A Case Study of the Effect of Organised Irrigation:

the Mwea Irrigation Settlement, Kenya, 1973

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Doctor of Philosophy

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1974

Declaration

I affirm that the composition of this thesis is my own work and that it is based on field research conducted and directed by me in the Mwea Irrigation Settlement, Kenya, during 1973.

Carey B. Singleton, Jr.

TO

MY MOTHER

ABSTRACT

Mwea is the most highly sophisticated and successful rice scheme under organised irrigation in Africa. Its production of 3 tons of paddy per acre ranks with that of the highest rice producers in the world. The scheme's major aim is to settle landless and unemployed peasants on land which has been provided with drainage and irrigation, and which is capable of intensive agricultural production. It is a combination of state agriculture and tenancy under a licence agreement. Mwea started from scratch in 1955. It is a constantly changing phenomenon in its sociological, economic, environmental and ecological setting.

The objectives of this study were directed to find out why the Mwea was a successful irrigation scheme; to discover what makes a successful paddy farmer; to ascertain the constraints on the future development of Mwea; and to determine whether the Mwea experience and success can be repeated elsewhere. Tenants were classified according to yield per holding, into high, average, and low-yielding groups. Correlation analysis was used to identify the major social and economic factors, which have resulted in the success or failure of the tenants.

Soil alkalinity is a major problem, and is spreading. In the past several years, substantial acreage has had to be abandoned. Mwea has been over-extended and is presently pushed beyond its capability. The irrigation system was designed to

serve approximately 12,000 acres. The addition of a new section of 2,000 acres involves a calculated risk, as the hydrological system is now in a state of disequilibrium. It is advisable to solve existing problems rather than to rush headlong into expansion. Problems often breed other problems. The lack of hired and/or casual labour at critical periods of harvesting and transplanting is now an acute problem. The statistical analyses and field enquiry substantiate that tenants in the low-yielding group are unable to mobilise their household labour. It is not the size of the household that matters, but the ability of the tenant to organise and mobilise it. Unemployment and underemployment, particularly of the youth, are major problems facing Mwea. Population build up at Mwea is increasing at an alarming rate. Mwea is economically sound, but sociologically a failure. The substantial profits from the Settlement have been used by the NIB to prop up failing irrigation schemes in Kenya. But benign neglect over the years makes it imperative that some of the profits are used to counteract the deteriorating social conditions at Mwea.

It is through identifying the economic, social and geographic aspects which resulted in success or failure of the tenants at Mwea and by recognising the vulnerability of Mwea that this study makes its contribution.

ACKNOWLEDGEMENTS

What is past is prologue. This thesis could not have been written without the help of many people. It is impossible to mention all; however, I would like to thank everyone connected with this study. The African-American Scholars' Council financed the travel and field research. Without this grant the study could not have been carried out. I am grateful to the Kenya Government for their approval of the study and for the invaluable co-operation of Mr. P.S.T. Mirie, General Manager, National Irrigation Board, Mr. Simon Kinai, Manager of the Mwea Irrigation Settlement, and their staffs. I am particularly indebted to the tenant farmers of Mwea for their willing participation and co-operation. For the services of my interpreter/enumerator, Mr. Charles Kihara and my research team, I am deeply grateful.

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My thanks go to Grace Hunter, Librarian, Centre of African Studies, University of Edinburgh, and Margaret Dowling, Librarian, University of Edinburgh, for their kind assistance in procuring the use of the many books and publications used in this thesis.

I wish to thank Lilian Robertson for her very competent typing of the final draft.

Last, but not least, I must mention the sacrifices that my family has made during my completion of the field work and the writing up of this thesis.

The sole responsibility for this thesis, and the opinions herein expressed are entirely mine! Mwea proved to be a tough nut to crack!

Edinburgh
November 1974

C.B. Singleton

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LIST OF MAPS AND DIAGRAMS

LIST OF PHOTOGRAPHS

All photographs used in the thesis were taken by the author during the field survey and enquiry work at Mwea.

TABLE OF CONVERSION FACTORS

1 Kenya shilling (Ksh)*	=	6 British pence
1 Kenya pound (K£)+	=	£1.17 sterling
1 U.S. dollar	=	Ksh. 7.14
1 kilogram	=	2.2046 pounds
1 metric ton	=	2.204.6 pounds
1 (long) ton	=	2.240 pounds
1 hundredweight (cwt.)	=	112 pounds
1 acre	=	0.4047 hectares
1 hectare	=	2.4711 acres
1 bag of paddy	=	160 lbs.
1 cusec	=	1 cubic foot per second
1 mile	=	1.6093 kilometers
1 kilometer	=	0.621371 mile
1 meter	=	3.28084 feet

* The Kenya shilling is divided into 100 Kenya cents

\+ The Kenya pound is divided into 20 Kenya shillings

ABBREVIATIONS*

MIS	Mwea Irrigation Settlement or Mwea (short title)
IO	Irrigation Officer
HFA	Head Field Assistant
FA	Field Assistant
HWG	Head Water Guard
WG	Water Guard
HC	Head Cultivator
DO	District Officer
DC	District Commissioner
M & PB	Maize and Produce Board
PAO	Provincial Agricultural Officer
PC	Provincial Commissioner
NIB	National Irrigation Board
NAL	Kenya National Agricultural Laboratories
ALDEV	African Land Development Board
UNDP	United Nations Development Program
FAO	Food and Agriculture Organization
EAC	East African Community
IRRI	International Rice Research Institute

* The full title is given for each abbreviation the first time it is mentioned in the thesis. Titles may be referred to in an abbreviated form as they are colloquially used in the study.

GLOSSARY

Abstraction	-	Consumption of water
Alluvium	-	Old river sediments as well as those now being added to the flood plain; lake deposits of geologically recent origin
Bilharziasis	-	Microscopic snail-borne disease contracted by being around irrigated waters
Boma	-	A thorn-bush barrier erected about an animal pen mainly for protection against wild animals
Bunds	-	Terraces three to four feet in height made of earth, generally with a grass cover
Cash crops	-	Any crops which are sold
East Africa	-	The nations of Kenya, Uganda, and Tanzania
EARH	-	East African Railways and Harbors Administration
Farm	-	Land which is occupied and worked as a unit by a person or group of persons. Where a farm is composed of parcels of land these are referred to as pieces or fragments.
Grumosol	-	Black cotton soils, black clay loams having clayey, generally calcareous subsoils
Halloysite	-	A clay-like earthy mineral, a hydrated aluminium silicate resulting from the decomposition of felspar
Hydrography	-	The description and study of seas, lakes, rivers and other waters; specifically, the measurement of flow of streams, with reference to utilisation of their waters
Hydrology	-	The science treating of water, its properties, phenomena, and distribution, especially with reference to water on the surface of the land, in the soil and underlying rocks, and in the atmosphere
IBRD	-	International Bank for Reconstruction and Development. Also called World Bank
KANU	-	Kenya African National Union; Kenya's major political party
Latosol	-	Soils derived primarily from volcanic rocks and are generally associated with peneplains. These soils are considered relics of a past more humid climate.
Local Government Authorities	-	Local authorities, particularly in rural areas, developed from the traditional tribal or subtribal authority. They were known in the past as Native Authorities.
Matatu	-	Small taxi usually referred to as the "happy taxi"
Mbati roof	-	Constructed with corrugated iron sheeting

Miombo	-	Open canopy type of woodland characteristic of the drier areas of 1,000 to 4,000 feet elevation
Paddy	-	Rice in the husk
pH	-	Negative logarithm of the H ion concentration
Pishori	-	Basmati rice
Pombe	-	African beer
Rotovation	-	Mechanical cultivation, "puddling" of fields, under 4 inches of water
Royal Commission (East Africa)	-	A commission appointed by Royal Warrant in the United Kingdom in 1953 "... to examine the measures necessary to be taken to achieve an improved standard of living ..." in the East African countries of Kenya, Uganda, and Tanzania
Shamba	-	A small African farm including land and house
Smallholders	-	Farmers, primarily African, of small landholdings producing subsistence and cash crops
Swahili	-	The official language of East Africa. It is the habitual language of many Africans along the coast but is a second language, taught in primary schools, in the inland areas. English is the most prevalently used language in official publications, periodicals, newspapers, and so forth.

CHAPTER 1

MWEA IRRIGATION SETTLEMENT: AREA SITUATION

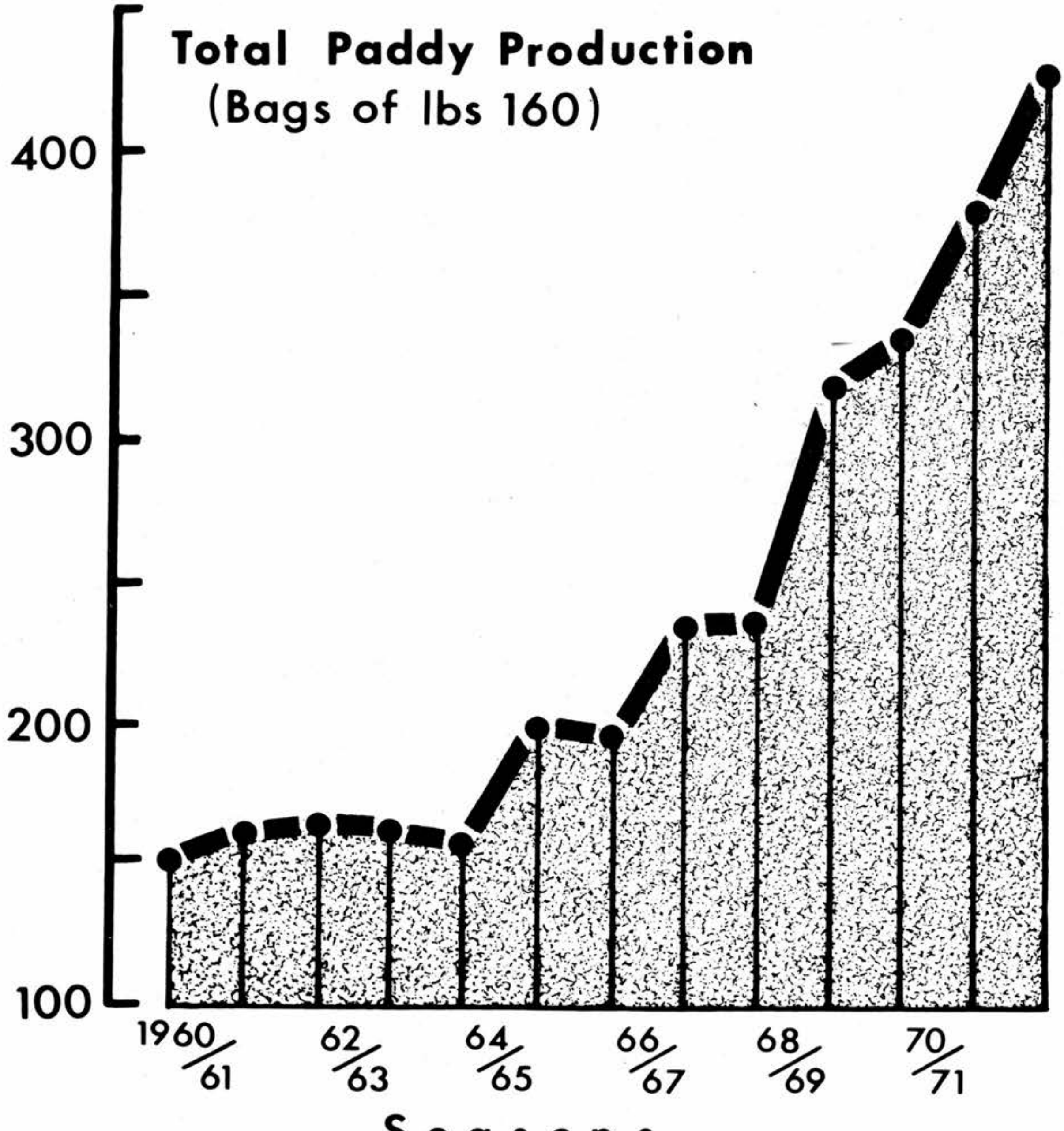
The major thrust of this thesis is to ascertain the factors which have made the success of the Mwea Irrigation Settlement (MIS) possible. Why is Mwea important? An attempt will be made to answer this provocative question by analysing the factors which have brought about the social and economic desirability of smallholder farming in Kenya. Paddy production at Mwea has been directed through close supervision combined with efficient production, marketing and processing functions. Primary emphasis will be put on geographic, economic, sociological, and environmental aspects of successful smallholder farming in the MIS.

There are at present two major types of irrigation in Kenya: large-scale organised and small-scale organised. The large-scale organised irrigation projects are all supervised by the National Irrigation Board (NIB) and cover a total area of approximately 25,000 acres. However, it should be kept in mind that these irrigation projects in Kenya are small in comparison with those in Egypt, Sudan, India and Pakistan. There are approximately 500,000 additional acres of underdeveloped irrigable land in Kenya. The NIB estimates that there are four jobs created by every hectare of land irrigated. The employment potential for irrigation projects in Kenya is very great. The availability of irrigable land is one necessary condition for development. Water in sufficient quantity, and at the correct time, is essential, and financing the irrigation scheme is of major concern. But the most important factors in an organised irrigation settlement are managerial and entrepreneurial expertise and the close supervision of the Field Extension Staff. Many of the unemployed labourers from the hinterland of Kenya are utilised as hired and/or casual labourers during the paddy production cycle. This is of great importance in densely populated areas such as in the foothills of the Aberdare Range and Mount Kenya. Many of the unemployed who come to Mwea come from the up-country. The areas in the up-country are ecologically speaking of medium potential; however, this potential is limited and the quality of life is substantially reduced by the intensive population pressure on the land. Irrigation is used in farming crops other than paddy such as sugarcane, pineapple, cotton, onions, chillies, pepper, and horticultural crops. This deserves to be encouraged because agriculture and horticulture are more labour intensive than the cultivation of field and non-horticultural crops. Irrigation increases the quality of the crop and ensures continuity in production.

A major objective of organised smallholder irrigation schemes in Kenya is to permit the maximum absorption of population. The application of this policy promulgated by the NIB is directed to find the optimum level of population absorption on organised irrigation settlement schemes. The current policy of the NIB on population absorption is based on the following objectives: (1) to relieve the accelerating population pressure in both the highlands and the urban centres, (2) to avoid the creation of increasing rural slums in urban centres, (3) to avoid the acceleration of unemployment and underemployment in the smallholder farm sector, (4) to bring about employment for many of the youth who are seeking jobs in urban centres, and (5) to

reward the smallholder for adjusting to the high degree of subjection, close supervision, and an unusual degree of discipline and regulation in an organised settlement scheme. The end result of these objectives is high income and a new life style for smallholders at Mwea. Over the past decade, Mwea's paddy production has increased phenomenally, from 167,474 bags (12,153 tons) in 1962/63 to a record 430,168 bags (31,218 tons) in 1972/73 (Fig. 1.1). This sharp increase is attributed to an increase in acreage (Fig. 1.2) and increased yields (Fig. 1.3). The average net income per farmer during 1972/73 was a record 3,865 Kshs. (Fig. 1.2). During the 1972/73 season there were 3,020 tenants at Mwea (Fig. 1.2) farming 11,698 acres of paddy under gravity irrigation (Fig. 1.2). Paddy yield per acre in 1972/73 reached a record high of 36.8 bags (Fig. 1.3) -- about 3 tons per acre -- ranking with the highest in the world. Net income from paddy farming at Mwea ranks with some of the highest production and net income from agriculture in Kenya. For the tenant it is also stable and secure income. The smallholders of Mwea must be considered a privileged group among the farmers of Kenya as a whole. The income-earning potential from irrigation is substantial.
During the 1973/74 season, 454 new tenants were added to the new Karaba Extension of the MIS. During my field enquiry I was informed by the Manager of the MIS that there is a waiting list of over 2,000 landless peasants. Government funds are utilised to develop organised irrigation schemes and the benefits in terms of profitable farming opportunities which may be created should be shared as far as possible among the landless peasants. It is of great importance that an elite group of farmers should not be created as a privileged class. Losses in efficiency and inefficient farmers in irrigation schemes should be

MWEA



SOURCE : MWEA IRRIGATION SETTLEMENT

FIG. 1·1

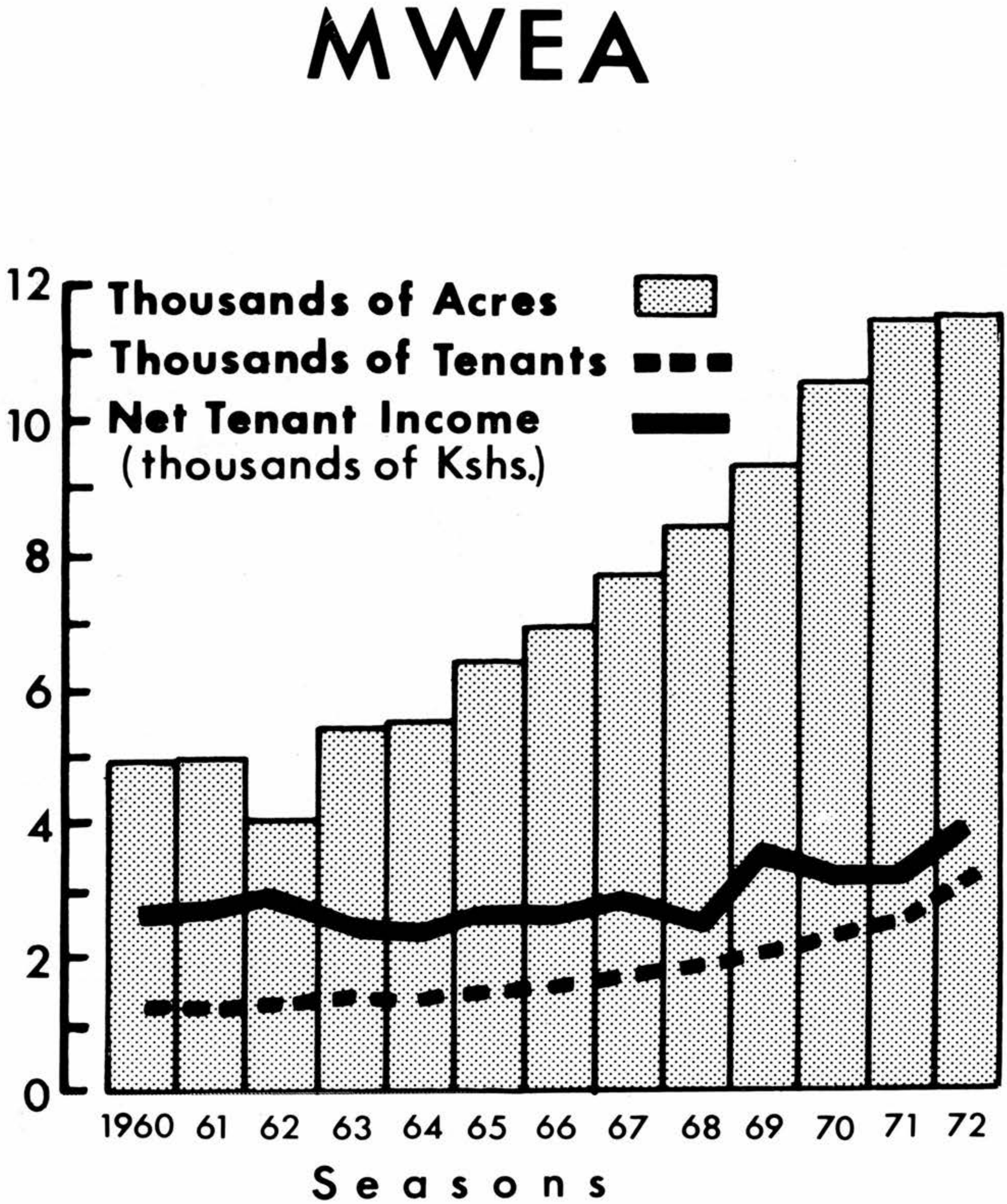

MWEA
Thousands of Acres
Thousands of Tenants
Net Tenant Income
(thousands of Kshs.)
12
10
8
6
4
2
0
1960 61 62 63 64 65 66 67 68 69 70 71 72
Seasons

FIG. 1·2

MWEA

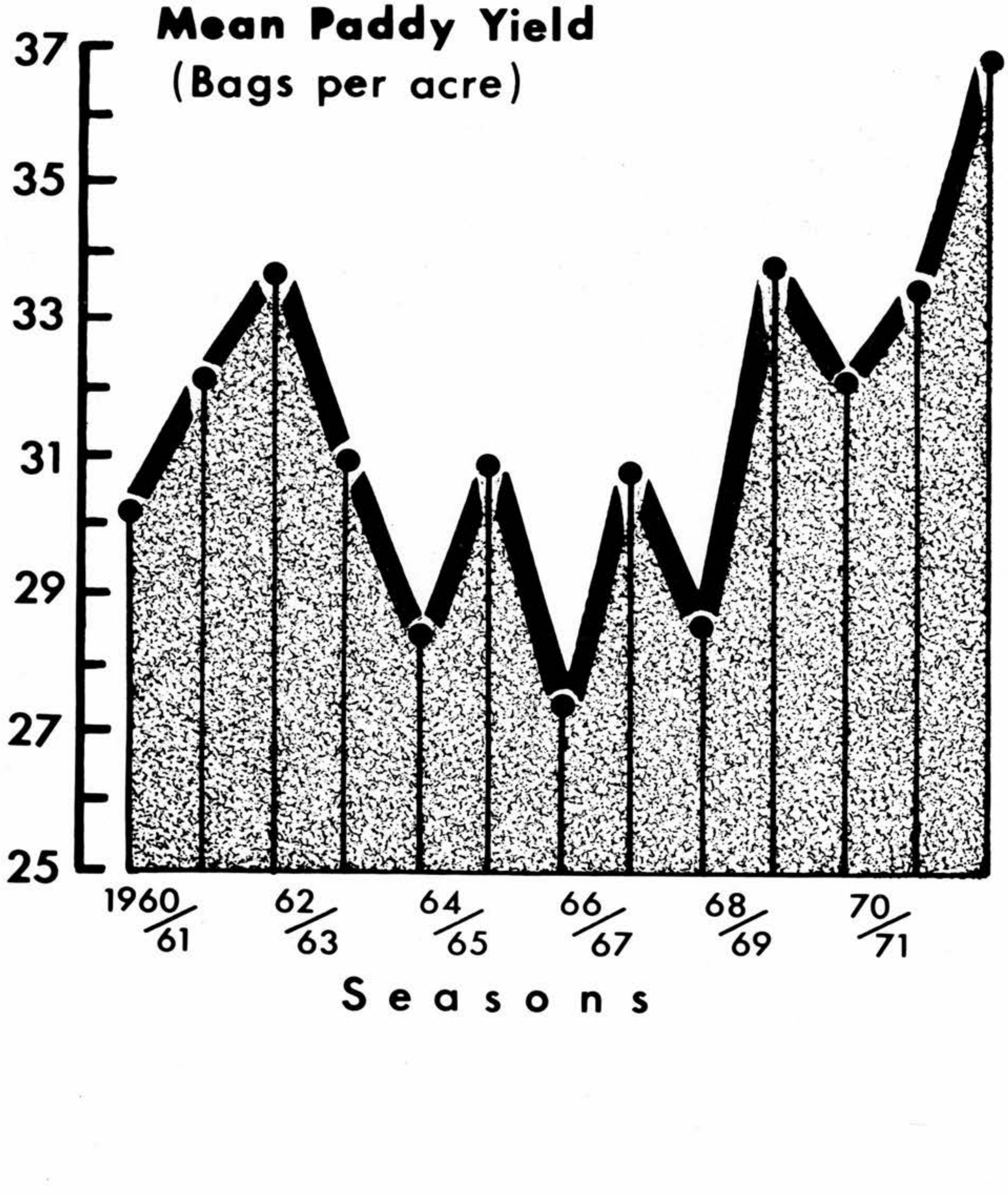

Mean Paddy Yield
(Bags per acre)
37
35
33
31
29
27
25
1960/61
62/63
64/65
66/67
68/69
70/71
Seasons

FIG. 1·3

replaced by farmers willing to meet the challenge of good crop husbandry and yields. The MIS was designed to intensify paddy agricultural production and to provide holdings for 3,000 farmers and their families. Irrigation settlement schemes in low income densely settled areas should be encouraged because they offer good prospects of improving the levels of living for the people. It is the purpose of this thesis to indicate the conditions which are necessary to duplicate or, at least to some extent, emulate the Mwea success in other irrigable areas in Kenya.

