.

(xv) Development Institutions

A number of development institutions or agencies are helping in the development of Masongaleni Settlement Scheme.

The following is a list of the development institutions and their contributions to the development of Masongaleni Settlement Scheme.

1. GOK

The GOK through the provincial administration has provided the following to Masongaleni Settlement Scheme:

- Agricultural extension services
- Food relief
- Infrastructure in form of rural access roads

2. **MOE**

The Ministry of Education provides teachers and school inspectorate personnel.

3. **MOH**

The Ministry of Health provides health services and agricultural extension services to the Scheme.

4. **MOALD&M**

The Ministry of Agriculture, Livestock Development and Marketing provides agricultural extension services.

5. **MOCSS**

The Ministry of Culture and Social Services has been involved in registration of self-help groups.

6. **AAK**

Action Aid Kenya at Kibwezi rural development station has been assisting in training, provision of infrastructure, provision of agricultural inputs and offering advice on trade and commerce.

7. CC

The Catholic Church has been assisting in the provision of agricultural inputs, food relief and provision of health services.

8. **AMREF**

Africa Medical Research Foundation is involved in the rehabilitation of the disabled.

9. **GVs**

Germany volunteers from Germany have been involved in the provision of infrastructure and agricultural extension services.

10. **Sub. DDCs**

The Sub District Development Committees are involved in planning, implementation, monitoring and management of projects. They have been doing that through assistance from such agencies like GOK, AAK, GVs etc.

11. **KARI**

Kenya Agricultural Research Institute is involved in the offering of extension services and provision of planting materials to the farmers.

12. **Pro.Ad**

The Provincial Administration is involved in the administration of the scheme.

13. **UON**

University of Nairobi is involved in demonstration and training farmers. UON has been doing this through the small farmers demonstration and training plots composed of member farmers from different parts of the Division including Masongaleni Settlement Scheme. The University of Nairobi through IDRDU and in conjunction with USAID, a United States

agency and CINADO, an Israeli based agency and European Union have been involved in the demonstration and training farmers on horticultural farming (Newspaper 5th, September 1996). These agencies have been assisting the farmers through Kibwezi Irrigation Project (KIP).

14. **CHEK**

The Council for Human Ecology Kenya is involved in the provision of infrastructure, education and training on nutrition.

There are about 18 development institutions in Masongaleni Settlement Scheme. Currently there is an NGO that is in the process of formation. The NGO is contemplating to be registered with the Ministry of Culture and Social Services. The proposed name of the organization is " Masongaleni Council For Sustainable Development (MACOSUD).

Once the NGO is registered, its main objectives will be:

- Agricultural extension services.
- Institutional capacity building. This will involve strengthening of local institutions in project planning, implementation, monitoring and evaluation. It will also be involved in influencing policy making by the GOK.
- Research and information dissemination and
- Gender and HIV/AIDS community sensitization,

plates (9), (10) and (11).

Plate (9) is portraying the role of KARI not only in Masongaleni Settlement Scheme, but also at the National level. The plate

shows a variety of rainfed horticultural crops that are suitable for Masongaleni Settlement Scheme.

plate (9). The role of KARI in Horticultural Development in Masongaleni Settlement Scheme.

Source: Field survey, 1995.

plate (10) portrays a KARI technical officer supplying one of the farmers in Masongaleni Settlement Scheme with cassava planting Materials.

Source: Field survey, 1995.

plate (11). Plate (11) portrays a women's group that has been assisted by AAK to construct a conference house , a shop and a canteen in Masongaleni Settlement Scheme.

Source: Field survey, 1995.

The contributions of the various agencies whether in financial or technical aid is important for the development of Masongaleni Settlement Scheme.

CHAPTER FOUR

DATA ANALYSIS, INTERPRETATION, SUMMARY OF FINDINGS AND SOLUTIONS

4.1 Introduction

After collecting data from the field, the author and his research assistants went through the questionnaires to fill in the missing cases. This was done to enable easy processing of the data. Then the questionnaires were coded. This involved assigning a number to each questionnaire. This was followed by preparation of a data structure to be used in the entering of data into the computer.

In the preparation of the data structure, the author together with the research assistants gave value labels to all the answers given by the respondents. This was followed by running of frequencies in the computer. The frequencies were used to make tables which were in turn used to present the data in a descriptive manner.

4.2 Analysis of the Untapped Agricultural Potentials in Masongaleni Settlement Scheme

Masongaleni Settlement Scheme has untapped agricultural potentials. These potentials are identified in the following sectors: in rainfed agriculture, irrigated agriculture, animal

rearing and bee keeping. Each of these potentials is analyzed below.

(i) **Rainfed Agriculture**

Natural rainfed agriculture is not fully tapped. To prove this, the author collected data on the average yields per acre of 5 selected crops over the years, i.e from 1992/93 to 1994/95. The crops selected were maize, sorghum, cow peas, green grams and pigeon peas. These crops were selected because they are the main food crops in terms of acreage occupancy. Other factors considered in selecting the crops were yields per acre and suitability to the area in terms of climate, diseases and pests tolerance.

The yields of the five selected crops are compared with the average yields per acre of the same crops recorded in the annual report for Makueni District for the years 1992/1993 to 1993/1994. The author compared the average crop yields per acre in the district on the basis that most parts of the district are in the same agro-ecological zone and therefore share the same rainfall and moisture indices with the Masongaleni Settlement Scheme. Therefore, the figures achieved from the average crop yields per acre would act as control figures for the data on the average crop yields per acre for each of the five crops in Masongaleni Settlement Scheme. The yields in Masongaleni Settlement Scheme are found to be far much lower compared to the average crop yields per acre of the same crops at the District

level. The deficit realised by getting the differences between the average crop yields for the District level (Makueni District) and the average crop yields for Masongaleni Settlement Scheme is the potential assumed to have been untapped by the farmers in the settlement scheme.

Table (9) represents the average crop yields in killogrammes per acre of the 5 selected crops in Masongaleni Settlement Scheme for three consecutive years i.e 1992/93, 199/943 and 1994/95.

Table 9: Crop yields of 5 selected crops in Masongaleni Settlement Scheme

CROPS	YEARS			TOTALS
	1992/93	1993/94	1994/95	
Maize	330.4	72.6	174.5	577.5
Sorghum	30	60.3	83.7	174
cow-peas	43.3	28.5	78.5	150.3
Pigeon peas	37.7	30.2	32.1	100
Green grams	34.2	13	33.6	80.8
Totals	475.6	204.6	402.4	1082.6

Source: Field survey, 1995.

Table (10) represents the average crop yields for Makueni District in killogrammes per acre of the same 5 crops used in table 9 for the same period.

Table 10: Crop yields for the 5 selected crops for Makueni District.

CROPS	YEARS			TOTALS
	1992/93	1993/94	1994/95	
Maize	445.3	222.3	-	667.6
Sorghum	162	183.2	-	344.2
Cow-peas	202.4	203.4	-	404.8
Pigeon peas	72.9	263.2	-	336.1
Green grams	160.7	162	-	322.7
Totals	1043.3	1032.1	-	2075.4

Source: Field survey, 1995.

A comparison between the two tables, (9 and 10) shows that the average crop yields per acre for the five crops in Masongaleni Settlement Scheme are much lower than the average crop yields per acre for the District level. The differences assumed to be the untapped potentials are shown in table (11). The differences are for the District and Masongaleni Settlement Scheme for 1992/93 and 1993/94 years.

Table 11: Untapped Rainfed crop potential in Masongaleni Settlement Scheme

Crops	1992/93 untapped potentials	1993/94 untapped potentials	Totals in untapped potentials
Maize	114.9	149.7	264.6
Sorghum	132.0	121.9	253.9
Cow peas	159.1	173.9	333.0
Pigeon peas	35.2	233.0	268.2
Green grams	126.5	149.0	275.5
Totals	567.7	827.5	1395.2

Source: Field survey, 1995.

If the farmers in Masongaleni Settlement Scheme fully tapped these agricultural potentials, they would have attained at least, full average crop yields per acre equal to those of the District. This would mean an increase in the average household income and hence better standards of living. With increased agricultural yields, food security would also be realised. The untapped potentials in Masongaleni Settlement Scheme can be ascribed to a number of major constraints. The tables below represent the major constraints to rainfed crop production as given by the farmers and evidenced by the author and the research assistants during the field survey.

Table 12: Constraints to rainfed agriculture in Masongaleni Settlement Scheme

Constraints	Respondents	Percentage
- Pests and diseases	30	37.5
- Inadequate farm implements and tools	28	35
- Inadequate agricultural extension officers	12	15
- Inadequate erratic and unreliable rainfall	6	7.5
- Lack of transport and communication	2	2.5
- Missing cases	2	2.5
Totals	80	100

Source: Field survey, 1995.

Table (12) shows that the three major constraints in order of severity are pests and diseases, inadequate farm implements and tools, and inadequate agricultural extension officers. Inadequate, erratic and unreliable rainfall is the fourth major constraint to crop production.

4.3 Other Constraints to full Utilization of Rainfed Agriculture

Table (13) represents the frequency and percentage of responses given by farmers concerning the planting methods they used.

Table 13: Planting methods used in Masongaleni Settlement Scheme.

Methods used	Respondents	Percentage
Dibbling Stick	37	46.3
Hoe	37	46.3
Oxen Ploughing	3	3.8
Tractor Ploughing	3	3.8
Totals	80	100%

Source: Field survey, 1995.

Table (13) shows that the common planting methods used by the farmers are: dibbling stick/panga and a hoe. Table (14) shows the reasons for the preference of the dibbling stick/panga and the hoe over other planting methods, plate (12). It portrays a farmer in Masongaleni Settlement Scheme using a Panga as a dibbling stick to plant her seeds during the rainy season.

Plate (12). A Woman using a panga as a dibbling stick to plant in Masongaleni Settlement Scheme

Source: Field survey, 1995.

Table 14: Preference to dibbling stick/panga and the hoe over the other planting methods.

Reasons	Respond-ents	Percentage
- Lack of oxen and a plough	52	65
- Unaffordability of farming implements and tools	16	20
- Inter-cropping	12	15
Totals	80	100%

Source: Field survey, 1995.

The data in table (14) indicates that majority of the farmers (65%) in Masongaleni Settlement Scheme used a dibbling stick/panga to plant their seeds because they lacked oxen and ploughs. Other reasons include inability to afford farm tools and implements (20%), and because the farmers had intercropped their crops (15%). From the data analysis, it is evident that, the two serious problems facing the farmers in planting were lack of oxen and a plough and inability to afford farm implements and tools.

The methods used by the farmers to weed are shown in table (15).

Table 15: Weeding methods used in Masongaleni Settlement Scheme.

Method used	Respondents	Percentage
Hoe	70	87.5
Oxen ploughing	10	12.5
Totals	80	100%

Source: Field survey, 1995.

The data in table (15) indicates that majority of the farmers (87.5%) in Masongaleni Settlement Scheme used a hoe to

weed while only 12.5% used oxen plough. The reasons why they used such weeding methods are shown in table (16).

Table 16: Preference of the hoe and oxen ploughing for weeding

Reasons	Frequency	Percentage
Lack of oxen and a plough	55	69.4
Inter-cropping	18	22.2
Unaffordability of FITs	4	5
Affordability of oxen ploughing	3	3.3
Totals	80	100

Source: Field survey, 1995.

According to the data analysis in table (16), the farmers preferred to use a hoe to weed because they lacked oxen and ploughs. This accounted for 69.4% of the responses from the interviewed farmers. The farmers also used hoes to weed because they intercropped their crops in their farms and this accounted for 22.2%. Unaffordability of farm implements and tools also made the farmers to prefer the hoe to a plough (4%). On the other hand, (3.3%) of the interviewed farmers used oxen ploughing. The farmers either hired or used their own oxen and plough to weed. The (3.3%) that used oxen ploughing are a negligible number compared to those who used other weeding methods.

The planting and weeding methods and the reasons for preferring such methods explains why the agricultural potentials are not fully tapped by the farmers in Masongaleni settlement Scheme. To support the above data, it is important to note that there has been considerable evidence to suggest that substantial

improvements in agricultural output by small-holders has been achieved through improved availability of appropriate tools and equipment.

For example, in a study carried out by Mortimore and Wellard in Machakos District, it was observed that adoption of the oxen plough in combination with other agricultural practices has enabled local small holders to increase their output by 500 per cent between 1910 and 1980 (Mortimore et. al. 1991). The authors further noted that the time required for weeding can be reduced by 95 per cent through the use of appropriate equipment.

