SOCIO – ECONOMIC ASPECTS OF IRRIGATION SCHEMES IN KENYA, THE CASE OF RICE PRODUCTION IN MWEA IRRIGATION SCHEME

BY

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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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DEDICATION

This thesis is dedicated to the memory of my late daughter Wanja Thuo my one and only "baby angel" whom I carried in pregnancy during my course work and who passed on at the age of two years after my data collection exercise. Wanja, you will never be forgotten for as long as there is memory and for as long as I live. I miss you and always will.

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ABREVIATIONS AND ACRONYMS

AIRS:	Ahero Irrigation Research Station
ALDEV:	African Lands Development
ASAL:	Arid and Semi Arid Land
ASDS:	Agricultural Sector Development Strategy
EPZA:	Export Processing Zones Authority
FAO:	Food and Agriculture Organization
GDP:	Gross Domestic Product
Ha:	Hectare
IDB:	Irrigation and Drainage Branch
IFPRI:	International Food Policy Research Institute
IITA:	International Institute of Tropical Agriculture
INGER:	International Institute for Germplasm Evaluation of Rice
IRRI:	International Rice Research Institute
IWMI:	International Water Management Institute
IWUA:	Irrigation Water Users Association
JICA:	Japan International Cooperation in Africa
KARI:	Kenya Agricultural Research Institute
KG:	Kilogram
KNBS:	Kenya National Bureau of Standards
KSHS:	Kenya Shillings
KVDA:	Kerio Valley Development Authority
LBDA:	Lake Basin Development Authority

MDG:	Millennium Development Goals
MIS:	Mwea Irrigation Scheme
MOA:	Ministry of Agriculture
MOWD:	Ministry of Water development
MRGM:	Mwea Rice Growers Multipurpose Cooperative Society
MTP:	Medium Term Plan
MWI:	Ministry of Water and Irrigation
NIB:	National Irrigation Board
NRDS:	National Rice Development Strategy
PRA:	Participatory Rural Appraisal
PWD:	Public Works Department
SIRMOD:	Surface Irrigation Simulation Model
SPSS:	Statistical Package for Social Sciences
SRA:	Strategy for Revitalizing Agriculture
TARDA:	Tana River Development Authority
UN:	United Nations
UON:	University of Nairobi
USDA:	United States Department of Agriculture

ABSTRACT

Mixed performances have been experienced in the National Irrigation schemes (NIB) over time, social and economic aspects in the schemes were studied given the various management regimes. Baseline data for the study was first recorded in year 2000 from 118 farmers and in year 2010 the same set of farmers provided data on the same variables. The study documented; the rice production system, the relative profitability of irrigated rice and other crops, tested the efficiency of the rice marketing system and finally the performance of NIB was assessed and compared to integrated management.

Descriptive statistics, analysis of variance, Gross margin and Regression analysis were used to document the agricultural system, rice and other crops margins, marketing efficiency and performance of the scheme under different management systems. Results revealed that the scheme performed better under NIB than during farmers' management. Farmers in the planned area realized higher profits than those in the unplanned area, *ceteris paribus*. The current rice marketing system was efficient while former NIB marketing was in-efficient. Traders along the rice value chain received high and consistent profits.

The study recommends; Integrated management of irrigation schemes where both NIB and farmers each have a say in production and marketing, market forces of supply and demand be left to determine the input and output prices in the irrigation schemes and agricultural extension along the rice value chain be availed to rice farmers to improve on their profits.

CHAPTER ONE

INTRODUCTION

1.1. Background

The problem of food insecurity represents the biggest crisis of the 21st century worldwide. The impact is spreading from developing to the developed world. The United Nations estimates there are 840 million undernourished people in the world. The majority of undernourished people (799 million) reside in developing countries, most of which are on the continents of Africa and Asia (Jenkins *et al.*, 2001). In Africa, the major challenge to food security is its underdeveloped agricultural sector that is characterized mainly by over-reliance on primary agriculture. Ninety five percent of the food in Sub-Saharan Africa is grown under rain fed agriculture. Hence food production is vulnerable to adverse weather conditions (Inter Academy Council, 2004).

In order to cope with the problems of aridity, rainfall variability and the lack of food self-sufficiency, irrigation is acknowledged as of great importance in sub-Saharan Africa since colonial times (Akané and Jürgen, 2005). Irrigation is vitally important in meeting the fiber and food needs for a rapidly expanding world population that reached six billion on October 12, 1999 and is currently increasing by about 80 to 85 million people each year (Jenkins *et al.*, 2001).

Kenya, the largest and most diversified economy in the East African region (estimated 2008 Gross Domestic Product (GDP) of 31 billion American Dollars) has not been spared the negative effects of food insecurity. Of its total population of 38.6 million people, 10 percent are classified as food insecure (United States Department of Agriculture, 2009). The figure becomes an underestimate in times of drought, civil strife and natural disasters (floods and plagues) (Berardi, 2009). The country, just like all the United Nations (UN) member states, pledged to reduce extreme hunger and poverty by the year 2015 through the Millennium Development Goals (MDG).

1.1.1. Agriculture and Irrigation in Kenya; an Overview

The Agricultural Sector in Kenya is still the major engine for economic growth, directly contributing 26 percent of the GDP, 80 percent of formal employment and 60 percent of the export earnings. It contributes a further 27 percent of GDP through links with manufacturing, distribution and service-related sectors. This contribution can be enhanced through an innovative, commercially oriented modern agriculture. Irrigation accounts for only 1.7 percent of total land area under agriculture, but contributes 3 percent to the GDP and provides 18 percent of the value of all agricultural produce demonstrating the potential of irrigation in increasing agricultural production and productivity (MOA, 2009).

A significant proportion of Kenya's land surface (83 percent) is unsuitable for crop production due to the extremes of aridity in some areas and swampy conditions in others (Alila and Atieno, 2006). More land could thus be reclaimed for crop use through development of irrigation infrastructures in the ASALs and reclaiming the

waterlogged soils in the swampy areas. It is estimated that intensified irrigation can increase agricultural productivity four-fold and depending on the crops, incomes can be multiplied ten-times (MWI, 2009).

Kenya has an estimated irrigation potential of 1,300,000 hectares (Ha) and a drainage potential of 600,000 Ha. Of the available irrigation potential, 540,000 Ha can be developed with the available water resources while the rest will require water harvesting and storage (MWI, 2009). Currently 114,600 Ha of irrigation and 30,000 Ha of drainage have been developed. The developed irrigation potential can be categorized into three main types: Smallholder schemes 49,000 Ha (43 percent); Public/National schemes 20,600 Ha (18 percent) and Private schemes 45,000 Ha (39 percent). The remaining potential of over 424,400 Ha and 570,000 Ha of irrigation and drainage respectively calls for increased focus to unleash this potential (SRA, 2004).

Several key government planning and policy documents and other sectoral plans and strategies have identified irrigation and drainage development as a key to increasing cropped area and crop yields and to enhancing quality and diversity of the produce, reducing climatic risk and increasing profitability and competitiveness of cropping enterprises (Government of Kenya; Agricultural Sector Development Strategy, Medium Term Plan 2008-2012, National Irrigation and Drainage Policy, Vision 2030). In fact, Vision 2030 recognizes the critical role that irrigation and drainage is expected to play and states that *"to promote agricultural productivity, the area under irrigation and drainage will increase from 140,000 to 300,000 hectares*".

The Irrigation act of 1966 cap (347) provided for the establishment of a National Irrigation Board (NIB), a statutory body under the Ministry of Agriculture. The Board was given the responsibility for the development, control and improvement of national irrigation schemes. Currently the core functions of NIB includes coordination of construction, rehabilitation, operation and maintenance of major irrigation and drainage infrastructure, administration of land in the public schemes and provision of technical advice on maintaining a cropping calendar and finally irrigation Expansion. Other non core functions include: Source funding for irrigation development, promotion of farmer based organisations, irrigated agriculture extension, operation research and training (NIB, 2011).

Rice remains the main cereal crop on Kenya's public irrigated landscape. It is now a commodity of strategic significance in Kenya, driven by changing food preferences in the urban and rural areas and compounded by increased urbanization. The national rice consumption is estimated at 300,000 metric tons against an annual production range of 45,000 to 80,000 metric tons. The deficit is met through imports, valued at Ksh.7 billion in 2008. About 80 percent of the rice grown in Kenya is from irrigation schemes established by Government while the remaining 20 percent is produced under rain-fed conditions. Rice is currently the third most important cereal in the country after maize and wheat. It is grown mainly by small scale farmers as a commercial food crop (MOA, 2009).

According to irrigation profile data, the size of irrigation schemes varies from 50 to 400 Ha with 50 percent of them being in the range of 50 to 100 Ha. Rice accounts for

22 percent, food and horticultural crops 25 and 53 percent of the irrigated areas respectively. Some of the public irrigation schemes have over time stalled or are operating intermittently or under-capacity (JICA, 1987; NIB, 2002; TARDA, 2002). Table 1.1 gives an indication of the status of the large public irrigation schemes.

Table 1.1: Features of Public Irrigation Schemes in Kenya, year 2010.

Project	Size (ha)	Status	Implementing agency	Crops
Bura	12000	Planned	NIB	Cotton
Bura	4000	Constructed	NIB	Cotton
Bura	2900	Settled	NIB	Cotton
Mwea	6000	Operational	NIB	Rice
Hola	540	Stalled	NIB	Cotton
Ahero	840	Operational	NIB	Rice Sugar cane
West Kano	920	Stalled	NIB	Rice, Sugar cane
Bunyala	220	Stalled	NIB	Rice
Perkerra	280	Operational	NIB	Horticulture, Seed maize
Kiambere	170	Operational	TARDA	Horticulture
Kibwezi	80	Operational	TARDA	Horticulture
Tana Delta	1200	Planned	TARDA	Rice
Tana Delta	2000	Constructed	TARDA	Rice
Tana Delta	200	Operational	TARDA	Rice
Yala Swamp	170	Operational	LBDA	Horticulture
Sigor	78	Operational	KVDA	Horticulture
TOTAL	**39,498**			

Source: National Irrigation Board, 2010.

1.1.2. The Study Area

The study was conducted in Mwea Irrigation Scheme (MIS) one of the National Irrigation Board's (NIB) schemes situated in Kirinyaga County. The Scheme is about 100 kilometers North East of Nairobi on the dry plains of South East of Mt. Kenya. The scheme is served by two main rivers; Nyamindi and Thiba rivers. Irrigation water is abstracted from the rivers by gravity with the help of fixed intake weirs, conveyed and distributed in the scheme via unlined open channels. There is a link canal joining the two rivers which transfers water from Nyamindi to Thiba River which serves about 80 percent of the scheme. Standing at about 3500ft above sea level, MIS is located in an area of impervious, heavy, black cotton soil which overlies a weathered trachyte bed (NIB, 2010)

According to Nguyo and Bezuneh (2000), MIS is the largest and most efficient Irrigation Scheme in Kenya and has become the most important scheme both economically and socially. The scheme is a major contributor to improvement of food security, farmer's incomes, employment creation and the reduction of the rice import bill. Social economic activities together with population has been increasing around the scheme over the years which could be attributed to rice production and marketing.

The scheme has been under various government agencies till 1998 to 2003, when the scheme management was taken over by Mwea Rice Growers Multipurpose (MRGM), a farmers' cooperative society. The cooperative was not successful in running the scheme due to; unskilled personnel, Lack of finances and Lack of machinery for

scheme maintenance, among others. Currently, the scheme is run by NIB and MIS farmers, mainly through the Irrigation Water Users Association (IWUA). NIB is responsible for the main irrigation infrastructures, water management in the main and secondary canals, making of cropping program and land administration. Farmers are responsible for tertiary water allocation and marketing of crops grown on the scheme (Ngigi, 2002; NIB, 2003). The farmers currently make decisions on what to produce and at what acreage, when to produce, and critical aspects of marketing. The scheme produces basmati rice variety the most popular commercial rice variety in Kenya (MOA, 2009).

1.1.2.1. Non NIB Rice Farming ("*Jua kali*")

This system of rice farming emerged in the 1990s when non NIB farmers decided to grow rice alongside the NIB farmers and nick named themselves "*Jua Kali*". Initially the farmers would use water from the NIB fields that was in excess. The hectarage went up with the liberalisation of rice marketing. The exit of NIB from the scene also brought an increase in this kind of farming due to illegal use of irrigation water meant for NIB fields. Currently, the farmers are part of the un-planned expansion of MIS.

1.1.3. History of Mwea Irrigation Scheme (MIS)

The Scheme started as a detention camp for Mau Mau suspects and was developed using Mau Mau detainee's labour. Mwea Development and Reclamation Scheme started in 1949 when a District Agricultural Officer in Embu, started black cotton soil irrigation experiments with rice near Nguka Swamp.

African Land Development Organization (ALDEV) Survey in 1951 suggested that 3,000 - 6,000 acres of the area were suitable for irrigation. With detainees' labour, canal digging proceeded and the reclamation of Mwea became a reality. Further surveys followed in 1954 and it was suggested that 40,000 acres could be irrigated and 10,000 - 12,000 families settled.

Personnel to run the scheme were progressively posted in 1956, including the first manager, working for ALDEV and some for the public works department (PWD). For co-ordination purposes Mwea/Tabere Irrigation Committee was formed with a District Commissioner (DC) as chairman and a joint irrigation committee in Nairobi to co-ordinate the departments. Nguka Swamp was drained and layout of one-acre fields began, which enabled settlement of the first potential tenant farmers and planting of rice on black cotton soils.

The Tabere head works on the Nyamindi River was completed in 1956 and the rice crop realised an encouraging £7000. The Mwea division was formed and a district officer was posted. In 1963, 391 acres were developed and a further 2000 acres completed in 1967. The MIS has a gazetted area of 30,350 acres. A total of 16,000 acres was developed for paddy production but recently, there has been unplanned expansion of the scheme. The rest of the scheme is used for settlement, public utilities, subsistence and horticultural crops farming.

1.2. Problem Statement

The National Irrigation Board (NIB) took over the activities of African Lands Development (ALDEV) program in 1966 which at the time involved the management of Mwea, Perkerra and Hola irrigation schemes (Onjala, 2001). The Board later developed other schemes. The Mwea Irrigation Scheme (MIS) rice farmers were tenants who had no titles to land and lived in tightly packed villages. The NIB strictly regulated all aspects of production; the crops to produce, the time of planting and the acreages besides other irrigation scheme practices were centrally controlled up to the end of the 1990. It also provided all the agricultural inputs, which the farmers paid for with market earnings. Lack of farmers' participation in decisions making provided the genesis of farmer lobbying for increased representation in the running of the Irrigation schemes from the early 1990s.

The underlying problem was the control strategy of the rice production and marketing systems in the scheme besides controlling the social lives of the tenants. Before liberalization of the cereal market, NIB had full control of the production system and even after liberalization NIB continued controlling rice producer prices. Farmers lobbied against this management structure and subsequently formed cooperatives to take over many of the NIB's management functions. However, the farmers' cooperative, Mwea Rice Growers Multipurpose (MRGM) was unable to run the scheme. In year 2003, the farmers sought for Government assistance in the management of the scheme and a joint farmer and NIB management emerged as a means to integrate the rice production and marketing system.

With the shift in management from NIB total control to integrated management, mixed performances have been experienced in the National Irrigation Schemes over time. The study took advantage of the different systems of management to compare their effectiveness in production and marketing and to study and understand the social and economic circumstances in the irrigation schemes. The aim was to generate information that would be used to inform policy in efforts to improve irrigated agriculture in the country in line with Kenya's Vision 2030 and contribution to achievement of the Millennium Development goals.

The rice-producing MIS being the most viable irrigation scheme in the country was adopted as a case study. While all the other NIB irrigation schemes collapsed at the end of the 1990s, the scheme remained in operation. Rice, the main crop in the scheme is the third most important staple food in Kenya after maize and wheat. It forms part of the larger diet for urban population and an increasing number of the rural inhabitants (EPZA, 2005).

1.3. Objectives of the Study

The overall objective was to evaluate the socio – economic aspects of Irrigation schemes in Kenya under different management systems with special emphasis on rice production and marketing in MIS.

The specific objectives were to;

1. Describe the agricultural system in MIS during the exclusive NIB management era and the integrated management period and bring out the social and institutional problems that contributed to the near collapse of NIB and MIS.
2. Assess the gross margins of irrigated rice and some major crops in MIS during the two management regimes to carry out a comparative analysis of relative competitiveness of irrigated rice production.
3. Determine whether the margin between the producer price of rice and the wholesale price is significantly different from total marketing costs given NIB marketing and current farmers marketing.
4. Assess and compare the overall performance of NIB with the current management.