POPULATION AND PRESSURE

There is need for more commercialised agriculture in Kenya. There is also great need for a more intensive agriculture in the cultivable areas of the country. Kenya's population is estimated at 13.5 million in 1974 and is growing at a rapid rate of 3.5 per cent a year. Non-Africans represent approximately 2 per cent of the total. A significant characteristic of Kenya's demographic makeup is that 50 per cent of the population is under 16 years of age. There are about 49 people per square mile. Over 75 per cent of the total population is dependent on agriculture. The rural population in Kenya has declined since 1960 because of accelerating migration from farm to city. Kenya has a number of social problems with long-range economic implications, including unemployment, rapid population growth, housing shortages in urban areas, and the flight of people from rural areas to urban centres. The unemployment situation is acute. The African urban population has increased substantially during the past 10 years. Because of the rapid population growth, the 4 largest cities -- Nairobi (550,000), Mombasa (250,000), Nakuru (50,000) and Kisumu (35,000) -- have required increases in personnel in administrative, social and commercial services. For several years there has been an influx of rural young men and women, many with primary and secondary education but little in the way of urban skills, who are seeking jobs. Stopgap measures are being used to absorb some of these unemployed and underemployed young people. Long-range plans have been made to employ others. However, urban employment opportunities are not likely to grow fast enough to absorb the increasing number of young migrants. Therefore, it is the agricultural sector (and agribusiness) which must be largely relied on to provide jobs and reduce this chronic unemployment and underemployment problem. Essentially, through organised settlement schemes such as Mwea, an increase in the number of trained farmers and farm workers is necessary to obtain higher agricultural output and improvement in the quality of agricultural products through irrigation (Singleton, 1974, 9).

ORGANISED SMALLHOLDER IRRIGATION PROJECTS

A major objective of the NIB authorities is directed toward developing fully the water resources of the Tana River Basin and the Kano Plains Area. The development of the Upper and Lower Tana River Basin has been established as technically and economically feasible as described in the Kenya Government Study *Upper Tana Catchment Survey*, Volumes I and II. The International Land Development Consultants (ILACO) Report (*United Nations Development*

Programme, 1972, 416) states:

> It is estimated that by 1990, the number of families (people) settled on 2-acre plots under the Upper Tana, Lower Tana and Kano Plains schemes respectively would amount to 125,000, 50,000 and 35,000 at a capital cost of £600, £800 and £1,400 per family. The Upper Tana scheme would also increase employment indirectly through the generation of 657 megawatts of hydro-electric power. At present staffing densities, 8,000 senior, office and field extension staff will be required. Construction might also provide an average of 20,000 jobs a year over the period 1980 to 1990.
>
> Small-scale organised irrigation could be encouraged, particularly for horticultural crops. To facilitate this, there must be more training, more credit, perhaps more subsidies for equipment or recurrent costs, more extension advice, and more channels for marketing.

In evaluating the complexity of agricultural development in Kenya and the need for a strategy for increasing agricultural productivity, Johnson (1964, 91-96) writes:

> It is widely recognized that the development of agriculture is one of the crucial requirements for overall economic growth. There is, however, little consensus with respect to the most appropriate strategy for securing increased farm output and productivity in an underdeveloped country. Rational choice of measures in a particular country or region that will give maximum returns to the resources allocated to agricultural development must obviously take account of specific bottlenecks and possibilities as defined by its physical and human environment -- soils and climate, the skills and responsiveness of local farmers, the state of technical knowledge, and the availability and relative prices of land, labour and capital. There are, however, several important general considerations suggested by the nature of the process of economic development and by the experiences of other areas which throw light upon the

problem of designing an efficient agricultural development programme.

Lack of knowledge of many of the important physical and economic relationships between farm inputs and output and insufficient understanding of the way in which farmers are likely to respond to new production possibilities make it exceedingly difficult to calculate the returns in increased output that can be expected from various development activities. In this situation, determination of agricultural development priorities inevitably depends heavily upon the general experience, intuition and judgement of the agricultural officers and administrators concerned.

The crux of the problem of designing an efficient agricultural development programme for any country is to choose a combination of measures that will lead to the desired increase in farm output at minimum cost. The rate of increase in agricultural output is determined by the interaction of a host of proximate factors related to production decisions by individual farm operators and various conditioning factors that depend upon government programmes and other outside influences that affect the nature of the production possibilities available to farmers and the extent to which they have the knowledge, desire and control over resources required to seize the opportunities that exist.

There is no easy answer to the central problem: what level of resources should be devoted to fostering agricultural development and how should funds and personnel be allocated as between agricultural research, extension activities, irrigation or settlement projects, subsidies on inputs, promotion of cooperatives, or other measures which a government may utilize to influence farm productivity and output? Some guidance is provided, however, by certain considerations suggested by the nature of the process of development and the experience of countries that have achieved success in increasing farm productivity. Four general propositions seem to be especially pertinent to the design of a rational programme of agricultural development.

(1) It is important during the earlier phases of economic development to distinguish

between resources that are particularly scarce and others which are already committed to the agricultural sector and relatively abundant in agriculture, and to design programmes to increase farm output and productivity that minimize requirements for scarce resources of high opportunity cost.

(2) An underdeveloped country is almost certain to have a sizeable potential for increasing agricultural output and productivity by relying mainly on the widespread introduction of various technological innovations that make relatively small demands on the particularly scarce resources.

(3) Because of the highly important inter-relationships among some of the factors important to agricultural development, the effectiveness of a development programme will be increased if it consists of an appropriate combination of 'complementary inputs'.

(4) Limitations on the financial and personal resources available for agricultural development make it essential to concentrate efforts on a limited number of factors of strategic importance. It has been aptly noted by Kellogg that it is a characteristic feature of an underdeveloped country 'that nearly everything seems to need doing at once'. Moreover, the existence of important 'complementarities' among certain of the inputs important to agricultural development means that it is often necessary to give attention to a number of inter-related factors in order to achieve satisfactory results. A plant breeding programme, for example may have only limited impact on agricultural output unless it is accompanied by the full range of complementary inputs -- seed multiplication and a programme of distribution to farmers, fertilizer supplies, and instruction of farmers in the use of the complement of techniques necessary to obtain full benefit from the improved seed. Kellogg questions whether significant results can be expected from use of commercial fertilizers without attention to such complementary relationships or 'interactions' as he terms them: 'Since the old varieties were selected for generations to grow on poor soil'.

Kellogg asserts that 'failure to understand this principle of interactions is by far the greatest handicap to operational planning in most of the underdeveloped countries'. Although the notion of 'interactions' or 'complementarity' is highly important, it can be pushed too far. On the basis of his 'principle of interactions', Kellogg argues that there are four factors indispensable for efficient farming: '(a) adequate water, without waterlogging, in the rooting zone when the plants need it, (b) a balanced supply of nutrients in the rooting zone, (c) a kind of crop and a variety of crop with the genetic potential to respond to the modified environment and (d) a scheme for protection of the crop against pests of all sorts'. Under East African conditions, economic considerations argue against going too far in fulfilling the optimum conditions with regard to these physical requirements for maximum production. Provision of 'adequate water' every year would necessitate enormous outlays for irrigation projects, the marginal returns from which would be much less than those obtainable from other development activities such as research and extension. Kellogg's suggestion to avoid spreading resources too thinly is that efforts should be concentrated on particular areas of high potential. There is much to be said for concentrating resources on 'strategic areas' as well as 'strategic factors'. Higher returns can generally be obtained by giving priority to areas of high potential for export crop production or which have locational advantages in supplying the food requirements of expanding urban centres; but there is a problem of balance involved that is akin to the classical issue of choice between the intensive and extensive margins. With regard to Kellogg's suggestion that introduction of fertilizer must be associated with introduction of improved varieties, Frank W. Parker, formerly Director of the Technical Department of FAO and now with the U.S. Agency for International Development, reports that trials initiated by those agencies on farmers' fields in a number of countries and other evidence indicates that fertilizers often give an economic response with existing local varieties. Greater returns can naturally be obtained when improved varieties and cultural practices are also used. The importance of using combinations of improved practices increases

> as the rate of fertilization is increased for the purpose of achieving high yields (personal communication, 25 March 1963).

There is great merit in the development of organised irrigation settlements in Kenya which blends in with the general philosophy of the government based on *Harambee*, or a self-help basis. These organised irrigation schemes are economically and sociologically feasible and can be operated and directed by the Government of Kenya through the NIB. Stress is needed to study the economic and agricultural implications of the conditions which have made Mwea such a successful organised irrigation Scheme. This will indicate the conditions necessary to duplicate Mwea in other organised irrigation schemes in Kenya. It is of great importance that this success at Mwea should not be overlooked in the development of future organised irrigation schemes.

My approach to the study of Mwea was directed toward the aim of using a comprehensive questionnaire for the field enquiry, supplemented by an intensive field survey during my 5-month period living with the tenants at Mwea. My intent was to design an open-ended, comprehensive questionnaire to identify those factors which make the success of the Mwea possible - Who are the successful tenants? Why are they successful at Mwea? Can the success of Mwea be extended to other irrigable areas in Kenya? What are some of the major bottlenecks and weaknesses in the Mwea Scheme? Is Mwea vulnerable under different management? My original aim was designed toward a general study of Mwea, approaching the Settlement with an open mind. Mwea is a constantly changing Scheme -- dynamic -- with a complex inter-relationship between the tenant and paddy production. There were no particular premature findings on my part. My major interest was directed toward an open-minded enquiry. However, I was quite aware of the following characteristics of Mwea: for example, the size of family; constraints of seasonality; a hierarchical organisational superstructure; a hybrid between smallholder farming and plantation agriculture through centralised management; age of tenants; average net income; average production and yields; and intensive paddy production under close supervision. During my field survey I was able to see first hand all of the operations in the paddy production cycle with the exception of harvesting.

The reasons why Mwea has been a successful organised irrigation settlement will be seen in the subsequent chapters of this thesis.

The question arises: how much was known about Mwea before my work? This is a fair question and worthy of an elaboration. In 1969, R. Chambers published a study entitled *Settlement Schemes in Tropical Africa: A Study of Organizations and Development.* Chambers' work concentrated primarily on an analysis of the history of organisations at Mwea and the administrative structure of the Mwea Scheme. His work devotes only cursory attention to the important role of entrepreneurial and pragmatic expertise involved in the management of Mwea. He pays no attention to the high degree of capability displayed by the Field Extension Staff at Mwea, which was trained and disciplined by the Manager during the period between 1959 and 1966. Chambers analysed Mwea as a successful organisational structure. His stress was placed on the creation, organisation and administrative structure of Mwea.

Chambers' thesis is that the success of an irrigation scheme is due to its organisational structure. This is certainly true; but Chambers overlooks a crucial point -- the human element. A scheme is made successful by the direction of the Manager and by the individuals who make it go and <u>not</u> just by the organisation. A serious limitation of Chambers' study was his failure to investigate and perform field enquiries of the individual tenants and their operations and problems in paddy production. This was part of the reason for my doing this intensive field study and work on Mwea. This is why I went to Mwea to fill a void in research and field investigation of this successful organised irrigation scheme. Chambers' work does not give credit to the importance of managerial ability which deserves major attention. One can often forget too readily how important an individual with a high degree of expertise is to a project.

The second major work on Mwea was by Rudolph Golkowsky, published in 1969: *Bewässerungslandwirtschaft in Kenya*. Golkowsky's study devotes undue emphasis to the role of minor crops, such as cotton, maize, and beans, and also livestock production at Mwea. Golkowsky makes a major issue of the black-market operation in and around Mwea. Mwea is a highly sophisticated rice scheme, under organised irrigation. Other aspects are of minor significance toward the fulfillment of the major purpose of Mwea. Golkowsky's failure to see this represents a serious limitation of his work.

Since 1968 there has not been a comprehensive study of

Mwea until now. In retrospect, the timing of my field survey and enquiry was of major significance. I came to Mwea at a critical moment. The former Manager of Mwea, a European, had been replaced two months prior to my arrival by an inexperienced African Manager with no knowledge of rice production or the management of an organised irrigation settlement. The former General Manager of the NIB from 1966-72, a European, was replaced in January 1973 by an African with marginal and questionable experience for managing and controlling all the irrigation schemes in Kenya. The development of the Karaba Section took place during my field survey. This was an extension of 2,000 acres of the Mwea Settlement Area. Essentially this was a political move, directed toward settling landless peasants from the Kirinyaga District. This represented perhaps the largest expansion of an established irrigation scheme in Anglophone Africa in recent times, though not comparable in extent with the Managil Extension of the Gezira. The bringing into the Mwea Settlement of 454 new tenants to be settled into the Karaba Section, which took place during April-August 1973, was done with a minimum of planning. Also the significant change from growing Sindano to Basmati rice variety in the Thiba Section was made during the 1973/74 season.

Can Mwea continue its phenomenal growth of the past decade, under African managerial control? Can the Mwea Management operate the Mwea Rice Mills Ltd. successfully, under African control, and with the high degree of expertise needed? Will the trade-off from Mwea from the past managerial and entrepreneurial ability, 1960-72, be continued into the future? Figures 1.1, 1.2

and 1.3 show the dramatic growth of Mwea since 1960. Will the impact of the Karaba Extension of 2,000 acres permanently impair the former balanced equilibrium of Mwea, which had been meticulously designed for only 12,000 acres under paddy irrigation, rather than the present 14,000? Will Mwea's phenomenal history of success be protracted into the future and the experience gained be used as a guide and framework for future organised irrigation settlements in Kenya and Anglophone Africa? These are provocative issues. An attempt will be made in the following chapters of this thesis to shed some light and find some answers to these questions, from my field survey and enquiry.

CHAPTER 2

EVOLUTION OF IRRIGATION DEVELOPMENT IN KENYA

Organised irrigated settlements are a comparatively recent phenomena in Kenya and had their inception in the early 1950's. The development of irrigation schemes was only one aspect of the major progress of agricultural improvement undertaken in response to the pressures generated by the Mau Mau Emergency. During this period there was no local tradition or experience in irrigated cropping to draw on; no experience in hydrological engineering or available agricultural expertise. Also, there was very little research done on preliminary investigations in irrigation possibilities in the country. On the other hand there was a very strong socio-political demand for tangible results from a practical point of view. There were as well substantial funds available for agricultural development projects. These factors interacted to produce an atmosphere in which planning was reduced to an *ad hoc* level. Major importance was attached to physical achievement in the field. There was neither the time nor the opportunity to carefully appraise and assess what the long term effects of a particular agricultural project would be.

In 1960, with the end of the Mau Mau Emergency in the background, the first phase of irrigation construction ended and a calmer and financially more austere climate prevailed. The irrigation settlements in existence were Mwea, Perkerra, and Galole. It became a matter of priority to make them work successfully, to discover and rectify mistakes, and to evolve a methodology for the planning and operation of future irrigation settlements of this type. By 1963 it was apparent that despite a number of errors a valid set of principles for planning and running irrigation settlements had been evolved. Hence in 1963 the Kenya Government established *The Trust Land Ordinance* (Appendix I) which included the trust land rules for irrigated areas in Kenya. The achievement was reflected in the renewed interest taken by the Kenya Government in irrigation settlements as exemplified by additional extensions of Mwea and investigations into the potential of the Lower Tana River Basin. In March 1966 the Kenya Government, by Act of Parliament, No. 13, established the *Irrigation Act of 1966* (Appendix II); this act created The National Irrigation Board (NIB) (Fig. 2.1) of Kenya as a semi-autonomous organisation accountable to the Ministry of Agriculture. Figure 2.1 illustrates the organisational structure of the NIB and the lines of authority.

The NIB commenced its activities in 1966 when it took over the management of Mwea, Perkerra, and Galole Irrigation Schemes. The Board by Act of Parliament No. 13 of 1966 (Appendix II) shall be responsible for the development, control and improvement of national irrigation schemes in Kenya.

In particular, the Board has powers:

(a) to conduct research and investigation into the establishment of national irrigation schemes;

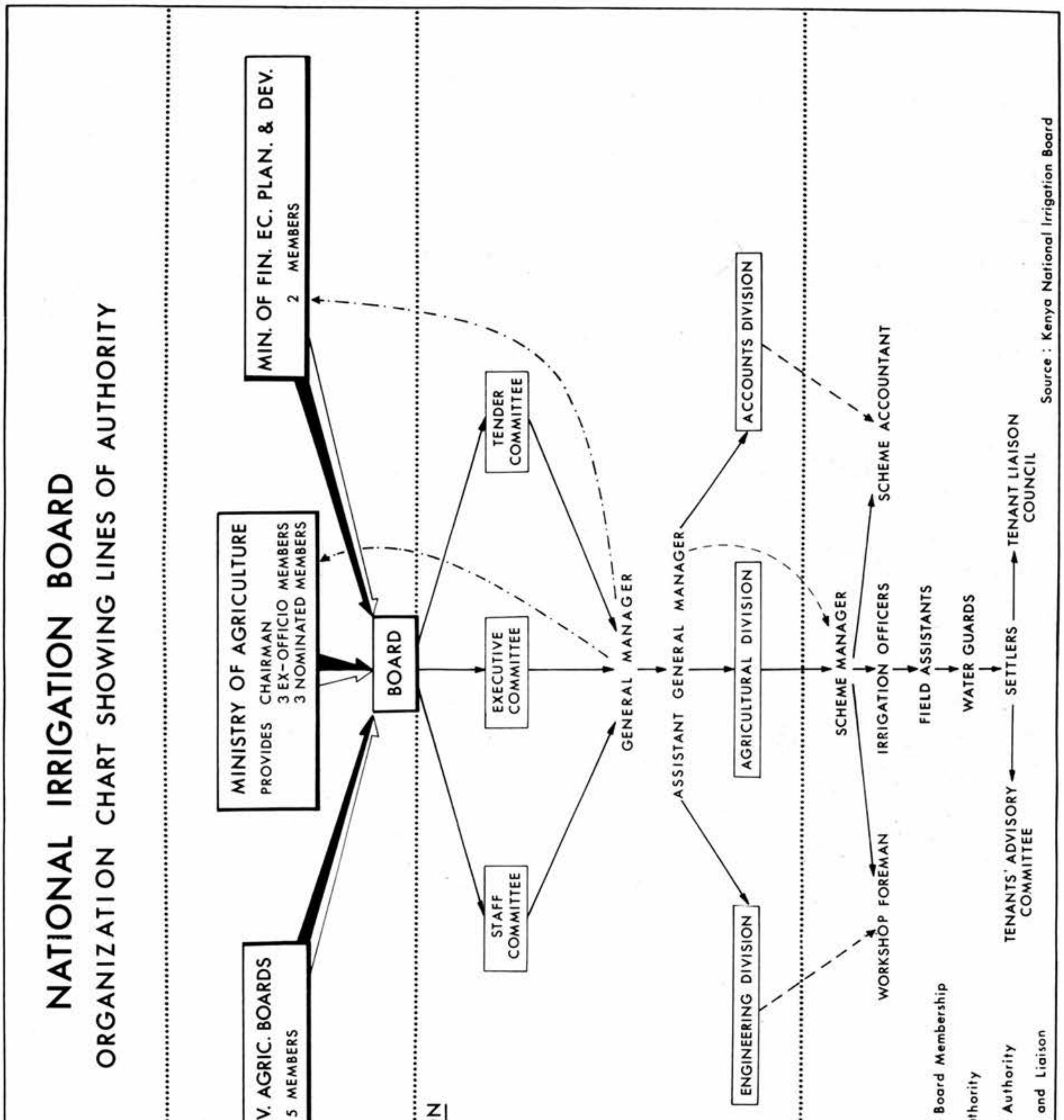

NATIONAL IRRIGATION BOARD
ORGANIZATION CHART SHOWING LINES OF AUTHORITY
POLICY
IMPLEMENTATION
OPERATIONS
PROV. AGRIC. BOARDS
5 MEMBERS
MINISTRY OF AGRICULTURE
PROVIDES CHAIRMAN
3 EX-OFFICIO MEMBERS
3 NOMINATED MEMBERS
MIN. OF FIN. EC. PLAN. & DEV.
2 MEMBERS
BOARD
STAFF COMMITTEE
EXECUTIVE COMMITTEE
TENDER COMMITTEE
GENERAL MANAGER
ASSISTANT GENERAL MANAGER
ENGINEERING DIVISION
AGRICULTURAL DIVISION
ACCOUNTS DIVISION
WORKSHOP FOREMAN
SCHEME MANAGER
IRRIGATION OFFICERS
SCHEME ACCOUNTANT
FIELD ASSISTANTS
WATER GUARDS
SETTLERS
TENANTS' ADVISORY COMMITTEE
TENANT LIAISON COUNCIL
Source of Board Membership
Direct Authority
Technical Authority
Feedback and Liaison
Source : Kenya National Irrigation Board

FIG. 2·1

(b) in conjunction with the Water Resources Authority established under the Water Act, to formulate, and be responsible for the execution of, policy in relation to national irrigation schemes;

(c) in consultation with the Minister responsible for finance to raise funds for the development of national irrigation schemes;

(d) to co-ordinate and plan settlement on national irrigation schemes;

(e) to design, construct, supervise and administer national irrigation schemes;

(f) to determine the number of settlers to be accommodated in a national irrigation scheme;

(g) to provide land in national irrigation schemes for public purposes;

(h) to promote the marketing of crops and produce grown or produced on national irrigation schemes and to liaise with organisations responsible for the marketing of agricultural produce;

(i) to provide, either by itself or by agreement with other persons, for the processing of agricultural produce grown or produced on national irrigation schemes;

(j) to award scholarships and bursaries for the study of irrigation (both in Kenya and elsewhere) or any other subject which the Board considers to be of benefit to the Board. (*National Irrigation Board 1974-1978 Development Plan*, 1972, 2).