On the other hand, unavailability of appropriate tools and equipment constitutes a major constraint in agricultural production. The most basic farm implements and tools required by the small holders in Kenya are jembes, fork jembes, shovels, rakes, traditional hoes, wheel-barrows and oxen ploughs.

However, many farmers do not have adequate supply of these. The Masongaleni Settlement Scheme farmers are no exception. Also, a recent study in Embu District found that there was an inadequate supply of ploughs and as a result many farmers were unable to plant at the optimum time just as the rains were starting (Skinner, 1993).

Many farmers had to wait until a plough was available before they could get a plough and plant their crops. A delay in 10 days in planting can lead to 52 per cent reduction in yield.

Research has also shown that the use of draught animal power can reduce this time needed to cultivate a farm by over 60 per cent compared to cultivation by hand, and generally the more mechanized, the higher output per unit area of land under agricultural activity. (GOK, 1986; Ministry of Agriculture, 199;19).

4.4 Summary of Findings in Rainfed Agriculture

Basing the research findings on rainfed agriculture with the general objective and assumption (iii) of the research, it is evident from the data analysis that rainfed agriculture is a potential in Masongaleni Settlement Scheme that has not been fully tapped by the farmers. This is in line with assumption (iii) that, there exists a variety of crop potential that needs to be fully tapped.

Basing the findings with objective (i) of the research, the research has found out that a number of constraints have hindered the tapping of rainfed agricultural potential. The main constraints are:

(i) Pests and diseases

(ii) Inadequate farm implements and tools/lack of oxen and plough or inability to afford these.

(iii) Inadequate agricultural extension Officers

(iv) Inadequate, erratic and unreliable rainfall and

(v) Lack of transport and communication networks.

According to objective (ii) of the study, a summary of solutions to those constraints may be applied. These are given in (4.5).

4.5 Solutions to Rainfed Agriculture in Masongaleni Settlement Scheme

There are several possible solutions the study came up with as informed by the data collected from the field. The author and the research assistants ensured what they were told by the respondents was checked against what they saw (author and research assistants). The author and the research assistants cross-checked whether what the respondents suggested or said was necessary or viable.

The first solution to rainfed agriculture is to encourage the farmers to buy FITs for themselves. The GOK and other agencies involved in the development of the scheme, especially in agriculture, may be requested to assist in giving soft loans or provision of loans in kind to the farmers. This would enable the farmers acquire ploughs and oxen for ploughing. The farmers can also be sensitized on the importance of sharing ploughs and oxen. For instance, if a farmer has a plough and the other neighbouring farmer has a bull, then the two farmers may combine to plough together. This is a viable solution because the farmers' farms are small in size. Even if the farmers combined in ploughing, they will still finish ploughing their farms when the rains are still adequate for the different crops. In other

words, the community needs to be sensitized on the importance of Community Based Organisations (CBOs) in ploughing. This solution accounted for 27.5% of the responses from the interviewed farmers.

The other second solution is for the farmers through assistance from the GOK and other agencies to make sure they have their Community Own Resource Persons (CORPs). These CORPs will act as the farmers' own technical Officers in agriculture and therefore eradicate over-reliance on government and other agencies' technical Officers. Besides government extension officers may not be as sustainable as the CORPs in the long run. This solution accounted for 27% of the responses.

The third solution is to advice the farmers to grow drought, pest and disease resistant crops such as Katumani composite B maize, sorghum, millet, green grams, cow peas and pigeon peas among others. These drought resistant crops would contribute to food security. This solution accounted for 13.8%.

The fourth solution is to eradicate mosquitoes that cause malaria to the farmers especially during the rainy season. During the field survey, those interviewed by the author and the research assistants complained that malaria caused shortage of labour to the households during the farm activities' peak season. This contributed to late planting, weeding and harvesting of the crops hence low agricultural yields. The mosquitoes are mostly harboured in the stagnant water around the farmers' compounds. The farmers should be sensitized on the

importance of draining stagnant water around their compounds. This solution accounted for 12.5% of the responses from those farmers who were interviewed.

Other solutions are to sensitize the farmers on the importance of timely planting, weeding and harvesting of their crops and provision of 2 main all weather murram rural access roads. These two solutions accounted for 6.2% and 5% respectively. The provision of the access roads will enable the farmers market their farm produce. The author recommends that the provision of the rural access roads be accompanied by the formation of a co-operative society charged with the responsibility of transporting and marketing of the farmers' agricultural produce. This co-operative will eradicate the exploitation of farmers by middle men who offer low prices for the farmers' produce. If those solutions for rainfed agriculture are implemented, the farmers will tap the potentials in rainfed agriculture.

4.6 Irrigated Agriculture

Irrigated agriculture is possible if the waters of Kibwezi, Athi, Mukange, Thange rivers and Umanyi spring was tapped for irrigation. Irrigated agriculture would be made possible by constructing large sub-surface dams along the rivers and the spring. Canal irrigation would be viable from these dams. One of the advantages is that after getting the water from the dams, it can be supplied from a central point through canals (furrow

irrigation) with the help of gravitational force. See the cross section Figure (3) from Umanyi Spring on the North-Western direction from Masongaleni Settlement Scheme through Masongaleni Settlement Scheme to river Athi on the South-Eastern direction from Masongaleni Settlement Scheme. The land is gently sloping from Umanyi spring through Masongaleni Settlement Scheme up to river Athi. This means that gravitational irrigation is possible in most parts of Masongaleni Settlement Scheme. The only areas where irrigation water has to be pumped is from river Athi and part of Kibwezi river.

Through irrigated agriculture, growing of both food and cash crops would be possible but the choice of the crops to grow should depend on environmental tolerance, water requirements, crop yields per acre, market demand and the market prices of such crops. It is important to look at the rainfall regime and crop water requirements in Masongaleni Settlement Scheme. The following is the analysis of rainfall regime and crop water requirements for Masongaleni settlement scheme. The average rainfall is about 239 millimetres for the months of March, April and May and 339 millimetres for months of October, November and December. The annual rainfall distribution shows a clear peak during this time of the year. The lowest irrigation water requirements are expected this period of the year. The highest irrigation water requirements are expected in January to February and June to September.

4.7 Water Demand in Masongaleni Settlement Scheme.

It is important to analyze the water demand in Masongaleni Settlement Scheme because if the water supply from the various sources is not adequate to meet the water demand in the Scheme, then irrigated agriculture which takes about 73% of the available water supply according to Habitat would not be possible.

The study classifies water demand in Masongaleni settlement scheme into three main categories, namely: irrigated agriculture, human consumption and livestock water demand. The total amount of water from the various rivers' minimum flow is 86,416,530 cubic metres per day. It should be noted that this amount of water is the one that may be harvested directly from the rivers without having to construct reservoirs. Therefore, once the water is harvested from the constructed reservoirs, then the amount of water available for different uses will be more.

The total amount of water that would be available from the 11 boreholes and/or shallow wells including the existing ones is 791.1 cubic metres per day. Roof catchment will yield 0.631 cubic metres of water per square metre of an iron sheet thatched house. Rain water harvesting can also be used for irrigation. The rain water can be tapped by use of underground tanks and the water can be used for irrigation purposes among other domestic water uses. The farmers need to be trained by the technical

officers from concerned agencies on how to do this type of rain water catchment.

Irrigated agriculture will consume 423,360 cubic metres of water per day. This amount of water will be able to irrigate 2 acres per day per household. The 2 acres irrigated by each household if the irrigation water is provided by the Government in conjunction with the other agencies will provide enough employment opportunities to the farmers. The farmers should keep 1 cow of the Boran type or cross-bred and small tolerant animals like 5 goats, 5 sheep and a number of rabbits and poultry. Poultry and rabbits take negligible amount of water, therefore, their water demand is not a critical issue. The author therefore, computes water demand for 1 cow, 5 sheep and 5 goats.

The farmers need to practise zero grazing or near zero grazing by feeding the livestock from the agricultural by products like maize stalk etc. A cow is more economical to keep than a bull because of a variety of reasons. The cow is able to give protein from its milk and its related by-products. The milk products may be sold to earn the farmer incomes. This contributes to the diversification of the farmer's sources of income. Keeping a bull will not be economical to the farmers in Masongaleni because it requires high amounts of dry matter annually while it is able to provide fewer uses to the farmer. For example, it can provide animal power for ploughing. The farmer may hire animal power for ploughing his farm or join CBOs

concerned with ploughing activities in the Scheme. The formation of these farming CBOs will mean that each farmer may not need to have a bull.

However, irrigated agriculture will consume 423,360 cubic metres of water per day. Cattle (1 cow) will consume 0.5 cubic metres per day. The 5 goats and 5 sheep will consume 0.1 cubic metres of water per day. The 10,190 human population will consume 254.8 cubic metres of water per day. Total potential water supply from the rivers is 86,416,530 cubic metres per day.

Total water demand from all the above sectors is (423,618 cubic metres per day). This water demand will leave a water balance of 85992912 cubic metres of water per day. If loss of water through evapotranspiration and other ways during the irrigation process is taken to be equivalent to the amount of water used for the irrigated agriculture i.e 423,360 cubic metres of water per day, a water balance of 85,569,555 cubic metres per day will be left. This water balance will be used in future and will take care of water demand for various sectors in future. The same amount of water balance will take care of the neighbouring areas of Masongaleni Settlement Scheme and its environs. To calculate the water demand for the human population in the Scheme, the author assumed that a half of the population will have their own water points and the other half will be drawing water from communal ones. However, water for drinking may be fetched from boreholes as they can provide

enough water for drinking. Water for drinking can also be tapped from rain water catchment. The rain catchment may be done through construction of underground tanks. These underground tanks are a cheaper method of harvesting rain water without using iron sheet-roofed structures which may be expensive to the farmers in the short run.

Table 17: A computation of Water Demand in Masongaleni Settlement Scheme. (Amount in cubic metres per day).

Sector/total water supply	Amount of water supplied/demanded in cubic m
Total amount of water supplied	86,416,530
Irrigated agriculture	423,360
Evapotranspiration	423,360
Human consumption	254.8
Livestock	0.6
Total water demand	(423,618)
Water balance	85,569,555

Source: Field survey, 1995

However, since water is a very important element in life, and especially in ASALs, to continue providing sufficient water in future, the following ways should be used.

(i) Roof catchment. It is assumed that with the introduction of irrigated agriculture the farmers will be able to get enough incomes to have iron sheet-roofed houses or any other roofing materials that are safe for tapping safe drinking water.

(ii) Potential for shallow wells should be investigated in all the sub-locations of the scheme.

(iii) Where there are perennial springs, the water should be protected and enhanced to serve communities in the immediate surrounding.

(iv) The available community-run piped water systems in the neighbouring areas and those to be in the scheme in future should be extended to serve more people in the scheme.

(v) Water should be provided in schools and other institutions by constructing adequate tanks in schools and other institutions. This should be extended to cover almost every school or institution in all the areas in Masongaleni settlement scheme.

Table 18: Irrigation crop water requirements in Masongaleni Settlement Scheme and its immediate surrounding areas

Irrigation water requirements	Period of the year
Lowest irrigation water requirement	March, April, May, October, November and December
Highest irrigation water requirement	January, February, June, July, August and September

Source: Field survey by Aqua plan, 1992.

Table (18) illustrates the general irrigation water requirements of irrigated crops in Masongaleni Settlement Scheme and its environs. The period of the year when the irrigation water requirement is realised is shown in the same table.

4.8 A Comparison in Income Earnings between Irrigated and Rainfed Agriculture.

Tables (19) and (20) represents the incomes that farmers may earn in Masongaleni settlement scheme through irrigated and rainfed agriculture. Table (19) shows the incomes that could be earned from irrigated agriculture from the 5 selected crops. Table (20) on the other hand shows the income levels that could be earned from the 5 selected rainfed cash crops. The costs of such inputs like fertilizer and pesticides have been deducted and therefore what is given is the net incomes in terms of market prices for the different crops. Again, it should be

noted that the author selects the best crop yield year for the different rainfed cash crops.

Table 19: The would be realised incomes from the five irrigated crops:

Type of crop	Yield per acre in kilogrammes	Market price in Kshs. per kilogramme
Tomatoes	33,000	19
Okra	7,000	15
Chillies	15,000	6
Egg-plant	16,000	6
'Karella'	15,000	15
Totals	79,700	61

Source: Field survey, 1995.

Table 20: Incomes Realised from Rainfed Cash Crops.

Type of crop	Yield per acre in kilogrammes	Market price in Kshs. per kilogramme
Maize	330.4	10
Sorghum	83.7	6
Cow-peas	78.5	24
Pigeon-peas	37.7	15
Green grams	34.5	30
Totals	564.8	85

Source: Field survey, 1995.