1.4. Hypotheses Tested

The following hypotheses were tested:-

- There is no significant difference in the mean incomes of MIS farmers under NIB and those of non- NIB farmers.
- The margin between the rice producer price and the wholesale price is not significantly different from estimated marketing costs given NIB marketing and the current marketing.
- The overall performance of NIB is not significantly different from farmers' management.

1.5. Justification of the Study

For the agricultural sector to continue contributing significantly to the overall goal of economic growth, wealth and employment creation, food security, farm incomes and poverty reduction, it must be transformed from subsistence to a commercial business enterprise. The larger segment of the country's agriculture is rain-fed. As widely acknowledged, rain-fed agriculture is mostly inefficient, unpredictable and risky. Energy, fertilizers and time are wasted if rains fail or come late.

In the face of adverse impacts of climate change, expanding irrigation through development of sustainable irrigation production systems will contribute to the stabilization and subsequent growth of agricultural production. Irrigation management system in Kenya has undergone crucial transformations, it was important to study and understand the effective management system for improved productivity and profitability of NIB and the rice farmers. The issues have been correlated with the production levels, profitability and marketing efficiency of the irrigation schemes.

Preliminary findings from a study in year 2000 along the same lines revealed that the NIB rice marketing system was inefficient. From discussions held with the farmers it was revealed that they had been facing a lot of socio-economic problems. Among the problems cited were; control of farmers social life, poor rice producer prices, high service charge, decisions made by NIB only and especially a poor working relationship with the NIB, which affected productivity and household incomes negatively. In addition, the MRGM SACCO that the farmers opted to market their

produce through at the time did not have the capacity to handle the rice volumes from the scheme because of limited financial base and underdeveloped infrastructure.

While most research efforts to improve the performance of irrigation projects focus on the physical structures, technology and environmental issues, very few have investigated the socio-economic perspective of the irrigation projects. This study has assessed and described the performance of the irrigation schemes during different management regimes; the era of exclusive NIB central management, farmers' management and the era of joint farmer and NIB management.

The outcome of the study, it is hoped, will provide material for irrigation planners to model irrigation systems that will contribute positively to the economy and in part provide a basis for the much needed reforms in the irrigation sector.

1.6. Outline of the Study

This thesis is organized in five chapters. Chapter one begins with an introduction, a brief overview of the subject under investigation and gives the problem statement, the objectives of the study, hypotheses, justification, a description the study area and outline of the study. Chapter two presents the literature review, focusing on a review and a critique of past studies on irrigation with a wide range of sub themes including irrigation water pricing and efficiency, irrigated agricultural production and management of irrigation projects, just to mention a few.

Chapter three is on methodology and it describes the study's conceptual framework, the data needs, data collection methods and data analysis while chapter four gives the results of the analysis, together with the discussions, focusing on the results of the descriptive analysis, the marketing results, gross margin analysis and the testing of hypotheses. Finally, chapter five gives the summary and conclusions made from the study, together with the recommendations. The final part gives the appendices and the references that have been used in this study.

CHAPTER TWO

LITERATURE REVIEW

This chapter reviewed a selection of the existing literature on irrigation. The review covered not only literature specific to Kenya but also some from other developing countries. Most studies on irrigated agriculture in developing countries focused on the technical aspects of water use efficiency, water pricing and designing of irrigation structures. The studies reviewed offer a relatively more comprehensive socio-economic audit of the irrigation schemes in question.

2.1. Irrigation Potential

Irrigated agriculture has expanded significantly over the past five decades. World irrigated areas have almost doubled from one hundred and thirty nine million hectares in 1961 to over two hundred and seventy three million hectares in 2001. Much of this expansion has taken place in developing Asia, with India, China and Pakistan accounting for around 48 percent of the total irrigated area (IWMI, 2002). Kenya's irrigation potential according to the Ministry of Water and Irrigation (MWI), is estimated to be 497,400 hectares (Ha), with Lake Victoria, Tana and Rift Valley Basins accounting for 45 percent, 26 percent and 18 percent of the potential respectively. Of this potential 183,900 Ha has been developed and a total of 354,772 Ha, 75,577 Ha and 66,071 Ha are classified as high, medium and low potential (MWI, 2007).

2.2. Irrigation Management and Agriculture

Langat and Raine (2006) used experimental data collected from small-holder irrigation plots in the Tana River Basin to demonstrate the benefits of using the Surface Irrigation Simulation Model (SIRMOD) to evaluate the performance of surface irrigation practices. They showed that farmers, with the assistance of the Tana River Development Authority (TARDA) among others, may obtain performance benefits by optimizing irrigation inflow rates and cut-off times. The study however was silent on the technical approaches the farmers could use to achieve the optimum irrigation water inflow rates. The study further failed to determine the potential capacity of the farmers, *ceteris paribus,* to adopt or ensure the optimum irrigation inflow rates. If the organizational arrangement to enforce the optimum water inflow was there, then the study failed to point this out.

It is indicated elsewhere that water use in most irrigation schemes in sub-Saharan Africa are extravagant and farmers tend to use "all that is available when available only to have none to use when unavailable" (Sagardoy *et al.*, 1986). In Mwea Irrigation Scheme (MIS) an increasing water shortage was reported due to the following reasons among others; un-planned expansion of the irrigated areas, upstream abstraction, deterioration of irrigation infrastructure, competition with other water uses and poor water management by the National Irrigation Board (NIB) and Irrigation Water Users Associations (IWUA). Irrigation water use efficiency was not within the scope of the current study however the study contributed by evaluating the relative profitability of rice versus other crops grown in Mwea to answer the question

of wether the scarce water resources are put to the best use. High land rice varieties which use less water are currently cultivated in Kenya but the this study has concentrated on irrigation systems management in MIS in order to bring out socioeconomic aspects and institutional problems that brought about the near collapse of NIB and MIS. Water harvesting and storage can ease the pressure on the availlable water resources and can availl water in times of shortages however this study did not persue this line of study.

Grimm and Richter (2006) carried out a study on the role of financing in small scale irrigation implementation in sub-Sahara Africa. The study was part of a wider world bank commissioned study on 'financing small-scale irrigation in Sub-Saharan Africa'. This was a country case study where Kenya was selected. The study noted that there was general lack of researched analysis on the actual small scale irrigation production systems and their financial performance under the different agro-ecological and socio-economic conditions of the country.

The study recommended that unless the access to markets for small scale irrigation produce was assured it was unrealistic to expect financial markets to provide the required financing on a commercial base. This was a valid case for having an organized and functional irrigation scheme management structure that would handle all aspects of production, post-harvest handling and marketing. The starting point was to understand the existing management structures in the irrigation schemes and their effectiveness in meeting the commercial objectives set from the beginning. The MIS had an organized and functional irrigation scheme management structure under NIB

that handled all aspects of production, post-harvest handling and marketing which was not sustainable. The question that the current study set out to answer was why MIS framers dis-engaged themselves from NIB even after provision of all services and crop marketing. The agricultural production and marketing system was evaluated. Gross margins of irrigated rice under NIB were assesed in order to determine their relative competitiveness over those of Non NIB rice and other crops grown in the same zone. The MIS was used as a case study to asses the efficiency of the NIB rice marketing system as opposed to farmers marketing.

Onjala (2001) carried out a study in Mwea and West Kano irrigation schemes on the divergence between current water costs, the actual price based on marginal costs and the "true" scarcity price which takes into account the scarcity of the water resource. Primary data obtained from the schemes and by interviewing NIB staff was used. The ultimate purpose was to draw findings useful for the implementation of water pricing reforms in Kenya's irrigation schemes. The study, by use of econometric approaches, found that the application of a blanket price tag to water irrespective of location relative to the source of water was not fair. The study also questioned the rationale behind the pricing and the efficiency with which all the other services were organized within the scheme. Noting that farmers are rational decision makers, the study recommended that they should be given autonomy to choose the type of crop to produce instead of rice in the two schemes. The proposed study pursued these recommendations to determine whether farmers left to decide on what crops to produce actually post more profits than otherwise. The study was credited with suggesting output based water pricing for which charges were implemented by

providing the farmers with greater autonomy and participation in management and choice of practicable solutions. The MIS farmers were interviewed on the choice of crops produced in the scheme and all of them would continue growing rice if given a choice. The current study also found out that rice was relatively more profitable than horticultural crops, was considered to be an important food crop to the MIS farmers and was in high demand thus the farmers were rational decision makers.

Machethe, *et al,* (2004) carried out a study on smallholder irrigation and agricultural development in six irrigation schemes in Olifants River basin of Limpopo province, South Africa particularly addressing management transfer, productivity, profitability and food security issues. Findings from the study were that South Africa was one of the heavy investors in domestic irrigation and also in Limpopo Province alone, there were 171 irrigation schemes with assets valued at R4 billion. However, most of the irrigation schemes underperformed; defeating the original objective of generating employment and reducing rural poverty through the establishment of schemes which were not achieved in many instances. The authors assessed productivity and profitability of smallholder irrigation and examined the institutional and organizational arrangements affecting irrigation besides other objectives. A multi-disciplinary approach involving participatory and questionnaire surveys were used to collect data on socio-economic aspects while agronomic experiments and other tools of measurement were used to collect data of a technical nature. Other findings from the study were that, although farming played a dominant role in poverty alleviation and food security, it did not generate sufficient household income regardless of farm (plot) size. The study further found out that the organizational arrangements in the

irrigation schemes were characterized by major shortcomings as they did not meet gender equity objectives and adequate participation of disadvantaged groups. The major problem identified was that irrigation management transfer process from government to the farmers was done hurriedly before the necessary success factors were put in place. This was the core reason behind the failure of the irrigation schemes in Limpopo province. This was an interesting finding that has a bearing on the Kenyan scenario.The current study therefore sought to address these questions; whether the Kenyan farmers had the capacity to handle irrigation management responsibility and how much irrigated agriculture generated for the households concerned.

Tawonezvi and Mudimu (2000) studied the socioeconomic effects of investments in irrigated agriculture in Zimbabwe. This was a socio-economic impact study carried out on ten smallholder irrigation projects through Participatory Rural Appraisal (PRA) covering the farmers, various institutions and local authorities. Comparative impact analysis was effected across agro-ecological zones, between different irrigation systems as well as between farmers managed and government managed schemes. Five of the schemes were found to be operating well and the other five were judged to be poor. The study identified factors, which determine the performance of an irrigation scheme to include; planning, group cohesion, institutional support, strength of the Irrigation Management Committee (IMC), choice of crops, and appropriateness of the technical design and the commitment of the farmers. Good schemes resulted in increased productivity, improved incomes and nutrition, employment creation, food security and drought relief savings for the government. The study however assumed

an irrigation scheme to be homogenous, a feature that is no longer applicable to the Kenyan scenario due to the current management system where there are core farmers who produce one crop under the guidance of the NIB, while others make their own decisions on what to produce and when. The current study addressed the gap of homogeinity presented by the Zibwabean study by introducing the heterogenous nature of farmers in Mwea through evaluation of their socioeconomic aspects under NIB, Non NIB rice farmers and other crops farmers.It also presented an opportunity to comparatively determine relative competitiveness of rice irrigated areas with emphasis in making a distinction, on which category performed well and otherwise.

Hartenbach and Schuol, (2005) gave a classic case of a poorly planned irrigation system that predictably failed in meeting its objective. The study sought to find out why the Bakolori Irrigation Project on Sokoto Rima River in Northern Nigeria failed. In total disregard to a FAO recommendation to develop the whole Sokoto Rima River basin, the government because of political interest developed a small section of the basin upstream. Problems of water distribution between the scheme and the people downstream who had traditionally produced crops through irrigation started. Further, the people who had been displaced to pave way for the project were not comprehensively compensated for their land causing a lot of agitation. The government disengaged and the project collapsed completely. The study recommended that a "development from below", using local resources to meet locally perceived needs through small projects, appeared to be a more advisable approach. However, those Nigerian case reccommendations were not enough to apply to the Kenyan case. The current study was relevant in MIS which was set up from clear

settlement policies as a result of the need to settle Mau Mau detainees who were landless. The MIS farmers had reported numerous social-economic issues and the study combined the evaluation of the socio-economic aspects of irrigation schemes under different rice production systems and their impact on performance. The resulting policy prescriptions were relevant to the Kenyan case particularly after evaluating the socioeconomic and institutional problems that led to near the collapse of the NIB and MIS.

Mambala (2007) undertook a baseline survey of Munaka out-growers community based organization in Bunyala irrigation scheme on River Nzoia in Western Kenya. The study sought to know the strengths and weaknesses of out-grower paddy farmers in Bunyala irrigation scheme. Despite rice being the most profitable enterprise in the region, farmers continued to produce below capacity due to financial constraints besides low literacy levels. This translated into low revenues that reflected the rampant poverty among the households. The study recommended provision of credit and extension services to the out grower farmers in Bunyala irrigation scheme. The current study filled the gap of the need to determine the relative profitability of rice versus other crop enterprises in MIS and the neighboring locations. Issues regarding credit availability, extension and farmers' constraints to production were also addressed.

Wanzala (1993) carried out a study on rain-fed rice production on small holder farms in Busia District, Kenya. The objectives of her study were (a) To describe the farming system in Busia District in which rain-fed rice farming is found (b) To determine the

relative competitiveness of rain-fed rice production (c) To find out if a rain-fed rice production enterprise could feature in the optimal farm plans. Linear programming technique was used as the major tool of analysis. The study concluded that rain-fed rice was not profitable to produce at the prevailing economic conditions in the Amukura area. Among the recommendations, she recommended that; a) The Government should increase the producer price of rice and b) Farmers should be educated on modern ways of rice production. The present study is different from Wanzala's in that Wanzala's study was carried out on a rain-fed rice production system, which is different from the NIB production system. The study was also carried out before the Government liberalized grain marketing and the recommendation that the Government increase producer prices of rice is not valid any more.

Ayoo, (1992) carried out a study in Hola Irrigation Scheme on production constraints and optimal enterprise mix in an irrigation scheme. Ayoo had three objectives namely: to describe the present farming system, examine major constraints to agricultural production and to examine the present farm plans in the scheme and determine if a reallocation of the scheme's resources would improve the farm incomes. He noted that an important specific factor to which the poor performance of the irrigation schemes can be attributed to resource allocation between and within the various enterprises being operated. The Hola farms which were the focus of Ayoo's study were characterised by uncertainty, production of several commodities and use of several production factors. Linear programming was considered to be the appropriate analytical methodology because of its ability to generate an optimal farm plan and

reveal the binding agricultural production constraints. Ayoo's study established that scope exists for increasing the farm incomes through a reallocation of the available resources.

Studies by Irea (1979), Makanda (1989), Mukumbu (1987) and Kamunge (1987) were carried out in order to examine the patterns of resource allocation in Perkerra, Kibirigwi, West Kano and Mitunguu Irrigation Schemes, respectively using Linear Programming. The studies found out that through an alteration of the resource allocation patterns and enterprise combinations, it was possible to increase the farm incomes significantly. As compared to the determined optimal farm plans, the existing farm plans were sub optimal. Constraints to increased agricultural production identified by the study were labour and working capital.

All these studies which were carried out in irrigation schemes came with the conclusion that scope exists to significantly increase farm incomes through an alteration of the resource allocation patterns. These studies left a research gap in that no socio-economic studies were carried out at the time to determine what effect the agricultural production system and management of the schemes had on crop production and marketing and if NIB followed the recommendation to alter the resource allocation patterns in the schemes.

Rice research in Kenya is co-ordinated by a joint irrigation research committee. The committee is composed of members from NIB and the Kenya Agricultural Research Institute (KARI). Research is carried out by NIB with the help of KARI. Since 1969

this effort, under the co-ordination of Ahero Irrigation Research Station (AIRS) has been confined to operational research geared towards problem solving as the need arises due to budgetary constraints. NIB collaborates with other rice producers in the world and subscribes to international bodies like International Network for Germplasm Evaluation of Rice (INGER), International Rice Research Institute (IRRI) and International Institute of Tropical Agriculture (IITA). The Japanese International Co-operation Agency (JICA) has funded NIB schemes in a number of areas especially in research. Most of the research carried out is on agronomic trials, diseases control and pest control. No socio-economic and sustainable development research studies were carried out by the researchers and the present study filled this gap.

A number of studies were carried out on the prospect of multi-cropping in MIS. In a report from NIB on prospects of multi-cropping it was noted that in the 1996/97 production year, multiple crop farmers earned Kshs 7271, more than single crop farmers. Studies have also been carried out on the prospect of having a second rice crop in the long rains and analysis of 1997 long rain trial indicate a marked improvement in yield performance. Farmers realised reasonable profits from both soya beans and rice production. For rice production, it was found out that there is no significant difference between cropping during the long rain or short rain season (NIB report, 1998). Having a second rice crop to improve on incomes was of interest.