For the first time, the 1966-1970 Development Plan recognised the contribution which could be made by irrigated settlement to the overall agricultural development of Kenya. The plan provided for the administrative machinery on a national scale to operate existing irrigation schemes and to assess future, proposed, and potential irrigation projects envisaged for the 1970's. E.G. Giglioli (1967, 2), the first General

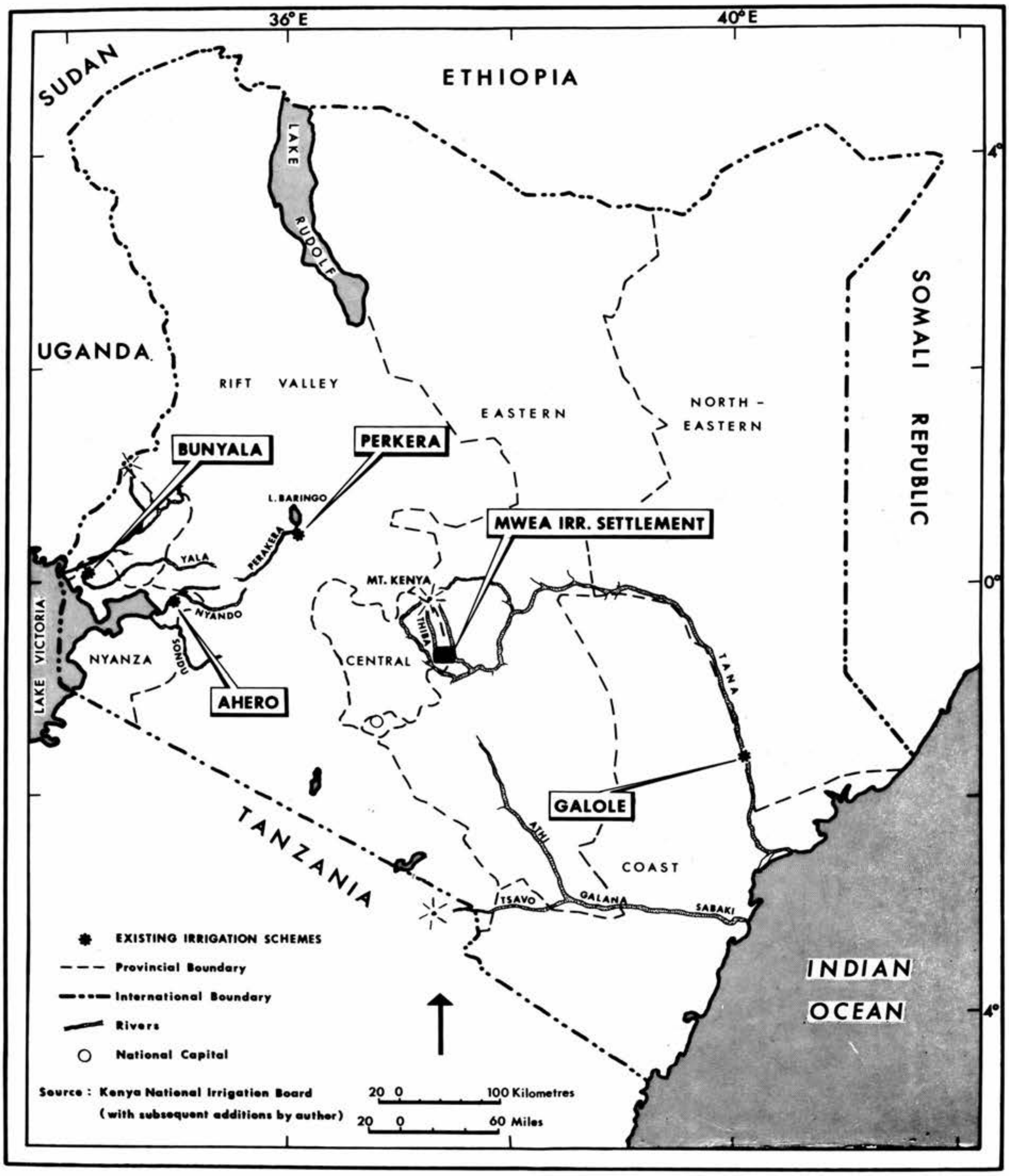
Manager of Kenya National Irrigation Board, states:

> In any discussion of planning criteria used for the development of irrigated settlement in Kenya, it should be emphasised that the guidelines that are employed and the modus operandi evolved have all been tested in the crucible of actual commercial-scale operations. The validity of the methodology is attested by its successful application under a variety of ecological conditions, with a range of crops and above all with a wide diversity of people with highly different attributes and aptitudes.

It should be kept in mind that although the total potential (about 520,000 acres) for irrigation development in Kenya is significant to the country, it is extremely modest when seen in the light of what is available in some other African countries. An indication of comparative scales can be had by noting that the Gezira Scheme in the Sudan covers approximately three times the area of Kenya's maximum known potential for irrigation.

Kenya is not well endowed by nature in terms of irrigable land. There are no large bodies of water lying entirely within the national boundaries nor are there extensive tracts of fertile and flat land within easy access of water. Irrigation development is consequently expensive both in capital outlays and in recurrent costs.

Table 2.1 shows that in the 1973/74 season a total of about 21,000 acres of land were under irrigation on Kenya's five major irrigation schemes: Mwea, Perkerra, Galole, Ahero, and Bunyala. The location of these existing national irrigation schemes is shown in Figure 2.2.



IRRIGATION SCHEMES IN KENYA, 1973

FIG. 2·2

TABLE 2.1

IRRIGATED AREA IN KENYA 1963/64-1973/74 (in acres)

SEASON	1963/64	64/65	65/66	66/67	67/68	68/69	69/70	70/71	71/72	72/73	73/74[1]
Mwea	5,456	5,541	6,408	6,992	7,659	8,508	9,361	10,652	11,515	11,698	14,176
Perkerra	1,200	1,200	1,200	1,440	1,440	1,440	1,410	1,410	1,410	1,026	1,026
Galole	1,179	1,179	1,233	1,220	1,236	1,196	1,322	1,416	1,426	2,002	2,002
Ahero	-	-	-	-	-	1,295	2,281	2,924	3,079	3,264	3,264
Bunyala	-	-	-	-	-	-	524	524	524	524	524
TOTAL	7,935	7,920	8,841	9,652	10,335	12,439	14,898	16,926	17,954	18,514	20,992

1 Estimated

Source: *National Irrigation Board*, 1973

These five schemes range in size from 500 acres to over 14,000 acres (Table 2.1). About 85 per cent of the irrigated area produces paddy, about 10 per cent produces seed cotton and the remaining 5 per cent is devoted to onions and hot chillies. All the schemes have been constructed and are operated by the NIB. The NIB has the responsibility for the development, control and improvement of national irrigation schemes in Kenya.

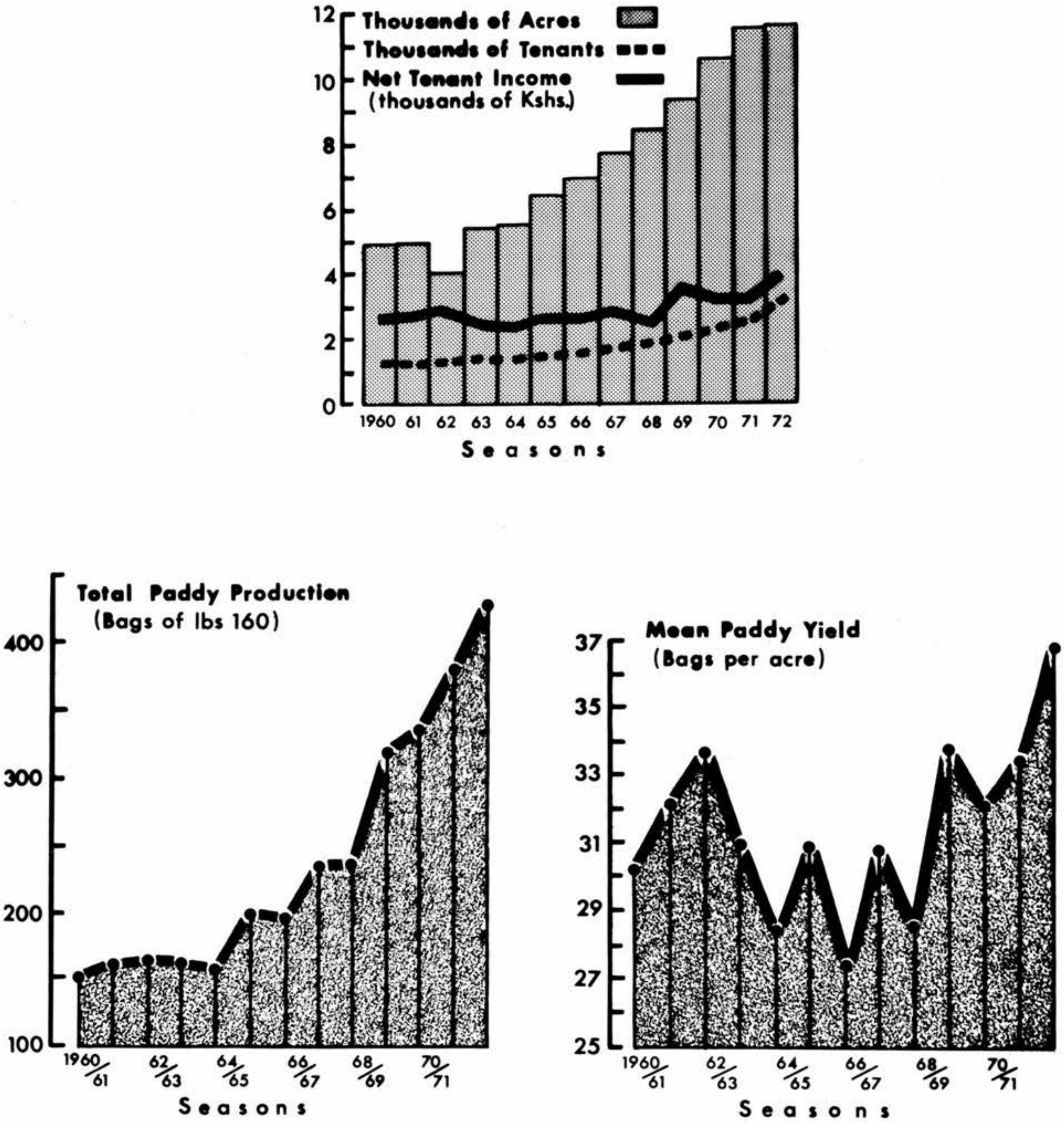
EXISTING IRRIGATION SCHEMES

Mwea

The Mwea is the largest and most successful organised irrigation settlement in Kenya. The Mwea currently encompasses 14,176 acres of irrigated land based on paddy production (Table 2.1). During the 1972/73 season the area under irrigation at Mwea was 11,698 acres (Fig. 2.3). Paddy production has increased more than threefold since 1960 (Table 2.2). In 1972/73 there was a record high of 430,168 bags (31,218 tons) of paddy produced at Mwea (Fig. 2.3). Paddy yields have varied from a low of 27.3 bags per acre (1966/67) to a high of 36.8 in 1972/73 (Table 2.2). Figure 2.3 illustrates the fluctuation in paddy yield since 1960. The number of tenants and net income from paddy production have increased steadily since 1960 (Fig. 2.3). Average net income from paddy production at Mwea reached a record high of 3,865 Kshs. in 1972/73 (Table 2.2).

Paddy is grown solely by African farmers. During the 1972/73 season there were 3,020 tenant farmers at Mwea (Fig. 2.3).

MWEA



SOURCE : MWEA IRRIGATION SETTLEMENT

FIG. 2·3

Since January 1972 Mwea has been managed solely by Africans. The area served by Mwea accounts for about 90 per cent of Kenya's annual paddy production. Other paddy producing areas are Ahero and Bunyala (Fig. 2.2). The total area of paddy under irrigation in Kenya is about 19,600 acres. All the paddy produced is transplanted. The varieties used are Sindano and Basmati, a medium long slender grain which matures in approximately 6 months.

TABLE 2.2

MWEA: ACRES, PRODUCTION, YIELD AND AVERAGE ANNUAL NET INCOME FROM PADDY, 1960/61 - 1972/73

Season	Acres	Bags[1]	Metric tons	Average yield bags per acre	Average net income per farmer Kshs.[2]
1960/61	4,958	149,999	10,885	30.25	2,854
1961/62	4,973	159,812	11,598	32.14	2,721
1962/63	4,065	167,474	12,153	33.73	2,812
1963/64	5,456	167,474	12,037	30.99	2,483
1964/65	5,541	156,711	11,372	28.28	2,322
1965/66	6,407	199,162	14,454	31.08	2,549
1966/67	6,992	190,889	13,853	27.30	2,624
1967/68	7,731	239,335	17,369	30.96	2,781
1968/69	8,430	240,673	17,466	28.54	2,427
1969/70	9,361	317,153	23,016	33.88	3,570
1970/71	10,652	341,156	24,758	32.03	3,241
1971/72	11,516	384,943	27,936	33.43	3,163
1972/73	11,698	430,168	31,218	36.80	3,865

[1] One bag of paddy = 160 pounds net, clean, dry paddy @ 14 per cent moisture.

[2] One Kenya Shilling (Ksh) = 6 British pence as of August 1973.

Source: *Mwea Irrigation Settlement Annual Report 1972/73*, 1973.

One crop of paddy is grown annually. The short rainy season, October/November, is the main growing period for paddy. Paddy harvesting takes place from late December to March. Kenya produced approximately 35,000 tons of paddy during the 1972/73 season, 16,000 tons above the 1961/65 average (Singleton, 1974, 26). Approximately 80 per cent of the annual crop is sold for cash, primarily in the East African Common Market (EAC) and domestic markets. The outlook for increased paddy production in Kenya is encouraging. The NIB estimates that approximately 21,000 acres will be in paddy production by the 1977/78 season (*National Irrigation Board*, 1972, 15). During the 1973/74 season a total of K£ 570,407* was allocated by the NIB for the development of the 2,000 acre Extension of the Karaba Section. The cost of this Extension was estimated at K£ 328 per hectare. Financial assistance was obtained from the Government of West Germany. During the 1972/73 season the gross value of paddy produced at the MIS was approximately K£ 700,000. The capacity of the Mwea Rice Mills Ltd. has been increased to 40,000 tons. The mills now have the capability to process all of the paddy produced in Kenya. Financial assistance for enlarging the capacity of the mills was obtained from the Government of West Germany. The Mwea Rice Mills Ltd. is owned jointly by the NIB (60 per cent) and the Mwea Credit Co-operative Society (40 per cent) of which the tenant farmers are shareholders.

The power keys which have been responsible for the success and development of Mwea over the past 20 years are: water in

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* 1 Kenya pound (K£) = £1.17 Sterling as of August 1973.

abundance, no displacement of people, good and plentiful soils for paddy farming, a botanically disease-free area for paddy production, and a high degree of entrepreneurial expertise.

During my field survey work at Mwea, an Ethopian delegation visited the area and assessed the operations for possible adaptation of irrigated paddy to Ethiopian conditions. During recent years the Mwea Irrigation Settlement's methods of operation have been closely studied by technical personnel involved in similar irrigation developments in Malawi and the Somali Republic.

Mr. P.S.T. Mirie, General Manager, National Irrigation Board, appropriately summarised the importance of the Mwea success and impact during one of our meetings in his office in Nairobi:

> The importance of Mwea with its long history of success through trial and error, should serve as a useful guide of the greatest value for the National Irrigation Board's future planning of other irrigation schemes in Kenya. The experience gained and data compiled at Mwea over the past 20 years offers excellent background and experience for adaptation to other irrigable areas of Africa and also perhaps in some other areas of the world.

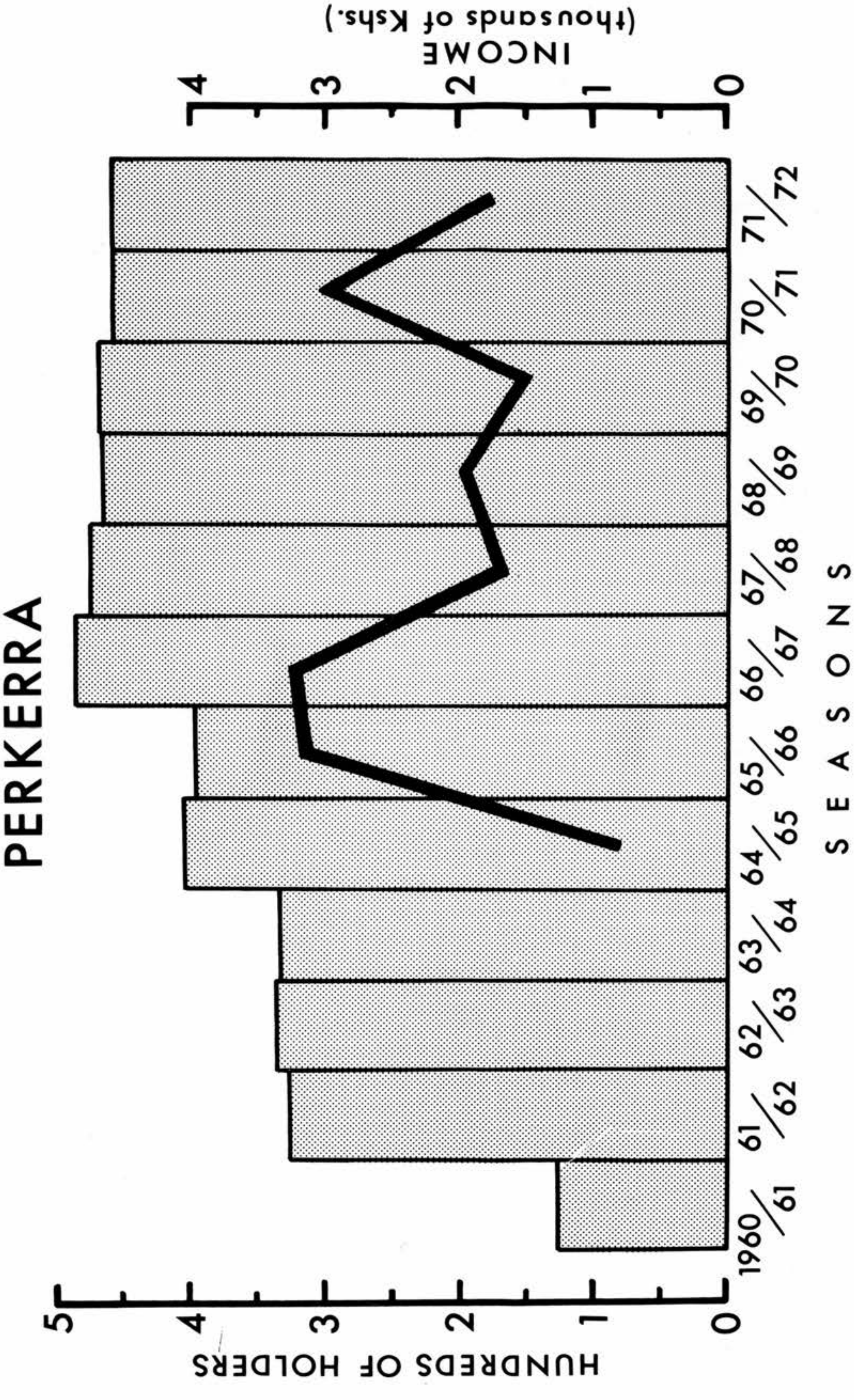
The experience gained at Mwea should be utilised fully by the NIB as a basic guide for future irrigation development in Kenya. Increasing paddy yields (Fig. 1.3) is of major concern to the Mwea Management, but there is urgent need to expand the research programme and focus more attention in finding new paddy varieties with increased protein and quality for improved nutrition (see Chapter 7).

Perkerra

This Scheme consists of only 1,026 acres (Table 2.1). The major crop grown is onions, which has had a long history of low yields and volatile price fluctuations. An onion price stabilisation fund has been initiated under the direction of the NIB to stabilise prices. Figure 2.4 shows the number of tenants at Perkerra from 1966 to 1972 and the considerable fluctuations in average net income since 1964. Perkerra has not been successful and losses have been incurred since its inception. It is difficult for a scheme as small as this to cover its overhead costs. However, in recent years, with the introduction of higher-yielding varieties, onion yields have improved considerably. Perkerra has many serious problems which restrict its development. A major problem is the lack of water in the Perkerra River during the dry season. Many of the soils present technical difficulties due to high alkaline content. Imposing tenant discipline is of major concern. The NIB has encouraged farmers at Perkerra to try to diversify crops. During the 1971/72 season hot chillies were produced for the first time. However, only 14 per cent of the total area is devoted to the production of chillies. Field trials have been conducted with other crops namely: pawpaws, groundnuts, kenaf, and passion fruit.

Galole

The Galole Scheme located on the Lower Tana River (Fig. 2.2) consists of 2,002 acres of irrigated land (Table 2.1). The major crop produced is seed cotton. Galole started out as a



Scource : Mwea Irrigation Settlement Field Enquiry

FIG. 2·4

failure but has been transformed into a success. Figure 2.5 illustrates the dramatic growth of average net income to the tenants resulting from substantial increases in cotton production. During the past several seasons emphasis has been placed on improving cultural practices and increasing seed cotton yields. A programme of crop diversification is being appraised at Galole and field trials with kenaf and sugarcane are being conducted.