Tables (19) and (20) show that irrigated horticultural crops are far much better in earning incomes to the farmers in Masongaleni settlement scheme than the rainfed cash crops. For instance, tomatoes, can earn the farmer 33,000 Kilogrammes x Kshs. 19 = Kshs.627,000 per season of about 3 months. On the other hand, a farmer according to the field survey would earn from Green grams (37.7 kilogrammes x Kshs. 30 =) 1035. The incomes in horticultural crops may be increased per year by how many times or seasons per year the crops are grown under irrigation while the incomes from rainfed crops would depend solely on natural rain. The data, therefore, illustrates the potentials that could be exploited if irrigation water was provided to farmers in the Masongaleni Settlement Scheme.

4.9 Local and Export Market for the Irrigated Agricultural Produce

Table (21) illustrates both local and export demand for the irrigated agricultural produce. The table also indicates the period of the year when the two types of demand peak. The crops grown under irrigation are mostly horticultural crops like Okra, Chillies, Tomatoes, Egg-plants, Karella, Guar, Turia tinda, etc.

Table 21: Local and Export Demand for horticultural crops in Masongaleni Settlement Scheme and its immediate surrounding areas.

Type of demand	Period of the year
Local demand	June, July and August
Export demand	November, December, January, February, March, April and May

Source: Field survey, 1995.

4.9.1 Expected Impact of Irrigated Agriculture on the Community

(i) Farmers will be able to adjust cropping patterns according to market demand through the use of irrigation techniques.

(ii) The introduction of irrigation and agro-techniques methods will increase yield and quality in all irrigated crops.

(iii) Improved water management and fertilizing practices would probably be the most beneficial impact. An increase in the crop yield is expected with special attention to prevention of soil salinity build-up.

(iv) Finding the best crop rotation while using both irrigated and rainfed crops. The rotation aspects are of utmost importance since root knot nematodes exist on a large scale in Masongaleni area and significantly affect irrigated agriculture.

(v) There will be increased incidence of water borne-diseases especially along the Kibwezi river which is contaminated with bilharzia, cholera and amoebiasis causing organisms. Malaria incidence will also increase due to flooding of fields which will be good breeding grounds for mosquitoes.

(vi) The per capita income of the farmers is expected to rise with the introduction of the irrigation agriculture. This rise in per capita income of the farmers is expected to raise the living standards of the farmers who currently have low incomes of kshs. 1242 per month compared to the number of activities they would wish to undertake.

(vii) Loss of part of the farmers' land in those areas where the water reticulation system passes through including furrowed areas and water fetching points etc.

(viii) Buying of irrigatable land by the rich people from both within and outside the scheme thus leading to loss of high value land of the poor people.

(ix) Provision of employment opportunities to more than 11,880 farmers within and outside the scheme.

4.9.2 Suggestions to some of the above Expected Impacts on the Community

(i) For the increased incidence of water borne diseases, the community will require a lot of education concerning prevention methods of the various water borne diseases.

(ii) The community should be ready to provide the portions of land in those areas where the water reticulation system will pass through since it will be a benefit to all the farmers.

(iii) The community should seriously be educated on the need of not selling their irrigatable land to the rich. This should be done through sensitizing farmers on the importance of retaining their irrigatable land.

4.9.3 Community participation in Irrigated Agriculture.

According to the field survey, the people of Masongaleni are willing and ready to undertake the following tasks:

(i) To help in the project design stage i.e clearing of the bush, digging the trenchs and any other tasks deemed necessary to the irrigation project.

(ii) The community is ready and prepared to help in the project implementation stages especially the labour aspect.

(iii) After the project completion, the farmers will have monthly contributions for the maintenance and upkeep of the project.

(iv) The farmers will form a marketing body to help market their crops and also purchase fertilizers and pesticides in bulk and pass on the discount benefit to the individual farmers.

4.9.4 Summary of Findings in Irrigated Agriculture

Referring to the general objective and assumption (iii) of the research, it is evident from the data analysis on irrigated agriculture that Masongaleni Settlement Scheme has a potential in irrigated agriculture. The data analysis portrays that irrigated agriculture is not fully exploited in Masongaleni Settlement Scheme. From the analysis on water demand in the Scheme, the study finds that there is adequate water to cater for irrigation water after water demand in human and livestock sectors has been met adequately. Also, the study finds that incomes from irrigated agriculture are far much higher than those incomes realised from rainfed agriculture.

However, basing the findings on objective (i) of the study, a number of constraints to irrigated agriculture have been identified. These constraints include among others:

(i) Pests and diseases of the various horticultural crops.

(ii) Inadequate agricultural inputs such as farm implements and tools, fertilizers, pesticides and seeds.

(iii) Lack of irrigation water.

(iv) Lack of farming and irrigation technology.

(v) Competition among a number of horticultural crops against small plot size.

(vi) Competition between rainfed and irrigated crops.

(vii) Crop irrigation water requirements during the course of the year.

(viii) Difficulty in tapping fully both the local and export markets without interfering with irrigated crops or rainfed agriculture.

Using objective (ii) of the study, a summary of strategies and/or solutions may be applied to give possible opportunities for agricultural development in Masongaleni Settlement Scheme.

4.9.5 Solutions to Irrigated Agriculture

A number of strategies could be applied to offer possible solutions to the constraints in irrigated agriculture, with one strategy being used to provide multiple solutions.

The constraint of pests and diseases can be solved by applying a variety of appropriate pesticides and proper crop rotation. The farmers need to be exposed to the demonstration and training services like those conducted by Kibwezi Irrigation Project (KIP). KIP is a University of Nairobi project through

its IDRDU in conjunction with USAID (an American agency) and CINADO (an Israeli agency). The project is involved in demonstration and training of farmers on horticultural farming through small group owned plots. These groups involve farmers from different areas in Kibwezi Division including Masongaleni Settlement Scheme. The same technical services, if extended to cover all the farmers in Masongaleni Settlement Scheme would eradicate the problem of lack of knowledge for the appropriate agrochemicals and other horticultural technical services in the Scheme.

Also, when growing these crops a plot size equal to the one grown with these crops should be set aside for proper crop rotation.

Early and timely, planting, weeding and harvesting of the horticultural crops are also possible solutions.

Inadequate agricultural inputs like farm implements, tools, fertilizers and seeds can be solved by farmers own purchase of these inputs.

The farmers can also be accessed to credit facilities. One important way through which the government can assist the farmers in getting agricultural credit from possible credit institutions is to encourage the farmers to complete paying their land allocation dues. This will enable the farmers get title deeds for their land and hence the collateral required by credit agencies.

Lack of irrigation water can be solved by choosing those horticultural crops with lower irrigation water requirements and growing them (that is the crops) under the natural rainfall. The deficit in water requirements during the rain season may be compensated by irrigation from the potential irrigation water sources in the Scheme. For example, during the rainy months of March, April and May, horticultural crops may be grown and the deficit in water requirements compensated by irrigation. The irrigation water may be abstracted from constructed sub-surface dams along the various river basins. This means that for the irrigated crops the only period when there is a high irrigation water requirements is June, July and August. It should be noted that the 4 rivers suggested by the author according to the analysis of the data have adequate water for irrigation. If the water is tapped, then the problem of lack of water will be solved. For irrigation crops, one of the criteria used to select the horticultural crops to grow should be low irrigation water requirement.

For the irrigation technology to be sustainable, gravitational water flow through furrow irrigation is necessary. Gravitational irrigation is viable especially if the irrigation water is tapped from Umanyi Spring, Kibwezi and Thange rivers because the landscape slopes gently from those irrigation water sources to the irrigatable areas of the Scheme. Figure (3) is on the cross section of Masongaleni Settlement Scheme from Umanyi spring to river Athi. Sprinkler and drip

irrigation technologies may be unsustainable and expensive to maintain in the short run.

Competition among a variety of horticultural crops for small plot sizes could be solved by choosing to grow crops occupying smaller land units but with high yields per unit area and higher market prices. Tomatoes are a good example in this case. One acre of tomatoes yields 33,000 kilogrammes of tomatoes and sells at Kshs.19 per Kilogram compared to egg-plant which yields 15,000 kilogrammes in an acre and sells at Kshs.6 per Kilogramme.

Competition between rainfed and irrigated crops can be solved. For instance, irrigated crops could be grown as from 15th of march to end of September annually.

The preparation to grow rainfed crops in Ukambani normally starts at around September and by mid March the following year, most of the annual crops are harvested and stored. Therefore, by mid March, land preparation for irrigated crops should start. This strategy would ensure that each of the two types of farming is taken care of and thus food security is realised.

Lastly, both the local and export markets can be tapped without interfering with food and cash crop security. For instance, the highest demand in the local market is in June, July and August. Planting of the selected horticultural crops need to start in March through April and May so that by June, those crops taking about 90 days to mature are ready for marketing. Crops requiring fewer days to mature need to be

planted closer to the period when the local market is being realized. For instance, a crop that matures 2 months after planting needs to be planted at the beginning of April so that by June, it is ready for sale in the local market.

The long rains experienced between March and May are not reliable in Masongaleni and therefore, this is the time when irrigated crops should be grown.

However, for the export market, land preparation for these horticultural crops need to start in mid March every year so that by the end of April, the crops maturing 45 days after planting are harvested and marketed in May, November, December, January, February and half of March the following year. Although there is a high demand for these crops in the export market, they should not be grown at the expense of food crops. Perennial crops like pigeon peas need to be planted in separation with horticultural crops to avoid inconvenience to other crops. Crop rotation can be done where the horticultural crops may occupy that plot the following season. This would prevent diseases in horticultural crops like root-node caused by nematodes in tomatoes.

The horticultural crops to be grown should be selected on the basis of their tolerance in terms of pests, diseases and drought. They should also be selected on the basis of yields per acre and market prices of the various crops. The crops should also be selected on the basis of the length of their growing period. This is because, the shorter the growing period

for the particular horticultural crop, the more intensive labour is required and therefore more employment opportunities created for the people within and without the settlement scheme.

4.9.6 Livestock Keeping

4.9.6.1 Animal Rearing

Animal rearing is one of the agricultural potentials in Masongaleni Settlement Scheme. This would involve keeping animals tolerant to the local environment. These include poultry, rabbitry, goats, sheep and the local Zebu/Boran. According to the research findings, virtually all the settlers' animals died immediately they were introduced in Masongaleni Settlement Scheme. The most affected animals were cattle. According to the study, sheep, goats, and poultry were the most common. However, referring to the general and assumption (iii) of the research, the research found that Masongaleni Settlement Scheme has a potential for animal rearing. The area's tolerant animals are the Zebu/Boran and others are sheep, goats, poultry, and rabbitry. Masongaleni Settlement Scheme therefore, has a potential of supporting such types of farming. However, a number of constraints have been identified by the research as facing animal production in the Scheme.

Table 22: Constraints facing Animal rearing in Masongaleni Settlement Scheme.

Constraint	Frequency	Percentage
Trypanosomiasis	25	31.25
Small land sizes	18	22.5
Tick borne diseases	13	16.25
Inadequate AEOs	12	15
Predators	6	7.5
Distant Water	6	7.5
TOTALS	80	100%

Source: Field survey, 1995.

Table (22) indicates that trypanosomiasis is the major constraint to animal rearing in Masongaleni Settlement Scheme. This constraint accounted for 31.25% of the interviewed farmers' responses. Experience from the other parts of the world shows that it is very difficult to eradicate tsetse flies in the short run. Therefore, to eradicate the menace from the scheme, a tsetse fly eradication programme should be initiated in future.

Other constraints facing livestock are small land sizes (22.5%), tick borne diseases (16.25%), inadequate AEOs (15%), predators and distant water each accounting for (7.5%).

Table 23: Solutions to Animal rearing in Masongaleni Settlement Scheme.

Solution	Frequency	Percentage
Advice on appropriate veterinary medicine by AEOs	39	48
Better animal houses/sheds	15	18
Clearing of tsetse fly infested bushes	13	16
Keeping tolerant animals	9	13
Use of hand pumps to spray the animals	4	5
Total	80	100%

Source: Field survey, 1995.

To tap livestock rearing as one of the most important agricultural potentials in Masongaleni Settlement Scheme, a number of solutions are viable. It should be noted that the above solutions were arrived at after consulting with a variety of respondents. These included the farmers themselves and the livestock development officers among others.

The farmers need advice on appropriate veterinary medicine, which entails the co-operation of the government and concerned non-governmental organisations and have the farmers' community own resource persons (CORPs) as technical officers. The CORPs will, for example, advise the farmers on better houses or sheds for their poultry and animals, especially rabbits, goats and

sheep which according to the study findings face the problem of predators.