In a discussion paper on poverty in irrigated settlements, Alukoya (1993) noted that most farmers in MIS were not able to generate sufficient income to sustain comfortable life styles due to the general increase in the cost of agricultural inputs.

The frequent upward prices of farm inputs particularly fertilisers and other agrochemicals, as well as machinery which were imported from countries with stronger currencies was largely to blame for the more or less stagnant farm incomes. He also noted that the basic principal of alleviating poverty was to increase the net income per head of work force involved in irrigated agriculture. The fundamental involved in this was to increase employment rate and to increase returns. These comments called for a socio-economic research that would look at the farming system as a whole to bring out major socio-economic problems faced by the MIS farmers.

Ariga (1993) reviewed rice production and marketing comparing cost and revenue for different rice production systems and noted the following; the labour and intermediate costs for rain-fed farm systems were nearly the same as that for irrigated agriculture. The difference was that for those farmers who sold privately, the revenue per unit was higher. For the irrigation systems, intermediate costs were higher for the NIB schemes compared to private schemes. The private scheme farmers used more labour input than NIB schemes in form of 2-3 weedings and ploughing manually or by oxen. The yields from NIB system were found to be higher than those from private schemes. This was attributed to more input usage and planting of the right variety at the right time under NIB guidance.

The study further noted that at the time, about 50-55 percent of the rice consumed in Kenya was imported and consumers were exposed to a variety of rice products from various sources. There was a significant shift towards consumption of imports most of which were of a higher quality in terms of cooking quality and aroma. This

competition had forced NIB to reduce the prices of 'sindano' and increase that of 'basmati' rice variety to recoup any losses that may have occurred. Most of the imported sindanos were found to be of better cooking quality than local similar products. It was noted that there was a big difference between the import parity and ex-mill prices of rice from the two sources. It was clear that the Kenyan system was inefficient in the production of rice. The authors noted that "There is need to look at the costs involved at production, milling and marketing in order to point out the areas of inefficiencies". To fill this gap, the current study investigated the performance of NIB versus community management to understand why the NIB nearly collapsed though the system had higher yields than the private schemes. The MIS rice marketing system during the NIB era and currently was assessed to determine the efficiency of rice marketing system.

In a study on economic analysis on some aspects of production and marketing of cashewnuts in Kenya Ommeh (1984) found out that the cashewnuts marketing system was inefficient. This was done by analysing the margin between the producer price and the consumer price to find out if it was significantly different from the marketing cost. This study used the same method as Ommeh's in measuring the NIB's efficiency in marketing the scheme's produce before 2000 and at the present time without NIB. Efficiency in marketing is concerned with the cost of performing several marketing functions of transportation, milling, storage, exchange and packaging. Underlying the concept of efficiency and its use as a measure of marketing performance is that the marketing functions must be performed in connection with a given volume of food stuffs and that resources used should be kept

to a minimum in accomplishing the tasks. Also involved is the concept that, for the marketing system to be functioning efficiently there should only be a moderate charge to the system over actual costs involved in carrying out each marketing function.

Analysis of variance (ANOVA) was used in most studies reviewed above to analyse the data. The heart of ANOVA is a significance test, using F distribution for detecting differences among a set of population means. The assumptions of ANOVA are that for each group the population distribution of the response variable, Y is normal, standard deviations of the population distribution is the same for each group and that sample from the populations are independent random samples. The reason this method is called ANOVA is because the test statistic compares two estimates of variance. That is, the variability between each sample and the overall means are compared (Toothaker *et al.,* 2009). For instance, Mambala (2007) compared gross margins between farmers growing crops under irrigation and those growing crops under rain-fed agriculture in Bunyala district. The author found out crops grown under irrigation had high productivity and hence were more profitable than crops grown under rain-fed system. Hartenbach and Schuol, (2005) case on the failed irrigation scheme in Nigeria was resolved using ANOVA where the authors compared the performance of irrigation schemes with involvement of community members and that without community participation and reccomended a development from below (with involvement of community members) was more successful than that without community participation. Tawonezvi and Mudimu (2000) studied the socioeconomic effects of investments in irrigated agriculture in Zimbabwe using ANOVA where farmer managed and government managed irrigation schemes performance was compared

and findings were that homogeinity (farmers forced to grow certain crops only) was a major problem in government managed irrigation schemes as compared to farmer managed irrigation schemes where each farmer was allowed to choose their most profitable enterprise hence enhancing advantages of heterogeinity in crop choice.This study reccomended that the farmer managed irrigation schemes were profitable and longlived than the government ones. The current study used ANOVA to find out if the socioeconomic and institutional aspects were significantly different between NIB rice, Non NIB rice and other crops. It was also used to determine if there was a significant difference between NIB and farmer management. Gross margins for NIB rice were compared to the Non NIB rice and Other crops using the same method. Finally ANOVA was used to find the significant difference between marketing margins from the total marketing costs for the NIB and non NIB marketing system.

The studies reviewed in this chapter showed that irrigation is key in developing countries and aspects of socioeconomic and institutional problems required to be addressed. Proper management of irrigation schemes is a key driver to food security. Different studies reviewed above used different ways to analyze the data collected. However, most studies used ANOVA to compare variance across groups. The current study was also built on use of ANOVA as it permited cross-cutting decisions across enterprises chosen by farmers in either category; NIB, Non NIB and other crops farmers to be analysed.

This study looked at the farming system as a whole in order to come up with ways to meet farmers' needs and get relevant technologies and improvements permanently

integrated into the existing farming system. In the agricultural systems research, the wider agricultural environment with its physical, socio-cultural, economic and institutional characteristics are more explicitly included in description and analysis. Agricultural systems research allows for a breakdown of a complex problem into its components for a definition and resolution of the specific tasks and on the other hand to ensure that they remain together as a single entity. Some of the reasons leading to inefficiencies in the Kenyan production and marketing system have been studied. A thorough understanding of the existing farming patterns and farmers decision making environment was explicitly required. The identification of suitable, ecologically stable, socially acceptable and economically attractive development opportunities for the farmers in MIS is of paramount importance.

An Institutional and rural environment conducive to the adoption of technology and implementation strategy which allows farmers to get to grips with the new technology or practices and to adapt them to their specific conditions in terms of resources, risks and constraints is required of MIS. Functional irrigation systems built on the commercial principal of profitability and efficiency is vital to meeting the national domestic demand for rice and other such crops of strategic importance to the country.

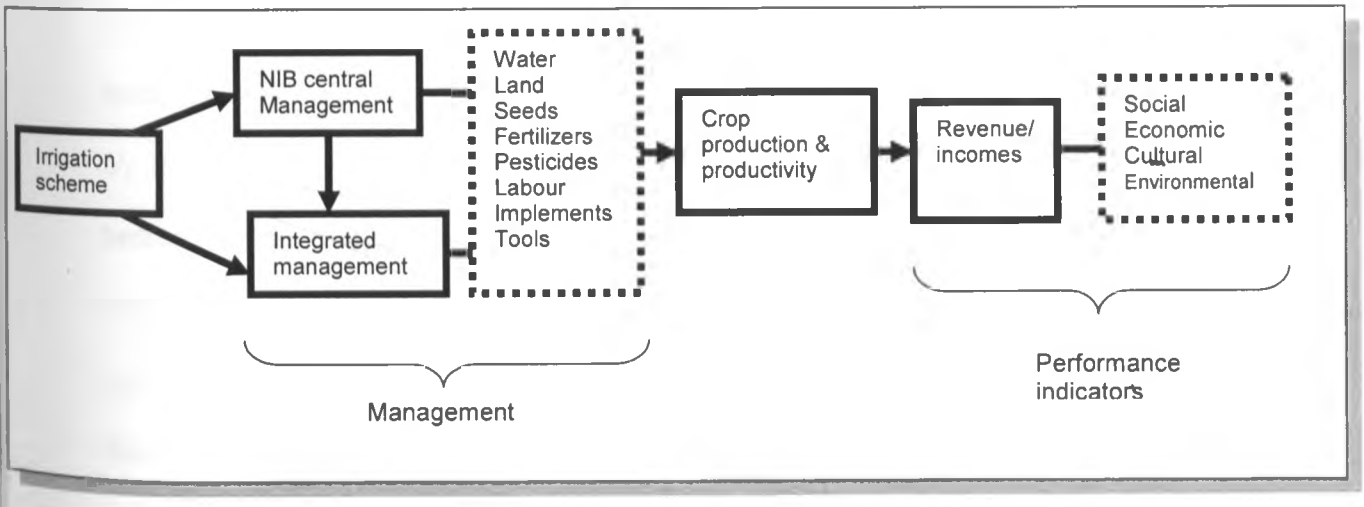
CHAPTER THREE

METHODOLOGY

3.1. Conceptual Framework

The study was conceptualized on the understanding that irrigated agriculture landscape in Kenya has undergone a change occasioned by the shift in the management of the irrigation schemes from National Irrigation Board (NIB) central management where farmers had no voice, to integrated management where farmers are involved in nearly all spheres of land management, crop production and marketing. On the one hand, the organ for making decisions on management of the irrigation scheme determines the performance of the scheme. On the other hand, the social, cultural and economic circumstances of households also determine scheme performance. Figure 3.1 below presents the conceptual framework adopted for this study.

Figure 3.1: Irrigation Scheme Management: Conceptual framework



Source: Authors' work, 2010

The survey of socio-economic and demographic characteristics was carried out in order to understand and determine how these factors influenced the performance of the schemes. Collected data was assessed to determine how the variables contributed to the state of affairs in the irrigation schemes.

3.1.1. Theoretical Framework

This study was based on the Random Utility Model (RUM). According to Thurston, (1972) a household is assumed to maximize a welfare-enhancing factor which is the utility in this case. Household utility maximization is a function of household characteristics, as well as on other attributes related to the consumption of goods and services. In this study households were assumed to choose the the enterprise that maximized their unobserved utility. The Random Utility Model (RUM) was used for each enterprise by either of the groups; NIB, Non NIB and other crops farmers to form a linear function of the observed factors plus an error term. The Random utility model was used to link crop enterprises selected by each farmer in every category and utility maximization hence making it useful in deriving and modelling the households' choices of the crop enterprise. Given two crop enterprises to select from K_1 and K_2 with their associated utilities U_1 and U_2 and where U_2 is greater than U_1 Based on RUM, a household would adopt crop enterprise K_2 instead of K_1 because K_2 has a higher utility than K_1. The household would choose the crop enterprise that yielded the highest utility. The utility derived from the use of any enterprise selected by a farmer was expressed as a linear sum of two components; a deterministic part, V_{ij} that captures the observable components of the utility function

and ε_{ij}, a random error term that captures unobservable components of the function including measurement errors. The random utility model was represented as follows;

$$U_{ij} = V_{ij} + \varepsilon_{ij}$$

where U_{ij} is the utility derived by an individual household i from the crop enterprise j, V_{ij} is the observable component which contains the vector of household, economic and institutional factors as well as the vector of parameters or the coefficients to be estimated while ε_{ij} is the unobserved component or the error term.

3.1. Data Needs

The following data was required for analysis in order to achieve the study objectives;

- Farm resource base (family sizes, age, type of land tenure, water rights, capital, equipment, labor and cropping calendar)
- Production levels and income situation (income/expenditure structure,)
- Credit availability and type (formal / informal, interest rates),
- Advisory services (capacity, availability and quality)
- Production inputs (costs, availability, time, place, type, quantity, etc)
- Marketing (producer & consumer prices, demand for products, processing cost, opportunities, Transportation), farmers Constraints and possibilities.
- Management (experience, skills, goals, decision-making & expectations.)
- Policies (agricultural, development, irrigation, pricing, income, employment, access to resources and services)

- Non-agricultural opportunities, off-farm incomes, rents, taxes
- Farmer's organizations / associations
- Special programs (machinery hire services, crash programs)

The rationale of selecting the above variables is their influence on production and performance of the scheme. Among the socio-economic variables, the education level of the house hold head is likely to influence the adoption of new technology. Educated farmers are more conversant with new technologies since they have easier access to information. Membership of farmers to formal or informal groups has extensively been shown to enhance adoption of technologies in many developing countries (Grootaert, 2002). Credit and extension services variables are also regarded as external support services which influence farmers positively in decision making and adoption of technology. Construction of roads and other infrastructure is the role of the Government to ease production and marketing constraints.

3.2. Data Collection

This study was based on the assessment and evaluation of both primary and secondary data collected in year 2000 and 2010. A semi-structured questionnaire was used to collect the primary data. This was administered directly to NIB farmers, non NIB rice farmers and also farmers growing other crops. To evaluate the socioeconomic aspects of irrigation schemes farmers were selected using the stratified sampling technique.

The sampling frame consisted of three groups of farmers as follows: -

a) NIB rice farmers, b) Non NIB rice farmers ('*Jua Kali*' farmers) and c) Other crops farmers in Mwea division.

To sample NIB farmers living in thirty six villages, a list of all farmers was obtained from MRGM. Due to time and financial constraints, the sample size was estimated as follows; For the purpose of representiveness one farmer was selected at random from each of the 36 villages for NIB Rice farmers category. For the Non NIB rice farmers group, six rice growing locations were in existence and six farmers per location were randomly sampled to form a total of 36 Non NIB rice farmers. For farmers growing other crops, a list of all farmers in the same zone as NIB farmers was obtained and 36 farmers were randomly selected.

Baseline data on rice and other crops was first recorded in 2000 in the study area from 118 households. These were taken to represent the scenario covering the period just after exclusive NIB management. Data representing the integrated management era was collected through a survey of the same households in the same area in 2010.

A reconnaissance survey was carried out for three days in the study area to familiarize with the area of study and with the problems existing between the rice farmers and the National Irrigation Board. During this period it was clear that the farmers and the irrigation board were in very bad terms to the extent that any visit made to the farmers' fields together with NIB officials was seen as a betrayal. Three enumerators were trained and were used in the data collection exercise. Prior to the data collection in year 2000 and 2010, the questionnaire was pre-tested by administering it to nine farmers from the rice growing area and nine farmers from the other crops area.

The randomly selected farmers were interviewed either in their homes or in the fields; those not present during the first visit would be visited again until all sampled farmers were interviewed.

In 2010 a similar reconnaissance survey was carried out to familiarise with the current situation at the time. The same set of farmers/categories interviewed in 2000 was interviewed again in 2010, including 8 millers, 8 wholesalers and 24 small scale traders. The categories of farmers interviewed were; NIB rice farmers, '*Jua Kali'* rice farmers (now part of the un-planned expansion of NIB rice farmers) and other crops farmers in Mwea. After a period of ten years, the major constraint was to locate the same farmer/households. The NIB farmers did not pose a major challenge since the farmers interviewed owned the land on tenancy basis for many years and were not allowed to sell the land and in case of death or movement, the families were traced in the villages. The farmers that posed a major challenge in the data collection were those from the informal rice growing areas where some of the farmers had hired land in 2000. In cases where it was not possible to get the same farmers, the same hired piece of land was revisited in 2010. In the NIB farmers category three (3) respondents were missing where two had died and one had moved, while in the *Jua kali and other crops* farmers seven (7) respondents were missing [One from rice growing category had died and three had rented out their land. One from the other crops category had sold out his land while two had rented out their pieces], thus 8 percent of the total sample respondents were absent, but the farms were still there and provided the needed data.

3.2.1. Primary Data Collection

Primary data for the study was generated through a field survey using a structured questionnaire and through informal discussion with the farmers. The main methods of primary data collection included: House hold survey using questionnaire guide, key informant interviews with extension staff, NIB staff, MRGM staff and the provincial administration and focussed group discussions. This was done through formal and informal surveys, direct observations, structured and unstructured interviews.

The questionnaire generated data required for the study in the following areas; Land availability and allocation, labor availability, operating capital, credit availability, subsistence food requirements, production costs, farmers' level of education, age of household head, non farm income opportunities, extension services, marketing, cropping calendar, inventory of farmers assets, farmers organization and problems facing farmers in their farming activities. Three focused group discussions were held with each of the groups to gain an insight into the various groups of peoples' opinions and attitudes towards the operations of MIS.

3.2.2. Secondary Data Collection

The existing related documents including annual reports and technical bulletins/briefs were collected from NIB offices (Mwea and Nairobi), Ministry of Water (MOW), Ministry of Agriculture (MOA) offices at the district and divisional offices in Mwea and Kirinyaga. Other materials came from academic and research institutions (e.g., KARI library, University library), journals and use of personal advantage to contact

researchers and friends who had carried out their researches concerning irrigation and related issues in order to get in-depth understanding about this study.