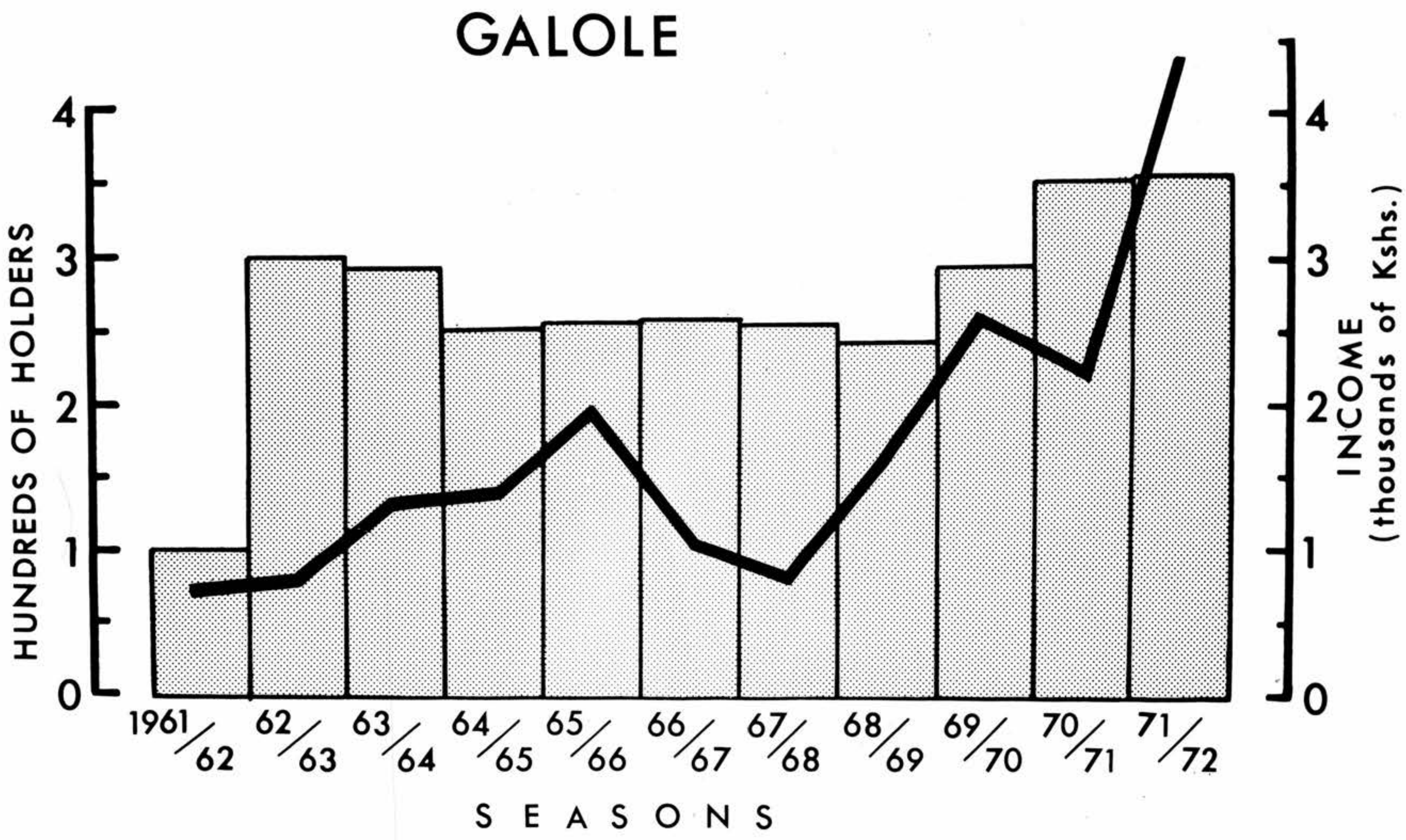
Any future expansion of the Scheme will require substantial expenditure on infrastructure. It is hoped that Galole will serve as a demonstration and training centre for the ultimate development of the irrigation potential in the Lower Tana River Basin.

M.E. Gillard (1973, 8) writes:

> In most irrigation schemes, it is not possible for landholders to meet charges associated with the supply of capital, but it is most desirable that annual costs including some charges for depreciation or accrued maintenance should be met by the scheme. In the case of Galole, the farmers could meet additional costs with good incomes received, and in view of the possible larger scale development in the area, it would be desirable that the Galole scheme should present a viable picture to encourage the Government to proceed with this form of development.

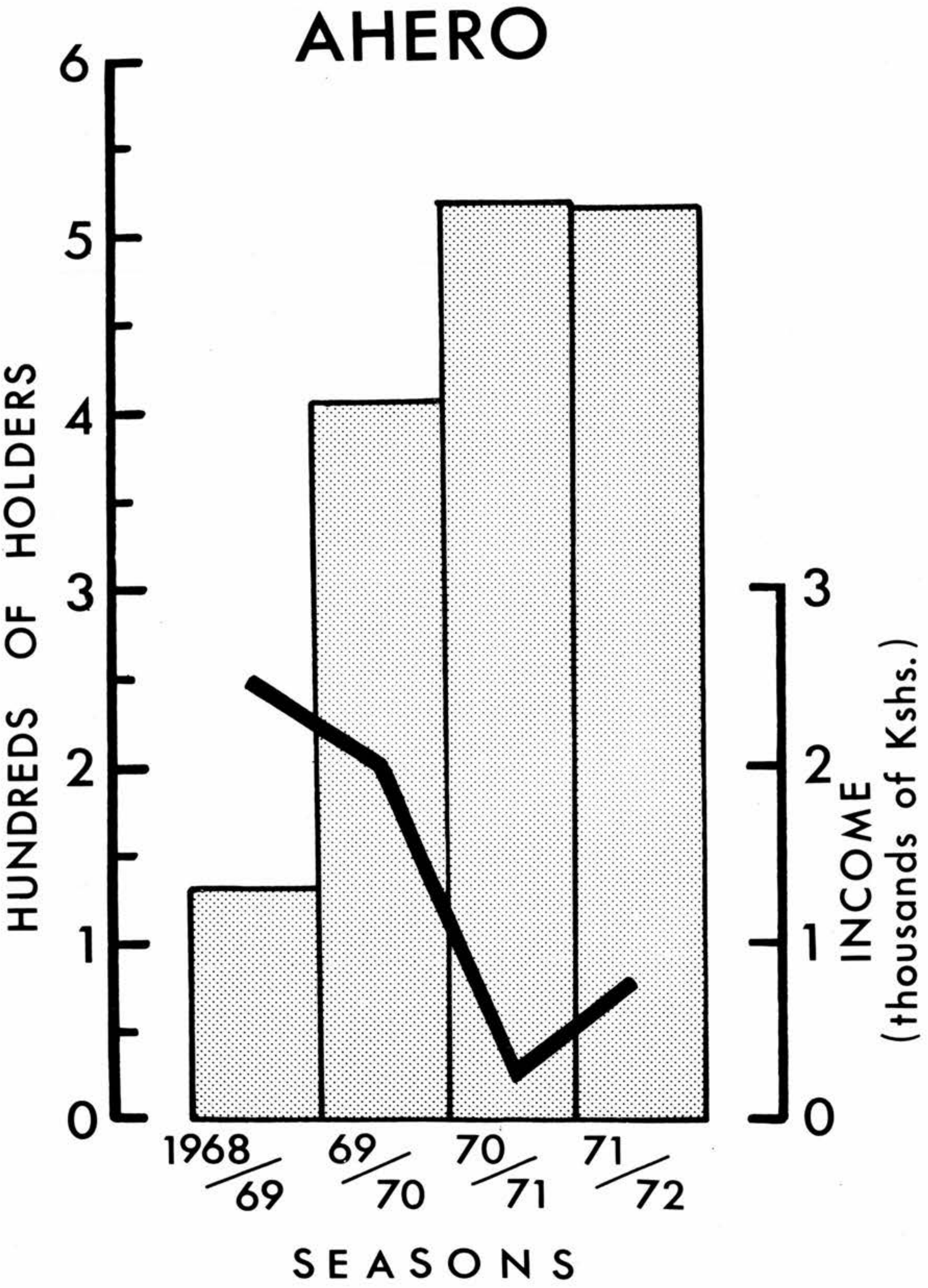
Ahero

The Ahero Scheme consists of 3,264 acres of irrigated land (Table 2.1). Two crops of Basmati paddy are grown annually. Construction of the Ahero Scheme (Fig. 2.6) was completed in 1969.



Source : Mwea Irrigation Settlement

FIG. 2·5



Source : Mwea Irrigation Settlement

FIG. 2·6

During the 1972/73 season 3,000 tons of Basmati paddy were produced. Figure 2.6 shows the number of tenants and the severe drop in average net income to the tenants since 1968. Irrigation water is supplied to the paddy fields by abstraction from the Nyando River through 4 pumps with a capacity of 15 cusecs each. The Nyando River carries a very heavy silt load which has a high sand content. Apart from the effects of substantial pumping costs, the Scheme has suffered from a constant shortage of water. The inability to obtain an adequate and reliable supply of water has made crop planning extremely difficult. Also the paddy crop has had a serious incidence of paddy blast which has resulted in lower yields and depressed farmers' earnings (Fig. 2.6). The hot, humid climate at Ahero unfortunately provides the ideal environment for the spread of paddy blast. Research is being conducted on sugarcane, cotton, sunflower, groundnuts, and field beans as alternative crops. Agronomic work on all crops tried has been paralleled by detailed investigations into optimum water management practices. The Ahero Scheme has been costly because it is located in a densely populated area and therefore required large expenditures for resettlement and land consolidation.

This was the first time that the problem of existing land rights had been encountered in irrigation development in Kenya. These land rights had to be eliminated subject to a fair compensation to the farmers living in the area. The experience gained at Ahero gave the NIB useful small-scale data and experience in resolving the problems of land rights and the selection of tenants before tackling the same problem on a much larger scale in other irrigable areas of Kenya.

Difficult heavy soils limit the choice of crops at Ahero to paddy, sugarcane, and cotton. During the first season 1969/70, Sindano variety was planted; however, the yield level declined substantially resulting from heavy attacks of paddy blast and a mottle virus disease. As a result of plant diseases the Sindano variety was changed to the higher quality, but lower-yielding, Basmati variety.

The work at the Ahero Research Station has been primarily concerned with rice varieties; however, interesting results have been obtained for sugarcane, soya beans, and groundnuts. From an agronomic viewpoint, additional research work is needed in selecting rice varieties which meet the criteria of disease resistance, good yield, and acceptable milling and cooking qualities.

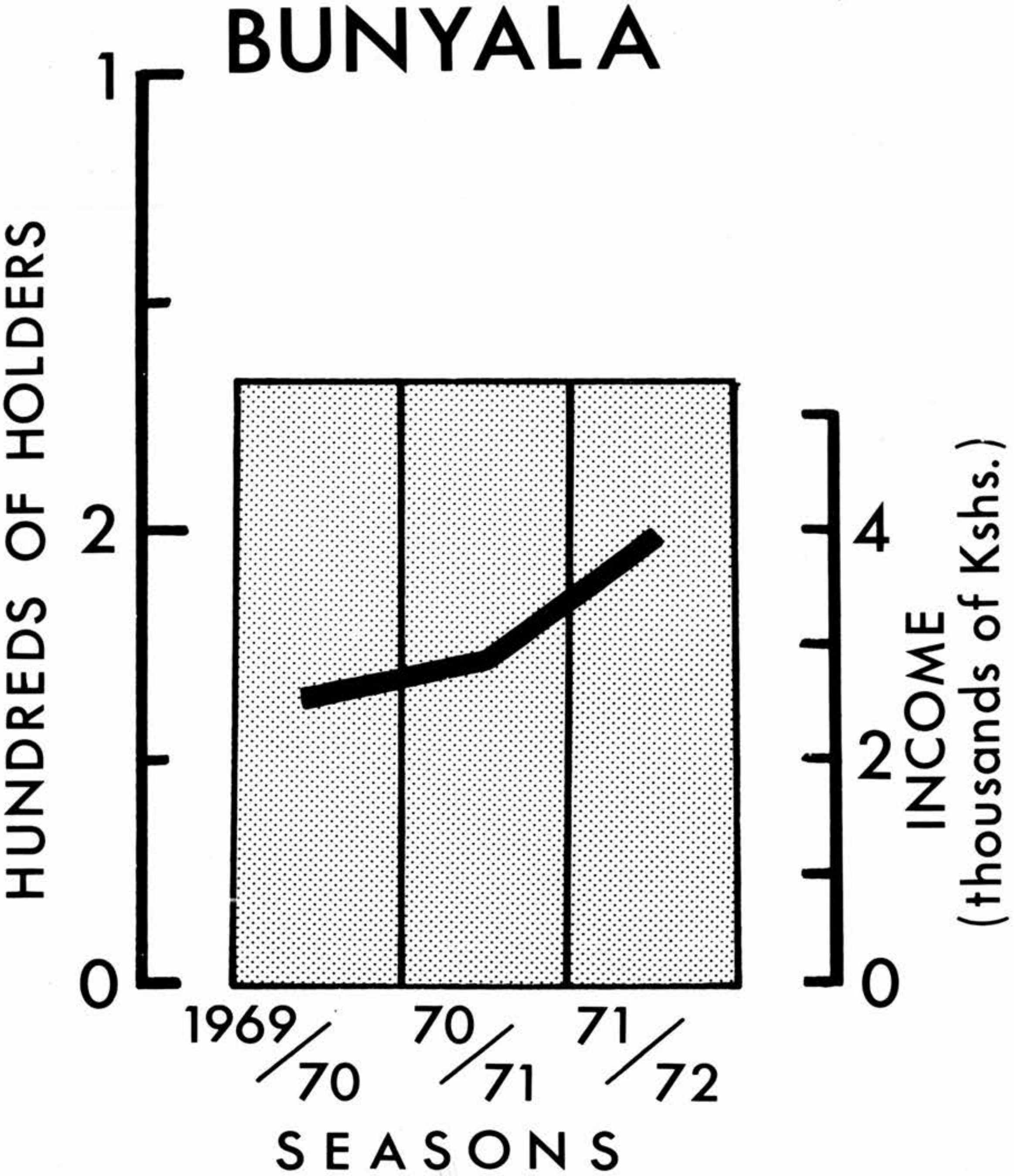
At Ahero 75 acres have been planted in sugarcane to assess the feasibility of production on a commercial scale. Sugarcane production at Ahero is promising and output is urgently required for domestic consumption in Kenya. There are several sugar factories in this Area which are undersupplied. However, research is required on irrigation and drainage problems to provide more information on crop water requirements, water management practices, irrigation layouts, and drainage. M.E. Gillard (1973, 12) writes:

> It is most essential that practical design criteria for future irrigation projects be developed, and that project members from such a project should provide active assistance with the investigation design and operation of new and existing irrigation developments.

The Ahero Scheme is faced with a number of problems which react against the success of the Scheme: plant diseases, low yields, poor crop husbandry, low tenant incomes (Fig. 2.6), and deteriorating morale of the farmers.

Bunyala

This Scheme consists of only 524 acres of paddy under irrigation (Table 2.1) located on the southern edge of the Nzoia River close to the Yala Swamp Area (Fig. 2.2). Construction of the Bunyala Scheme was completed in 1969. Two crops of paddy are grown annually. Sindano is planted as the first crop and Basmati planted as the second crop. Figure 2.7 illustrates the substantial increase in average net income to the tenants at Bunyala. The number of tenants has remained stable over the past 3 seasons (Fig. 2.7). It is hoped that the experience gained at Bunyala will provide useful data which will be helpful in ascertaining the best method of developing the land reclaimed at Yala Swamp. Bunyala is located on high ground in an inhabited area where traditional land rights exist. This was the second time that the problem of existing land rights had been encountered in irrigation development in Kenya. These rights had to be eliminated subject to a fair compensation to the farmers in the Area. The mediocre performance at Bunyala has resulted from the high incidence of paddy blast, difficulty of mobilising the farmers to produce two paddy crops a year, and poor cultural practices.



Source : Mwea Irrigation Settlement

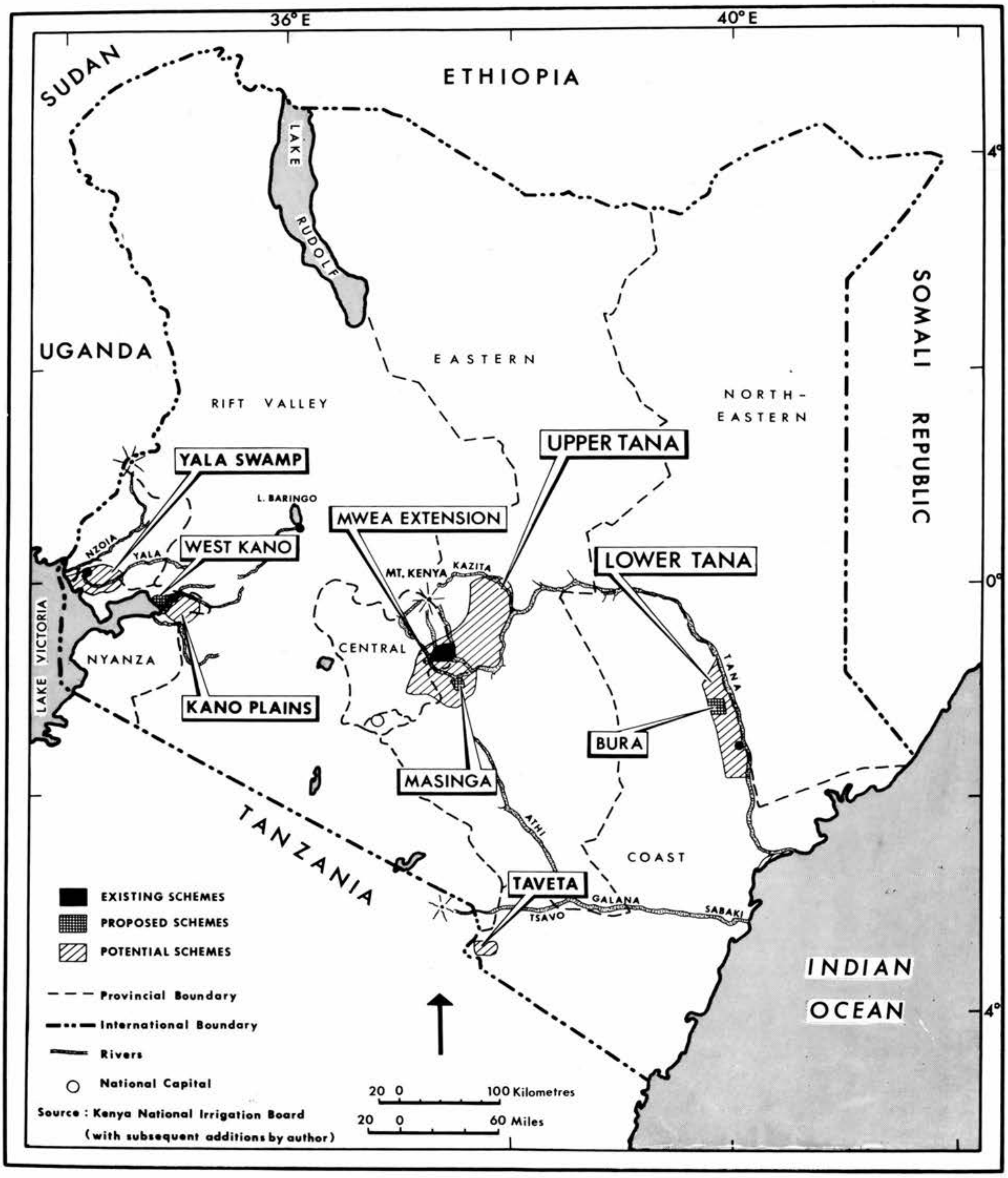
FIG. 2·7

NATIONAL IRRIGATION BOARD DEVELOPMENT PLAN 1974-1978

Proposed Irrigation Schemes

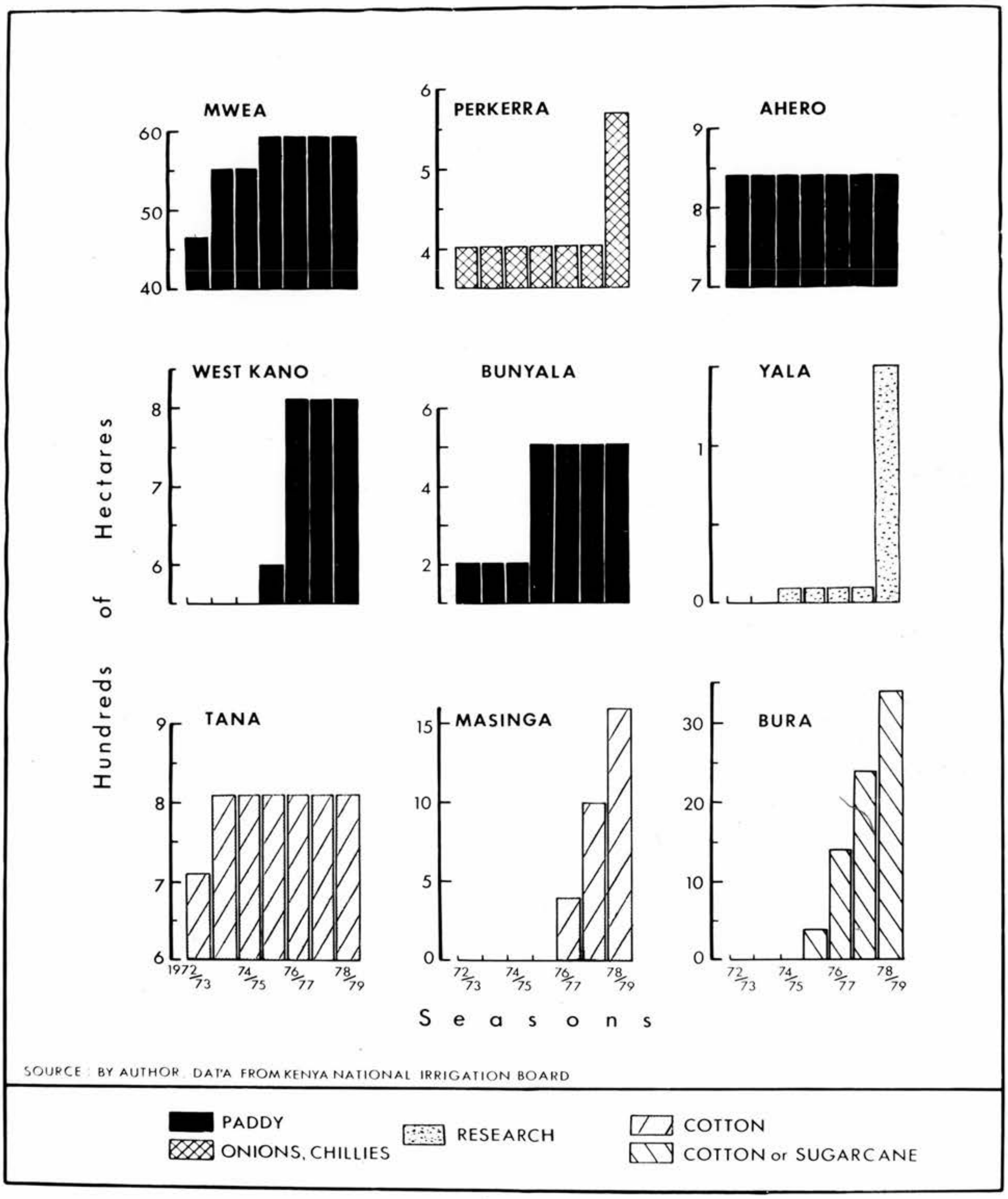
Under the 1974-1978 Development Plan the NIB has allocated approximately 18,000 acres for four proposed irrigation projects: Bura (10,000 acres), Masinga (5,700 acres), West Kano (2,000 acres), and Yala Swamp (300 acres). The location of proposed irrigation schemes by the NIB is shown on Figure 2.8. The area currently under irrigation is projected to increase over twofold: from about 21,000 acres in 1973/74 to over 40,000 acres by the end of the 1974-1978 Development Plan period (Table 2.3).