Clearing of bushes could also eradicate tsetse flies that cause trypanosomiasis to the livestock. This solution is not very effective, therefore, a tsetse fly eradication programme should be started in future as an alternative method.

Keeping of animals tolerant to the environment can also help to tap the livestock potential. The farmers interviewed expressed preference for poultry, goats and sheep because of their environmental tolerance. Their food and water requirements are less compared to cattle. They are also disease resistant animals compared to cattle that was wiped out by tsetse fly and tick borne diseases immediately the farmers settled in the settlement scheme in 1992.

During an interview, the Kibwezi Livestock Development Officer suggested that in order to tap the livestock potential in the scheme, the settlers should buy animals (livestock) from the neighbouring areas because they are tolerant to tsetse fly and tick borne diseases. It is viable to keep cross breed or better quality cattle. For example, Boran cattle should be encouraged in the scheme since they are better than the Zebu in terms of quantity and quality of both meat and milk .

If the government had carried out an Environmental Impact Assessment before the farmers settled in the Scheme, the farmers would have been advised to sell their animals before settling in the area and afterwards buy others from the neighbouring areas.

The use of hand pumps to spray the livestock is also a viable solution. This can save the farmers and the government the high costs involved in the construction of cattle dips. This can solve disease causing vectors like ticks, among others.

The constraint of small land sizes and hence inadequate grazing land for the animals did not have any solution from the respondents. However, this constraint can be solved by advising the farmers on the advantages of maintaining the land carrying capacity for different animals. The farmers, need to keep those animals that require less food and water, are environmentally tolerant and those with more uses to them. The author suggests that the farmers keep one cross bred cow or the Boran type, a few number of goats and sheep. Poultry and rabbitry are viable to keep in big numbers even on the small plots since they can be kept indoors. It is also viable to practise zero grazing for the different animals. In the long run, the farmers can also feed their animals on industrial animal feeds. The farmers incomes will have increased in the long run to afford these industrial animal feeds.

The constraint of distant water can be solved by establishment of sub-surface dams along the rivers.

4.9.6.2 Summary of Findings on the Constraints and Solutions to Animal Rearing

A summary of 6 major constraints have been identified by the author as facing animal husbandry in Masongaleni Settlement

Scheme. These have been found out in relation to objective (i) and assumption (ii) of the research. These constraints are:

(i) Trypanosomiasis

(ii) Small plot sizes

(iii) Tick born diseases

(iv) Inadequate Agricultural Extension Officers

(v) Predators of goats, sheep and poultry due to lack of proper housing.

(vi) Distant watering places for the livestock.

The summary of the solutions to animal keeping include:

(i) Advising the farmers on the appropriate veterinary medicine by Agricultural Extension Officers.

(ii) Construction of proper houses for the small animals to avoid predation during the night.

(iii) Clearing of tsetse fly infested bushes

(iv) Keeping tolerant poultry and animals (i.e local zebu/boran cattle, sheep, goats and rabbits).

(v) Use of hand pumps to spray animals against pests and diseases.

Although maintenance of land carrying capacity was not suggested by the farmers and other interviewed respondents, the study recommends the maintenance of the land carrying capacity for the different preferred animals to solve the small plot size constraint.

4.9.6.3 Bee Keeping

Bee Keeping is one of the potentials that can be tapped in Arid and Semi-Arid lands like the Masongaleni Settlement Scheme. In the neighbouring Kinyambu area about 30 women groups have adopted a new bee keeping method that was introduced from Ethiopia, (Nation newspaper, Wednesday, January 24, 1996).

This method of bee keeping involves the use of a brick or mud-made hive house. The house is grass-thatched and it can accommodate between 10 to 15 brick-made bee hives.

4.9.6.4 A Comparison between the New Improved and the Traditional Bee keeping Methods

(i) The new method requires a smaller piece of land compared to the traditional method.

(ii) The new method can accommodate 10-15 bee hives in one house while the traditional ones are hung on one big tall tree, one bee hive per tree.

(iii) The new improved bee hives are environment-friendly and therefore, can co-exist with the farmer and his animals. The traditional hives are not environment friendly. They need to be located in a distant, quiet place from the homestead.

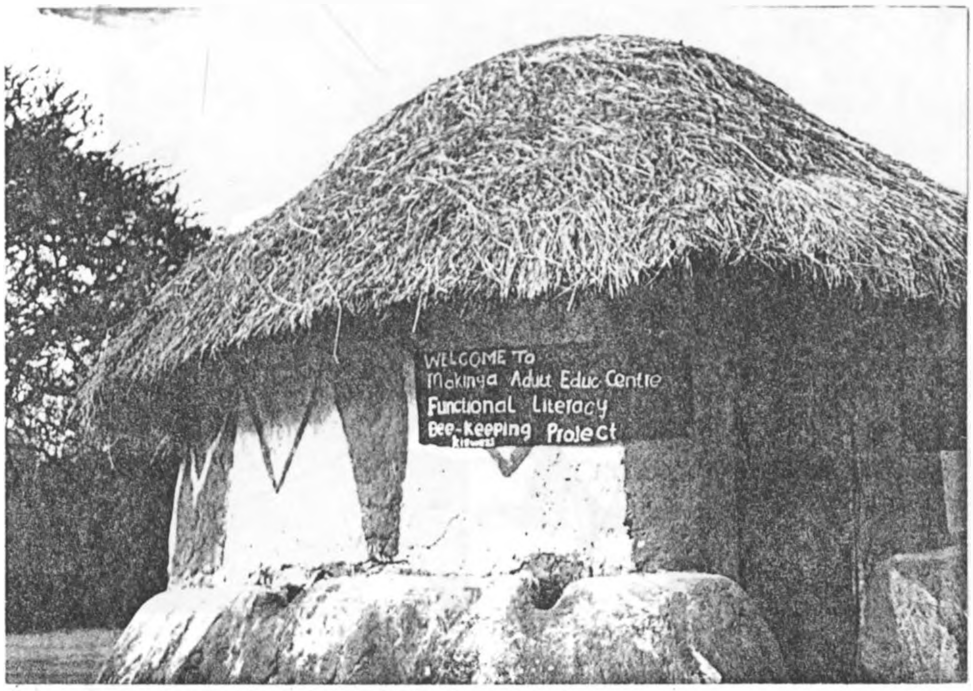
(iv) The new method does not contribute to the depletion of tree species since it is made up of bricks unlike the traditional bee hives which contribute to depletion of the tree species used for making them, like the acacia species.

(v) The quality of honey from the new improved hives is higher than that from the traditional hives.

(vi) The honey yields from the new hives are higher, about 20 kilogrammes per hive compared to the traditional hive that yield about 10 kilogrammes.

(vii) The new method of bee keeping encourages women to participate in the bee keeping industry that was traditionally a men's domain, plates (13) and (14). Plate (13) shows an example of a brick-made hive house of the new bee keeping method. The new bee keeping method requires a grass thatched house like the one shown in the plate. This house can accommodate 10-15 bee hives of the improved type. Plate (14) shows a man and his wife leaning against the new improved bee hive. This bee hive is made of cheaply acquired raw materials.

Plate (13). A Mud Grass-thatched House used for keeping the new improved bee hives in Masongaleni Settlement Scheme and its surrounding area



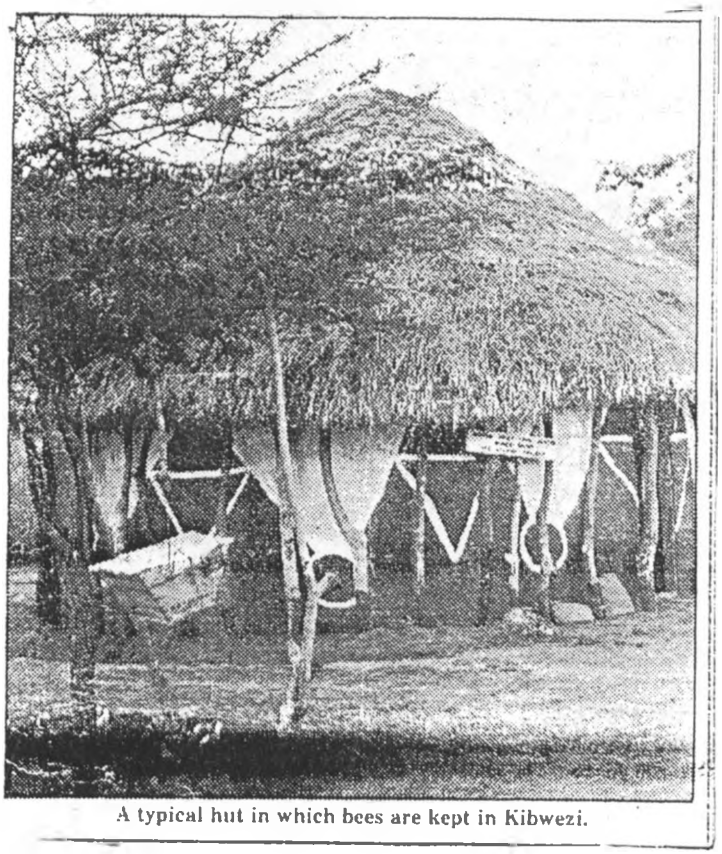
Source: Field survey, 1995.

Plate (14). A Man and his Wife leaning against the new improved bee hive

Source: Field survey, 1995.

Also, pictures 1 & 2 represents the two types of bee keeping methods discussed in the text. Picture 1 represents the new improved bee keeping method practised in the areas neighbouring Masongaleni settlement scheme. It should be noted that, of the total number of respondents interviewed on bee keeping method used, only 1% said they kept the new improved bee hive. This new method is more advantageous to the farmer than the traditional method. Picture 2 represents the traditional bee keeping method commonly used in Masongaleni settlement scheme despite the disadvantages named above.

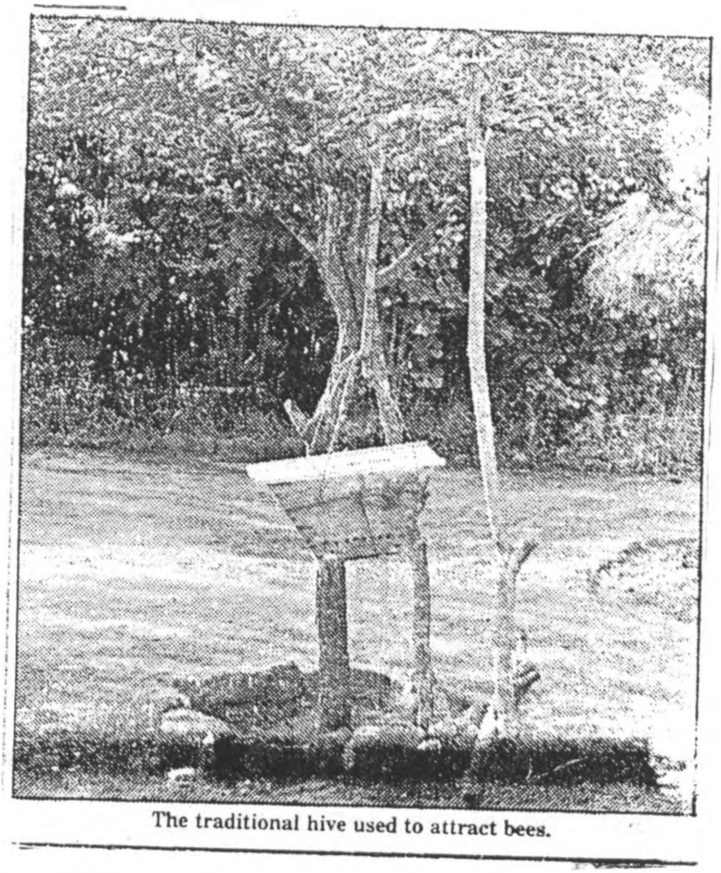
Picture (1). A Typical Hut in which Bees are kept using the new improved bee hives in Kibwezi near Masongaleni Settlement Scheme



A typical hut in which bees are kept in Kibwezi.

Source: Nation Newspaper, Wednesday, January 24th 1996.

Picture (2). The traditional bee hive in Masongaleni Settlement Scheme



The traditional hive used to attract bees.

Source: Nation News paper, Wednesday, January, 24 1996.

However, from the foregoing, it is apparent that the new method of bee keeping in the area neighbouring Masongaleni Settlement Scheme is more advantageous than the traditional one. The new method has seven major advantages over the traditional method as stated in the text. Table (24) represents the frequency and percentage of household members who practise bee keeping and those who do not practise bee keeping. The data collected was used to assess the potential and suitability of bee keeping in Masongaleni Settlement Scheme. Data was collected from both the traditional and the new improved bee

hives. Data on these methods is represented in the following successive tables.