The data gathered from secondary sources included data on the following: production costs, NIB producer prices of paddy, consumer prices of rice, rice marketing costs, which include processing costs, packaging, transportation, distribution and storage costs, total rice deliveries to NIB and MRGM and production levels. Interviews with various officials in the following institutions were conducted and provided very useful information for this study: Mwea Multipurpose Society, Ministry of Water and Irrigation, National Irrigation Board, Ministry of agriculture and Mwea Rice Mills.

3.3. Data Analysis

Descriptive statistics involving cross tabulations of means and frequencies were used in determining crop and livestock production aspects, marketing and household characteristics among the various farmer groups. The survey results were tabulated using frequency tables and charts to show the existing socio-economic situation in the study area. These were compared by use of t-test and Analysis of Variance (ANOVA) method. ANOVA was used to campare means between the NIB, Non NIB and other crops farmers since some socioeconomic and institutional variables were categorical. The relationship that exists among farmers in MIS with the irrigation board and their goals and objectives were determined. This involved description of the farming system, family sizes, labor requirement, marketing activities, incomes, farmers education level, farm sizes, inventory of farmers assets, operating capital availability,

subsistence food requirements, gender roles, farmers opinion on various matters e.g. preferable crops, self management of the scheme, establishment of farmers organizations, preferable methods of farming, involvement of NIB / other organizations, preferred marketing channels and problems facing farmers in their farming activities

In order to carry out a comparison of the relative profitability of alternative enterprises that are grown in MIS, Gross margin analysis was used. Gross margin per hectare of rice and other crops as well as cost of production per unit were obtained for NIB farmers and non-NIB farmers, the mean marketing costs and mean marketing margin were determined and correlated to assess whether they were different from each other to assess the efficiency of the rice marketing system. Regression analysis was carried out to determine the factors affecting rice productivity within the scheme. The software used was Ms Excel and the Statistical Package for Social Sciences (SPSS).

The hypotheses tested were; "There is no significant difference in the mean incomes of NIB farmers and those of non- NIB farmers growing rice and other crops. The margin between the rice producer price and the wholesale price is not significantly different from estimated marketing costs given the different marketing systems, and the overall performance NIB is not significantly different from that of farmers".

The methods used in gross margin analysis, analysing the difference between the marketing margin and the marketing cost, testing for statistical significance and testing the performance of the National Irrigation Board follow;

3.3.1. Gross Margin (GM) For Enterprise

In Gross Margin Analysis, the following definitions of main components are used (Bernard and Nix 1982).

i.e. $GM_i = GOi - TVCi$

$$GM_i = GOi - \sum_{j=1}^{n} Cj$$

Profit = $GO_i - VC_i - FC_i$

Where:

GM_i = Gross Margin for enterprise i

GO_i = Gross value of Output for enterprise i

VC_i = Variable Cost for enterprise i.

C_j = Cost of input j

a) **Variable Costs (VC):** A variable cost is one that does change when the level of output alters. For a cost to be regarded as variable, it has to satisfy two criteria, which are also satisfied by enterprise outputs. It should be specific to a single enterprise, hence attributed to it and it should vary approximately in proportion to the size of the enterprise.

b) **Fixed Costs (FC):** These are costs which once incurred generate a continuous flow of services, whether they are used or not. Fixed costs as defined in gross margin analysis are of two types: those that are absolutely fixed e.g. rent and general overhead expenses which will remain the same whatever enterprises are selected and whatever their size and indivisible or integer costs which will vary but only in "steps" e.g. building, machinery depreciation.

c) **Gross Output (GO);** this is the total value of production of the enterprise. It also includes the value of any produce consumed on the farm, e.g. by the household or hired workers or transferred to another enterprise.

3.3.2. Marketing Margins and Marketing Costs Determination

The mean marketing costs and mean marketing margins were determined and correlated to assess whether they were different from each other using the following descriptions (Ommeh, 1984).

i) $$R^2_{MC} = \frac{\sum (MC)^2}{\sum M^2 \sum C^2}$$

Where: R^2_{MC} = correlation coefficient between marketing margin (M) and marketing cost (C)

M = Observed marketing margin

C = Observed marketing cost

$\overline{D} = (\overline{M} - \overline{C})$

Where: $\overline{D}$ = Difference between mean marketing margin ($\overline{M}$) and mean marketing

cost ($\overline{C}$), where

$\overline{M}$ = Mean marketing margin

$\overline{C}$ = Mean marketing cost.

Statistical significance of the R^2_{MC} and $\overline{D}$ was tested as follows; -

I) Statistical significance of the correlation coefficient (R^2_{MC}) was determined through the likelihood ratio F, where F is given by

$$F = \frac{R^2 mc}{1 - R^2 mc} \times \frac{K}{n - k - 1}$$

Where F is distributed as F (k,n-k-1)

K = Number of parameters to be estimated

n = Sample size

R^2mc = Coefficient of determination

ii) Statistical significance for the $\overline{D}$ was determined through analysis of variance (ANOVA) method.

In an efficient marketing system, marketing margin should not be significantly different from marketing costs. The difference between the mean marketing margin and the mean marketing cost was determined and tested for statistical significance

3.3.3. Determining Role of Management in Scheme Performance

This was done through a regression analysis where rice production was taken as the dependent variable and management besides other farm and household characteristics were taken as the independent variables. The following linear regression model was specified.

$Y_t = c + \beta_1 Paddy_{it} + \beta_2 Size + + \beta_3 Management + \beta_4 Drought + \varepsilon t.$

Where:

Y_t the dependent variable is rice yield in year t

Paddy represents Paddy production in Tons in year t.

Size is area cropped divided by plot holders.

Management is a dummy variable for Management of the irrigation schemes (with 0 if government management and 1 if community management).

Drought is a dummy variable (1 if there was drought in year t and 0 if otherwise)

The data used was panel data employing fixed effects. As indicated, these secondary data came from the National Irrigation Board, Food and Agriculture Organisation, Kenya National Bureau of Standards (KNBS) and Mwea Rice Growers Multipurpose. The data was corroborated by information from Ministry of Agriculture annual reports over the years.

In summary, rice yield in tonnes per year is a function of the size of area cropped, drought, paddy production in tonnes and management. Management was measured as a dummy variable with 0 if government managed the scheme and 1 for community management. High paddy production was expected to have a significant and positive effect to rice yield per year in tonnes. High crop area coverage was also expected to have a positive and significant effect to the amount of rice yield per year. Management on the other hand was expected to be significant either with a positive or negative sign depending on the type of management.

CHAPTER FOUR

RESULTS AND DISCUSSION

This section gives the descriptive analyses of the survey results providing a glimpse into the production and marketing system characterizing the MIS over the period of exclusive NIB management, farmers' management and integrated management. An economic analysis of the production and marketing aspects of rice and other crops within the scheme and the periphery follows.

4.1. Household Characteristics

This section discusses the socio-economic and demographic characteristics of the sample households in the study area. The socio economic variables include sex, age, marital status, education level, family size, gender and labor.

4.1.1. Sample Dynamics, Family Size and Age of the Household Head

Household heads were interviewed in 2000 and in 2010. In Mwea, the average family size in 2000 was 8 people with a minimum of 3 and maximum of 16, while in 2010; it was 10 people with a minimum of 2 and maximum of 38. In the "planned rice production area" the average family size in 2000 was 7 people, while that of Non NIB rice farmers at the same time was 4 members. The t-test showed that there was no significant difference in family size between the two rice production systems at 5 percent level of significance.

Family labor was the main input for rice production. The study showed that the households' average family labor force was 4 in man-equivalents. The mode was 4.0 man-equivalents. The t-test also indicated there was a significant difference in family labor force between MIS "planned area" and Non NIB rice production systems at 5 percent level of significance.

Table 4.1: Age, family labour and family size of households in year 2000

Characteristics	N	Mean	Std Dev	Min	Max	t-value
Age of household head	118	40.35	16.32	22	90	1.183
Family labor (Man-equivalent)	118	3.53	0.68	1	6.34	2.398***
Family size	118	7.79	3.35	3	16	0.076

Source: Survey data, 2000.

The age of the household head is considered a crucial factor, since it determines whether the household benefits from the experience of an older person, or has to base its decisions on the risk-taking attitude of a younger farmer. Based on Table 4.1, the age of the household heads ranged from 22 to 90 years with the median of 46 and multiple mode of 38. The mean age of heads of households was about 40.35 years for all rice growing farmers in MIS i.e. 51.85 for NIB, 41.73 for Non NIB rice farmers and 27.75 other crops farmers. There was no significant difference in ages of the sampled households between NIB and non-NIB rice producers.

4.1.2. Sex, Education and Gender

Normally the head of the household was responsible for the co-ordination of the household activities. As such it was pertinent to include some attributes such as sex and education of the head in the specification of market participation decisions especially for the 2010 data where marketing decisions were not controlled. The sampled respondents in 2010 were 76.4 percent male headed as opposed to 73 percent in 2000.

Another attribute of importance was the level of education attained by the heads of the households who, normally, were the decision-makers. Education also enabled the person with basic knowledge to do communications for business purpose. From all household heads 38.2 percent were found to be illiterate, 42.3 percent attained primary education 15.4 percent had attained secondary school education and the rest 4.1 percent had tertiary level of education. These groups were able to interpret market and other information better than those who had less or no education.

Table 4.1.1.2. **Gender and Education of respondents in year 2010**

		Proportion	Std. Err.	[95% Conf. Interval]	
Gender	1	.236	.038	.160	.312
	0	.764	.038	.688	.840
Education	1	.382	.044	.295	.469
	2	.422	.045	.334	.511
	3	.154	.033	.090	.219
	4	0.401	0.018	.005	. .076

Source : Author's work 2010 Gender: (1 denotes male, 0 female) Education: (1 denotes illiterate, 2 primary school, 3 secondary school, 4 tertiary Education)

Women were found to be playing an important role in rice production in providing the major source of labor at 76.3 percent. Females were also found to be playing major roles in decision making as it was realized that in 32 percent of households, decisions were made jointly by the husband and wife, in 10 percent the decisions were made by the woman, 44 percent by the man and in 12 percent by others.

4.1.3. Employment Opportunities

The major source of employment other than farming was found to be casual employment. Off farm employment opportunities in Mwea were found to be very few. The farmers interviewed had 35 percent of the household members in paid employment. Farmers gave the following options for increasing their income: Rental income, trading in rice, dairy farming, and irrigation of other crops outside NIB, formal employment, poultry keeping and small businesses in the shopping centre. Some farmers (43 percent) were prepared to grow a second crop of paddy or cultivate an upland crop during the long rain (LR) season to increase income, 57 percent were for an increase in production per hectare in the short rain (SR) season, meanwhile 55 percent wanted to increase production of crops outside the scheme.

4.1.4. Irrigation and Human Health

The use of irrigation to flood agricultural land during rice cultivation has over the years been associated with an increase of disease vectors and corresponding increase in health burden due to malaria and other vector and water-borne diseases. Malaria was identified by (87.6 percent) of the respondents as the most serious problem followed by typhoid (8.3 percent) and Bilharzias (4.1 percent).

Among the total households studied, a malarial illness was identified in 50.2 percent of the households. Although 3.8 percent did not seek treatment, majority (96.2 percent) of the households with malaria reported having used some form of treatment. About 70 percent of the households knew the symptoms of malaria and how to manage it.

In year 2000, 7.8 percent of the household members failed to work on the rice fields per season because of sickness from malaria. This decreased to 0.3 percent in 2010 implying that the integrated malaria management efforts had borne positive impact.

4.2. Farm Characteristics

4.2.1. Land Holding

From the analysis, farm holding refers to all land holdings which are mainly used for both crop and livestock production. Depending on the type of activities the farmer was engaged in 3 categories of land holdings were identified: These were crop land, livestock land and both crop and livestock land (mixed). In 2000 much of the land "owned" by farmers in the planned area was for rice cultivation. In 2010, still a great proportion of the land owned was cultivated (93 percent) but cultivation involved the production of rice (73 percent) and horticulture (27 percent). The uncultivated land (7 percent) offered grazing grounds for donkeys mainly. Donkeys were the main providers of transport in MIS, since no vehicles were allowed in the scheme by order of the NIB.

Further in this study, analysed results show that, the average land holding for households in the year 2000 was 2.67 acres. In 2010, the average had shot up to 3.76 acres (Table 4.2) as more people joined the rice production fray under the Non NIB rice farmers system. This was significant at 95 percent significance level with a ρ=0.0247. About 33.3 percent of rice farmers had land that ranged between 0.5 to 3.5 acres and 9.5 pecent of the farm households had an area above 5 acres of land. In 2000, majority (34.3 percent) of the farmers had rented land on which they were farming while others (20 percent) were utilizing land registered in the name of parents. A sizeable number (28.6 percent) farmed their own lands registered in their names. In 2010, the proportion of farmers who had access to additional land for production of rice through renting had shot up to 63.5 percent. There was a significant difference in land holding (private, pasture land and cultivated land) among the three sampled rice production systems (NIB, Non NIB rice farmers and other crops farmers) at 1 percent and 10 percent level of significance in both 2000 and 2010.

Table 4.2: Land holding in the year 2010 per household in acres

Land use	N	Average (acres)	Std Dev.	F-Value
Land holding	118	3.76	1.92	4.28***
Cultivated land	118	3.52	1.99	2.67**
Pasture land (Uncultivated land)	118	0.26	0.11	7.85***

Source: Survey data, 2010

4.2.2. Type of land Ownership

Farmers were interviewed on land ownership and future use of their pieces of land. All NIB farmers interviewed had no title deeds to their land and were tenant farmers operating under NIB. All the NIB farmers (100 percent) wanted to own their land and have title deeds. The reason they gave as to why they wanted to have titles to the land was for security of tenure. Most farmers said that the current system made them feel landless and at the mercy of NIB. Farmers were interviewed on what they would do if they had title deeds and 95 percent would not sell land if given title deeds. All farmers interviewed (100 percent) would continue growing paddy while 61 percent of the respondents in year 2000 said they would subdivide their land.

The issue of subdivision of land would have to be studied to come up with the minimum economic unit per household. This will be a major problem in future due to the tradition of sharing land among siblings through inheritance. Although not official, most of the farmers were already sharing the land with their extended families. Most of the land had been sub divided unofficially, of the farmers interviewed in 2010, 68 percent said that they would sub divide the land officially if given titles. A further 81 percent said they would also be interested in using the land as collateral to borrow money. Most farmers were interested in development loans to build houses. Of the farmers interviewed 57 percent operated land that was leased; this was found to be a common practice for horticultural farmers and Non NIB rice farmers.

4.3. Choice of Enterprise

All NIB farmers interviewed said that if given an option to produce a crop of their choice, they would still want to produce rice. This was due to the following reasons: Rice was a major food crop for their families, it was reliable and not perishable, there was a ready market, it was their major source of income and they had gained a lot of experience over the years in rice production. Rice also does well in black cotton soils that are prevalent in the scheme.

4.4. Crop and Livestock Production

4.4.1. Rice Production

A total of 72 households were interviewed from the 2 rice production systems (NIB or "planned area" and Non NIB rice farmers) and all of them were producers of paddy /rice during the main cropping season. The major reasons for growing rice were home consumption and sale. Rice straw was also used for animal feed and roof thatching in some cases. In terms of land utilization, Table 4.3 below shows that, on average, 3.81 acres of land per household was allocated to rice as compared to 1.31, 0.84 and 0.83 acres for tomatoes, maize and French beans respectively. Overall, mean land area under rice was significant at 10 percent. That is, the land allocated to rice is higher by 4 percent higher than that allocatted to other crops combined (ρ=0.0402).

Table 4.3: Cultivated area and crop yield per acre, year 2000.

Type of crop	Cultivated area (acres)			Productivity (kg/acre)		
	N	Mean	Std. Dev	N	Mean	Std dev
Rice	70	3.81	1.16	67	5692	22357
Tomatoes	18	1.31	1.16	12	112	85
Maize	15	0.84	1.32	15	841	2037
French Beans	15	0.83	0.64	14	1013	1397

Source: Survey results, 2000

The standard measure per bag was 75 kilograms. The mean production of milled rice was 68.5 bags per household per four acres of land. Out of this, 24 bags were used for consumption purposes and 44.5 bags of rice were marketed.

4.4.1.1. Rice Production: Annual Calendar

The Mwea scheme specializes in growing two varieties of rice; the aromatic variety (basmati) and the non-aromatic varieties (sindano) within which are several varieties. The sindano variety has no scent, gives higher yield and is more resistant to rice blast. Basmati variety has better taste, has a scent but is less resistant to blast and gives lower yields and is the dominant variety in the scheme.