The major increases in irrigable areas will be in proposed projects. It is proposed that the National Irrigation Board's annual irrigable development area be expanded from its present level of approximately 2,000 acres to about 5,000 acres annually by 1978, the end of the current 1974-1978 Development Plan period. By 1978 the irrigated area on major schemes would be approximately 41,000 acres, consisting of about 50 per cent paddy and the balance in seed cotton and/or sugarcane. Projected production would be: 55,000 tons of paddy, between 4,000 and 9,000 tons of seed cotton (or 112,000 tons of sugarcane depending on the crop mix in the proposed schemes) 2,400 tons of onions, and 350 tons of dried chillies. Figure 2.9 illustrates the National Irrigation Board's estimate of projected areas and existing and projected irrigation schemes from 1972 to 1979. Simultaneously with the expansion of the two existing schemes - Mwea and Perkerra - and construction of four new ones, additional feasibility



IRRIGATION STRATEGY IN KENYA, 1973

FIG. 2·8



N. I. B. : PROJECTED AREAS AND CROPPING, 1972 – 79

FIG. 2·9

studies will be carried out and staff training will be intensified. Provisional cost estimates are K£ 7 million for the 1974-1978 Development Plan period (*National Irrigation Board Development Plan 1974-1978*, 1972, 13).

TABLE 2.3

PROPOSED AREAS UNDER IRRIGATION BY THE END OF THE 1974-1978 DEVELOPMENT PLAN PERIOD

Scheme and Crop	72/73	73/74	74/75	75/76	76/77	77/78	Area Irrigable by end of 77/78
Mwea Paddy	11,698	14,176	14,176	14,656	14,656	14,656	14,656
Perkerra Onions, Chillies	1,026	1,026	1,026	1,026	1,026	1,026	1,409
Galole Cotton	2,002	2,002	2,002	2,002	2,002	2,002	2,002
Ahero Paddy	3,264	3,264	3,264	3,264	3,264	3,264	3,264
Bunyala Paddy	524	524	524	1,273	1,273	1,273	1,273
Yala Swamp Research	-	-	28	28	28	28	300
West Kano Paddy	-	-	-	1,483	2,002	2,002	2,000
Bura Cotton or Sugarcane	-	-	-	988	3,460	5,931	10,000
Masinga Cotton	-	-	-	-	988	2,471	5,700
TOTAL	18,514	20,992	21,020	24,720	28,699	32,653	40,604

Source: *National Irrigation Board, 1972.*

Using current farm gate prices the gross value of total produce is projected to reach K£ 2.3 million. Major agricultural research programmes will be conducted at Mwea, Ahero, Galole, and Yala Swamp, testing new varieties to be grown, introduction of secondary crops and the development of a crop diversification programme. Approximately 10,000 new tenants are expected to be settled on the proposed schemes by the end of the 1974-1978 Plan period. Assuming a family size of 6, this would mean that about 120,000 people will depend on irrigation for their livelihood (*National Irrigation Board Development Plan 1974-1978*, 1972, 13). The major objective of the new projects is to provide irrigation holdings for landless farmers, to give employment and to establish a reasonable level of farm income for the tenants. The future tenants on the proposed projects will be recruited from various areas of Kenya. The major share of the proposed irrigation development funds will be allocated for the Bura project (K£ 2.5 million) and for Masinga (K£ 5 million). M.E. Gillard writes:

> It is very important that all aspects of scheme development including sociology, economics, and design and construction details should be fully assessed in the light of long term operational requirements. It is the long term recurrent costs which have a vital effect on the viability of any scheme. In order to provide employment, schemes have to be developed on a labour intensive basis both for constructions and operation. This aspect should be looked at on a very broad basis to see if such labour will be always available, and modify the design accordingly. It is often quite difficult and certainly uneconomic to mechanise activities undertaken by hand labour unless initial planning provides for this contingency.

> Finally, what must be determined is the size of the manageable scheme units. There are many activities to be handled by an irrigation scheme manager, and the area he can manage will depend on the complexity of the individual activities. However, it has been assessed by previous consultants that the general limiting size of a manageable scheme is 10,000 acres.

Potential Irrigation Schemes

Kenya has an estimated 532,000 acres of potentially irrigable land. The potential irrigable tracts are located as follows: Lower Tana (225,000 acres), Upper Tana (225,000 acres), Yala Swamp (37,000 acres), Kano Plains (35,000 acres), and Taveta (10,000 acres). The distribution is shown on Figure 2.8. Almost 80 per cent of this irrigable land is located in the Lower and Upper Tana River Basin (Fig. 2.8). The remainder occurs in various parts of the country, but primarily around Lake Victoria, in the Kano Plains and Yala Swamp Areas (Fig. 2.8). Major constraints to irrigation development on these lands are high investment costs, substantial infrastructure costs, difficult heavy soils which limit the choice of crops, and general inexperience with irrigation farming in these areas.

The estimate of 532,000 acres of potential irrigable land by the NIB is, at best, highly optimistic! Approximately half of this area may prove to be irrigable at the present cost of constructing irrigation projects in Kenya. The potential is there but the key questions are how to develop it and who will finance the development.

The Tana River Irrigation Schemes

The Tana River Basin, consisting of the Lower Tana and Upper Tana Areas, is Kenya's most important fluvatile water resource and accounts for approximately 80 per cent of the known irrigable potential in Kenya. In the early 1950's a small scheme of 1,200 acres was developed at Galole on the Western Bank of the Tana River. Between 1963 and 1970 the Kenya Government and United Nations Development Program/Food and Agriculture Organization (UNDP/FAO) conducted several surveys to assess the feasibility of a major irrigation settlement in the area. The results of these surveys indicate that 250,000 acres could be irrigated, but that the cost/benefit ratio would be close to marginal. On the other hand, mounting population pressure and the limited availability of high potential irrigable land will make development of the Lower Tana more attractive in the not too distant future than it is by today's banking criteria (Giglioli, 1967, 4).

With this long term objective in mind the NIB, with the assistance from the Government of the Netherlands, through the ILACO Consultant Company, Arnhem, Netherlands, is currently engaged in a project to completely rehabilitate the Galole Scheme and to convert it into a major demonstration, investigative and training irrigation operation, as a precursor to future major irrigation developments in the Tana River Basin. However, it should be noted that if the Upper Tana potential (225,000 acres) is fully developed it is likely that the potential in the Lower Tana (225,000 acres) will be reduced by about 75,000 acres.

In the Annual Report of the NIB for 1970/71 E.G. Giglioli expressed an optimistic future of the Lower Tana Basin:

> It would appear that the effect of irrigation development at Mwea has been to bring in 11 people per holding developed. It is doubtful whether the 'sponge effect' of irrigation is quite so marked on other existing schemes, but there is no reason to suppose that a similar or even greater trend would not be found in presently uninhabited areas like the Lower Tana Basin. It is exciting to think that the known irrigable potential in this area could gainfully accommodate some 750,000 people on a small section of a District, now supporting only 50,000 people at a poor subsistence level. (*National Irrigation Board Annual Report*, 1970/71, 10).

These figures and impressions have been influenced by the Mwea experience. Population absorption and unemployment are likely to remain important criteria in the appraisal of irrigation settlement investment.

A Tana River Development Authority has recently been created and a Chairman appointed. Its main tasks are to monitor the design and execution of planned projects in the Tana River Basin; to gather and compile resource data and monitor water abstraction in close collaboration with the Water Department of the Ministry of Agriculture; and to carry out additional studies necessary to optimise resource development in the Tana River Basin (*National Irrigation Board*, 1973, 2).

Yala Swamp

This large papyrus swamp lies northwest of Kisumu on the shores of Lake Victoria (Fig. 2.8). It is estimated that a total of 37,000 acres could be reclaimed as irrigable land and utilised for irrigation settlement (Fig. 2.8). The NIB and the UNDP/FAO are presently conducting a survey to determine the feasibility of reclamation of the Yala Swamp area for irrigation settlements.

The project envisages drainage of higher lying areas of the Yala Swamp and the construction of two pilot schemes of 500 acres each. This uninhabited swampland could accommodate a surplus population from the nearby densely populated areas.

Kano Plains

This area is located southeast of Kisumu along the shores of Lake Victoria (Fig. 2.8). The Kano Plains are located in a depression and are subjected to severe periods of drought and flooding. The irrigable potential of the area is estimated at 35,000 acres (Fig. 2.8). Unlike other areas of irrigable potential in Kenya, the Kano Plains are densely populated. Many of the people living in the area depend, to a large extent, on income received from migrant relatives employed elsewhere. The development of the irrigation potential of the Kano Plains could lead to increased crop productivity and employment, but it is estimated by the NIB to be a very expensive project. However, the NIB places high priority on the development of the Kano Plains because of the population pressure of the area and the hazardous nature of farming under existing climatic conditions. The central problem is the presence on the plains of a population with an average density of over 500 people per square mile. The difficulties of carrying out the irrigation development of the plains with a minimum dislocation in the life style of the people, the phasing of irrigation construction to avoid a hiatus between the "uprooting period", when a farmer's traditional livelihood is destroyed, and he has to start a new life style as a tenant farmer, the fate of those displaced families becoming landless in the process of creating economically viable irrigation holdings, are some of the most serious and thorny issues associated with the development of the Kano Plains. Perhaps the best approach of tackling such a complex socio-economic problem is to demonstrate to the local people that the returns from an organised irrigated settlement compensate for all the discomfort of departing from the traditional forms of life.

Taveta

The irrigable potential in the Taveta Area, located near the Tanzania border, is estimated at 10,000 acres (Fig. 2.8). The area is near Mombasa and in proximity to a railway; thus it could feasibly produce crops for the domestic and export market and take advantage of economical transport. Development of Taveta would not require expensive storage structure since there is a plentiful supply of good spring water, some of which is already being used on three small irrigation schemes controlled by the local county council. However, the Taveta Scheme faces two major problems: alienation of land - most of the land best suited to irrigation is owned by a sisal company - and soil alkalinity problems. Some of the soil types are toxic to plant growth because of high alkalinity. Careless irrigation on the existing small schemes has led to a rapid spread of alkalinity.

Any irrigation development at Taveta will require expensive deep drainage facilities. Here again it is imperative not to move forward in potentially irrigable areas without a detailed feasibility study and pilot scheme. The success and experience gained at Mwea could go a long way toward a greater understanding of the feasibility of a viable irrigation settlement in the Taveta Area, as indeed in the other potential areas. Furthermore, it already represents the most impressive step yet taken to establish successful irrigation farming in this area of Kenya which holds the greatest overall prospects.

CHAPTER 3

THE PHYSICAL SETTING OF MWEA

LOCATION

Mwea is located in the low-lying areas of the Mwea Plains about 80 miles northeast of Nairobi (Fig. 2.2) at an elevation of 3,800 feet. The MIS is situated near the southern foothills of Mount Kenya and the Aberdare Range on 0^{o} 40' south latitude and 37^{o} 20' east longitude (Fig. 2.2) and covers an area of approximately 30 square miles (Reference Map).* The area has a gently undulating relief. Basaltic escarpments and broad, well-defined ridges with slight slopes are interspersed with wide, gently-sloping or flat-bottomed basins (Photo. 3.1). An area of 14,000 acres has now been developed for lowland irrigated rice cultivation (Reference Map). The standard field size is one acre, surrounded on four sides by bunds of between 3 to 4 feet in height (Photo. 3.1), and bordered on two sides by quite deep, minor drains or furrows (Photo. 3.2). The paddy fields are rectangular, with a ratio of width to length of 1:4 and water courses are at right angles to the long axis of the field (Photos. 3.1 and 3.2).

The total arable area of the MIS is about 30,000 acres (Reference Map); 14,000 acres in black cotton soils devoted to

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* Reference Map of the Mwea Irrigation Settlement is located in the pocket of the thesis.

PHOTO. 3.1: A TYPICAL VIEW OF THE MWEA BASIN

The Aberdare Range is in the background. The author is crossing over a paddy field via the bund which separates the fields. In spite of the apparent flatness of the Mwea area it is at an altitude of 3,800 feet. The Aberdare Range rises to over 12,000 feet.

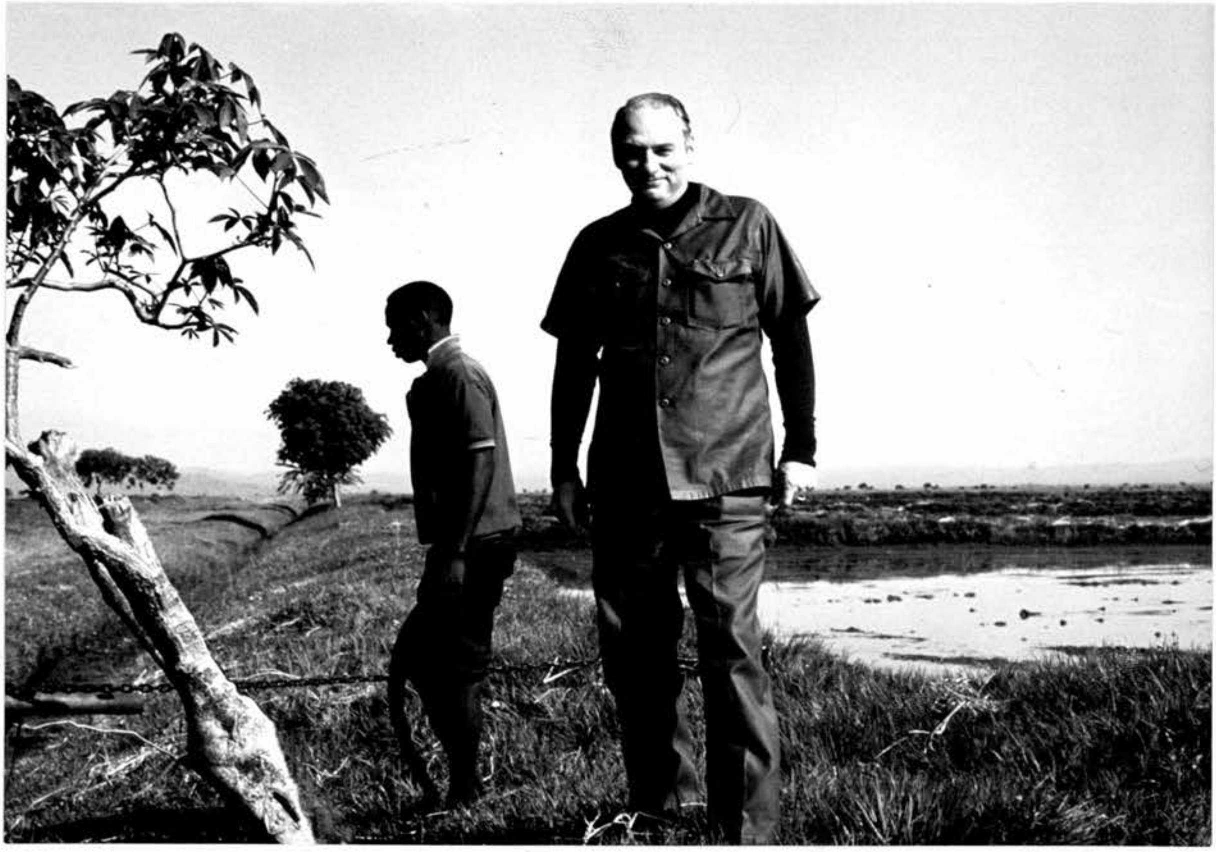


PHOTO. 3.2: A TYPICAL PADDY FIELD LANDSCAPE WITH A MAJOR DRAIN OR FURROW AND BUNDS

The author has just observed the levelling operation of the tenant's holding. The tenant farmer is removing a chain which was hooked to the levelling board with spikes. The paddy fields are rectangular with a ratio of width to length of 1:4 and water courses are at right angles to the long axis of the field.

paddy farming and 16,000 acres in red soils used mainly for subsistence farming.

CLIMATE

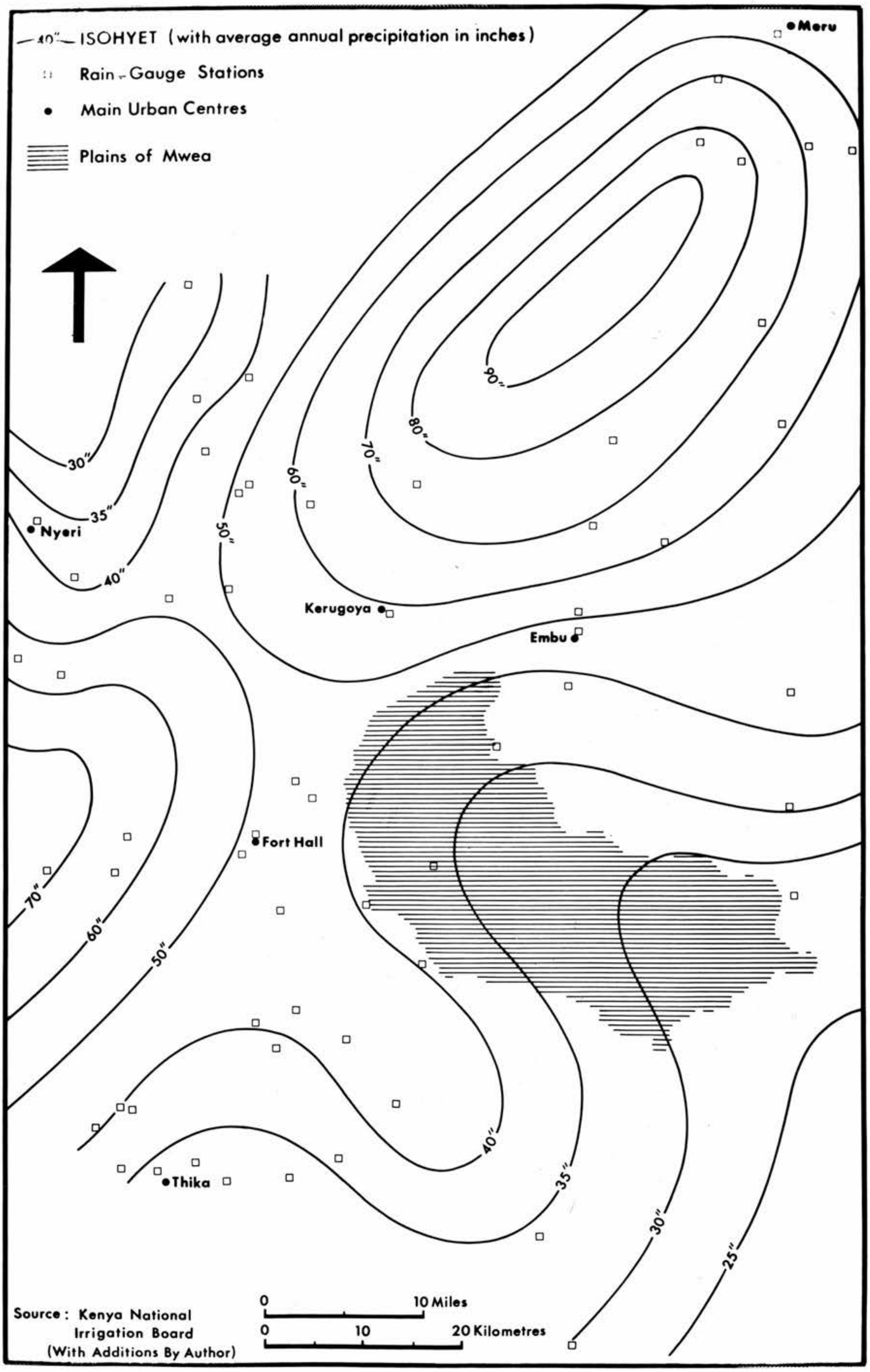
The climate of Mwea is savanna. Figure 3.1 illustrates by isohyet lines the distribution of average annual precipitation in central Kenya and the Mwea Plains Area. The average annual rainfall of Mwea is about 38 inches. But annual rainfall at Mwea has varied from a maximum of about 53 to a minimum of 26 inches over the past nine years (Table 3.1).

TABLE 3.1

MWEA IRRIGATION SETTLEMENT MONTHLY AND ANNUAL RAINFALL, 1965-1973 (in ins.)