Table 24: Bee hive Keeping

Do you keep bee hives?.	Number of respondents	% age of respondents
Yes	25	31.5
No	49	61.3
No response	6	7.2
Totals	80	100%

Source: Field survey, 1995.

Table (24) indicates that majority of the farmers in Masongaleni Settlement Scheme do not practise bee keeping.

Table 25: Type of bee hives kept.

Type of bee hive kept	Number of respondents	% age of respondents
Tradition type	20	25
New improved type	1	1
None kept	59	74
Totals	80	100

Source: Field survey, 1995.

Table (25) shows that the majority of the people did not keep any type of bee hives. On the other hand, majority of those who kept bees used the traditional bee hives.

Table 26: Number of Bee hives kept by each Farmer.

Number of bee hives kept by the farmer	Respondents	Percentage
None	30	37.2
1-5	22	27.9
6-10	10	13.1
11-15	5	5.7
16-20	3	3.8
21-25	2	2.6
26-30	2	2.1
Over 30	6	7.4
Total	80	100

Source: Field survey, 1995.

Table (26) indicates that majority of the farmers in the Scheme (37.2%) said they never kept bees. However, those farmers who kept between 1-5 bee hives each were the majority.

The bottle-necks to full exploitation of the bee keeping industry in Masongaleni Settlement were identified. Table (27) represents the frequency and percentage of the reasons given by the informants as to why they never practised bee keeping.

Table 27: Reasons why some Farmers in Masongaleni did not Practise bee keeping

Why don't you keep bee hives ?.	Respondents	Percentage.
- Small land sizes	33	1
- No big and tall trees in the land	10	13
- Not conversant with bee-keeping.	5	6
- Don't like bees	4	5
- Too expensive	3	4
- I keep bee hives	25	31
Totals	80	100

Source: Field Survey 1995

Table (27) indicates that small land size is the major constraint to bee keeping. Lack of big and tall trees was another major constraint.

Table 28: Honey Yields per Bee hive.

Honey per bee hive in Kilogrammes	Respondents	Percentage
None	20	24.4
1-5	31	38.4
6-10	16	19.8
11-15	4	4.7
16-20	10	12.0
Over 20	1	0.7
Totals	80	100

4.9.6.5 Solutions to Bee Keeping

The constraints to bee keeping in Masongaleni Settlement Scheme can be solved by introducing and adopting the new method of bee keeping. If the new method is introduced, it will solve the problems of having small plot sizes. This is because the new method involves construction of a mud or a brick-made house. This house can accommodate between 10-15 bee hives unlike the traditional method which involves hanging traditional bee hives on big, scattered trees. Lack of big, tall trees in Masongaleni Settlement Scheme will no longer be a problem to bee keeping once the new-improved method is adopted.

It should be noted that, almost all the trees in the household's plot of land in Masongaleni Settlement Scheme have been cleared by the farmers for charcoal burning due to lack of other sources of income.

The new bee keeping method would also arrest the depletion of the tree species used to make the traditional bee hives. But it should be noted that, even if there were big, tall trees in the Scheme, it is far much better to adopt the new improved bee keeping method because of its many advantages.

The problem of not being conversant with bee keeping by the farmers in Masongaleni Settlement Scheme can be solved by having more agricultural extension officers.

The government in conjunction with concerned NGOs operating in Masongaleni Settlement Scheme should train locals as technical officers. This is better than relying on government or private agencies to provide technical officers.

Also, the constraint of the farmers saying they do not like bees/bees sting, can be solved by convincing the farmers that the new improved method of bee keeping is environment friendly. Bees in the new improved hives can comfortably exist with man and his animals. Again, the farmers should be sensitised on the importance of bee keeping industry as a way of diversifying their sources of income. The constraint of the traditional bee hives being expensive is possible to solve because the new improved method requires cheap, locally available raw materials to implement.

- It requires bricks which can be made of the local soil in the plots.
- It also requires a constructed house which can be made of bricks made locally.

- Almost all the raw-materials used in the improved bee hives are found locally and cheaply.

The new improved bee hives are able to give more yields of honey per bee hive (about 20 killogrammes compared to about 5 kilogrammes from the traditional bee hive).

The bee keeping industry can achieve more honey through the new improved method because it allows participation of women in the bee keeping industry unlike the traditional bee hive keeping which was and is the domain of men only. Incomes realised from the sale of the more kilogrammes of honey and its products will improve the farmers living standards.

4.9.6.6 Summary of Findings on Bee keeping in Masongaleni Settlement Scheme.

According to the general objective and assumption (iii) of the study, the study would summarise that Masongaleni Settlement Scheme has untapped potential in bee keeping. This potential is identified in the new improved bee keeping method that has not been adopted in the Scheme. According to the results of the study, only 1% of the interviewed farmers said they practised the new bee keeping method. The results of the data analysis on bee keeping reveals that the new and improved bee keeping method has seven advantages over the traditional bee keeping method.

On the other hand, basing the study's summary on objective (i) of the study, a summary of major constraints to tapping of

the bee keeping industry may be given. According to the results of the data analysis, these are:

(i) Small land sizes

(ii) Lack of big, tall trees in the Scheme

(iii) Some farmers are not conversant with bee keeping

(iv) Some farmers do not like bees/bees sting and

(v) Bee hives are expensive to afford

Using objective (ii) of the study, the study uses the results of the data analysis to come up with solutions and strategies to develop the bee keeping industry in the scheme.

A summary of the solutions to bee keeping constraints in the Scheme is to introduce and adopt the new and improved bee keeping method that is advantageous to practise than the traditional bee keeping method. When the new bee keeping method is adopted, the farmers need to have Community Own Resource Persons (CORPs) in the Scheme. These CORPs will be part and parcel of the farmers and they will be providing bee keeping demonstration and training services to the farmers. These CORPs will be sensitizing the farmers on the importance of adopting the new improved bee keeping method.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS OF THE STUDY:

5.1 Introduction

The objective of this chapter is to present results obtained from this study in the form of general conclusions and recommendations informed by the research findings. Besides, an attempt is made to make recommendations to be considered in any future research and development programmes in Masongaleni Settlement Scheme.

5.2 Conclusion of the study Findings

From the experience gained from the study and from the data analysis about the agricultural potentials in Masongaleni Settlement Scheme, the study concludes that:

i) There are a variety of untapped agricultural potentials in Masongaleni Settlement scheme, both in crop and livestock production. In the crop production, there are rainfed and irrigated agricultural potentials. In livestock production, there are animal rearing and bee keeping production potentials.

ii) There is need to exploit fully these untapped agricultural potentials for Masongaleni to have sustainable development.

iii) To tap these agricultural potentials, the identified major constraints should be overcome through the various strategies suggested by the research. The solutions and opportunities identified should also be applied to attain sustainable development in the area.

iv) The introduction of an integrated rainfed, irrigated agriculture and livestock production is the main strategy to adopt for sustainable development in Masongaleni settlement Scheme.

5.3 General Recommendations

As a long term plan, the study recommends integration of irrigated, rainfed agriculture and livestock production. The irrigated agriculture needs to involve vegetable/horticultural crop production. As noted earlier, irrigated agriculture has the advantages of creating employment, raising of the farmers' incomes and producing multiple crops even when there is no natural rainfall etc.

One of the most important recommendation for a long term implementation is that an efficient management system should be initiated to run the scheme's irrigation project. The system should be responsible for the following:

i) Entering into agreement with the farmers on water use and irrigation on credit.

ii) Determine the section of the farm (0.8 hectares) to be irrigated for the prescribed horticultural crop growing.

iii) Organise water supply and its maintenance.

iv) Provision of seeds, fertilizers and agrochemicals on credit where necessary.

v) Ensure that operations delegated to the farmers are carried out according to plan.

vi) Collecting, sorting, grading and marketing of the produce. This body should be a strong market-supporting body to avoid exploitation of the farmers by middlemen.

vii) Central organised transportation system, preparation and sale of the horticultural produce.

viii) It should recover all debts from the farmers produce delivery.

ix) The management is to have direct interaction with the farmers for the organisation of production, sale and payment of the produce.

x) The management should relate the farmer to the Government which should be the main supporting agency and collect taxes on behalf of the central and local Government.

xi) The farmers are to be responsible for all the manual work, seeding,weeding harvesting etc.

xii) The farmers should surrender to the scheme management the horticultural produce grown on the irrigated plots.

xiii) The farmers should join such co-operative bodies as the Masongaleni Irrigation Farmers Co-operative Society (MIFCS) to represent their interests at the scheme level through an elected committee.

xiv) The farmers should continue growing other non-irrigated crops in the non-irrigated areas of their holding as was the case before the introduction of the irrigation project. Thus except the production of the prescribed crops on the irrigated areas according to plan, the production pattern in the rest of the holding should not be interfered with.

Also the study recommends that KIP's horticultural farming technology should be sought by way of training farmers and basing extension services on research findings from Kibwezi Irrigation Project (KIP). KIP's demonstration and training on horticultural farming should be based on the traditional set up of the communities to enable the farmers to be exposed to appropriate modern or traditional farming technology.

Again there is need for co-operation between the agricultural extension officers, farmers and researchers so that knowledge on appropriate farming and environment friendly strategies are imparted to the farmers for sustainable living. For example, in order to effectively introduce the new method of bee keeping in the scheme, there is need to have more agricultural extension officers in Masongaleni settlement scheme. More emphasis should be put on CORPs because they are more sustainable than the GOK's provided technical officers. These CORPs will train the community on modern or traditional appropriate technologies in farming, including the new bee keeping method, among other agricultural techniques.

The study recommends maintaining of land carrying capacity

by farmers. Since there is a serious constraint of small land sizes, it is advisable for the farmers to keep poultry, rabbits, dairy goats, sheep and at least one Boran or cross bred cow. The idea is to encourage rearing of animals that are environment-friendly.

The number kept should be based on the land carrying capacity of the area. Again the choice to keep certain animals should be based on the number of uses or advantages they provide to the farmer. For example, sheep, goats, poultry and rabbits were found to be tolerant to drought, pests and diseases in Masongaleni settlement Scheme unlike cattle, which died enmasse due to pests and diseases as well as drought.

The small animals require little food and water unlike the big ones like bulls and cows. The small animals like goats will provide the farmers with meat, milk, bride wealth and skins. Poultry will provide the farmer with meat, eggs and income. In short, small animals are more advantageous to keep in the low potential areas of the Masongaleni Settlement Scheme.

In connection to cattle rearing, the study recommends keeping of one cow, preferably a cross-bred, which is better than a bull because a cow will provide milk for household consumption and a surplus for sale. This will consequently diversify the farmers' incomes. The cow has also the advantage of contributing to the increase of the stock over and above its low food and water requirements.

The study forecasts that the farmers will depend on hired labour in the long run because it is uneconomical for farmers to keep bulls for ploughing small farms and only during ploughing season. The farmers can also form CBOs for ploughing. This would involve combining farm implements and sharing the few bulls among a number of neighbours. However, keeping of the recommended animals should be based on zero grazing or near zero grazing.

The study also recommends rain catchment in the scheme through establishment of underground wells to collect water for domestic purposes including livestock purposes. This is a cheaper method that involves digging of underground pits or rock catchment. It is viable because it will save the funds the poor farmers would have used to buy iron sheets for rain harvesting structures and expensive tanks.

But it should be noted that in the long run the farmers may have rain catchment structures by the use of incomes realised from agricultural development.

From the data collected from the 11 sample boreholes, there is potential of shallow well/borehole water in the Scheme. These shallow wells can be dug manually and therefore they are cheap sources of domestic water.

Alot of campaign and sensitization programmes on agro-forestry, reafforestation and afforestation should be initiated in Masongaleni Settlement Scheme. This is because by the time the research was being conducted, the author and the research

assistants established that there was an alarming rate of deforestation to the extent that there was a serious scarcity of building materials such as poles and grass. In fact, the building materials are so scarce that most of the responses given by the farmers about the supply of the materials indicated that the materials were of poor quality, were unavailable within their own plots or were far away and could only be bought.

Fuel-wood constitutes another acute constraint. The firewood available is of poor quality and the distance to get it has been increasing over time. The cause of this problem has been largely due to high rates of charcoal burning which is the second high ranked source of income after farming. This of course, means that, faced with no other gainful means of incomes especially during the dry season, majority of the population engage in charcoal burning for survival. Therefore, reafforestation, agro-forestry and afforestation programmes need to be seriously encouraged at the governmental and Non-Governmental levels. Such programmes should however, aim at promoting those tree species that are able to provide most uses to the farmers and their animals. For example, provision of food in form of fruits, provision of shades, soil fertility, building poles, ornamental and medicinal value, high calorific value for fuel wood, conservation of soil and water among others.