In Mwea Irrigation Scheme, one rice crop was grown annually in the exclusive NIB management era while currently farmers within the original MIS were found to be practicing mono cropping of rice while the newly developed areas practice both mono and double cropping of rice. The long rain crop was grown between January and June and the short rain crop between August and December. Between the two cycles, it was recommended that the land be left fallow for a minimum of 21 days. However, ratooning was encouraged over the second season crop since it was more

economically viable. The schedule of husbandry could be conveniently described under four operations namely land preparation, nursery development, transplanting and harvesting. The cycle began with preparation of the land, which involved burning of vegetable wastes, and repair of canals, roads and drains. This was closely followed by leveling and banding after which the land was ploughed and flooded with water. Following the ploughing, nursery beds were prepared in the corners of the paddies.

4.4.1.2. Rice Nursery Management

The nursery bed was first raised by wet bed method that involved puddling and leveling. Prior to introduction of rice seeds into the nursery, the seeds were first soaked in water for 24 hours followed by incubation under rice straw for a period of 48 hours to encourage germination. Thereafter, the seeds were uniformly broadcasted on wet nursery bed at a seedling rate of $100g/M^2$. Thereafter 57.5 kg/ha of sulphate of ammonia were applied as a source of nitrogen at the time of sowing while an additional 57.5 kg/ha of the same was applied 14 days later. Immediately after sowing, the water level in the nursery was adjusted to an average depth of 3 cm. Bird scaring was done until the rice germinated and became well established. Fentrothion was applied 7-10 days after sowing at a rate of 400ml/acre to control insect pests mainly the stem borers and leaf miners.

Most of the rice varieties grown in the scheme were disease resistant and therefore not treated before sowing. However, in cases where a susceptible variety such as IR was sowed, the seeds were usually top dressed with the fungicide Benlate, which is protective against fungal diseases including stem rot and brown-leaf-sheath-rot.

Seedlings were ready for transplanting 28 days after the sowing date. The timing of the sowing of the rice seeds in the nursery corresponded with the cropping cycle. For the long rain crop, it was between mid December and mid January and that of short rain crop July and August.

4.4.1.3. Rice Field Management

On the flooded paddy, animal paddling was done to soften and mix the mud. At final paddling time, Triple Super Phosphate (TSP) at a rate of 50kg/acre, Di ammonium Phosphate (DAP) or Single Super Phosphate (SSP) 100kg/ha was applied after which the land became ready for transplanting. During transplanting, the water level was lowered to a depth 5 – 10 cm. About 60 kg/ha of Murate of Potash and 39kg/ha of Sulphate of Ammonia (or Urea at 80kg/ha) were applied to provide for potassium and nitrogen, respectively. Seedlings were transplanted at a rate of two per hill (hole) and 20 x 20cm spacing and the water level was raised to an average depth of 5cm immediately thereafter. Ten days after transplanting, gapping was done to replace dry or weak seedlings. The main pests of rice in the scheme were leaf miners, stem borers and armyworms. Fentrothion was the main chemical used to control insect pests. It was applied at a rate of 400ml/acre 35 days after transplanting.

Weeds of economic significance in the scheme were *Vandelia anagallis*, *Lythraceae*, *Juncus effuses* (commonly known as *kitunguu*) and the sedges. They were controlled by application of Satunil herbicide at a rate of 90ml/ha at 1-2 leaf-stage of weed followed by manual weeding when necessary. The first, second and third weeding was done 16 days, 35 days, and 50-60 days, respectively after transplanting. Most parts of

the scheme were covered by an aquatic plant known as *Azolla*, which had been observed to suppress other weeds, by covering the entire surface of the paddy field with little effect on rice production.

During panicle initiation stage, 39kg/ha of Sulphate of Ammonia was applied to the crop as top-dressing. Other important operations included bird scaring from the onset of flowering until harvesting. Rouging to remove unwanted and damaged parts of the rice crop was carried out before the onset of panicle formation and near maturity.

When the paddy was 85percent mature, the level of the water was left to go down (for dry season) or drained (for wet season) in preparation for harvesting. Two weeks later, the rice was harvested and the paddy separated manually from the straw by threshing. The paddy was taken to the mills for milling. The total growth period was usually 4-5 months. After harvesting, the land was left dry until the commencement of the second season if the farmer was not interested in raising the ratoons.

4.4.2. Horticultural production

Besides rice production, farmers mainly in the "unplanned areas" (*Jua Kali*) were also producing other crops, mainly horticultural crops. This was one of the major sources of income, employment and food security to farmers in Mwea and was purely market oriented. Tomatoes had good marketing prospects due to high demand in Nairobi and were the major horticultural crops. Majority of the producers were small scale farmers who owned 0.5 to 3 acres. Tomatoes were inter-cropped with maize and/or French beans and were only cultivated twice a year. Tomato cultivation required different activities including plot preparation, sowing, planting, weeding, watering, staking,

spraying of pesticides, applying fertilizer and harvesting. Varieties mainly cultivated were OnyX, Cal J and Riogrande, notable for high yields and large fruit size. Initial sorting and packaging was done at the farm in readiness for delivery to the market. Packaging was performed either by the farmer and/or trader depending on the point of sale, though most traders who bought directly at the farm gate preferred to package. Majority of the farmers interviewed (57.6 percent) explained that they preferred selling their tomatoes at the farm gate to traders who transported to Nairobi than to selling at the local markets. Of the remaining farmers, 39.2 percent preferred selling at local markets and 3.2 percent at the roadside.

Other horticultural crops like French beans were produced for the export market. Competition in 2010 had since increased with a lot of new farmers joining this kind of production and the other crops farmers when interviewed said that their profits had reduced as a result. At times the farmers made huge losses when there was an over production and in the case of French beans when the export season was low. They mentioned the following problems: poor infrastructure, lack of transport, lack of horticultural marketing cooperatives, lack of credit, unstable prices, poor grading, poor markets, lack of market for perishables, exploitation by brokers, lack of processing factories and lack of market information.

4.4.3. Livestock Production

Livestock production was an integral component of the farming system in all three categories of farmers interviewed and contributed to rice production in particular and to crop production in general. Important livestock kept by the sampled farmers were

cattle, sheep, goats, donkeys and poultry as shown in Table 4.4. Oxen and donkeys were the main source of farm power for ploughing, short haulage, harrowing, and threshing. About 52 percent of the respondents owned cattle. The cattle were categorized into the various classes. There were significant differences in number of cattle, sheep, oxen, goats and in monetary value of livestock among the "planned area" rice producers, other crops and non-NIB rice producers.

Table 4.4: Number of livestock owned by sample households year 2000

Type	N	Mean	Std dev	F-value
Oxen	33	3	1.78	3.65**
Cows	37	2	1.40	0.83
Bulls	9	2	1.01	2.03
Sheep	7	4	1.34	3.62*
Goats	11	2	1.21	2.84***
Donkeys	28	2	1.42	1.84
Poultry	53	3	4.84	2.15**

Source: Author's survey 2000.

***, ** and * show the values statistically significant at less than 1percent, 5percent and 10percent respectively

Donkeys by use of carts were used to transport inputs from farmer's homes and paddy for home consumption from reception centers to farmer's homes. Oxen were used for wet paddy field leveling.

4.4.4. Producers' Constraints

Shortage of land was a key primary problem facing MIS farmers. Increase in population, and the constant threat posed by urbanization has meant that per capita

land availability in MIS has reduced. This situation has worked to reduce rice production per household and forced many farmers to produce rice on rented land.

Diseases and pests: About 47 percent of the farmers who responded were faced with the problem of pests and diseases, which increased production costs through spraying and reduced yields.

Shortage of seed supply: This problem was perceived by 42 percent of farmers. Apart from the Kenya Agricultural Research Institute (KARI), there are no other serious providers of rice seed to the farmers. Use of uncertified seed was one of the factors causing a decline in yields.

Water Shortage: There was an increasing water shortage due to the following reasons among others; unplanned expansion of the irrigated areas, upstream abstraction, deterioration of irrigation infrastructure, competition with other water users and poor water management by NIB and IWUAs due to lack of capacity and enforcement of rules and regulations.

Weak support services: Rice yields in the scheme were found to have decreased from the previous average of 22 bags per acre to the current 18 bags per acre. The decrease in yields could be attributed to a number of factors among them: Weak institutional arrangements and coordination mechanisms for farmers, inadequate agricultural credit arrangements and weak support services in research, extension and marketing.

4.5. Gross Margins and Farmers Incomes

4.5.1. Gross Margin Analysis

Representative crop gross margins were developed to estimate the costs and returns of producing key crops in Mwea. The value of crops produced by each household was estimated by multiplying gross margin per acre by the acreages reported in the interviews. Crops not sold but consumed at home were also included, the rationale being that if the crop was not grown, the household would have to purchase the corresponding amount. Similarly, the value of labour time whether hired or family, was calculated using wage rates and labour requirements for crops grown. Important categories of household expenditure such as food, school fees and medical expenses were valued.

4.5.1.1. Gross Margins for Rice and Major Horticultural Crops

Gross margin analysis for rice within the planned irrigated area revealed that a rice farmer obtained on average a gross margin of KShs 16,720 per acre per season (Table 4.5) before farmer takeover during the NIB era. However, Non NIB rice farmers posted a gross margin of KShs 20,854 per acre for the same time period. This meant that before 2000, Non NIB rice farmers were posting higher profit than the *MIS* farmers within the planned irrigation scheme. This was attributed to the lower intermediate costs and higher producer prices obtained for Non NIB paddy in the free market. NIB farmers had higher yields of an average of 26-27 bags per acre compared to 19 bags per acre for Non NIB rice farmers (Basmati variety). The difference in

production between NIB and Non NIB rice farmers came about because NIB rice farmers received organised services at the right time from NIB unlike the Non NIB farmers who were operating on their own.

After the farmers took over the scheme, they were able to obtain a gross margin of Kshs 36,546 per acre constituted an increase in earnings of over 50 percent compared with the expected earnings from NIB of Kshs 22,003 per acre (Table 4.5, 4.6, Appendix 1 and 2).

Table 4.5: Gross Margins for rice in Mwea Irrigation Scheme for planned & un-planned areas, year 2000 AND 2010

	COST; YEAR 2000		**COST; YEAR 2010**
ITEM	NIB PADDY (Kshs.)	NON NIB PADDY (Kshs.)	Planned and un planned areas (Kshs.)
Rotavation	2112	2500	2423
Leveling (by oxen 2000, tractor 2010)	365	1143	1320
Canal maintenance	2217	460	2593
Fertilizers	3238	3238	5598
Seeds	2588	1205	1165
Transplanting	1057	1650	2911
Bird scaring	4994	2612	4938
Weeding	2623	1367	5807
Gunny bags	5668	1700	725
Harvesting	1911	1990	4418
Winnowing	327	295	1611
Transportation	1000	1000	1321
Total Variable Cost (TVC)	**28100**	**19160**	**34830**
Gross Revenue/Output (GO)	**44820**	**40014**	**71638**
Gross Margin per acre (GO-TVC)	**16720**	**20854**	**36808**

Source: Survey data, 2000 and 2010

An interesting scenario arose when one considered the gross margin per acre of rice within the planned Irrigation Scheme in 2010, the gross margin had more than doubled for irrigated rice within the planned irrigation scheme. Though the costs of rice production had increased by a nominal value of 24 percent, the production per acre remained comparable at 26 bags (as compared to 27 bags in 2000). The difference lay in the nominal price of KShs 34 in 2010 as compared to KShs 26 in 2000. Much of the land that was taken as Non NIB rice farmers land in 2000 was seen as an expansion in the size of the scheme and the Non NIB rice farmers were now operating under NIB as "unplanned expansion" land in 2010; hence it became hard to separate the two farm categories.

Table 4.6: Gross Margins for Rice, Tomatoes and French beans year 2000/2010

Enterprise	Gross Output (Kshs/acre)	Total Variable Costs (Kshs/acre)	Gross Margins (Kshs/acre)
MIS Rice in 2000	53,480	16,934	36,546
Non NIB Rice 2000	46,434	23,715	22,719
French beans 2000	87,846	43,725	44,120
Tomatoes in 2000	107278	53303	53974
Tomatoes in 2010	71682	43250	28432

Source: Authors work, 2000 and 2010.

In 2000, horticultural farmers had the highest net income, followed by NIB farmers and Non NIB rice farmers respectively. The gross margin per acre of horticulture represented by tomatoes and French Beans was a value slightly higher than the GM of rice per acre. Most of the horticultural producers were non-NIB farmers. In fact, 77 percent of the Non NIB rice farmers produced horticultural crops. However, only 11

percent of the MIS farmers practiced horticulture in 2000. This in essence, meant that 88 percent of the rice farmers in both MIS and Non NIB rice farmers had some form of horticultural production in 2000. The scenario in 2010 was quite different. More than 90 percent of the farmers in MIS produced some horticulture besides rice production. Overall, horticulture exhibited a lower GM than rice in MIS by 2010. This was understood given the increased world cereal prices due to increased demand (Gitau *et al.*, 2010).

4.5.2. Farmers income

The average amount of income earned from farming activities per household was KShs. 79,778.00 per year and from non-farm activities was KShs. 6,452.00 per year. The most important items of expenditure were food, children's education and health in that order. Food expenditures accounted for over 50 percent of the total household budget and were between 44,000 and 50,000 Kshs per household but a few households with large irrigated farms had expenditure of up to Kshs 75,000. Education accounted for 30 percent of the household budget but for households who paid secondary education, the allocation rose to 60 percent. Taking into account all these expenditures one quarter of the households had negative net incomes. Almost all the households in the study area depended mainly on farming income.

According to the year 2000 data from this study, the average years of farming experience for the rice producer's households was 19.37 years. The survey results also indicated that farmers from the planned rice production area (NIB area) had more

experience in farming rice than the others (Table 4.7). The differences between the farm and non-farm incomes for NIB and *other crops* farmers are summarized in table 4.7. Two t-tests showed that there were significant differences, first in non-farm income ($p<0.025$) between NIB and Non NIB rice farmers, and secondly in farm income between the rice production systems and "other crops" at 5 percent level of significance. The NIB farmers had both higher non-farm income and farm income than the Non NIB rice farmers.

Table 4.7: Farming experience and household income for Mwea Irrigation Scheme farmers year 2010

Farming management system		**Farming experience**	**Annual income from farming**	**Average monthly income from non-farming**
NIB	**N**	**35**	**35**	**35**
	Mean	29.24	111,814	6,050
	Std dev	10.69	174913.01	9187.34
Other Crops	**N**	**35**	**35**	**35**
farmers	Mean	5.43	69,070	5,248
	Std dev	3.46	78814.67	4041.45
Total	**N**	**70**	**70**	**70**
	Mean	34.67	90442	5649
	Std dev	14.15	126863.	6614.40
T-value		0.247	2.364**	1.973*

Source: Author's survey result, 2010.

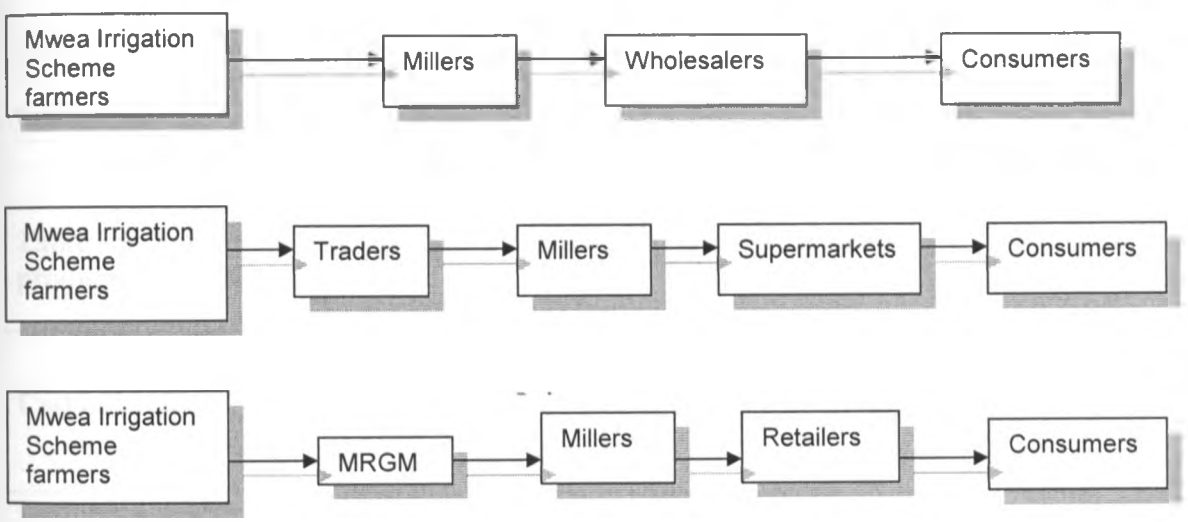
* And ** shows the value statistically significant at 1percent and 5percent level.