Month	1965	1966	1967	1968	1969	1970	1971	1972	1973
Jan.	1.32	1.77	0.80	Nil	1.26	1.95	Nil	1.33	1.99
Feb.	0.03	0.06	Nil	6.20	4.44	0.01	0.06	0.93	1.93
March	1.78	7.93	1.63	5.25	7.30	5.28	1.63	0.78	1.20
April	8.03	8.96	11.96	12.79	1.79	15.92	10.67	1.71	5.53
May	0.92	1.63	15.79	3.77	5.22	5.43	7.22	9.65	2.54
June	0.22	1.33	1.54	0.80	0.17	0.26	0.73	1.68	0.33
July	0.34	0.37	1.24	0.67	0.25	0.41	0.32	0.25	0.51
Aug.	0.49	0.31	1.05	0.29	0.51	0.54	0.04	0.17	0.11
Sept.	0.57	0.59	0.42	0.09	0.11	0.37	0.01	1.34	1.29
Oct.	1.80	4.92	7.66	5.67	1.00	0.59	1.20	7.40	2.28
Nov.	12.87	5.84	7.05	12.80	6.62	5.01	2.74	6.57	8.01
Dec.	0.98	0.34	Nil	4.65	0.81	1.25	1.40	1.50	0.47
Year Total	29.35	34.05	49.14	52.98	29.48	37.02	26.02	33.32	26.19

Source: *Annual Reports of the Mwea Irrigation Settlement*, 1965-1973

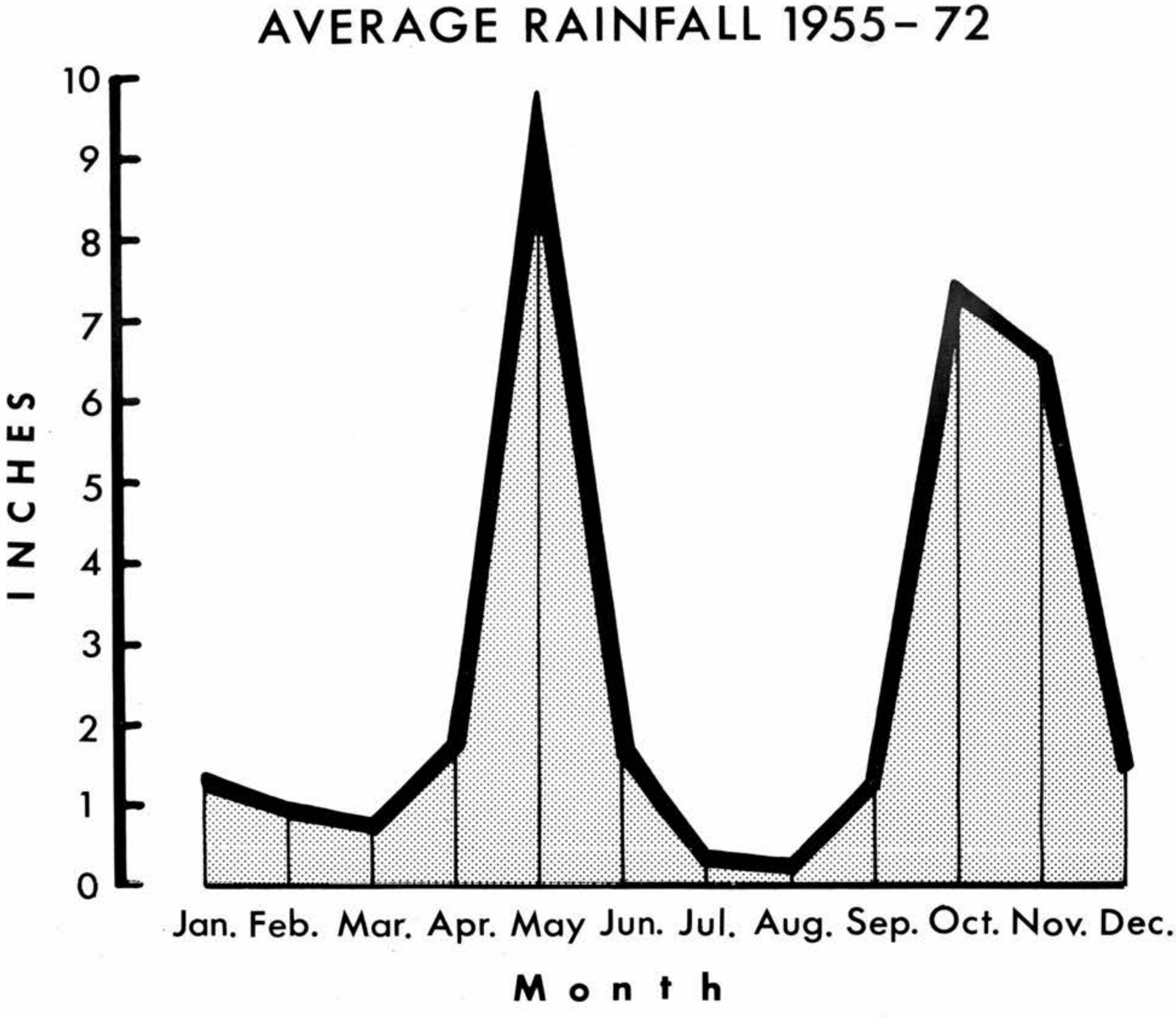


RAINFALL DISTRIBUTION IN CENTRAL KENYA

FIG. 3·1

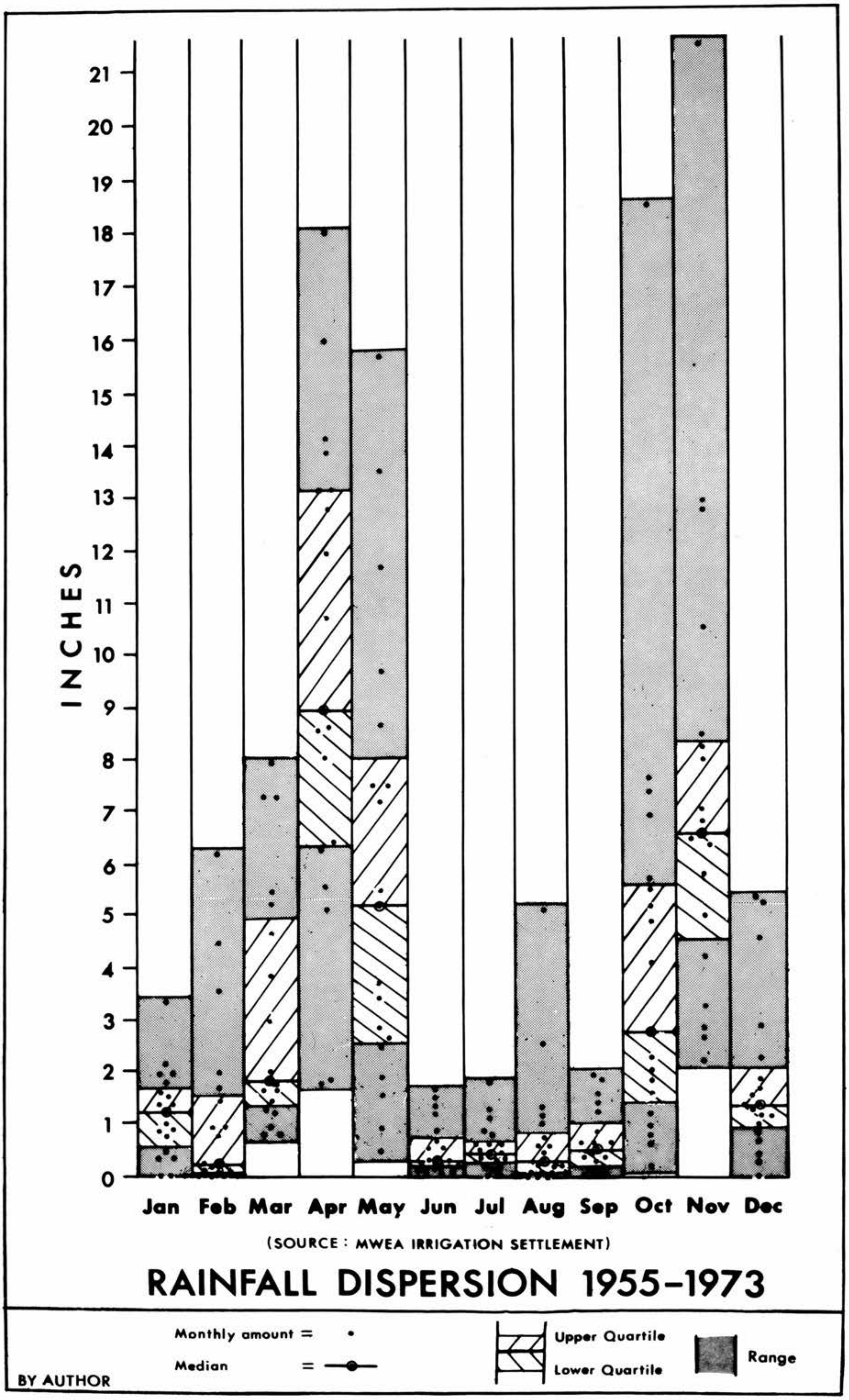
Figure 3.2 shows that the rainfall is concentrated in two seasons - April/May, the long rains, and October/November, the short rains. In most of the remaining months it is almost completely dry. Figure 3.2 shows rainfall distribution throughout the year at Mwea, based on the average rainfall from 1955-1972. It was observed that any precipitation in the form of convectional showers during the dry period is quickly soaked up by the soil or evaporates very quickly because of the high incidence of evaporation. Only minimal amounts of this rainfall are of any benefit to the vegetation. We are thus concerned with a semi-arid climate, the typical vegetation of which is dry savanna. Of the total rainfall, 45 per cent falls during the long rains and 30 per cent during the short rains (Fig. 3.2). In the MIS the most critical time for rainfall is in October/November, the main period for paddy growth. Figure 3.3 shows the monthly rainfall dispersion over a 19-year period. The median value of rainfall is much more relevant than the average value in the MIS because of the high seasonal incidence and the marked variability. Figure 3.3 shows the amount of rainfall Mwea may expect in any particular month of a given year, that is, the amount of rainfall to be no more than the upper quartile limit and no less than the lower quartile limit, for half of the years shown (Fig. 3.3). Therefore, half of the recorded values in the 19-year series lie between the upper and lower quartile values; half are more extreme.

In theory, irrigated paddy can be generally cultivated completely independent of the natural circumstances of precipitation and of the humidity of the atmosphere, as long as there is sufficient



Source : Mwea Irrigation Settlement Field Enquiry

FIG. 3·2


21
20
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12
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8
7
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5
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3
2
1
0
INCHES
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
(SOURCE : MWEA IRRIGATION SETTLEMENT)
RAINFALL DISPERSION 1955–1973
Monthly amount =
Median =
Upper Quartile
Lower Quartile
Range
BY AUTHOR

FIG. 3·3

irrigation water available and it is expertly applied. An immediate question is why two paddy crops during the year are not planted at Mwea. This has in fact been tried; but yields were very low and the operation was unsuccessful. In practice, it has been established that the short rain paddy crop gives the highest yields at Mwea. Heavy precipitation during the long rains often impedes the supervision of optimum water use, so that a drop in paddy yields can result. It takes 150 days to plant and harvest a paddy crop of the Sindano variety at Mwea. This is not enough time for two crops of paddy to mature, especially when June to August is a cloudy and relatively cool period with a low incidence of sunshine. A high incidence of sunshine occurs in November and December during the growing period when the paddy will flower and mature.

There are, furthermore, practical restraints on double-cropping: the MIS Management is not geared to such intensity. This would presently place a severe hardship on the farmers and the Field Extension Staff. There is also a serious lack of labour supply during the harvesting and transplanting periods.

The average daily temperature is about $72^{\circ}F$ in the MIS. Table 3.2 shows that the mean monthly temperature range is from $77^{\circ}F$ to $67^{\circ}F$. Sindano and Basmati paddy varieties require for best results an average temperature of at least $68^{\circ}F$ during the main growing season. Table 3.2 shows that this condition is always fulfilled.

TABLE 3.2

MWEA IRRIGATION SETTLEMENT MONTHLY AND ANNUAL AVERAGE TEMPERATURE, 1970-1972

Month	1970 °F	1971 °F	1972 °F
January	72.50	71.60	69.98
February	73.40	72.50	72.14
March	75.20	73.94	74.30
April	73.04	73.94	77.36
May	71.60	70.88	73.40
June	69.44	67.64	70.46
July	68.90	67.64	69.80
August	69.26	67.82	71.06
September	71.60	71.96	73.58
October	74.84	73.58	74.30
November	71.24	72.14	71.96
December	70.52	70.52	70.88
Annual Average	72.50	71.24	72.32

Source: *Annual Reports of the Mwea Irrigation Settlement*, 1970-1972

In this near-equatorial location the average number of sunshine hours a day is seven throughout the year. However, during the growing season, September - December, when the paddy is maturing, the average number of sunshine hours a day is about eight. Table 3.3 shows monthly, daily, and annual average sunshine hours. Maximum monthly sunshine during the year occurs in December; minimum monthly sunshine in August (Table 3.3).

TABLE 3.3

MWEA IRRIGATION SETTLEMENT MONTHLY, DAILY, AND ANNUAL MEAN SUNSHINE, 1969-1972 (in hours)

Month	1969		1970		1971		1972	
	Monthly Total	Daily Av.	Monthly Total	Daily Av.	Monthly Total	Daily Av.	Monthly Total	Daily Av.
Jan.	292.9	9.4	216.2	7.0	285.0	9.2	282.2	9.1
Feb.	204.4	7.0	294.1	10.5	292.9	10.5	202.0	7.0
March	237.2	7.7	226.7	7.3	279.8	9.0	283.5	9.1
April	260.5	8.7	232.0	7.7	230.3	7.7	226.4	7.5
May	232.8	7.5	222.1	7.2	181.0	5.8	190.7	6.2
June	172.5	5.8	167.8	5.6	130.4	4.5	154.9	5.2
July	103.5	3.3	124.0	4.0	83.4	2.7	129.3	4.2
Aug.	147.6	4.8	100.6	3.2	80.5	2.6	100.9	3.2
Sep.	213.2	7.1	179.6	5.9	214.2	7.1	182.1	6.1
Oct.	268.6	8.7	238.0	7.7	237.3	7.7	238.4	7.7
Nov.	208.2	6.9	237.3	7.7	232.4	7.7	210.8	7.0
Dec.	296.9	9.6	282.0	9.1	234.8	8.1	306.4	9.9
Annual Mean	219.9	7.2	209.6	6.9	206.8	6.9	220.1	7.3

Source: *Annual Reports of the Mwea Irrigation Settlement*, 1969-1972

It was observed that the amount of sunshine is reduced substantially during the low-sun months, June - August, when there is substantial cloud cover during most of the day. Because of the direct proximity to the equator, the days are regularly approximately 13 hours long all year round.

Table 3.4 shows monthly and average humidities. The mean monthly humidity is 74.8 per cent at 9.00 am and 46.7 per cent at 3.00 pm. Maximum humidity occurs from June to August in the Mwea Area.

TABLE 3.4

MWEA IRRIGATION SETTLEMENT MONTHLY AND ANNUAL MEAN RELATIVE HUMIDITIES, 1970-1972 (per cent)

Month	1970		1971		1972	
	9 am	3 pm	9 am	3 pm	9 am	3 pm
January	78.4	49.6	64.0	35.8	74.3	46.3
February	65.9	36.3	51.8	27.9	72.0	42.5
March	76.7	42.3	64.0	31.8	67.8	34.4
April	82.9	58.1	82.2	49.1	69.9	33.8
May	78.6	59.1	83.6	61.3	78.2	52.9
June	80.3	57.3	78.1	57.1	77.9	55.5
July	78.4	55.1	81.1	55.5	76.1	51.5
August	76.6	53.3	78.1	54.0	74.1	47.0
September	75.2	42.0	68.2	38.5	71.5	38.6
October	69.9	34.9	66.7	37.6	77.3	46.9
November	79.2	52.1	73.6	43.3	79.8	59.2
December	76.3	42.7	70.1	49.7	78.9	54.7
Annual Mean	77.9	48.6	71.8	45.1	74.8	46.5

Source: *Annual Reports of the Mwea Irrigation Settlement*, 1970-1972

Maximum evaporation takes place during January - March; minimum evaporation occurs during June - August (Table 3.5).

The high incidence of evaporation at Mwea is related directly to the problem of soil alkalinity which will be treated more fully in later pages of the thesis.

TABLE 3.5

MWEA IRRIGATION SETTLEMENT MONTHLY, DAILY AND ANNUAL MEAN EVAPORATION, 1969-1972 (in mm.)

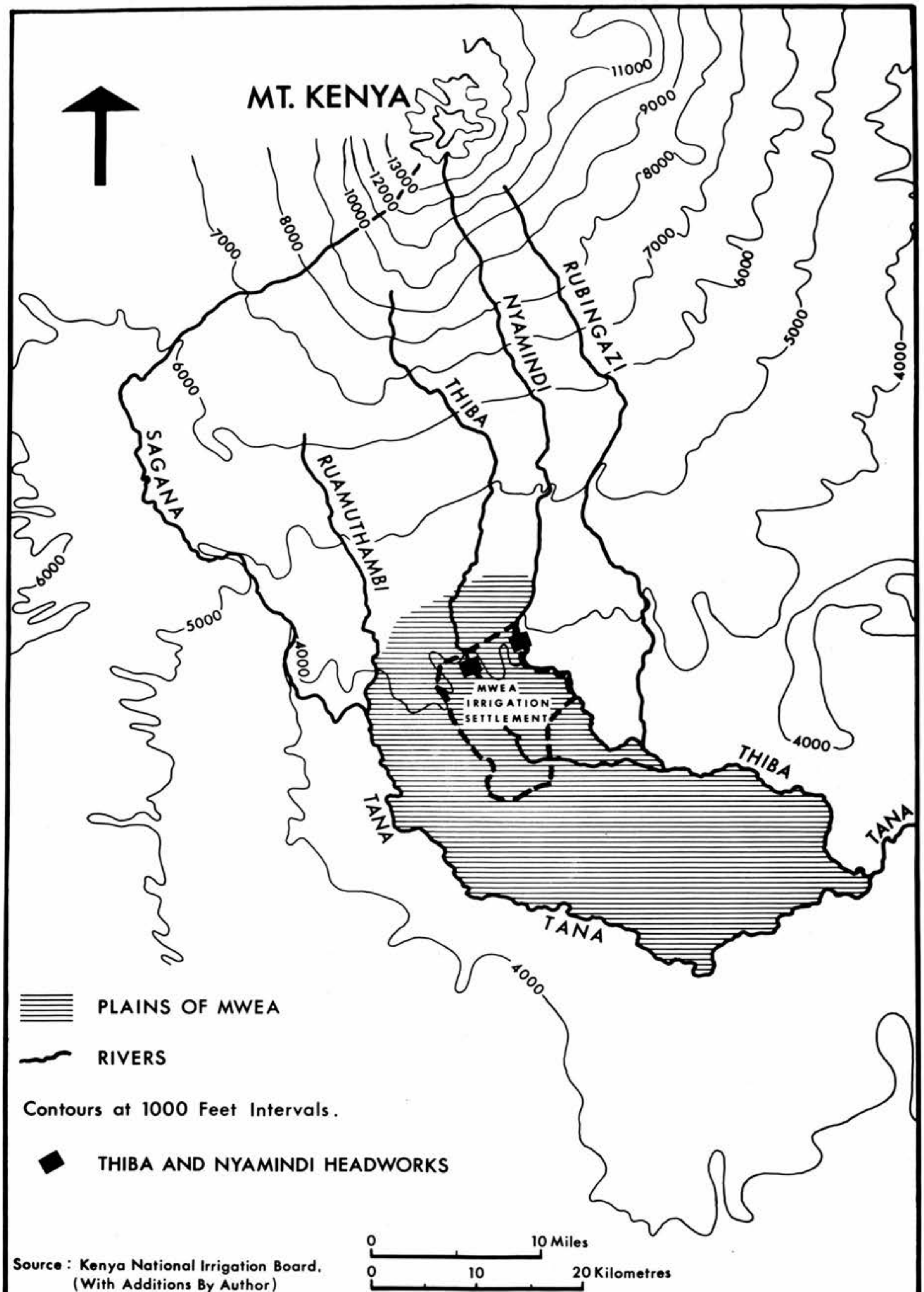
Month	1969 Monthly Total	1969 Daily Av.	1970 Monthly Total	1970 Daily Av.	1971 Monthly Total	1971 Daily Av.	1972 Monthly Total	1972 Daily Av.
Jan.	180.59	5.83	195.58	6.31	224.85	7.87	204.60	6.60
Feb.	146.56	5.05	250.95	8.96	279.65	9.91	192.60	6.60
March	165.86	5.35	230.38	7.43	291.59	9.40	253.00	8.20
April	154.18	5.14	171.45	5.71	169.42	5.65	244.00	8.10
May	154.94	4.99	154.69	4.99	132.59	4.28	161.80	5.20
June	145.54	4.85	121.67	4.06	121.41	4.06	129.30	4.30
July	137.16	4.43	128.01	4.06	120.00	3.90	145.70	4.70
August	154.18	4.68	137.92	4.32	131.50	4.20	172.30	5.60
Sept.	232.16	7.74	186.43	6.21	208.20	6.90	203.10	6.80
Oct.	250.70	8.09	246.88	7.96	242.60	7.80	226.90	7.60
Nov.	149.10	4.97	158.50	5.33	190.20	6.60	172.30	5.70
Dec.	201.20	6.49	211.58	6.86	200.80	6.50	191.50	6.20
Annual Mean	172.68	5.63	182.84	6.02	194.40	6.50	191.60	6.40

Source: *Annual Reports of the Mwea Irrigation Settlement*, 1969-1972.

HYDROGRAPHY

Water for irrigation is derived from two rivers, the Thiba and the Nyamindi, which rise in the high rainfall zone on the slopes of Mount Kenya (Fig. 3.4). The Thiba and Nyamindi Rivers drain the southern slopes of Mount Kenya and border, or cross the Mwea Area in their courses (Fig. 3.4). The run-offs from both catchments are relatively high, and the minimum flow in each river seldom falls below 100 cusecs, though the catchment area of the Thiba is only 140 square miles and of the Nyamindi 110 square miles. It was observed that there are no gauges or instruments to measure the amount of water entering the Mwea, Tebere, Wamumu, and Karaba Sections and individual units from the Thiba and Nyamindi Rivers' main canals. The only gauges to measure cusecs of water were located about 200 yards down from the Thiba and Nyamindi Headworks and at Unit H-20 in the Thiba Section (Table 3.6). The amount of water from the main canals used by the five sections, and their individual units and holdings, can only be roughly estimated.

Water is a scarce resource for Mwea and is expensive for the farmers. Therefore, it is of prime importance for the MIS Management and the officials of the NIB to have a precise and accurate measurement, at different times during the growing season, of the amount of water being used and needed by each section, unit, and holding in the MIS. This was not yet fully possible at the time of my field study at Mwea.



HYDROGRAPHY OF MWEA IRRIGATION AREA

FIG. 3·4

TABLE 3.6

MWEA IRRIGATION SETTLEMENT: DAILY CUSEC READINGS CROM THE NYAMINDI AND THIBA HEADWORKS AND THE THIBA SECTION UNIT H-20 DURING THE GROWING SEASON OCTOBER 1972[1]

Day of Month	Nyamindi Headworks	Thiba Headworks	Thiba Section Unit H-20
1	75	127	90
2	74	134	90
3	74	135	86
4	74	135	78
5	75	136	80
6	75	137	88
7	76	134	80
8	75	127	85
9	73	130	90
10	73	134	85
11	74	136	88
12	74	139	94
13	73	120	88
14	40	140	85
15	11	111	70
16	35	111	98
17	34	142	106
18	45	80	58
19	74	80	50
20	72	110	70
21	72	110	70
22	75	112	72
23	74	139	65
24	73	110	72
25	73	144	82
26	75	141	84
27	75	142	84
28	74	132	70
29	74	132	70
30	75	132	50
31	10	4	4

1 October is the major month in the growing season when water is in great demand in the Mwea Irrigation Settlement.

Source: *National Irrigation Board, Mwea Irrigation Settlement,* 1972.