There should also be a mixture of both fast and slow maturing tree species to avoid scarcity of the raw materials or

their provision during particular times of the year. The study also recommends sensitization of farmers to plant such indigenous tree species as Acacia and the Neem tree.

To curb scarcity of fuel wood, use of alternative energy sources should be encouraged such as agricultural by- products like millet husks, sorghum husks, maize cobs and stalks. Use of energy saving devices like the energy saving jikos should also be introduced. A good example of tree species with many uses is the neem tree, "Muarobaini", famed to cure over forty (40) diseases. Farmers should be encouraged to plant such multipurpose tree species.

The settlers need to be encouraged to pay their land allocation dues so that they may be issued with title deeds upon completion of payment. The settlers are supposed to pay Ksh. 600 per acre to the Ministry of Lands and settlement's headquarters. The government should establish an office at the divisional headquarters at Kibwezi so that the constraint of a long distance in paying the land allocation dues is overcome. Once these dues are paid, the settlers may have on their plots of land permanent establishments. During an interview with the settlers, majority of them said they would get a loan using the title deed if they had it.

To diversify the farmers' sources of incomes, the study recommends that farmers engage themselves in off-farm income generating activities. A good example of such income generating activities is to have an integrated, multi-purpose income

generating activities. The viable income generating activities in Masongaleni Settlement Scheme would be:

(i) Brick making for sale

(ii) Honey refinery undertaking

(iii) Small-scale income generating businesses like shop keeping etc.

This type of integrated, multipurpose off-farm income generating activities have been and are being undertaken by a group of Kibwezi Self-help women group and it is doing well. Therefore, such an example should be emulated.

Again, on the administration sector, Masongaleni Settlement Scheme needs to have more provincial administrators because by the time this research was being conducted, there were only four (4) assistant chiefs out of eleven sub-locations.

5.4 Recommendations for future research

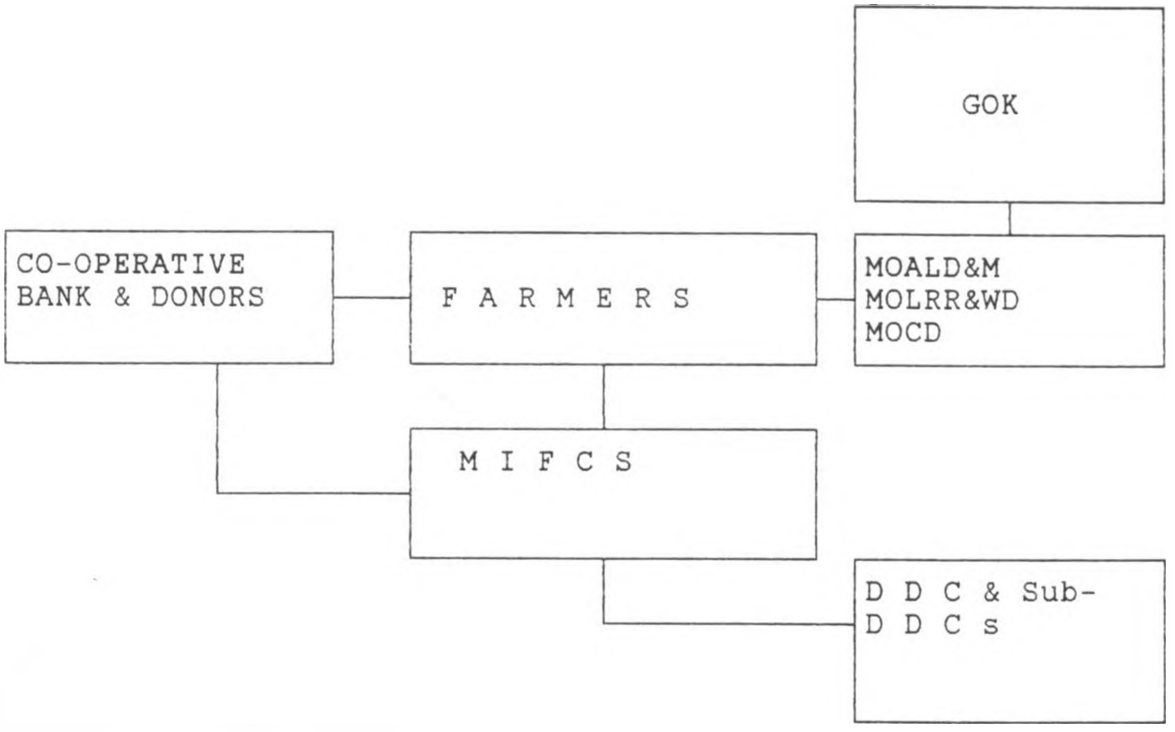
The study recommends that research be done in future to establish the cost of the proposed irrigation project. The cost should be arrived at by considering the viable water tapping methods depending on the sources of the irrigation water and the cheapest and sustainable methods.

After doing the costing of the irrigation project, the research should also establish how the cost should be shared among the various agencies in the scheme. These agencies include, among others: GOK through its line ministries, parastatals (e.g TARDA and UON, CINADO,USAID), NGOs/private

individuals and the community through the CBOs etc. Since from the study, the irrigated agriculture is more viable, it should be designed, planned, implemented, monitored, evaluated and lastly adopted. Here the study recommends that after the irrigated agriculture is implemented, there should be alot of sensitisation on the poor farmers not to sell their high value horticultural farms to the rich immigrants. This is because there might be displacement of the poor farmers by the rich and hence loss of their high value land. Future research should also be done on soils, forage and livestock blood to establish whether there are any deficiencies or toxicities in any of the trace or major essential elements. This is because deficiencies or toxicities of these elements can lead to various disorders, sickness or death of livestock.

Future research should also be done to have a tsetse fly eradication programme in Masongaleni Settlement Scheme.

Figure (5). A Diagram representing the proposed manner on how the irrigation project should be run



Source: own derivation

The organization structure of the proposed irrigation project in Masongaleni Settlement Scheme shows the centrality of the farmers in the structure. The farmers need to be involved in the designing, planning, implementation, monitoring and evaluation of the irrigation project.

Also, the farmers should contribute manual labour required in planting, weeding and harvesting of the horticultural crops. The construction of the dams and digging of the trenches for the irrigation system should also be the responsibility of the farmers. The farmers should be helped by the CORPs who should

be farmers in the Scheme. The CORPs will act as technical officers to assist the other farmers through demonstration and training on the appropriate technology.

The farmers should form such co-operative societies as the Masongaleni Irrigation Farmers Co-operative Society (MIFCS). Such societies should be entrusted with the responsibility of the general management of the integrated agriculture which includes training in harvesting, sorting, grading, packing, transportation and marketing of the farmers' produce. The society has to ensure that farmers get credit from lending institutions like the co-operative Bank. The society should also ensure that the credit borrowed by farmers is repaid through deductions from their produce sales.

The co-operative Bank in the structure should have the responsibility of offering financial credit to the farmers. Donors may also give farmers credit through it.

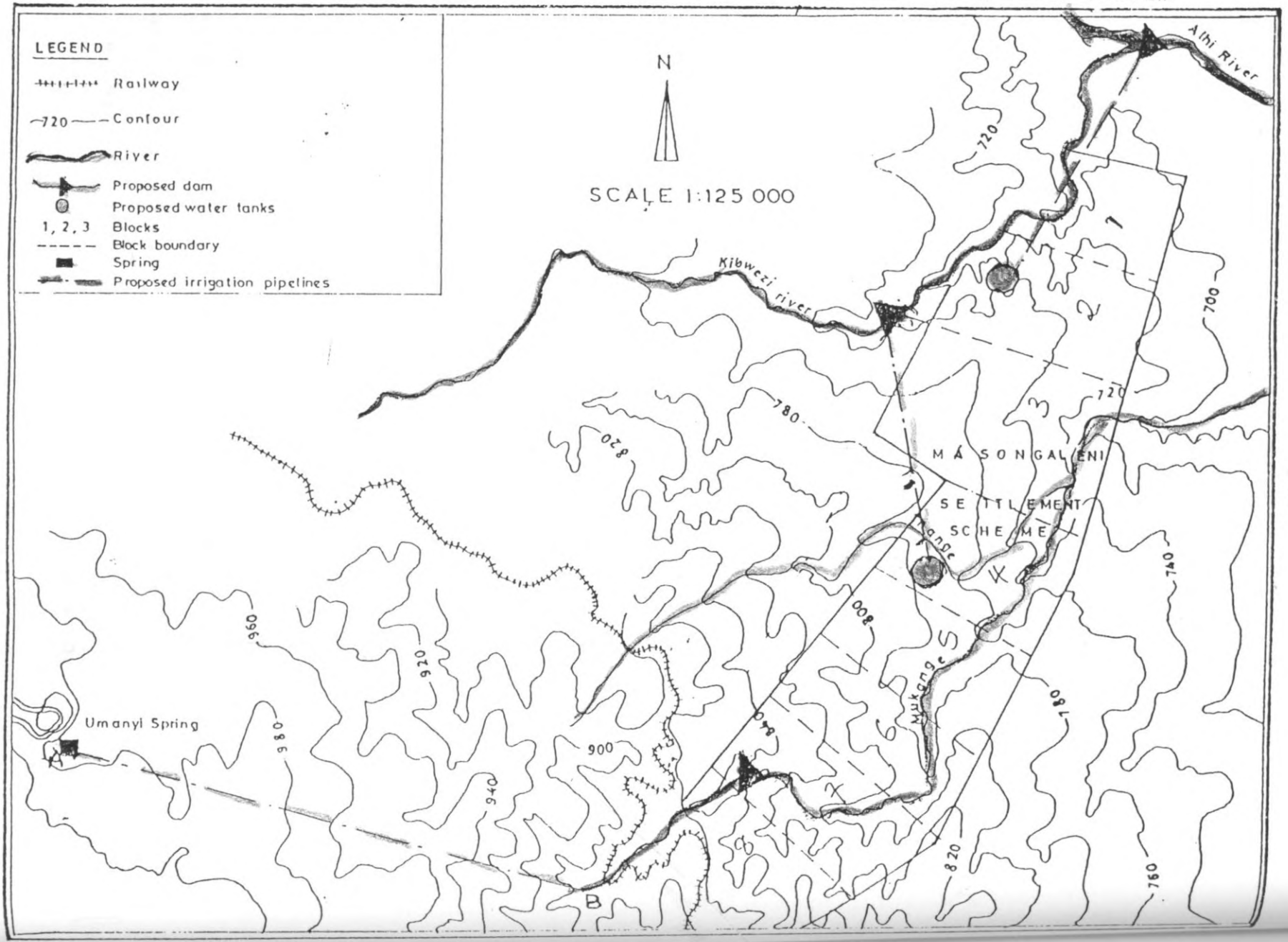
The role of GOK in the structure is to support the project in the provision of capital equipment. This may include the piping system and establishment of the sub-surface dams by using a bull-dozer. The Government also has the obligation to allocate land for the construction of the dams, one along river Athi and the other along Kibwezi river. The GOK should also support the project through formulation of sustainable policies.

Generally the government through the various line ministries (i.e MOLRR&WD, MOALD&M and MOCD) should provide the necessary capital and technical services in support of the

project. The GOK through the DDCs and the various sub-DDCs should assist in policy formulation among other types of assistance.

Lastly, the author proposes that all the costs incurred in the provision of infrastructure should be shared among the various agencies concerned with development in the settlement scheme. With the introduction of irrigated agriculture and with the assistance from the various development institutions found within and without the scheme, all the costs of providing infrastructure is likely to be provided.

Fig. 6 MASONGALENI SETTLEMENT SECHEME; PROPOSED IRRIGATION SYSTEM



Source: Survey of Kenya

5.5 General Conclusion

In conclusion, the author feels that if the strategies, solutions, opportunities and recommendations suggested by the study are adopted, the Masongaleni Settlement Scheme will achieve sustainable development.

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APPENDIX
UNIVERSITY OF NAIROBI
DEPARTMENT OF URBAN AND REGIONAL PLANNING

HOUSEHOLD QUESTIONNAIRE

Questionnaire number_____

Block number _____

Date: _____

HOUSEHOLD CHARACTERISTICS

1. Plot size in acres/hectares _____
2. Number of households in the plot _____
3. Number of members in each household _____
4. Do you have a title deed for the piece of land?.
   1. Yes
   2. No

5. If Yes, how do you intend to use the title deed?.
   1. Get a loan
   2. Security of land tenure
   3. Permanent establishments on the land

6. If you do not have a title deed, when are you to be issued with it?. _____
7. Do you pay some premium towards the piece of land?.
   1. Yes
   2. No
8. If yes, how much per month _____ or Year _____
9. How much money in total are you supposed to pay for the piece of land?. _____
10. How many members of the family are likely to inherit the land?.
    1. Males _____
    2. Females_____
11. Have you sold any portion of your land?.
    1. Yes
    2. No
12. If yes, how many acres did you sell?. _____
13. How much was the portion of land sold over the periods of time.