4.6. Rice Marketing, Marketing Costs and Marketing Margins

4.6.1. Rice Marketing Channels

The rice marketing channels from Mwea Irrigation Scheme (MIS) are represented in figure 4.1 below. Rice marketing was found to be at two levels; selling of paddy and that of rice. This study identified three major rice marketing channels. Various intermediaries were involved in the rice marketing system among them being local buyers, cooperatives, traders, local millers, wholesalers, retailers and consumers.

Figure 4.1: Mwea Irrigation Scheme rice marketing channels



Source: Author's work; 2010

4.6.2. Analysis of Rice Marketing Cost and Marketing Margin

The marketing margin refers to the difference between prices at different levels in the marketing system. The total marketing margin is the difference between what the consumer pays and what the producer/farmer receives for his paddy or rice, in other

words it is the difference between retail price and farm price. A wide marketing margin usually means high prices to consumers and low prices to producers. The total marketing margin may be subdivided into different components; total costs of marketing services and profit margins or net returns. An analysis of marketing costs would estimate how much expenses are incurred for each marketing activity. It would also compare marketing costs incurred by different actors in the channel of distribution.

4.6.2.1. Marketing Cost and Margins for Rice Producers

Marketing cost of producers are costs incurred in transportation, loading and unloading and cost of milling for those farmers who sold after polishing, summarized in Table 4.8.

Table 4.8: Marketing costs and profit for Mwea Irrigation Scheme rice producers year 2010

Cost of items	Paddy/Rice Cost per kg of rice (K.Shs)	Percentage cost
Production cost per kg	15.50	86.35
Transportation cost per kg	0.45	2.5
Other marketing costs (gunnies, Drying etc)	2.00	11.14
Total cost per kg	17.95	100
Average selling price paddy/kg	34.00	
Margin per kg	**16.05**	

Source: Survey data 2010, N=72

4.6.2.2. Marketing Cost and Margin for Rice Wholesalers

The marketing cost of rice for wholesalers in the study area is summarized in Table 4.9. On average, the total marketing cost of rice for wholesalers was KShs 3 per Kg. Milling comprised the greatest total cost for the wholesalers (at 66 percent of the marketing cost).

Table 4.9: Marketing costs and margins for rice wholesalers year 2010

Cost item	Average cost per kg	percent of total cost
Milling	2.00	66.0
Drying	0.30	9.9
Unloading	0.25	8.2
Loading costs	0.20	6.6
Storage fees	0.15	5.0
Watchman	0.10	3.3
Licensing fees	0.02	0.7
Electricity	0.01	0.3
Total cost per kg	**3.03**	**100**
Average selling price per kg	55	
Average buying price per kg	34	
Margin per kg	**21**	

Source: Survey data 2010, N=8

The correlation coefficient between the Marketing Margin (M) and Marketing Cost (C) for producers and wholesalers was determined using the formula $R^2_{MC} = \frac{\sum(MC)^2}{\sum M^2 \sum C^2}$

This gave an R^2_{MC} value of 0.144. The calculated F-value was determined as 0.168

using the formula $F = \frac{R^2 mc}{1 - R^2 mc} \times \frac{K}{n - k - 1}$. Given that the critical F-Value ($F_{(0.10, 122,8)}$) is 2.293 (which is greater than 0.168, the calculated F-value), it follows that the margin between the producer price and the wholesale price was not significantly different from total marketing costs. Given this therefore, it follows that producers and wholesalers margins were comparable and the marketing system can be said to be efficient. This analysis relied on data collected in 2010. A paired t-test was used to determine the significance of the difference between the mean marketing margin and the mean marketing costs of rice for the 2010 data. The values were picked from the producers, wholesalers, millers and traders (Table 4.10).

Table 4.10: Mean Marketing Margins and Mean Marketing Costs year 2010

Dealer	Mean marketing margin (per kg)	Mean marketing cost (per kg)
Wholesalers	21	3.03
Millers	63	47
Traders	25	2.78
$\rho = 0.009$		

Source: Authors work, 2010

The mean marketing margins were significantly greater than the mean marketing costs implying that the players in the rice value chain were making consistent profits.

From the data collected in 2000, the efficiency of the National Irrigation Board (NIB) marketing system was tested by analysing the extent of the margin between the final sales price and the price to the farmer in relation to the estimated marketing costs. In an efficient marketing system, mean marketing margin should not be different from mean marketing costs. The difference between the mean marketing margin and the

mean marketing costs would not be significantly different from zero if the system was efficient. Results of analysis of variance (ANOVA) between the marketing margins and marketing costs during the same period further indicated that there was a significant difference between the mean marketing margins and the mean marketing costs for the period under NIB management. Based on the foregoing results, one can conclude that the MIS under exclusive NIB management reflected inefficiencies in rice marketing.

4.6.3. Market Information and Extension Service

The distribution of market information refers to the availability of relevant market information to producers, about demand, supply and price of their farm produce. This is relevant in situations where the producers have a free hand in deciding where, when and at what price to sell their produce. For this reason, the 2010 data was used since previously; the NIB controlled every service provided to the farmers. The survey result indicates that 79.2 percent of the households had price information before they could sell their produce but 20.3 percent of the interviewed farmers did not have access to any information.

a) **Supply, demand and price information;** Out of 118 respondents, 42.9 percent obtained information about rice supply by using other rice traders and personal observation. About 40 percent of them got information about rice market demand from other traders and their personal observation.

b) **Quality of source of information**; In this regard, 42.6 percent respondents indicated that the quality was adequate; 21.7 percent also said that the sources were both reliable and adequate, 20.9 percent recorded only reliable and only 2.3 percent said the information was timely.

c) **Extension service;** only 27 percent of the respondents admitted receiving extension services within the past 12 months. The average number of contacts the farmers had with extension officers was about three times per month. The study shows that 6.7 percent of respondents had a weekly contact with extension agents. A majority of the beneficiaries (92.7 percent) rated the extension service as useful and the rest (7.1 percent) gave a rating of very useful. Of the respondents, 32.4 percent got advice on animal production, 15.4 percent got advice on production of crops, marketing, credit and health aspect.

4.6.4. Farmers' Involvement in Cooperatives

Of the farmers interviewed 63 percent were members of a cooperative society while 37 percent were not. Almost 100 percent of the NIB farmers were members of farmers' societies. Most farmers joined the societies in the 1960s and the 1970s. Asked why they joined the societies they gave the following response: To access savings and loan facilities, banking, cotton farming, marketing, development, to generate income, welfare, to buy land jointly and because others had joined. Farmers were asked to give the functions of their various cooperatives and they did as follows: Assist each other, marketing, offer credit, land buying, banking, inputs supply,

financing production, provision of food in times of scarcity and offer transportation. The functions of the cooperative were prioritized by farmers as follows: 1) Giving loans, 2) agricultural marketing and 3) Provision of agricultural services. It was noted that there was weak institutional arrangements and coordination mechanisms for farmer's organization.

4.6.5. Credit Availability

The need for sufficient farm credit is also related to marketing improvements and the ability of farmers to respond to programs undertaken for their benefit. This refers not only to credit needed for holding the crop while awaiting sale at a more favourable price later in the season, but also to sufficient credit for production purposes. The means by which credit is repaid determines the channels through which the farmer markets his crop, his ability to choose between different outlets and the possibility of bargaining over the price at which the produce is sold. Without some working capital or credit, marketing will be restricted to farmers selling their own production to consumers. Assuring access to credit is one of the ways in which governments support private marketing enterprises and ease competition between them.

Out of the interviewees 84 percent operated with loans for rice production obtained from various sources. Some farmers (28 percent) had also borrowed production inputs like pesticides and fertilizer from suppliers. A small percentage of farmers (20 percent) reported problems in loan repayment due to crop failure, low income and high living expenses. Loan procurement was reported to be a problem by 43 percent

of the farmers in 2000 and 58 percent in 2010, among the problems cited was: lack of collateral, low production, no source of credit, long procedure in procurement, lack of information, insufficient amounts offered and lack of willingness by business people to give loans. A small percentage of farmers did not require any loans and they gave the following reasons: good harvest the previous year, fear of inability to repay, high interest rates and having money from other sources. Of the interviewed farmers 76 percent of the farmers kept aside some money for farming activities, which was not enough to get them through the whole season. Extra money was required for hiring casual employees, buying inputs, transplanting and harvesting. The farmers were able to obtain extra money by obtaining loans from future buyers, friends and relatives, working as casual labourers, forming partnerships, selling livestock, using family labour, borrowing inputs, using oxen ploughing and by selling produce. The interest rates were reported to be fair (at 20-30 percent) by 56 percent of the farmers. Apart from production, various reasons were cited for borrowing being; school fees, construction, medical purposes, purchase of food and for luxury. Farmers said they still required loans in future.

Sources of credit included; Mwea Rice Growers cooperative society (MRGM) in 2000, Mwea Rice Farmers SACCO, Agricultural Finance Cooperation (AFC), Micro Finance Institutions (MFIs) and Banks. Challenges faced by farmers and credit institutions in obtaining credit included Lack of collateral, loan defaulters, cash flow problems and requirement for joining formal groups for MFIs. The study noted in 2010, that since the farmers' SACCO had collapsed and NIB stopped offering credit, there was no organised source of credit for rice farmers.

4.6.6. Traders' Constraints

a) **Wholesalers and Millers;** the major problem reported by wholesalers and millers was capital shortage. This was responded to by 53.7 percent followed by lack of information and high interest charges (20 percent). The wholesalers and millers also complained of unreliable paddy suppliers. This was probably caused by the liberal nature of the rice market where producers were free to take their paddy wherever they wanted resulting in undue competition.

b) **Problems Associated with Retailers;** the common problems perceived by sample retailers in Mwea were shortage of capital, quality of rice, adulteration, and lack of credit. The retailers complained of milled rice that was not clean and unfair competition from unlicensed retailers.

4.7. Management and Performance of Mwea Irrigation Scheme (MIS)

4.7.1. Period of Exclusive National Irrigation Board (NIB) Management

Up to November 1998 MIS was managed exclusively by the NIB. Total acreage in MIS under paddy production was 14400 acres, leaving 15,600 acres to be utilised for farmers' villages, schools, dispensaries, business plots, roads, swamps and red soil patches for subsistence farming dependent on rains. There were a total of 3246 households each cultivating about (1.6 Hectares) 4.0 acres of land. The NIB provided all inputs to farmers on credit. It further processed the rice harvests, packaged and marketed it, recovering the input cost and other statutory costs from the proceeds.

Average production per acre was 22 to 25 bags from which a household received an average of 3 bags (per acre) for home consumption for the year. Farmers were paid for their proceeds 6-12 months after delivery. Before cereal liberalization, paddy deliveries were 300,000 bags annually but after 1992, it reduced to an average of 200,000 bags, the rest was sold in the black market. The tenant farmers provided all the labour required for the production of paddy. Apart from transportation of farm inputs to the farm, land preparation and movement of output from the farm to the reception centre, all the activities were manually operated (Table 4.11).

Table 4.11: Paddy cultivation practices in Mwea Irrigation Scheme 2000/2010

Name of farm activity	Operation mode
Movement of farm inputs to the field	Tractor
Nursery preparation	Manual
Land preparation	Tractor and rotavator
Transplanting	Manual
Fertilizer application (TSP and Sulphate of Ammonia	Manual
Application of agro-chemicals (Fentrothion or Furadan)	Manual (use of sprayer)
Weeding	Manual
Water management	Manual
Harvest/post harvesting handling (cutting, threshing, winnowing, bagging)	Manual
Transport to reception centre	Hired transport

Source: authors work, 2000/2010

The main difference between the NIB and the farmers was the need to increase the producer price of paddy from KShs 17 to KShs 20, to which the NIB management

rejected. This coupled by the NIB's exclusive decision-making on the management resulted in farmer revolt. Matters were not helped by the emergence of multi-party politics. In 1998, the tenant farmers forcefully took over the running of MIS and proclaimed themselves owners and operators of the irrigation system. This resulted in a clash with security forces that resulted in the death of 5 farmers and injury to many others.

4.7.1.1. Issues of Conflict between the NIB and Farmers

The relationship between the NIB and farmers had a rough start that never warmed up for many years. The contentious issues according to the farmers were as follows:

(a) Land tenure: Under the irrigation Act, the farmers remained settlers and had no estate under the Law of Succession Act through which their descendants could inherit (The People, Sunday 24, September 2000). The Irrigation Act gave the NIB power to unilaterally terminate land leases and give the lands to other people.

(b) Small, Poor and high-Priced Housing: Initially, the mud-walled iron-roofed houses were given to singles or couples for residence as they farmed the irrigation scheme. The tenants were to pay an equivalent of Kshs 3,200 within a period of 30 years. As families increased, the houses could not accomodate more family members and scheme regulations forbade any new constructions by the tenants. As per the regulations family members were to move out of the scheme on attaining 18 years of age and this was not to be.

(c) Irrigation Water Use Restriction: Water was to be used in the irrigation of rice and diversion to other crops like tomato or French beans was prohibited. The regulations allowed the scheme manger to supervise the destruction of the crop and the cost of the activity was to be deducted from the farmer's rice proceeds.

(d) Control over Rice Harvests: The regulations stated that farmers could only retain 12 bags of 75kg of un-processed rice for family use per year. Given the large families, this was inadequate.

(e). Poor Producer Prices: Before takeover by the farmers, the producer price of paddy was K.Shs. 17.50 per kilogram and farmers were demanding KShs 20.00, which the NIB was not willing to pay. The farmers knew that the price they were asking was less than what their rice was worth and the problem lay in paying large overhead costs to a bloated inefficient NIB. Farmers revolted by failing to deliver rice to the collection centers and by destroying some of the collection centers. They gave mandate to their cooperative society to run the affairs of the scheme.

Despite all these, the NIB was credited with the following for the time it had exclusive management:

- **Proper and timely land preparation**

The NIB had purchased machinery for land preparation for the whole scheme. The land preparation was carried out under the supervision of the scheme manager and was done as per the agricultural recommendations at the right time. After farmer take over problems emerged on late land preparation and use of the wrong machinery.

- **Supply of quality inputs on time**

The agricultural inputs for rice production for the scheme were centrally purchased by the NIB and later used by farmers. The NIB ensured that the right quality of fertilizers, seeds and herbicides were purchased and used.

- **High and sustainable yields of rice**

During the NIB era the yields were relatively higher than when the farmers took over the scheme. This was due to a number of factors among them being; use of quality seed, extension and research, supply of agricultural inputs and credit availability.

- **Employed best practices in harvesting, drying, storage and processing**

Immediate and proper drying of newly harvested grain is an important post harvest practice in maintaining the quality of the grain. Harvested paddy contains between 15 and 27 percent moisture content depending on its maturity, incidence of rain and the humidity of the atmosphere. There are varieties of paddy, including some high yielding ones, which will sprout within 2 to 3 days after maturity if left with high moisture content. A variety of paddies are susceptible with high moisture content to mould, heating, and discoloration of the kernel and chemical changes in the grain. Moisture content and temperature determine the speed with which deterioration occurs. To avoid deterioration paddy must be dried to below 20 percent moisture content within 48 hours after harvest. In MIS rice drying was normally done by NIB at the reception centres where the rice would be dried to a moisture content of 14 percent. Poor quality paddy produces poor quality milled rice, which consequently has a lower value in the market.

- **Possession of an efficient rice mill that produced high quality rice**

During the NIB era the entire MIS paddy was milled by the Mwea Rice Mills Limited (MRM), which was established in 1967 and extended in 1972. The mill had four milling units with a total milling capacity of 14 tons per hour i.e. 2 tons / hour, 2 tons /hour, 5 tons / hour and 5 tons / hour. The facility also included storage for both paddy and milled rice and an administrative block and a storage capacity for 400,000 tones. The mill was jointly owned by the MIS farmers through the Mwea Amalgamated Rice Farmers Co-operative Society who owned 45 percent and the NIB, which owned 55 percent. As opposed to MRM there were over 100 simple rice hullers in and around MIS the common defect is that husking and polishing are done in one operation and the bran and husk cannot be separated, this reduces the value of the bran. The percentage of broken rice tends to be higher because the rice becomes overheated and too dry. The rice recovery is higher than the larger mills as no grading is done and whole grain is mixed with broken grain.