The Thiba River serves to irrigate four sections: Mwea (2,913 acres), Thiba (2,800 acres), Wamumu (2,945 acres), and Karaba (2,478 acres) (Reference Map). The Nyamindi River serves to irrigate only the Tebere Section (3,040 acres). The period of greatest demand for irrigation water in the MIS is during the growing season. Irrigation water at Mwea is used up primarily by: (1) seepage losses in the complex irrigation network and through the bunds in the paddy holdings; (2) transpiration through the paddy plants; (3) high incidence of evaporation; and (4) removal of water from the main canals and drains by the tenant families as a major source of drinking water. The Murubara River, which passes through the area (Reference Map), serves several villages as a major source of drinking water. The Thiba and Nyamindi Rivers are constantly used as a major source of water for consumption and domestic uses. The availability of water for irrigation through the Thiba and Nyamindi headworks (Fig. 3.4 and Photo. 3.3) is the most critical resource for paddy cultivation in the MIS. During my field survey I became very conscious of the great need for the MIS Management, Field Extension Staff and tenants to become more aware of the necessity to conserve and economise on irrigation water. The availability of water will be a restricting factor in any future extension of the scheme.

Within the MIS drainage system, irrigation water is channelled off from the rivers by two main canals. Major and minor drains distribute the water to feeder drains through the irrigation system (Reference Map). The only lined section in the MIS drainage system is located in the Nyamindi main canal which

PHOTO. 3.3: THE THIBA HEADWORKS AND MAIN CANAL

This headworks was constructed in the early 1950's, during the Mau Mau Insurrection. The detainees dug out the canal. On average, during the growing season, 80 cusecs of water flow from this headworks, supplying the Mwea, Thiba, Wamumu and Karaba Sections with irrigation water. The water and headworks are vital; without them there would be no irrigation settlement at Mwea.

is lined for a distance of approximately 300 yards down from the Nyamindi Headworks, serving the Tebere Section.

Tenants are charged an annual water rate of 200 Kshs. per acre. The rate covers the cost of indirect services such as the maintenance of canals, drains, ditches, structures, roads, and the administrative overhead of the scheme. All water charges are debited to the tenants' accounts and collected from the proceeds of his crop. All water control is in the hands of the MIS Water Staff. A tenant is not allowed to interfere in any way with the water regime in his holdings. The Irrigation Officer of each section establishes the watering programme after consultation with the Head Field Assistant. The Field Assistants, the Head Water Guard and his Water Guards are responsible for execution. The Head Water Guard is in charge of the main section intake from the irrigation headworks and supervises water movement in the individual units. His work calls for considerable travelling in and out of the section; so he is equipped with a motor-cycle. Each Water Guard is in charge of approximately 500 acres, the amount varying according to the size of the units making it up. He regulates the quantity of water going into a unit and feeds or drains individual holdings as required. It was observed that the best results were obtained by keeping the Water Staff completely separate from the Field Extension Staff. This arrangement helps water economy by making the Irrigation Officer accept the decisions, rather than leaving it to the more parochial point of view of the Field Assistants.

Water use observations in the MIS have been carried out in the Thiba Section Unit H-20 since 1964 (Table 3.7). The area of Unit H-20 is approximately 250 acres. Unit H-20 is equipped with measuring devices to measure and assess water usage in this particular unit accurately.

TABLE 3.7

MWEA IRRIGATION SETTLEMENT: NET WATER CONSUMPTION OF THIBA SECTION UNIT H-20, 1964/65-1972/73

Season	Water Use mm.	Paddy Yield kg./ha.
1964/65	1,026	5,887
1965/66	1,103	5,768
1966/67	756	5,224
1967/68	927	6,637
1968/69	972	4,984
1969/70	1,295	6,100
1970/71	928	6,322
1971/72	1,097	6,259
1972/73	925	6,808

Source: *Annual Reports of the Mwea Irrigation Settlement,* 1964/65-1972/73

Table 3.7 shows the fluctuations in water use and paddy yield. The increase in water use during the 1971/72 season was caused by dry weather prevalent for much of the year. The average annual rainfall in 1971 was 26 inches, the lowest since the record low of 23 inches in 1960. Proper control and use of water is of even greater importance to the MIS since the extension of 2,000 acres in the new Karaba Section. The Karaba Section became completely operational during the 1973/74 season.

The rise in gross abstraction at the Nyamindi intake, which serves the Tebere Section (3,040 acres), has increased substantially since 1968 (Table 3.8). This increase in water intake is not justified by changes in the weather alone but can be attributed partly to poor control of water in the Tebere

Section (*National Irrigation Board Annual Report*, 1971/72).

TABLE 3.8

GROSS ABSTRACTION OF WATER INTAKES AT THE MWEA IRRIGATION SETTLEMENT HEADWORKS, 1968/69-1971/72 (in mm./ha.)

Season	Nyamindi Headworks	Thiba Headworks
1968/69	1,914	1,234
1969/70	2,926	2,149
1970/71	3,331	1,990
1971/72	3,450	2,173

Source: *Annual Reports of the Mwea Irrigation Settlement*, 1968/69-1971/72

During the 1971/72 season there was an increase in irrigation water used in the MIS resulting from the dry weather prevalent for most of the year (Table 3.8).

Water control in the Tebere Section, served by the Nyamindi intake, is less efficient than in the sections served by the Thiba intake.

Drainage problems are encountered particularly in the Mwea Section. The northern part of this section is dominated by the Nguka Swamp which occupied a substantially larger area in the past than at present. The Nguka Swamp covers an area of about 2,000 acres (Reference Map). The units bordering the present Nguka Swamp Area are in an old, reclaimed swamp area or in the marginal area which formerly showed seasonally waterlogged conditions. Apart from the Nguka Swamp, minor swamp or swampy conditions occur locally, dispersed in the MIS Area, and along natural water courses. Low-lying terrain poses potential or actual problems of waterlogging.

Waterlogging conditions in the MIS are associated with evidence of soil alkalinity. Poor drainage is also caused by seepage of water from the ridges into the clay basins, whereby waterlogged conditions are induced in the transitional zone at the bottom of the ridge (Leyder, 1969, 3). In several fields near high ridges and escarpments large holes were formed from which the seepage water wells to the surface and spreads over the fields. Poor drainage can result in a complex of adverse soil conditions in the MIS.

The availability of irrigation water in the MIS at the peak periods of the growing season is now a critical factor with the additional burden on the irrigation system of the new Karaba Section of 2,000 acres.

In 1966, D.J. Duckett made a comprehensive report to ascertain whether the amount of water from the Thiba and Nyamindi Rivers would be sufficient to irrigate 12,100 acres in the MIS during the growing season, the period of greatest demand for water, September to November. A water balance table of the MIS was constructed by Duckett in 1966. Measurements of the quantities of water used by the MIS from the Thiba and Nyamindi Rivers were taken over a period of several years and used as a basis for the report.

Table 3.9 illustrates clearly that with a maximum of 12,100 acres of paddy under irrigation in the MIS during a single season, a substantial water deficit would occur in September and October.

However, with a well co-ordinated Water Staff trained in the importance of water conservation and economy, greater use can be made of the water available for paddy cultivation.

From the results of the report by Duckett, it appears that the calculated amount of land in the MIS available for paddy cultivation, from the point of view of water availability, is 12,100 acres. Duckett (1966, 7), reporting on his findings concerning the availability of adequate water during the critical growing season, writes:

> The month of greatest water shortage is September. The figure of 4,000 ac.ft. deficiency is brought about to a certain extent by the present practice of partly draining the fields before transplanting from the nurseries and then increasing the rate of application so as to again achieve normal water level in the fields. The Management should investigate to what extent this practice can be reduced.
>
> If normal water application is applied during the month of September ... then the deficiency is only 500 ac.ft. This deficiency should not affect productivity and would certainly not justify the construction of any costly diversion works ... However, water shortage will not occur until the whole scheme is developed and I would suggest that the cheapest method of supplementing supplies would be by direct diversion of drainage water to the main canal ...

The MIS Assistant Irrigation Officer stated to me during a field survey of the MIS in August 1973:

> The failure of the short rains during October/November has a great impact on the Mwea Irrigation System when water is greatly needed during the growing season. A partial solution toward redressing this water shortage problem is to conserve water during the transplanting period in August/ September by transplanting the fourth field of the holding next to the drain side first, and then use the water from the third field via the feeder drain. Thus, it is better to have 'old water' than to have 'no water at all'.

TABLE 3.9

MWEA IRRIGATION SETTLEMENT WATER BALANCE: IRRIGATION WATER AVAILABLE IN THE MIS DURING THE MAIN GROWING PERIOD WITH 12,100 ACRES UNDER PADDY (in acre feet)[1]

Water Supply	July[4]	Aug.	Sept.[5]	Oct.[6]	Nov.[6]	Dec.[6]
Total water available from the Thiba and Nyamindi Rivers	10,900	10,100	8,400	8,100	10,200	10,800
Total water available from rainfall[2]	nil	nil	nil	970	7,150	2,420
Total water available	10,900	10,100	8,400	9,070	17,350	13,200
Total water required in MIS during these months[3]	10,500	6,640	12,400	10,100	8,600	8,900
Total water deficit in MIS during these months	nil	nil	-4,000	-1,030	nil	nil

[1] 1 acre foot = 0.0123 hectare/meter or 123 cubic meters.

[2] These data fluctuate from year to year according to the start, length of duration, and amount of rainfall during these months (Table 3.1).

[3] These estimates of the amount of water required in the MIS during the growing season are based on the assumption that irrigated paddy requires about 580 mm. of rain per acre and at most 1,500 mm. per hectare, according to the monthly demands for water in the MIS.

[4] Flooding of fields at 2.5 x consumptive use.

[5] Topping-up fields after transplanting at 1.75 x consumptive use.

[6] Ordinary water application at 1.25 x consumptive use.

Source: D.J. Duckett, *Mwea Irrigation Scheme, Water Development Department, Nairobi, Kenya,* March 1966 (mimeo.), p. 5.

PHYSIOGRAPHY

The Plains of Mwea are flanked to the north by the Sagana-Embu tarmac road at about 4,500 feet elevation, on the west by the Tana River, and on the east by the Thiba and Nyamindi Rivers (Fig. 3.4).

This is a striking geographical feature. On descending from Mount Kenya or from the Aberdare Range in the west, suddenly an enormous flattish plain appears, like a giant's right footprint in the mud, stretching into the distant horizon. The Mwea Plains encompass a total area of about 215 square miles (Fig. 3.4).

The upper portion of the Plains has an undulating topography based upon volcanic lava flows, which spread out from Mount Kenya and have been dissected by permanent rivers into broad ridges and shallow valleys. The soils of the ridges are mainly reddish volcanic loams. The flatter areas consist of heavy impervious black clays. The mean annual rainfall is from 30 to 40 inches.

This environment can be viewed as a series of clay basins underlain by Olvine Basalt. The basins descend in a series of steps toward the east. Each step is demarcated by an escarpment formed of basaltic boulders. Scattered rock outcrops are seen in various areas of the Plains. Lateral drainage is from west to east. The higher-lying basins receive supplies of alluvium from the highlands consisting of alkaline material, primarily halloysite.[1] The clay minerals consist of montmorillonite and halloysite.

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[1] A clay-like earthy mineral, a hydrated aluminum silicate, resulting from the decomposition of felspar.

Because of the topographical location these soils are subjected to leaching. Alkalinity and also finer soil nutrients are transported to the lower-lying basins. Black clay grumosols are located in the flat low-lying basins. Paddy is cultivated under gravity irrigation on these black cotton soils. These black cotton soils vary considerably in relation to their proportions of sand, silt, and clay in the top soil and also in the subsoil. Black cotton soils under paddy farming show intense mottling in the surface layers (Leyder and D'Costa, 1969, 3). However, these tracts are generally very suitable for paddy farming because of the following characteristics:

1. In the upper courses of the main canals the land has a gradient of about 6 per cent but in the lower section of the canals the gradient drops off to about 3 per cent. Therefore, it is feasible to construct one-acre fields without substantial expenditure for levelling.

2. The Olivine Basalts are covered (unconformably) by fine montmorillonitic material of alluvial origin, which has accumulated to a varying depth of about three feet on the basaltic floor, forming heavy clay soils. These clays, under long standing, have developed into grumosols.

3. The black cotton soils are difficult to cultivate without irrigation. When dry they are generally hard and difficult to work but when wet they are sticky like gum and can be rotavated under optimal moisture conditions.

4. The black cotton soils have a high capacity for water retention. This property is of advantage for irrigated paddy cultivation.

However, within the basins of the plains the soil is often not uniform. Transitional soil types occur near the edges of the basins. The lower-lying basins show evidence of a higher degree of alkalinity (Leyder, 1969).

Soils under paddy cultivation show signs of chemical reduction. This reduction begins through the metabolism of anaerobic bacteria and results in anaerobic decomposition of organic matter, high concentrations of ammonia and carbonic acid, migration of reduced compounds of iron and manganese, production of sulphide, destruction of nitrate, increase in pH, and increased solubility of silica. These chemical changes tend to alter the character of the soil type.

The anaerobic decomposition of organic matter does not appear to be proceeding at the rate anticipated for paddy cultivation in the MIS. This is possibly because the prevailing temperatures in the MIS Area are lower than is usually found for paddy cultivation. Surface organic matter comprises between 3 to 5 per cent of the soil. From paddy holdings originating from the Nguka Swamp Area, the surface organic content exceeds 6 per cent (Leyder and D'Costa, 1969).

Alkalinity concentrations are often associated with lines of lateral seepage which appear to occur where there is a change in slope. At depth there is an abundance of precipitated calcium. Often the condition of the natural vegetation indicates that toxic seepage occurred prior to the development of the MIS Sections. Where paddy manages to survive from alkaline seepage lines, the straw is considerably shortened and tillering is inhibited.

The part of the land under paddy cultivation will not, in any case, remain static, but will vary according to soil moisture status, plant growth and season. In general, the pH can be expected to rise during flooding and fall during drainage of the fields. Long continued irrigation is likely to result in a depletion of basic minerals, especially sodium. Furthermore, substantial applications of ammonia sulphate and superphosphate will not only provide nitrogen and phosphate for the paddy crop, but may over a long period of time, also result in a decrease of alkalinity.

Substantial differences exist between different soil types in the quantities of nutrients removed from the soil by the paddy crop. R.A. Leyder, Soil Chemist of the Kenya National Agricultural Laboratories (NAL), observed that paddy takes up comparatively large amounts of nitrogen and potassium and low levels of phosphate. Potassium is particularly important in the early months of the growing season since it promotes the set of grain, improves tillering, increases disease resistance, and plays an important role in the promotion of starch.

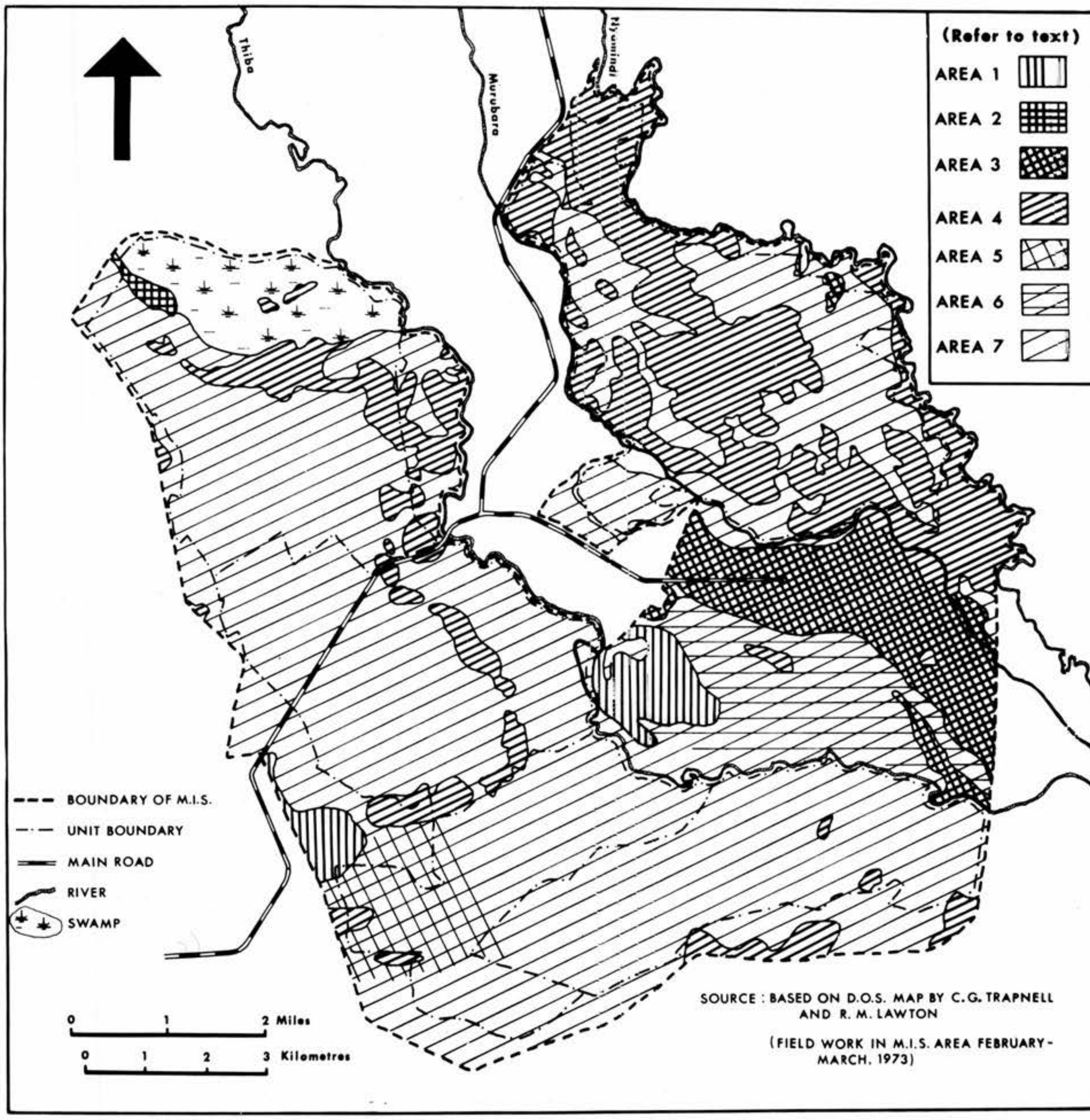
There is evidence from field investigations by the NAL to indicate that continuing irrigation with the water from the Thiba River is causing loss of nutrients through leaching, and ultimate soil impoverishment. Soil analysis indicates deficiencies in nitrogen and phosphates. However, the addition of a single element, nitrogen, to the paddy crop may be beneficial only within narrow limits, and may even cause a decline in paddy yields. At the MIS more than one nutrient is deficient. Increased paddy yields have been obtained in the MIS by the application of both ammonia sulphate and superphosphate (Leyder, 1969).

NATURAL VEGETATION

The indigenous vegetation of the Mwea Area is open savanna grass woodland, with scattered *Acacia*, mixed with dry *Combretum* and allied vegetation. Figure 3.5 shows the relatively large patches of *Themeda*, *Themeda - Pennisetum mezianum*, etc., accompanied by scattered blotches of cultivated and burnt-out savanna grassland areas (including *Cassia* grassland). A prominent narrow band of derived *Acacia*, *Acacia - Combretum* and undifferentiated *Combretum* types lies between the Murubara and Thiba Rivers (Fig. 3.5). Small scattered patches of *Acacia drepanolobium* and *Acacia senegal* are found in the southern part of Mwea (Fig. 3.5). An isolated clump of cultivated *Thespesia*, *Piliostigma* and *Croton* is located in the northwestern corner of the Mwea Area (Trapnell and Lawton, 1973). I also observed open scrub vegetation intermixed with subsistence plots. When the subsistence farms were abandoned, scrub vegetation developed on these areas.

SOILS

There are no resources more important to Mwea than the water and soil. However, the use of these resources must be managed in such a way that they are conserved and not exploited, for exploitation can result in the destruction of Mwea.



VEGETATION TYPES OF CENTRAL KENYA

FIG. 3·5

VEGETATION COMMUNITIES OF THE MWEA IRRIGATION SETTLEMENT, 1973*

COMBRETUM AND ALLIED BROAD-LEAVED SAVANNA TYPES

Eastern Combretum and allied vegetation:

AREA 1 Undifferentiated Combretum types

AREA 2 Cultivated Thespesia, Piliostigma and Croton areas

AREA 3 Derived Acacia and Acacia-Combretum

Faurea and Parinari-Combretum, eastern types:

AREA 4 Cultivated and burnt-out savanna grassland areas (includes Cassia grassland)

VEGETATION OF SOILS WITH IMPEDED DRAINAGE

Acacia and allied vegetation on clay plains:

AREA 5 Acacia drepanolobium dominant, eastern type

AREA 6 Acacia senegal dominant, eastern type

Open grasslands on clay plains:

AREA 7 Themeda, Themeda-Pennisetum mezianum, etc.

* Explanation of Fig. 3.5, Vegetation of the Mwea Area.

Source: Based on DOS map by C.G. Trapnell and R.M. Lawton from field survey work in the Mwea Irrigation Settlement Area during February/March 1973.

The black cotton soil on which paddy is grown at the MIS is a grumosol, overlying weathered trachyte bedrock, usually at 3 to 4 feet. The soil is a uniform black multiangular, blocky, cracking clay, usually with a coarse granular surface. It is moderately slowly permeable to water. Soil analyses give the following ranges: clay, 60 to 80 per cent; silt, 10 to 35 per cent; and sand, 5 to 10 per cent (Leyder, 1969).

Red to reddish brown lateritic clay loams are found on the higher areas which extend on lower ridges into the black cotton soil basins. These free draining lateritic soils are rather shallow and are underlain by murram (ferricrete) and volcanic tuff.

The red soils within the MIS are allocated as farm plots to the paddy farmers in the 34 villages within the Mwea Settlement. On the red soils the tenants grow subsistence crops, primarily maize and beans. Cotton is grown as a cash crop on the red soils in the Tebere Section and in a few areas in the Mwea Section. Cotton is not grown in the other sections in the MIS.

Tenants at the MIS are allocated 4 one-acre plots as a paddy holding. Only one crop of transplanted paddy is grown per year during the period July to January. Paddy holdings are held under annual licences, automatically renewable, providing the performance of good crop husbandry is practised.

Soil Alkalinity Problem

The trend toward accelerated alkalinity in the five sections of the MIS has been neglected. Alkalinity is on the increase and spreading (Fig. 3.6). From my field experience I do not foresee this trend reversing in the near future. Figure 3.6 illustrates that the most severe areas of alkalinity appear in the Wamumu and Karaba Sections, in the southern part of the MIS Area (Reference Map). The following questions are posed: Why has this alkalinity situation developed in the MIS? What circumstances cause alkalinity in the MIS environment? What circumstances accelerate alkalinity in the MIS environment? Alkalinity is a complex condition with no easy answers. Some of the factors which have contributed to accelerate this alkalinity trend are:

1. The lack of good planning in laying out of the canals, ditches, drains, and feeders before conducting a comprehensive soil survey.