Years	Amount sold at	Expenditure details
		1. Education of Children 2. Treatment of diseases 3. Subsistence 4. Buying livestock

14. Give the names of food crops you grow in the farm.
    1. Maize
    2. Sorghum
    3. Millet
    4. Pigeon peas
    5. Cow peas
    6. Green grams
    7. Beans
    8. Finger millet
    9. Cassava
    10. Sweet potatoes
    11. Others (specify)

15. Give the names of cash crops you grow, quantity attained and amount of money you realise per year.

Cash crops	Quantity	Kshs. p.a
1. Castor oil		
2. Maize		
3. Cotton		
4. Beans		
5. Green grams		
6. Pigeon peas		
7. Cassava		
8. Horticultural crops (specify)		
9. Others (specify)		

16. Give the expenditure details of the money realised from the sale of the cash crops and the amount spent for each of those.

Expenditure details	Amount spent in Kshs
1.	
2.	
3.	
4.	
5.	
6.	

17. Give the Acreage allocation for each of the food crops named in question 14 above over the years shown in the table below.

Crops	1992	1993	1994
1. Maize			
2. Sorghum			
3. Millet			
4. Pigeon peas			
5. Cow peas			
6. Green grams			
7. Beans			
8. Finger millet			
9. Cassava			
10 Sweet potatoes			
11.Others (specify)			

18. Give acreage allocation for each of the cash crops named in question 15 over the years shown.

Crops	1992	1993	1994
1. Castor oil	-	-	-
2. Maize			
3. Cotton			
4. Beans			
5. Green grams			
6. Pigeon peas			
7. Cassava			
8. Horticultural crops Specify			
9. Others (specify)			

19. Indicate the combination of planting methods you use in planting.
    1. Dibbling
    2. Using a hoe
    3. Oxen ploughing
    4. Tractor ploughing
    5. Donkey ploughing
    6. Others (specify)
20. Indicate the combination of weeding methods you use.
    1. Dibbling
    2. Using a hoe
    3. Oxygen ploughing
    4. Hands weeding
    5. Donkey ploughing
    6. Others (specify)

21. Give the reasons as to why you had the preference to the use of the planting combination of methods.
    1. Lack of oxen and a plough
    2. Lack of affordability of farm implements like a plough and lack of tractor fee.
    3. Intercropping

4. Can afford the method

22. Give the reasons as to why you had the preference to the use of the weeding combination of methods

1. Lack of oxen and a plough
2. Lack of affordability of farm implements like a plough and lack of tractor fee
3. Intercropping
4. Can afford the method

23 a. Do you apply any soil and water conservation methods?.
1. Yes
2. No

b. If yes, explain the soil and water conservation methods used.

_____

_____

24. Do you receive any agricultural technical assistance?
1. Yes
2. No

25. If yes, state whether this has been beneficial in improving farming activities in the farm. _____

_____

_____

26 a. Have you experienced any problems in practising any of the technologies received in question 24 above?.
1. Yes
2. No

b. Technology/Method	Problems
Livestock farming	
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.
Crop farming	
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.

27. Are you used to certain farming systems and not others?
1. Yes
2. No
Explain _____

_____

28. Has this tradition in question 27 changed 1.Yes
2. No

Expound the answer _____

_____

29. Give the constraints experienced in crop farming (under rainfed agriculture)
    1. Pests and diseases
    2. Inadequate farm implements and tools
    3. Inadequate agricultural extension officers.
    4. Inadequate, erratic and unreliable rainfall
    5. Lack of transport and communication networks.
    6. No constraint

30. Give the possible solutions to those constraints.
    1. Buy the fits themselves and also be assisted by the government and NGOs in giving them soft loans to buy a plough and oxen.
    2. Combination of the farmers , the government and NGOs in provision of community own resource persons as Agricultural Extension Officers through training.
    3. Use of drought, pests and disease resistant crops.
    4. Eradication of malaria causing mosquitoes by avoiding stagnant water around compounds during rainy season.
    5. Timely, early planting, weeding and harvesting
    6. Provision of murram rural access roads.
    7. No solutions.

31. Give the names of the animals you keep in the farm
    1. Hens
    2. Sheep
    3. Cows and Bulls (Cattle)
    4. Goats
    5. Donkeys
    6. Dogs
    7. Ducks
    8. Others (specify)

32. Why do you prefer keeping the animals mentioned in question 31 above.
    1. Hens
        1. Cheap to buy
        2. Can sell to help oneself
        3. Domestic consumption
        4. Tolerant to the environment in terms of drought, food and water requirements, pests and diseases
    2. Sheep
        1. _____
        2. _____
        3. _____
        4. _____
        5. _____
        6. _____

3. Goats
1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

4. Ducks
1. _____
2. _____
3. _____
4. _____

5. Cattle
1. Ploughing
2. Provision of meat and milk
3. Can sell to help oneself
4. Tolerant to the environment in terms of food and water requirements drought, pests and diseases.
5. Bride price
6. symbol of status.

6. Donkeys
1. Ploughing
2. Beast of burden
3. Tolerant to the environment in terms of water requirements, drought, pests and diseases.

7. Dogs
1. Security at night
2. Tolerant to the environment in terms of food and water requirements, drought, pests and diseases.
3. Others (specify)

33. For each of the above seven named animals you keep in the farm, name the cause of their death immediately you settled in the area or currently.

1. Hens 1. _____
2. _____
3. _____
4. _____
2. Sheep 1. _____
2. _____
3. _____
4. _____

3. Goats 1. _____
2. _____
3. _____
4. _____

4. Ducks 1. _____
2. _____
3. _____
4. _____

5. Cattle 1. _____
2. _____
3. _____
4. _____

6. Donkeys 1. _____
2. _____
3. _____
4. _____

7. Dogs 1. _____
2. _____
3. _____
4. _____

34. Enumerate in order of seriousness the major problems facing animal rearing in the farm.
1. Trypanosomiasis
2. Lack of food/inadequate land
3. Tick borne diseases
4. Inadequate agricultural extension officers
5. Predators
6. Distant water
7. Others (Specify)

35. Possible solutions to solve the constraints facing animal rearing.
1. Advice on appropriate drugs by agricultural extension officers.
2. Construction of better animal houses.
3. Clearing of tsetse fly infested business
4. Keeping, drought, pests and disease tolerant animals.
5. Use of hand pumps to spray the animals.
6. Maintain land carrying capacities of the types of animals preferred to keep
7. Keep those animals providing more uses to the farmer and also with little food and water requirements/
8. Others (specify)

36. Do you keep bees?
1 Yes
2. No

37. If yes in question 36 above, types of bee-hives kept.

Types of bee-hive kept	Number of respondent	% age of respondent
1. Traditional type		
2. New improved type		
3. None kept		
Totals		

38. Number of bee hives kept by each farmer

Number of bee hives kept by the farmer	Number of respondents	% age of respondents
1. None		
2. 1-5		
3. 6-10		
4. 11-15		
5. 16-20		
6. 21-25		
7. 26-30		
8. over 30		
Totals		

39. Average productivity of bee hives in killogrammes.

Honey yield per bee hive in kilogrammes	Number of respondents	% age of respondents
1. None		
2. 1-5		
3. 6-10		
4. 11-15		
5. 16-20		
6. over 20		
Totals		

40. Uses of Honey after its harvest.

Use	Number of respondents	% age of respondents
1. Consume at Home	-	-
2. Sell to traders	-	-
3. Sell to co-operatives	-	-
4. Make honey beer	-	-
5. No honey	-	-

41. Constraints to bee keeping
1. Small piece of land
2. Lack of tall, big trees
3. Not conversant with bee-keeping
4. Do not like bee / bees sting
5. Too expensive / bee-hive prices too high to afford.

42. Possible solutions to overcome the constraints to bee keeping.
1. Introduction of the new improved bee keeping methods
2 Provision of more agricultural extension officers in terms of community own resource persons.
3 Sensitise the farmers on the importance of bee keeping and tell them that the new method of bee keeping is environment friendly.

IRRIGATED AGRICULTURE (To be filled by those who practise irrigated agriculture)

43. Do you practise irrigated agriculture?.
1. Yes
2. No

44. If yes in question 43 above, What crops do you grow ?.
1.
2.
3.
4.
5.
6.
7.
8.

45. Give the acreage allocation for each of the above mentioned crops in question 44 for the years 1992, 1993, 1994 and 1995.

	A	C	R	E	A	G	E
Crops	1992		1993		1994		1995
1.							
2.							
3.							
4.							
5.							
6.							
7.							

8.

46. Give the yields realised per acre of the various horticultural crops.
    1.
    2.
    3.
    4.
    5.
    6.
    7.
    8.

47. What use do you put to the irrigated crops?.
    1. Domestic
    2. For sale
    3. others (specify).

48. Where do you sell the surplus ?.
    1. Local market (Kibwezi, Mombasa, Kisumu, Nakuru etc)
    2. Export market.

49. How do you market the horticultural products?.
    1. Sell to Co-operatives.
    2. Sell to traders.
    3. Villagers buy the produce at home.
    4. sell the produce for one self.
    5. Others specify.

50. Compared to rainfed agricultural produce, which of these two types of agricultural practices gives a higher return in incomes?.
    1. Rainfed agriculture.
    2. Irrigated agriculture.
    3. The returns from irrigated agriculture are negligible.

51. Give the current prices of the various horticultural crops you grow in your farm.

_____

_____

_____

52. What are the constraints facing irrigated agriculture?.
    1. Pests and diseases
    2. Inadequate agricultural inputs e.g fertilizers, farm implement and tools,pesticides and seeds
    3. Scarcity and source of irrigation water.
    4. Competition between a number of horticultural crops against a small plot size.

5. Competition between rainfed and agricultural crops
6. Irrigation methods to apply.
7. Lack of knowledge on the suitable horticultural crops to grow in terms of crop water requirements, yields etc.

53. Give your suggestions on the best ways to overcome such constraints.

_____

_____

_____

54. Give your sources of income in order of priority
    1. Agriculture
    2. Charcoal burning
    3. Business
    4. Formal employment (specify)
    5. Others (specify)

55. State your patterns of income
    1. Regular
    2. Irregular

56. Indicate the range of your average household income in Ksh.
    1. < 100
    2. 1000 - 1100
    3. 1101 - 1200
    4. 1201 - 1300
    5. 1301 - 1400
    6. > 1400

57. State in order of priority for what uses you spent your incomes.
    1. Subsistence
    2. Medical care
    3. Educating children
    4. Purchases of livestock
    5. Others specify

58. What are your strategies to achieve sustainable income.
    1. Better agricultural practices.
    2. Buy livestock.
    3. Engage in Business.
    4. Other (specify).

QUESTIONNAIRE TO THE LAND DEMARCATION OFFICER OF THE SETTLEMENT SCHEME:

1. Give the total land area covered by Masongaleni Settlement Scheme _____

2. Enumerate the plots in the scheme earmarked for different projects or any other purpose in each block.

Block	Projects	Land size	Purposes

3. Which of the above projects are in operation?.

1.
2.
3.
4.
5.
6.
7.
8.