- **Established network of rice distribution and marketing**

The National Irrigation board was charged with the responsibility of promoting the marketing of crops grown on the irrigation schemes. Before liberalization, NIB sold the rice directly to National Cereals and Produce Board (NCPB) and paid farmers directly after deducting their dues. With liberalization the NIB took over the marketing of rice without having to sell all the rice to NCPB. Consumers and distributors were allowed to buy directly from the NIB mills in Mwea. It was a requirement that all rice produced by the scheme farmers is marketed through the NIB, thus the board had an established rice marketing network.

- **Offered credit to farmers against their paddy**

All NIB farmers were offered credit in terms of supply of agricultural inputs and services which were deducted from the farmers market earning at the end of the season. After the exit of NIB, the MIS farmers complained of lack of credit for farming operations.

4.7.2. Management by Farmers

The Mwea Irrigation Scheme (MIS) farmers through their cooperative forcefully took over the running of MIS in December 1998. The farmers transferred all the responsibilities previously handled by the NIB to the Mwea Rice Growers Multipurpose Cooperative Society (MRGM). Though the cooperative had massive farmer subscription (over 90 percent), it had a skeleton staff to run the affairs of MIS.

The first case of land preparation was carried out by the cooperative in 5 months as opposed to 8 months previously by the NIB. The cooperative society had acquired some tractors from Cooper Motors Corporation (CMC) on credit and hired others from private owners for the exercise. In the 1998/1999 season, MIS farmers delivered 140,000 bags (75Kgs each) of paddy rice to the MRGM for processing, packaging and marketing. In fact, total deliveries in 1999 stood at 270,000 (75Kgs each) bags of paddy. Limited storage capacity resulted in loses. However, MRGM hired small scale mills and much of the paddy was milled, packaged, sold in the domestic market and farmers paid within 3 months. The MRGM was able to acquire a 3 ton/hr mill and construct 4 go-downs for paddy storage. The production costs of this paddy first marketed by MRGM were financed by the NIB.

With the MRGM takeover of the MIS, development of Non NIB rice farming escalated. This was not allowed under NIB management as NIB wanted to maintain a firm grip on rice production in order to control irrigation and marketing. The uncontrolled increase in Non NIB rice farmers resulted in reduced *per capita* water availability and an upsurge in conflicts. By 2003, there were 3,000 acres of Non NIB rice farmers. The roads, canals and the general infrastructure of the scheme were poorly maintained by the society due to lack of the required machinery like excavators and graders. Use of wrong rotavators for land preparation was a major problem. Milling and storage facilities were also in adequate.

There was lack of organized rice research and lack of certified seed was a major problem since the farmers with the supervision of the research centre produced certified seed. Soil sampling / testing was not done after the society took over.

Most of the available credit in MIS was provided by the NIB and deducted from the sale of the crop. After the farmers left NIB, MRGM took over the management of the scheme and provision of credit. This function was not well organized; with the result that farmers started getting credit from non-institutional sources, such as money lenders, produce brokers and relatives. Interest charges were usually very high ranging between 30 percent and 100 percent per month. Very often the loans were linked to marketing agreements, whereby the farmer was compelled to sell his paddy to the moneylender at a lower price agreed on at borrowing.

The following are some of the negative issues raised by farmers in 2000:

a) NIB farmers had sold their produce to the society for two seasons 1998/99 and 1999/2000. The first crop was paid in good time but the payments for the second crop were delayed unnecessarily. They complained that when payments get delayed, land levelling is not done due to lack of finances.

b) The MRGM had no mill and adequate storage facilities at the time of data collection in 2000. The management had promised farmers the previous year that they would purchase a mill and build warehouses for storage. Rice milled by simple hullers could not be graded and there was a lot of wastage due to poor storage, the previous year a lot of paddy was rained on.

c) Some farmers felt that MRGM was too political and was involving itself in anti government campaigns, which some farmers were not happy with. Some said that their removal from NIB was politically instigated. The farmers who would have wished to remain under NIB were issued with death threats. They felt that the management of the society was poor and the leaders were not elected but were handpicked by politicians. Farmers noted that there was poor water management, corruption and lack of communication between farmers and the society. They felt that the society was mismanaging their money and some alleged that some of the society leaders had appointed themselves agents to sell the rice after which they paid themselves commissions.

d) The MRGM did not have the proper kind of machinery required in the rice fields and it was found inadequate during the peak periods. Subsequent land preparation was done late and also was not organized like during the NIB era. Farmers were worried they would not be able to plant in time for the 2000/01 season. It was further noted in 2000, that the society lacked the capacity to adequately manage the scheme and it was only a matter of time before the whole system collapsed.

4.7.3. Current Management of Mwea Irrigation Scheme (MIS)

Apart from 1999, subsequent years of rice production were less successful as farmers came to grips with the reality of managing a complex agri-business of the scale of MIS. Paddy deliveries are used in this instance as a measure for success of management in the MIS. The trend of paddy deliveries to MIS for a period of thirteen years before farmers took over the operations of MIS and deliveries to MRGM and NIB for a period of eleven years after this take over are attached as appendix 3. Does change of management have an effect on productivity levels in irrigated rice schemes in Kenya? This data in conjunction with the primary data have been used to run a regression where the type of management in MIS is incorporated as an independent variable to determine the significance of the type of management in influencing paddy/rice productivity.

The amount of paddy deliveries to Mwea Rice Growers Multipurpose (MRGM) cooperative society could also indicate the performance of the management system (Figure 4.2). Secondary data on paddy deliveries to MRGM covering a period of five years is shown in Table 4.12. The data shows that there was a drastic reduction in

paddy deliveries to MRGM from 270,000 bags in 1999/2000 to 50,000 bags in 2002/2003 season. This is a strong indicator of poor performance by MRGM. The initial peak of 270,000 bags in 1999/2000 was mainly because; farmers were in a vibrant mood following successful take-over of the scheme and therefore delivered rice to MRGM willingly and in full.

Table 4.12: Paddy deliveries to Mwea Rice Growers Multi purpose society versus expected production in Mwea Irrigation Scheme & non National Irrigation Board rice farmers year 1998 to 2003

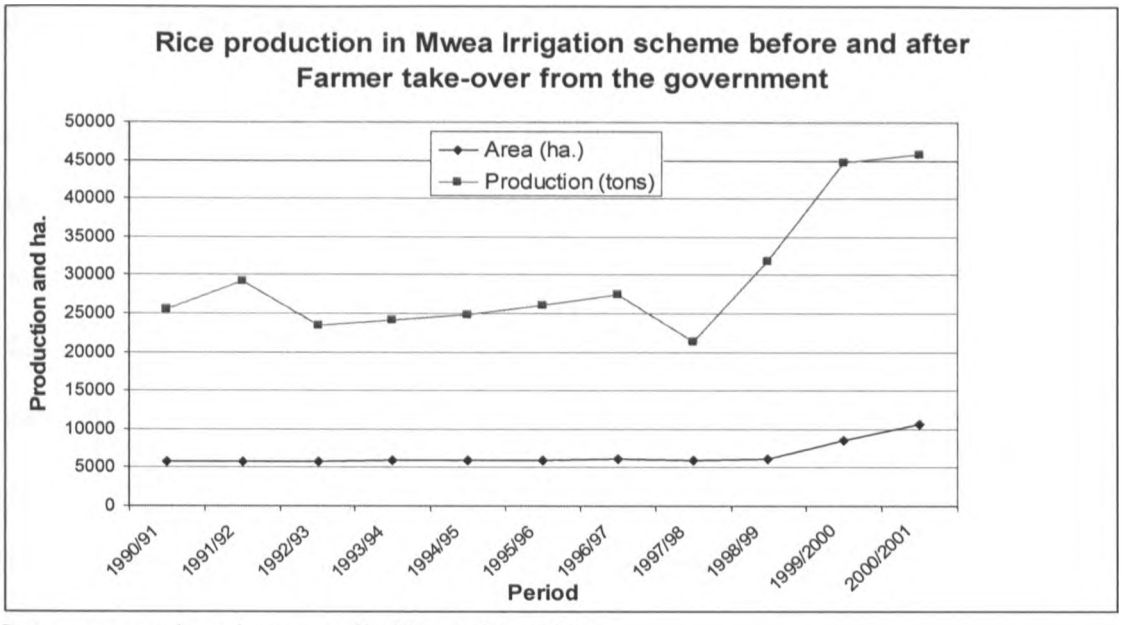
Season	Varieties and percent area planted in MIS	Actual paddy deliveries (75 Kg bags) to MRGM	Expected/estimated paddy production (75 Kg bags)	
			MIS	JUA KALI
1998/1999	Sindano (25percent) Basmati (75percent)	140,000	350,000	100,000
1999/2000	Sindano (25percent) Basmati (75percent)	270,000	350,000	100,000
2000/2001	Sindano (10percent) Basmati (90percent)	110,000	300,000	2000,000
2001/2002	Sindano (5percent) Basmati (95percent)	70,000	300,000	2000,000
2002/2003	Sindano (5percent) Basmati (95percent)	50,000	300,000	2000,000

Source: Mwea Rice Growers Multipurpose society; 2010

The general reduction in paddy deliveries to MRGM from 270,000 bags in 1998/1999 season to 50,000 bags in 2002/2003 season could be attributed to 3 reasons. The area under Sindano which is high yielding (6.5t/ha) had decreased from 25 percent in

1998/99 season to 5 percent in 2002/2003, its place being taken by Basmati which is low yielding (5.0t/ha), though much preferred by consumers because of its aroma. Secondly, there was a general decline in yield owing to poor availability of major inputs such as water (due to competition with Non NIB rice farmers) and fertilizers and finally farmers were not happy with MRGM and opted to go it alone.

Figure 4.2: Rice production in Mwea Irrigation Scheme before and after farmer take over 1990 to 2001



Source: secondary data compiled by author,.2010

The estimated production from Non NIB rice farmers increased over the years to 200,000 75 Kg bags in 2002/2003 in proportion to increase in area. The rice yields from Non NIB rice farmers was generally lower than from "planned area" production because in the latter there was better supply of inputs (water, fertilizer) through the cooperative arrangement than in the Non NIB rice farmers where there were no cooperative arrangements. In addition there was better land and higher expertise for rice growing in the "planned area" from the long experience than in Non NIB rice

farmers. The amount of paddy going to private mills could be estimated as the difference between estimated paddy production (in both MIS and the Non NIB rice) and the actual deliveries to MRGM. This increased from 180,000 bags in 1999/2000 to 450,000 bags in 2002/2003 and explains the emergence of both small and large mills in Mwea, Thika and Nairobi. It could therefore, be seen that MRGM controlled a very small share of the rice market, the main players being privateers.

4.7.4. Scheme Performance: Regression Analysis

A regression analysis was used to assess the factors affecting rice production and in the process capture the role of management in impacting on scheme performance. As indicated in the literature review, rice production and productivity could be used as a factor to reflect management effectiveness. This analysis drew heavily on secondary data from the Kenya National Bureau of Statistics (Appendix 3). As indicated, these secondary data came from the NIB, FAO, KNBS and MRGM. The data was corroborated by information from ministry of Agriculture annual reports over the years. Results are presented in Table 4.13 below.

Table 4.13: Regression results for panel data from Mwea Irrigation Scheme year 2010.

Variable	Coefficient.	Std. Error.	T-value	P-value
Paddy	0.0000672	0.0000069	6.21***	0.001
Management	-0.3668349	0.6152344	4.75***	0.008
Drought	0.1839187	0.0059269	0.14	0.836
Size	0.3517840	0.1621651	5.91***	0.008
Constant	5.032241	0.0817408	16.18***	0.0005
Observations	94			
R-squared	0.56			

Source: Secondary data, 2010

Results show that; Drought was not significant at 1 percent level of significance pointing to the system of rice production in MIS; irrigated rice production. Drought unless prolonged and spread widely would not affect yields much because the scheme was supplied by water from Rivers Thiba and Nyamindi which flow from the Central Kenya Highlands, Paddy was significant at 1 percent confidence level and had a positive coefficient which means that rice production increased with increase in paddy production and, Management was also significant at 1 percent Confidence level, with a negative sign which means that under community ownership, yields declined.

This was important for this study for it reflects the differences in impacts of management to performance of MIS. The NIB was more effective in realizing high scheme performance, the social satisfaction notwithstanding.

4.7.5. Conflict Resolution

Conflict resolution is conceptualized as the methods and processes involved in facilitating the peaceful ending of conflict. Often committed groups/ group members attempt to resolve conflicts by actively communicating information about their conflicting motives or ideologies to the rest of the group and by engaging in collective negotiation. Communication between the involved parties is an important ingredient without which conflict cannot be resolved.

4.7.5.1. Communication between Irrigation Managers and Farmer Users

Irrigation system management involves the partnership of managers and farmers. For efficient systems performance regular and effective communication between these

partners is necessary. To be effective, such communication must involve farmer leader representatives and managers who have authority to attend to the problems faced by the farmers. There is a need to enhance the farmer's role in decision-making in the use and management of resources.

4.7.5.2. Communication and Decision Making in NIB Management

In 2000 after farmers' takeover of the running of MIS, they were asked if they knew what channels NIB used to communicate with them and to name the channels of communication. The communication was through the following means: Field assistants, head cultivators, letters, meetings and pay slips. Farmers were asked if they were represented in management meetings held by NIB, 80 percent said yes and 20 percent said no. About 70 percent of the farmers attended farmers meetings and were enlightened on the deliberations between NIB and their representatives. Regarding decision-making 94 percent of the farmers said that NIB made all the decisions without involving the farmers. All NIB farmers interviewed said that farmers did not participate and did know the criteria used in deciding the service charge and producer price of paddy. Farmers had no information on the breakdown of service charge and no account of how it was spent. About 97 percent of the farmers believed that the service charge was too high and the producer price of rice was too low. Asked to comment on the services offered to them by NIB, most farmers agreed that the services were good but were expensive and unilaterally decided. About 60 percent of the farmers in 2000 wanted to manage the scheme without NIB but the rest were ready to join NIB if it was willing to make changes.

4.7.5.3. Current Management and Conflict Resolution

Following the new water reforms, (Water Act of 2002), water resource users associations (WRUAs) provide a forum for conflict resolution and cooperative management of water resources in designated catchment areas, mostly at the irrigation scheme level (Republic of Kenya, 2005). The introduction of a joint management of NIB and IWUAs has seen a reduction in conflict as farmers are represented and have a say in decision making.

4.8. Hypothesis Testing

The study tested the following hypothesis:

- **"There is no significant difference in the mean incomes of Mwea Irrigation Scheme (MIS) farmers under National Irrigation Board (NIB) and non NIB farmers."**

  Two t-tests carried out showed that there were significant differences, first in non-farm income ($p<0.025$) between NIB and Non NIB rice farmers, and in farm income between the rice production systems at 5 percent level of significance and other crops farmers. The hypothesis that "there is no significant difference in the mean incomes of MIS farmers under NIB and those of non NIB farmers growing other crops" was rejected based on these results. The NIB farmers had both higher non-farm income and farm income than the Non NIB rice farmers.

- **"The margin between the rice producer price and the wholesale price is not significantly different from estimated marketing costs given NIB marketing system and the current marketing system".**

This hypothesis was tested using 2000 data to test the efficiency of the NIB rice marketing system and using 2010 data to test the efficiency of the current rice marketing system. Results of analysis of variance (ANOVA) between the marketing margins and marketing costs for 2000 indicated that there was a significant difference between the mean marketing margins and the mean marketing costs for the period under NIB management. Based on this data the NIB rice marketing system was found to be inefficient.

Using data for 2010, the correlation coefficient between the marketing margin and marketing cost for producers and wholesalers was determined to be 0.144, the calculated F-value was determined as 0.168 and the critical F-Value ($F_{(0.10,\ 122,8)}$) was 2.293 (which is greater than 0.168, the calculated F-value), it follows therefore that the margin between the producer price and the wholesale price was not significantly different from total marketing costs. Given this therefore, it follows that producers' and whole sellers' margins were comparable and the system was efficient. On this basis, the study failed to reject the hypothesis that "the margin between the rice producer price and the whole sale price is not significantly different from the estimated marketing cost".

- **"The overall performance of NIB is not significantly different from that of the current system."**

A regression analysis was used to assess the factors affecting rice production and in the process capture the role of management in impacting on scheme performance. Management was found to be significant at 1 percent Confidence level, with a negative sign which means that under community ownership, yields declined. The hypothesis that "the overall performance of NIB was not significantly different from that of farmers" was rejected based on the results of the study that have shown management is significant to scheme performance.

CHAPTER FIVE

SUMMARY, RECCOMMENDATIONS AND CONCLUSIONS

5.1. Summary

This study set out to understand the socio-economic aspects of irrigation schemes in Kenya with Mwea Irrigation Scheme (MIS) as a case study. The study documented the rice production and marketing system, assessed the gross margins of rice and other crops and marketing margins and costs for rice from MIS during the different management eras. The aim was to try and understand the differences in scheme performance under different management systems; schemes under government, the period under farmer management and integrated management with a view to derive important policy recommendations for irrigation expansion in the country. Data were obtained both from primary and secondary sources.

Rice, the main crop in MIS was grown by farmers in the originally "planned area" and *Un-planned areas*. The latter gained prominence immediately after farmer takeover of MIS in 1998. All NIB farmers wanted to continue producing rice, besides rice, farmers produced other crops, more so horticultural crops. These included tomatoes and French beans. Maize was also produced by farmers especially in the unplanned area (*Jua Kali)*. Livestock production included cattle, small ruminants and poultry. Donkeys were an important livestock kept for draught power.

Gross margin analysis showed that rice farmers in the planned area realized more profit than those farmers in the unplanned area ceteris paribus. Gross margins from horticulture in 2010 were shown to be less than those from rice production, mainly because they involved use of a lot of chemicals for disease and pest control and increase in price of paddy between 2000 and 2010. Two t-tests showed that there were significant differences, first in non-farm income ($p<0.025$) between NIB and *Jua kali* farmers, and secondly in farm income between the rice production systems and "other crops" at 5 percent level of significance.

Data analysis on 2000 data revealed that the NIB rice marketing system was inefficient. From discussions held with farmers it was also revealed that the farmers had been facing a lot of socio-economic problems, which affected the farmers' relationship with the NIB. It was also revealed that the MRGM SACCO that the farmers opted to market their produce through did not have the capacity of providing similar services to the NIB.

An analysis of the marketing costs and margins for traders in the value chain revealed that the mean marketing costs were consistently lower than the mean margins and therefore, the players in the rice marketing value chain received high profits. In addition, the margin between the rice producer and wholesale price for the current marketing system was not significantly different from total marketing costs implying that the two players' share in the price margins was comparable.

A regression analysis to determine the factors affecting rice productivity within MIS revealed that the scheme under NIB management performed better than when the farmers took over. The unit of performance in this case was restricted to the amount of rice produced.

Women were found to be playing major roles in decision making as it was realized that in 32 percent of households, decisions were made jointly by the husband and wife, in 10 percent the decisions were made by the woman, 44 percent by the man and in 12 percent by others.

Loan procurement was reported to be a problem by 43 percent of the farmers in 2000 and 58 percent in 2010; this could be attributed to lack of organized credit provision after the collapse of the farmers SACCO. The study also found out that poor market organization and lack of farmers' cooperative capacity had led to dominance of cartels and rice adulteration.

The original MIS farmers interviewed (who were NIB tenants) felt strongly that they should be issued with title deeds for the land they occupy and all (100 percent) were in agreement.

5.2. Recommendations

- Integrated management of irrigation schemes where both the government through the NIB and farmers each have a say in production and marketing is a better way to move. The roles of each party should be determined and spelt out to prevent conflict.

- Market forces of supply and demand should be left to determine the input and output prices for enterprises in the irrigation schemes, more so for an important cereal like rice.

- Agricultural extension along the rice value chain in techniques related to rice production, processing and marketing should be availed to the producers to improve on their profits.

5.3. Conclusion

Putting farmers in charge of management, operation and maintenance of irrigation schemes is generally accepted as essential to achieving viable and sustainable irrigation systems. Dependency on government agencies in carrying out operation and maintenance of irrigation schemes has often led to ineffective and expensive services that are difficult to sustain and lead to rapid deterioration of the infrastructure. A sense of ownership of the system is an important pre-requisite for farmers' participation in management. The transfer of management to the beneficiaries is an attractive and cost effective alternative.

In the MIS case the process of farmer empowerment and the transfer of management and ownership of the schemes to the water users will require more time than originally envisaged. This will require further structural reorganization involving farmer empowerment, strengthening of the IWUA and eventual transfer of ownership and management of the scheme to the IWUAs with appropriate guidance, training, capacity building and support from NIB and other institutions for sustainability.

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APPENDICES

Appendix 1: National Irrigation Board's Farmers Budget 1998/99

Expenditure Items	Mwea Sindano	Mwea Basmati	W/Kano Sindano	W/Kano Basmati	Ahero Sindano	Bunyala Sindano
Land prep	2000	2000	2000	2000	2000	2000
Maintenance	1850	1850	2100	2100	2100	2100
Nursery Mgt	405	405	380	380	380	380
Fertilizer	4208	2722	2626	1786	2530	2718
Mowing	40	40	700	700	700	700
Bridges	36	36	50	50	50	50
Boards	89.5	89.5	80.5	80.5	80.5	80.5
Gates	207.6	207.6	105	105	105	105
Seed	335.7	448.5	712	900.9	700.8	727.4
Seed treatment	50	-	647.85	647.85	647.85	647.85
Nursery spray	70.7	70.7	-	-	-	-
Field spray	1146	1146	268.65	268.65	268.65	268.65
Transplanting	840	840	800	800	800	800
Weeding	1200	1200	700	700	700	700
Harvesting	1800	1605	1620	1620	1620	1620
Loading	400	260	120	80	104	120
Handling	1992	1245	502.5	335	435.5	502.5
Loan repayed	20	20	-	-	-	-
Land leveling	900	900	750	750	750	750
Bird scaring	700	700	500	500	500	500
Field security	200	140	200	140	200	200
TVC	19,561.70	16,996.90	15,949.26	14,968.81	15,725.05	16,086.74

Source: National Irrigation Board, 2000

Appendix 2: National Irrigation Board's Farmers expected Income for 1998/99 season

	Mwea Sindano	Mwea Basmati	W/Kano Sindano	W/Kano Basmati	Ahero Sindano	Bunyala Sindano
Bags/acre	33	21	28	20	25	30
Home	7	5	6	4	6	6
Total yield	40	26	34	24	31	36
Kgs	3000	1950	2550	1800	2325	2700
NIB price	12.50	20	12.5	20	12.5	12.5
Value Kshs	37,500	39,000	31,875	36,000	29,062.50	33,750
Return/acre	17,938.30	22,003.10	15,925.74	21031.19	13,337.45	17,663.26
Return/4Ac	71,753.20	88,012.40	63,702.96	84,124.76	53,349.80	70,653.04

Source: National Irrigation Board, 2000

Appendix 3: Rice Production, Acreage and Number of Plot in Mwea Irrigation Scheme for 25 years

Year	Number of plot owners	Area cropped (Ha)	Paddy production (tons)
1985	3234	8271	26407
1986	3236	5799	25236
1987	3236	5795	27163
1988	3238	5818	27555
1989	2248	5820	26713
1990	3240	5802	25504
1991	3240	5815	29274
1992	3240	5865	26765
1993	3242	5882	24205
1994	3242	5878	24892
1995	3243	5901	25987
1996	3270	6145	27488
1997	3392	6000	21352
1998	3381	6052	31876
1999	3500	8617	44830
2000	3381	10590	45810
2001	3835	6054	14802
2002	3200	15800	35550
2003	3400	10000	46875
2004	5400	10000	59520
2005	5400	10332	57422
2006	7267	8325	51458
2007	7257	7806	38560
2008	4936	7432	32604

Source: Kenya National Bureau of Statistics, 2010

Appendix 4: Research Survey Questionnaire

QUESTIONNAIRE FOR MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS STUDY, UNIVERSITY OF NAIROBI YEAR 2000/2010

SOCIO – ECONOMIC ASPECTS OF IRRIGATION SCHEMES IN KENYA, THE CASE OF RICE PRODUCTION IN MWEA IRRIGATION SCHEME

HOUSEHOLD INFORMATION

1. Date of interview _____
2. Name of respondent _____
3. Relationship of respondent to farm owner

   [1]. Self [2] Child [3] Sibling [4] Employee
4. Location _____
5. Sub Location _____
6. Village _____

   [1] NIB Farmer [2] Non-NIB Farmer

FARM AND FARMER CHARACTERISTICS

7. Name of farmer _____
8. Gender of farmer (household head) [1] Male [2] Female
9. Marital status [1] Married [2] Single
10. Spouse's approximate age in Years _____
11. Marital class [1] Monogamous [2] Polygamous
12. Number of children below 11 years _____
13. Number of children above 11 years _____
14. Education level of farmer [1] None [2] Primary [3] Secondary [4] College
15. Land size within scheme in acres [_____] or ha [_____]
16. Land tenure for land within the scheme [1] Registered with title [2] Rented
17. Do you operate other pieces outside the scheme? [1] Yes [2] No
18. Land tenure for land outside the scheme [1] Registered with title [2] Rented

NON FARM INCOME

19. Any other source of income for the farmer apart from farming? [1] Yes [2] No
20. If yes, indicate approximate amount of annual income in Kenya shillings ____

21. Any other household member in paid employment apart from farming?
[1]Yes [2]No

22. If yes, approximate total amount of annual income in Kenya shillings _____

23. What would you think are the options available to increase your income as a farmer? ----------

EXTENSION AND CREDIT

24. Did you receive any visit from extension staff in the last twelve months?
[1]Yes [2]No

25. If yes, from which organization did the extension staff come from?
[1] Ministry of Agriculture [2]NIB [3]NGO [4] Private company [5] Others

26. If yes, how many times? _____

27. How do you rate the advice given by the extension staff? [1]Useful [2] Not useful

28. What improvement would you like to see in the extension services? _____

29. Did you receive a loan/credit (including farm inputs) in the last 12 months?
[1]Yes [2]No

30. If yes, for what purpose? _____

31. Was the loan sufficient for the purpose? [1]Yes [2]No

32. Did you have any difficulties in repaying the loan (cash or inputs)? [1]Yes [2]No

33. If yes, how did you manage to repay the loan? _____

34. Did you have any problems in loan procurement? [1]Yes [2]No

35. If yes, explain

36. Are the repayment terms of the loan reasonable [1]Yes [2]No

37. If no, explain

CROP ENTERPRISES

38. Do you grow rice? [1]Yes[2]No

39. If yes which variety did you grow last season? How many acres did you put under rice last season?

40. How much did you spend on each of these operations? Acreage _____

Operation	Cost per unit	Total cost
Rotavation		
Ploughing		
Harrowing		

Canals / structure		
Roads		
Mowing		
Land levelling		
Bird scaring		
Field security		

41. How much of the following inputs did you buy and what was the cost? Acreage ---

Input	Amount used	Price per unit	Total spent
Seed			
Sulphate of ammonia	Nursery/Field		
Tsp			
Nursery spray			
Field spray			
Gunny bags			

42. How much of the following inputs did you buy and what was the cost?
Acreage_____

Input	Amount used	Price per unit	Amount spent
Seed			
Sulphate of ammonia	Nursery+ Field		
Tsp			
Nursery spray			
Field spray			
Gunny bags			
Others			

43. How much money did you spend on the following operations? (value even if family labour)

Activity	Amount paid per acre
Nursery management	
Fertilizer application	
Spraying pesticides	
transplanting	
Weeding 1. 2. 3. 4.	
Harvesting Threshing	
Winnowing	
loading	
Bagging	

44. Who bought your rice last season? _____

45. Any special reason why you sell your rice there? _____

46. Did you sell your rice at the farm gate? [1]Yes [2]No

47. If no, how much money did you spend on transportation?

KShs _____per bag to the house

KShs _____ per bag to the selling centre

48. The weight of each bag was _____Kgs

49. Amount harvested _____

50. Amount consumed at home including and gifted _____

51. Amount sold _____

52. Price per unit _____

53. Gross income _____

54. What problems do you encounter in rice marketing? _____

55. What improvement in your opinion would you like to be made in the marketing of rice? _____

LABOUR REQUIREMENTS FOR RICE

56. How many family members are available for farm work on the rice field? ____

57. Is the family labour adequate [1]Yes [2]No

58. If no, do you hire labour [1]Yes [2]No

59. If yes, how many permanent labourers do you have? _____

60. How much (in total) do you pay them per month? _____

61. Do you employ casual labourers? [1]Yes [2]No

62. If yes, how much on average do you pay (in total) per day? KShs_____

63. For which operations in a calendar year do you require casual labourers

Month	Operation	Yes=1, and zero otherwise
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		

ORGANIZATION

64. Do you have a farmers' organization in the scheme of which you are a member?
    [1]Yes [2]No
65. If yes, how were the representatives selected?
66. If no, why haven't you joined the farmers' organization?
67. Rate the performance of the farmers' representatives
    [1] Good [2]Fair [3] Poor
68. Who decides the prices for the following?

    Irrigation water _____

    Rice producer price _____
69. Are you aware of the criteria used in fixing prices for the above two items?
    [1]Yes [2]No
70. Do you think the prices are fair? [1]Yes [2]No
71. Give reasons
72. What activities in the irrigation scheme are managed by farmers alone? _____
73. What activities in the irrigation scheme are managed by the NIB alone? _____
74. What activities are managed by farmers and NIB jointly?
75. What activities managed by farmers would you like to see managed by the NIB instead?
76. What activities managed by NIB would you like to see managed by the farmers instead? _____
77. What do you think are the 2 major problems farmers' face in the scheme?
    _____
78. If you had your own way, would you continue growing rice alone in the scheme?
    [1]Yes [2]Yes
79. If no, which other crops would you cultivate and what are the reasons?
80. If you had your own way, would you grow rice and other crops at the same time in the scheme? [1]Yes [2]Yes
81. If yes, which other crops would you produce besides rice and why?
82. If you had your own way, would you grow rice and other crops in the subsequent season in the scheme? [1]Yes [2]Yes
83. If yes, which other crops would you produce alternate with rice and why?___

LABOUR REQUIREMENTS FOR OTHER CROPS

84. Is the labour you have on your farm enough for all the activities you carry out in the farm? [1]Yes [2]No
85. Do you employ permanent labourers? [1]Yes [2]No

86. If yes, how much on average do you pay your permanent labourers per month? ___

87. Do you employ casual labourers? [1]Yes [2]No

88. If yes, how much on average do you pay your casual labourer per month? __

89. List the farm operations for other crops and show whether you employ casual labourers or not in a year

Month	Operation	Yes = 1 and zero otherwise
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		

90. How many different crops did you grow last season and how many acres of each crop did you plant?

Crop	Variety	Total area (acres)

91. Name of major other crop _____ Acreage _____

92. How much of the following inputs did you buy and what was the cost?

INPUT	AMOUNT USED	PRICE PER UNIT	TOTAL SPENT
SEED			
FERTILIZER 1 2 3			
PESTICIDES 1 2 3 4			
GUNNY BAGS			

OTHERS 1 2 3 TRANSPORT ATION	DISTANCE _____	KSHS/BAG _____	CENTRE WHERE SOLD_____

93. How much money did you spend on the following operations? (value even if family labour)

ACTIVITY	AMOUNT SPENT PER ACRE
Land preparation	
Nursery management	
Transplanting	
Fertilizer application	
Spraying pesticides	
Irrigation	
Weeding 1. 2. 3. 4.	
Harvesting Thrashing	
Winnowing	
loading	
Bagging	
Others: Depending on crop 1 2 3	

94. Figures on the main crop

AMOUNT HARVESTED	AMOUNT CONSUMED AT HOME	AMOUNT SOLD	PRICE PER UNIT	GROSS INCOME

HOUSEHOLD BASICS

95. How much (approximately) do you spend on food per month? _____

96. How much (approximately) do you spend on medical bills per year? _____

97. How much (approximately) do you spend on clothing per year? _____

98. Do you pay school fees for any children? [1]Yes [2]No

99. If so approximately how much per term /year? _____

100. Do you pay rent? [1]Yes [2]No

101. If so approximately how much per month? _____

102. Do you own any of the following assets? What is the current value?

Asset	Ownership [Yes] [No]	Current value
Animal Cart		
Hand sprayer		
Animal plough		
Oxen spike harrow		
Water pump		
Vehicle		
Bicycle		
Motor bike		
Radio		
Television set		
Mobile phone		
Camera		
Others (specify)		

LIVESTOCK ENTERPRISES

103. State the number of livestock heads you had in the last 12 months

Draught oxen	Cows	Bulls	Sheep	Goats	Poultry

104. How much approximately did you spend buying animal feeds in the last 12 months?

Type of feed	Cost per unit	Total value

105. How much did you spend on dipping / spraying in the last 12 months? _____

106. How much did you spend on veterinary charges in the past 12 months?

107. How much milk did you produce per day? Morning_____evening_____

How much was consumed at home daily? _____

108. How much was sold per day? _____

How many months did you milk your animal in the past 12 months _____

109. What monthly income category best describes this household?

[1]0-1000 [2]1001-5000 [3]5001-10000 [4]10001-20000 [5] More than 20000