4. Do the settlers have title deeds for their land?.
   1. Yes 2. No
5. If no, when are they to be issued with title deeds?. _____
6. Are the settlers to pay for their plots of land allocated?.
   1. Yes 2. No
7. If yes, explain the procedure of paying their dues. _____

---

8. If one completes paying for his or her plot of land, is he/she to get the title deed?.
   1 Yes 2 No.

9. If yes, what about those who will be unable to pay for the plot of land? _____

_____

10. In your opinion, what could you cite as the agricultural potentials in the scheme.
    1. _____
    2. _____
    3. _____
    4. _____

11. Enumerate the various constraints in tapping those potentials
    1. _____ 6. _____
    2. _____ 7. _____
    3. _____ 8. _____
    4. _____ 9. _____
    5. _____ 10. _____

12. In your view how could the constraints be overcome to tap those potentials.
    1. _____ 6. _____
    2. _____ 7. _____
    3. _____ 8. _____
    4. _____
    5. _____

LOCATIONAL AGRICULTURAL EXTENSION OFFICER

1. Enumerate in order of priority, the major food crops suitable to be grown in Masongaleni settlement scheme.
    1. _____ 5. _____
    2. _____ 6. _____
    3. _____ 7. _____
    4. _____ 8. _____

2. Give the major cash crops suitable to be grown in the area.
    1. _____ 5. _____
    2. _____ 6. _____
    3. _____ 7. _____
    4. _____ 8. _____

3. Give reasons for saying the crops mentioned above are the suitable ones for the area.

_____

_____

4. State the first 8 constraints facing crop growing.
    1. _____ 5. _____
    2. _____ 6. _____

3. _____ 7. _____
4. _____ 8. _____

5. How have you tried to solve the constraints?.

_____

_____

6. What agricultural potentials would you say exist in the scheme concerning crop growing?

_____

_____

7. How could these potentials be tapped?

_____

_____

QUESTIONNAIRE FOR KENYA AGRICULTURAL RESEARCH INSTITUTE (KARI)

1. Enumerate both major rainfed and irrigated/horticultural crops that are suitable for Masongaleni settlement scheme.
   a. Rainfed crops

      _____
      _____
      _____

   b. Irrigated/horticultural crops

      _____
      _____
      _____

2. Enumerate the major livestock (animals) that are suitable for the scheme

   1. _____ 6. _____
   2. _____ 7. _____
   3. _____ 8. _____
   4. _____

3. Enumerate the major agricultural potentials that can be tapped from the scheme.

   1. _____ 5. _____
   2. _____ 6. _____
   3. _____ 7. _____
   4. _____ 8. _____

4. What are the constraints that may be faced in tapping these potentials?.

   1. _____ 5. _____
   2. _____ 6. _____
   3. _____ 7. _____
   4. _____ 8. _____

5. In your view, what could be the strategies to overcome these constraints.

   1. _____ 5. _____
   2. _____ 6. _____
   3. _____ 7. _____
   4. _____ 8. _____

QUESTIONNAIRE TO THE SMALL-HOLDER IRRIGATION PROJECTS BY PRIVATE INDIVIDUALS NEIGHBOURING MASONGALENI SETTLEMENT SCHEME

1. What crops do you grow?.

1.	_____	5.	_____
2.	_____	6.	_____
3.	_____	7.	_____
4.	_____	8.	_____

2. Give the acreage allocation for these irrigated crops in the years 1992, 1993, 1994 and 1995.

crops	1992	1993	1994	1995
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				

3. Give the yields realised per acre of these crops.

1.	_____	5.	_____
2.	_____	6.	_____
3.	_____	7.	_____
4.	_____	8.	_____

4. What use do you put to the irrigated crops?.
   1. Domestic consumption
   2. For sale
   3. Others (specify)

5. Where do you sell the surplus if any?.
   1. Local market (Kibwezi, Mombasa, Kisumu, Nakuru or bought at home by villagers.
   2. Export market

6. Which of the above mentioned crops fetch a high price in the market in order of priority?.

1.	_____	5.	_____
2.	_____	6.	_____
3.	_____	7.	_____
4.	_____	8.	_____

7. Give the current prices of the various horticultural crops.

_____

_____

_____

8. How do you market the crops?.
   1. Sell to co-operatives
   2. Sell to traders
   3. Villagers buy the produce at home
   4. Sell the produce for one self
   5. Others (specify)

9. Enumerate the constraints facing irrigated agriculture

1.	_____	5.	_____
2.	_____	6.	_____
3.	_____	7.	_____
4.	_____	8.	_____

10. What are your suggestions on the best ways to overcome those constraints?.

1.	_____	5.	_____
2.	_____	6.	_____
3.	_____	7.	_____
4.	_____	8.	_____

11. Which time or months of the year does the produce get high demand locally.

12. Which times or months of the year does the produce get high demand in the export market.

_____

13. State the approximate income realised from these horticultural crops per year.

_____

14. Which irrigation methods do you use
    1. _____ 2. _____
    3. _____

15. Why do you prefer that particular method.

_____

_____

QUESTIONNAIRE TO THE DISTRICT OFFICER (KIBWEZI DIVISION)

1. State the initial objectives for establishing Masongaleni settlement scheme:
   1. _____
   2. _____
   3. _____
   4. _____

2. Give the short term and long term plans for the scheme
   1. Short term plans

   1. _____
   2. _____
   3. _____
   4. _____

   2. Long term plans
   1. _____
   2. _____
   3. _____
   4. _____

4. Of the short term plans given above, state the ones you have attained.
   1. _____
   2. _____
   3. _____
   4. _____

5. If there are some short term plans you have not attained, explain why you have not been able to attain them.

   _____
   _____

6. State whether you involved the participation of the local settlers, local authority, NGOs and other agencies in the plans to achieve both the short and long term plans.

   _____
   _____

7. If you involved the various agencies mentioned in question 6 above explain how.

   _____
   _____

8. Was there any Environmental Impact Assessment carried out before or after the settlement in the area.
   1. Yes 2. No 3. Does not know

9. If yes, explain how it was carried out _____

_____

10. How have you or are you trying to enhance the biodiversity of the environment through local community, NGOs and other agencies?

_____

_____

11. What projects or programmes do you have in place for enhancing biodiversity of the area
    1. _____
    2. _____
    3. _____
    4. _____
    5. _____

12. Give the agricultural potentials in the scheme.
    1. _____
    2. _____
    3. _____
    4. _____
    5. _____

13. Give the various constrains faced in the attempt to tap these potentials.
    1. _____
    2. _____
    3. _____
    4. _____
    5. _____
    6. _____

14. How can these constraints be overcome to achieve sustainable development in the scheme.

15. Give any other constraints apart from the ones given above:-
    1. _____
    2. _____
    3. _____
    4. _____

QUESTIONNAIRE TO ACTION-AID KENYA: (AAK) KIBWEZI STATION:

MASONGALENI AREA DEVELOPMENT CO-ORDINATOR

1. According to (AAK) 1993 baseline survey in Masongaleni give the following details.

   1. Total number of people in the scheme _____
   2. Total number of household _____
   3. Average household income _____

2. Enumerate all the community development projects in the scheme, their purpose, Initial capital investments, operation and maintenance costs per annum.

Project Name	Initial capital investment	O and M costs
1.		
2.		
3.		
4.		
5.		

3. Give any other contributions you have done towards community development in the scheme:

   1. _____
   2. _____
   3. _____
   4. _____

4. For the provisions of the projects in questions 2 above, give the contributions of the following agencies in the process of providing the various projects.

   1. Local community

   _____
   _____

   2. Provincial Administration (Central Government)

   _____
   _____

   3. AAK

   _____
   _____

4. Other agencies

5. State the major agricultural potentials in the scheme.
   1. _____
   2. _____
   3. _____

6. Enumerate the major constraints facing the scheme in the taping of those potentials in question 5 above.

7. Give any other problems facing the settlers. _____

8. How can the above constraints be overcome?

Constraints	Strategies to overcome them
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____
6. _____	_____

9. Give your views about the scheme towards achieving sustainable development in future.

QUESTIONNAIRE TO DIVISIONAL FORESTER(KIBWEZI)

1. Enumerate the various tree species that are suitable for Masongaleni settlement scheme.

1.	_____	5.	_____
2.	_____	6.	_____
3.	_____	7.	_____
4.	_____	8.	_____

2. Give a list of the ones that are fast and slow maturing

a - Fast maturing

1.	_____	5.	_____
2.	_____	6.	_____
3.	_____	7.	_____
4.	_____	8.	_____

b. Slow maturing

1.	_____	5.	_____
2.	_____	6.	_____
3.	_____	7.	_____
4.	_____	8.	_____

3. Give a list of these tree species and for each list all its various uses.

a.	_____	f.	_____
	_____		_____
b.	_____	g.	_____
	_____		_____
c.	_____		
	_____		
d.	_____		
	_____		

4. What constraints face the establishment and growth of those various tree species

1.	_____	5.	_____
2.	_____	6.	_____
3.	_____	7.	_____
4.	_____	8.	_____

5. How can these constraints be solved?

_____

_____

_____

6. What programmes/projects have you put in place to overcome these constraints.

1.	_____	5.	_____
2.	_____	6.	_____
3.	_____	7.	_____
4.	_____	8.	_____

QUESTIONNAIRE FOR LIVESTOCK DEVELOPMENT OFFICER (KIBWEZI)

1. Enumerate the major constraints to the rearing of the different animals in the scheme.

   (a) Hens
   1. _____ 2. _____
   3. _____ 4. _____

   (b). Ducks
   1. _____ 2. _____
   3. _____ 4. _____

   (c). Goats
   1. _____ 2. _____
   3. _____ 4. _____

   (d). Sheep
   1. _____ 2. _____
   3. _____ 4. _____

   (e). Cattle
   1. _____ 2. _____
   3. _____ 4. _____

   (f). Donkeys
   1. _____ 2. _____
   3. _____ 4. _____

   (g). Dogs
   1. _____ 2. _____
   3. _____ 4. _____

   (h). Others (specify)
   1. _____ 2. _____
   3. _____ 4. _____

2. In order of seriousness, state the major causes of livestock death since the farmers settlement in the area.
   1. _____ 2. _____
   3. _____ 4. _____
   5. _____ 6. _____

3. Which animals would you recommend raising in the area and why.
   a. Animals
   1. _____ 2. _____
   3. _____ 4. _____
   5. _____ 6. _____

b. Why recommend those animal

Animals	Preference
1.	_____
2.	_____
3.	_____
4.	_____
5.	_____
6.	_____
7.	_____

4. How are you trying to overcome the constrains

1.	_____	5.	_____
2.	_____	6.	_____
3.	_____	7.	_____
4.	_____	8.	_____

5. What recommendations about livestock development in the area would you give.

_____

_____

6. Do the settlers practise bee keeping?.
   1. Yes 2. No

7. If yes, what type of bee hives do they keep?.
   1. Traditional bee hives
   2. New improved bee hives

8. Enumerate the advantages and disadvantages of each of those types of bee-hives.

1.	Traditional beehives	Advantages
	_____	_____
		_____
2.	New improved bee-hives	_____
		_____
3.	Traditional beehives	Disadvantages over the new improved method
		_____
		_____

4. New improved bee hives

Disadvantages over the traditional ones _____

_____

9. Enumerate the constraints facing the bee keeping industry in Masongaleni Settlement Scheme.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

10. What are the solutions to those constraints

Constraints	Solutions
1.	_____
2.	_____
3.	_____
4.	_____
5.	_____
6.	_____

11. What agricultural potentials would you say could be tapped in the scheme as far as livestock development is concerned.

_____

_____

12. How could these potentials be tapped.

_____

_____

QUESTIONNAIRE FOR THE MINISTRY OF LAND RECLAMATION, REGIONAL AND WATER DEVELOPMENT

1. Give the details of the following four rivers

Athi			
Kibwezi			
Thange			
Umanyi			

2. Approximately how many acres of land in the scheme can the 4 rivers irrigated per day when the water is got directly from the flowing river.
   1. Athi River _____
   2. Kibwezi _____
   3. Thange _____
   4. Umanyi _____

3. Which methods are best to abstract the water for irrigation from the various rivers.
   Choose: 1 Use of pipes
   2. Canal irrigation
   3. Bucket irrigation

   1. River Athi _____, _____, _____,
   2. Kibwezi River_____, _____, _____,
   3. Thange River_____, _____, _____,
   4. Umanyi _____, _____, _____,

4. When the water is abstracted from the main river flow, which methods are appropriate for irrigation of crops in the different areas in the scheme.

   1. Drip irrigation
   2. Sprinkler irrigation
   3. Furrow irrigation
   4. Bucket irrigation

5. Explain why you prefer the irrigation methods given above

   _____

   _____

6. Explain the major problems associated with water from the 4 rivers for the following uses:
   Irrigation:

a. 1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

b. Animal drinking
1. _____
2. _____
3. _____
4. _____
5. _____

c. Human drinking and bathing
1. _____
2. _____
3. _____
4. _____
5. _____

7. In your view, explain how the above problems can be solved.
_____
_____

8. How is the geological status for ground water in the scheme?
1. Poor 2. Fair
2. Good 4. Very good

9. Give the average water yield from boreholes in the scheme
_____

10. Give the average cost of establishing a borehole in the area from its drilling stage to putting up a pump
_____

11. Enumerate the problems or constraints faced in having ground water.
_____
_____
_____

12. How can these constraints be overcome to have sustainable domestic safe ground water?
_____
_____

13. Give the average rain water volume that can be realised in one metre squared of an iron sheet roofed house.
_____

14. What are the major constraints experienced in getting rain water?

_____
_____
_____

15. How can these constraints be overcome?

_____
_____
_____