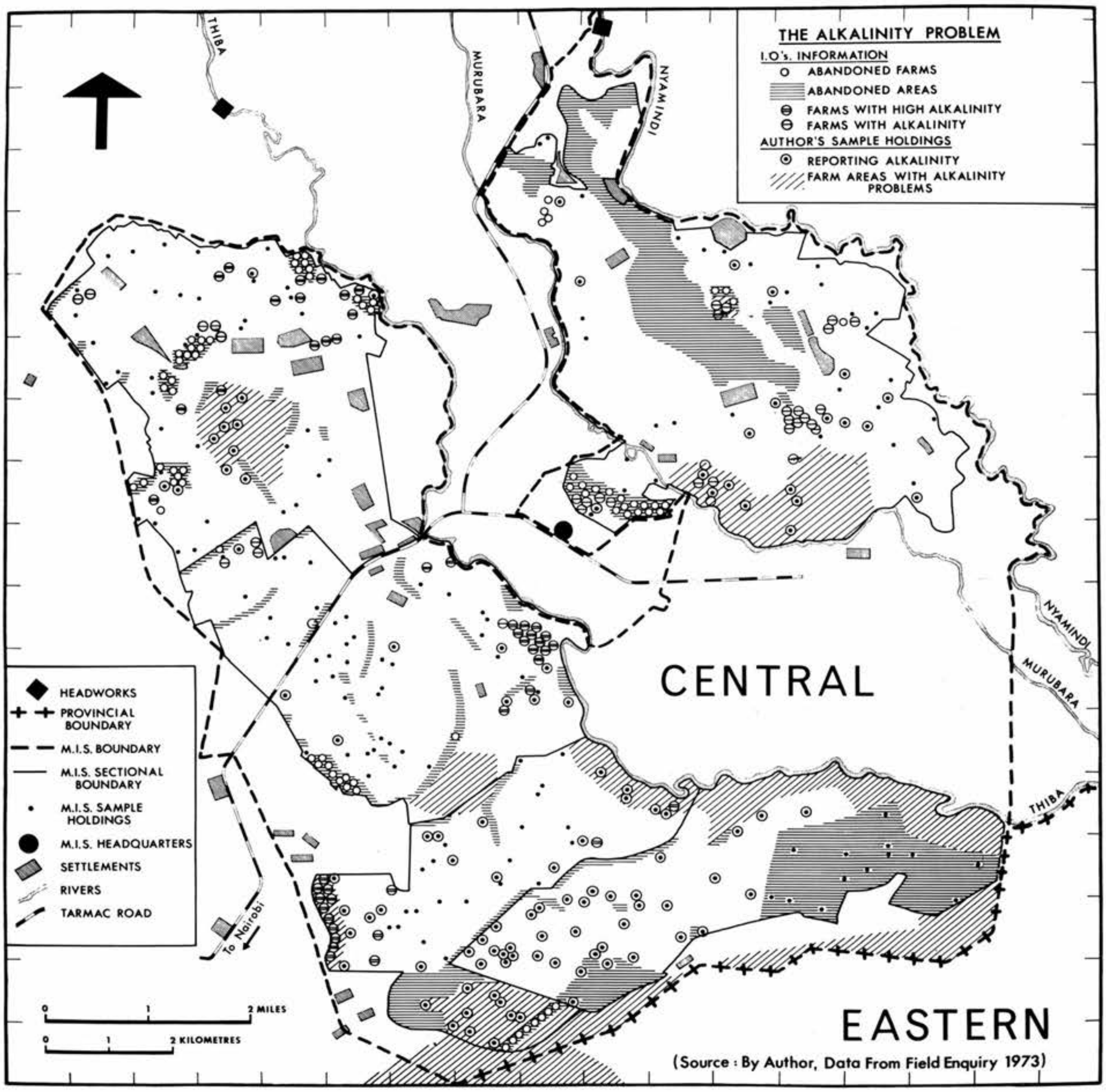
2. Basaltic rock escarpments located in specific areas above the paddy holdings result in alkaline seepages in the contiguous paddy fields.

3. The high evaporation rate in the Mwea Area resulting in an accumulation of salts.

4. Lateral seepage of alkaline water between the bunds separating the holdings and seepage from the drains and canals contiguous to the fields.

5. The problem of draining the fields after harvest to prevent waterlogging tends to add to soil alkalinity.

Excessive alkalinity of Mwea soils causes a substantial decline in yields, uneven stands of paddy, and uneven growth of



THE ALKALINITY MAP

FIG. 3·6

paddy plants in the fields. A patchy appearance in paddy fields can be seen and is often associated with slight changes in elevation. The result is generally an accumulation of alkalinity in these low-lying areas. In the final analysis it is the consequences of the alkalinity problem which really matter.

R.A. Leyder (1974)[1] elaborates on the Mwea alkalinity problem:

> It is not yet certain that alkalinity (= excess exchangeable sodium) will increase. But if this would be the case, influx of sodium from external sources must take place and/or sub soil sodium, if present, must rise to the surface as a result of evaporation.
>
> In some specific areas in the MIS, alkalinity could be caused by seepage from nearby 'high ground', particularly if a major canal runs over the high ground. For seepage to take place, so as to induce poor alkali soil conditions, the difference in level between the black cotton soil of the basin and the red soil of the high ground should be considerable, and the transition abrupt. In those cases, an interception drain is recommended as a remedy against further build up of alkalinity. Some alkali areas in the MIS may in fact be the remains of a lateral accumulation pattern (within the basin). These particular areas lie near high ground, but the difference in level is not great, and the transition from the black cotton soil to red soil is not abrupt.
>
> Good farming practices along the established methods at the MIS alone will not result in good yields on the alkali soils. Measures to reclaim the alkali soils, or to counteract the alkalinity, or to correct induced deficiencies caused by the alkalinity should be taken at the same time. Studies should be undertaken to provide the necessary

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[1] Letter, Soil Chemist, Kenya Soil Survey Project, NAL, to Author, 12th February 1974.

> recommendations. If the alkalinity problem spreads, the process will not be halted by good farming practices alone, but additional measures will have to be taken particularly on improved drainage conditions in the MIS.

1. Mwea Section

Topographically, the Mwea Section is relatively higher-lying as compared with the other sections of the MIS (Reference Map). The effects of prolonged poor drainage conditions and the continuous Nguka Swamp Area of 2,000 acres result in lower yields in the northern part of this Section. Swampy conditions prevail on the fringes of the Nguka Swamp, along the water courses, and at the foot of the steep escarpment which divides the Mwea Section into two parts.

A detailed section-by-section treatment of the alkalinity problem in the MIS is presented. This comprehensive analysis is based primarily on my field enquiry and survey in the MIS in 1973. This information was derived from my field enquiry with the sample tenants and from discussions and field surveys of each section with the Irrigation Officer and the Head Field Assistants. The detailed treatment also reflects conferences with the soil scientists from the NAL. Alkalinity findings were also based on published studies by J.K. Gitau, R.A. Leyder, and V. D'Costa.

Table 3.10 shows there were 35 holdings representing 145 acres abandoned in the Mwea Section resulting from excessive soil alkalinity (Fig. 3.6). There are evidences of high alkalinity

TABLE 3.10

ALKALINITY AREAS IN THE MWEA SECTION
MWEA IRRIGATION SETTLEMENT, 1973

Section and Unit	Evidence of Alkalinity (Farm numbers)	High Alkalinity (Farm numbers)	Abandoned (Farm numbers)
M-1	Nil	1637, 1647 (8 acres)	Nil
M-2	Nil	1657 (4 acres)	Nil
M-3	Nil	1753, 1755 (8 acres in total)	1741, 1742, 1743, 1744, 1745, 1757, 1758, 1759, 1762, 1764, 1765, 1769 (54 acres abandoned because of excessive alkalinity)
M-4	Nil	1693, 1715, 1722 1766, 1767, 1768 (28 acres in total)	Nil
M-7	Nil	Nil	1521, 1567, 1569, 1583, 1584, 1585, 1586, 1587, 1589 (36 acres abandoned)
M-8	1590, 1600, 1601 (12 acres in total)	Nil	Nil
M-9	1802, 1805 (8 acres in total)	Nil	Nil
M-10	Nil	Nil	Nil
M-11	Nil	Nil	1842, 1843, 1845, 1846 (15 acres abandoned)
M-12	Nil	1774, 2216 (4 acres in total)	
M-13	Nil	2302, 2304, 2309 12 acres in total)	2295, 2296, 2297, 2298, 2300, 2301, 2310, 2311, 2312, 2319 (40 acres abandoned because of excessive alkalinity)
M-14	Nil	1950, 1956 (8 acres in total)	Nil
M-17	Nil	2198, 2204, 2208 2212, 2219 (20 acres in total)	Nil

on 23 holdings representing 92 acres. Evidence of alkalinity appears on 5 holdings representing 20 acres in Units M-8 and M-9.

I observed that there is a serious lack of cultural practices in various parts of the Mwea Section. This exacerbates the soil alkalinity problem in the Section. Many of the main drains and feeders had excessive weeds which impeded the flow of water into the holdings. Maintaining the water level in each particular holding also plays an important role in controlling weeds and in paddy yields as well. If the holding is not covered with the correct amount of water after rotavation, weeds increase rapidly. Also connected with the alkalinity problem are problems of waterlogged fields and improper levelling of the holdings.

2. Tebere Section

The Tebere Section is located in a high-lying area of the MIS (Reference Map). This Section has the highest percentage of red soils in Mwea. Table 3.11 shows there were 30 holdings representing 124 acres that were abandoned due to excessive alkalinity. Evidences of alkalinity appear on 32 holdings representing about 130 acres (Fig. 3.6).

TABLE 3.11

ALKALINITY AREAS IN THE TEBERE SECTION, MWEA IRRIGATION SETTLEMENT, 1973

Section and Unit	Evidence of Alkalinity (Farm numbers)	High Alkalinity (Farm numbers)	Abandoned (Farm numbers)
T-5	Nil	Nil	15, 32, 33, 34 (16 acres abandoned)
T-6	140, 145, 147 (12 acres in total)	Nil	148, 149, 150 (12 acres abandoned)
T-8	312, 316, 318 (12 acres in total)	Nil	317 (4 acres abandoned)
T-11	547, 558 (8 acres in total)	Nil	Nil
T-15	415 (4 acres in total)	Nil	Nil
T-17	244, 245, 247 (12 acres in total)	Nil	246 (4 acres abandoned)
T-19	262, 269, 270, 271, 278, 279, 280, 281 295, 296 (40 acres in total)	Nil	268, 272, 276, 277 (16 acres abandoned)
T-20	647, 648, 656, 657, 658, 661 (24 acres in total)	Nil	640, 641, 642, 643, 644, 645, 646, 647, 649, 650, 651, 652, 653, 654, 655, 659, 660 (72 acres abandoned
T-21	420, 427, 450 (12 acres in total)	Nil	Nil
T-25	495 (4 acres in total)	Nil	Nil

3. Thiba Section

The Thiba Section is located on the flat plains of the MIS (Reference Map). Many of the holdings have shallow soils. Table 3.12 shows that 15 holdings or 64 acres have been abandoned resulting from excessive soil alkalinity. There are evidences of high alkalinity on 17 holdings representing 68 acres (Fig. 3.6). This is the result of excessive alkalinity in these holdings. Evidence of alkalinity is found on 7 holdings representing 28 acres.

TABLE 3.12

ALKALINITY AREAS IN THE THIBA SECTION,
MWEA IRRIGATION SETTLEMENT, 1973

Section and Unit	Evidence of Alkalinity (Farm numbers)	High Alkalinity (Farm numbers)	Abandoned (Farm numbers)
H-2	2464, 2482 (8 acres in total)	Nil	Nil
H-3	Nil	2381 (4 acres in total)	Nil
H-4	Nil	Nil	2804, 2805, 2806, 2807, 2808, 2809, 2810, 2811, 2812, 2813 (48 acres in total)
H-5	Nil	Nil	2539 (4 acres in total)
H-6	Nil	2591, 2594 (8 acres in total)	Nil
H-7	2666 (4 acres in total)	2684, 2685, 2686, 2687, 2688, 2689, 2690, 2691, 2692, 2693, 2694, 2695 (48 acres in total)	2673 (4 acres in total)
H-8	Nil	2703, 2735 (8 acres in total)	Nil
H-18	2089, 2090, 2101, 2115 (16 acres in total)	Nil	2087 (4 acres in total)
H-20	Nil	Nil	2086 (4 acres in total)

4. Wamumu Section

The Wamumu Section is located in the low-lying basin of the MIS (Reference Map). Table 3.13 shows that there were 162 acres in Unit W-6 abandoned resulting from excessive alkalinity. There are also 16 holdings representing 68 acres in Units W-3, W-4, and W-5 which have high alkalinity (Fig. 3.6). Evidence of alkalinity appears on 29 holdings representing approximately 120 acres.

TABLE 3.13

ALKALINITY AREAS IN THE WAMUMU SECTION, MWEA IRRIGATION SETTLEMENT, 1973

Section and Unit	Evidence of Alkalinity (Farm numbers)	High Alkalinity (Farm numbers)	Abandoned (Farm numbers)
W-1	3103, 3120, 3121, 3144, 3167 (20 acres in total)	Nil	Nil
W-2	3300 (4 acres in total)	Nil	Nil
W-3	3341, 3358, 3362, 3379, 3385, 3413 (24 acres in total)	3375, 3386 (8 acres in total)	Nil
W-4	3415, 3450, 3454 3459, 3468, 3488 (24 acres in total)	3412, 3413, 3414 3422, 3430, 3438 3439, 3448, 3455, 3461, 3467, 3471, 3476 (56 acres in total)	Nil
W-5	3588 (4 acres in total)	3591 (4 acres in total)	Nil
W-6	3615, 3636, 3646, 3648, 3659, 3662, 3666, 3681, 3685, 3689 (40 acres in total)	Nil	3700, 3701, 3702, 3703, 3704, 3705, 3706, 3707 (162 acres in total abandoned because of excessive alkalinity)

5. Karaba Section

The Karaba Section is located in a depression basin of the MIS (Reference Map). This is the lowest-lying area of the MIS. An estimated 300 - 400 acres have evidence of high alkalinity in Units K-3 and K-4 (Table 3.14). It is anticipated that this acreage will be abandoned next season (Fig. 3.6). During the 1973/74 season 400 acres were abandoned due to excessive soil alkalinity in Units K-5, K-6, and K-7 (Table 3.14).

TABLE 3.14

ALKALINITY AREAS IN THE KARABA SECTION, MWEA IRRIGATION SETTLEMENT, 1973

Section and Unit	Evidence of Alkalinity (Farm numbers)	High Alkalinity (Farm numbers)	Abandoned (Farm numbers)
K-1	3717, 3719, 3721, 3731, 3733, 3741, 3742, 3747, 3748, 3752, 3764, 3779, 3801, 3804, 3811, 3812 (64 acres in total)	Nil	Nil
K-2	3850, 3851, 3868, 3885, 3892, 3897, 3930, 3932 (32 acres in total)	Nil	Nil
K-3	3945, 3956, 3958, 3964, 3977, 3996, 4014 (28 acres in total)	300-400 acres	Nil
K-4	4020, 4043, 4064, 4103 4105 (20 acres in total)		Nil
K-5	4127	Nil	(400 acres (abandoned
K-6	Nil	Nil	(because of (excessive
K-7	Nil	Nil	(alkalinity

Approximately 400 acres in the newly developed fields in the Karaba Section have completely failed to raise a paddy crop during the 1973/74 season in spite of several attempts to replant the fields.

An additional 400 acres in the Karaba Section are also faced with a severe alkalinity problem and very low yields. Assistance from the NAL has been obtained and soil samples of the affected alkali areas have been made. Chemical analyses of the soils in the Karaba Section are expected to take considerable time to be completed; however, it is hoped that a comprehensive reclamation programme will be drawn up at the beginning of the 1974/75 season *(Mwea Irrigation Settlement, Quarterly Report for the Period October - December, 1973, 4).*

R.A. Leyder (1974)[1] states:

> The Wamumu and Karaba Sections are experiencing, at present, serious soil problems, which the NAL are now investigating. The affected alkaline areas generally lie near the high (red) ground and it seems that a high pH is often associated with poor paddy crop conditions. During investigations in 1968/69 of the Mwea, Tebere, and Thiba Sections, the problems of soil alkalinity were analysed. Alkali (sodic) areas were found to be scattered over the scheme area. As a possible cause for the development of alkali (sodic) conditions, seepage from higher ground was considered.
>
> After completion of a report in 1969, the NAL did not follow up the first reconnaissance of soil fertility conditions of the Mwea Scheme. The NAL are not so sure

---

1 Letter, Soil Chemist, Kenya Soil Survey Project, NAL, to Author, 21st January 1974

any more that the sodium accumulations found in the scheme should always be linked to seepage. It may well be that these alkali accumulations are relics of the past and related to terrain features, such as depressions and gullies.

I have suggested strongly to the NIB that detailed aerial photographs should be made available of the whole scheme, in order to get a better understanding of the various soil problems which affect the scheme, and which are almost certainly correlated to physiographic features.

CHAPTER 4

THE HUMAN CONTEXT OF MWEA

The role of man in his environment is the central theme of this chapter. An attempt will be made to demonstrate the influence of the human element on the environment and the ecology of Mwea and its surroundings over the past two decades. Mwea is an area in which changes in the environment are immediately and strikingly manifest in geography and ecology.

In evaluating the role of the human element in changing the ecological equilibrium of an area, McMaster (1972, 9) succinctly states:

> In the life, development, and history of simple societies, ecological factors are of central importance. Man, however, is an active agent in deciding and altering the ecological equations of which he is a part. These two facts soon become apparent to the geographer who works in tropical Africa ....

Human geography means many things to many people. It has been a controversial issue among geographers, sociologists, and economists for years. Perpillou (1966, XX) states:

> ... human geography is a science of patient research rather than one of spectacular generalisations. It leads neither to laws or to definitions. It regroups its facts and arranges them in series which it then compares with other series from other parts of the earth or found in more or less distant past. It arrives at partial and cautious

> syntheses which are suggested by the facts themselves and not deduced *a priori*. A deep sense of relativity should be the cardinal virtue of true human geography.

Man, the human element, and the changing ecology over time, are in a dynamic changing equilibrium state. Prothero (1972, 6) elaborates:

> The great problem is time: is there enough to permit gradual progress, given the present rates of population growth? Even before the growth rates started to rise, production barely kept pace with demand, and under-nutrition and malnutrition were common. Living standards have risen and are manifest in improved nutrition and increased power to purchase consumer goods. Political stability has increased, permitting a better distribution of resources yet the rise in living standards has affected few Africans - and in many areas malnutrition and even under-nutrition are the norm.

In Africa the importance of increasing food production, with emphasis on increasing yields and acreage with high protein crops, is urgent. Providing additional food and more nutritious types equitably to support man's survival and advancement continues to be one of the most important and overriding concerns of the world. With populations of the developing countries of Africa continuing to increase at an alarming rate, doubling every 20 to 50 years, or even less, and agricultural production lagging in the underdeveloped countries, it is imperative that agricultural research efforts and production management be supported at the highest possible priority level.

Increases in a country's agricultural output are a function of changes in the quantity and quality of its human resources, land, capital, technical knowledge, and production incentives. These factors are reflected in, or influenced by , price-cost relations, tenurial arrangements, tax practices, and other factors affecting relations between effort and its rewards. If one country increases its agricultural output at a more rapid rate than do others, it does so because it excels the others in improving this complex of factors, because unique circumstances give it a larger potential for progress than other countries possess, or because of the willingness of its leaders and people to make greater effort and sacrifices (*Foreign Agricultural Economic Report No. 27*, 1965, 14).

The *per capita* food production has risen very little in most developing countries of Africa and has actually declined in recent years in many. In total numbers, more people are regularly going to bed hungry today than ever before. Further, adequate balance in the diet remains a problem in nearly all African developing nations. For example, I found during my field survey, from first-hand observations, that poverty and rural under-employment in Kenya were evident throughout the subsistence sector. Records, such as they are, suggest that protein consumption per person has declined steadily in Kenya over the past decade. Malnutrition continues to plague a substantial percentage of the population, which is expanding in total at well over 3 per cent annually.

A significant change has taken place in the caloric intake of the people living in the rural areas. Subsistence farmers in the Kenya hinterland have been forced into the drier zones for crop production because of the accelerated population expansion. Land once farmed in sorghum and millets (high in protein content) now produces maize, which is low in protein in comparison to sorghum and millets. This alone has resulted in a substantial decline in the protein caloric intake obtained from grains in the African diets. Thus the people living in the bush have a greater imbalance of protein in their diets than 20 years ago. Kenya, like many other African countries, is now a protein-hungry country. Providing additional food supplies, particularly of high protein crops, and more nutritious types necessary to support the survival and advancement of under-developed countries, continues to be one of the most important and overriding concerns of the world.

Protein deficiency in human diets results in ill health and lowers productivity in adults, but is most serious in pregnant mothers, infants, and young children. It causes high mortality, chronic disease, and permanent impairment of the central nervous system, frequently ending in irreversible mental retardation.

Protein shortages and deficiencies in protein quality are perhaps two of the most insidious factors in the low rates of economic development in the underdeveloped countries. I have had first-hand observation of these facts on various field trips into Eastern Africa over the past decade. Production and utilisation of higher protein crops is one of the most pressing needs in the underdeveloped countries of Africa today.

My work is directed towards this critical problem and gives guidelines for future agricultural developments.

Man does not have at his disposal the means to increase production on a volume basis. What is needed is to breed food crops to provide higher yields of quality protein and to improve their distribution (Litzenberger, 1972, 1).

D.F. Owen states (1973, V):

> There is, of course, only one real problem: rising human numbers and expanding human demands on the limited resources of the world. All other problems stem from this and all efforts at development are sooner or later thwarted by the number of mouths that have to be fed.

Emphasis is placed on the human resource as a key factor of production and on population and population characteristics as a source of supply of labour and entrepreneurship. Population is also important as a source of demand for goods and services. The importance of a country's population as a source of supply of labour and entrepreneurship depends both (1) upon its size relative to the supply of other complementary resources, and (2) upon qualitative characteristics of the population which influence labour capacity and work participation.

The size of a country's labour force influences its *per capita* agricultural output because of applicability of the principle of diminishing returns, or more accurately, the principle of variable proportions. According to this principle, output per worker varies with changes in the number of persons who work a given area of land, *ceteris paribus*. These variations follow a three-stage pattern: (1) the stage in which output per person increases as population increases; (2) the stage in which output per worker decreases with increases in population, but in which the marginal output of labour is positive and total output increases with increases in numbers of workers; and (3) the stage in which total output decreases with increases in number of workers.

Agricultural population, rather than total population, is the more relevant statistic for examining the operation of this principle as it applies to agricultural production. Precise measurement of the influence of size of a country's agricultural population upon its agricultural output would require knowledge of the contours of the curves relating output to changes in intensity of labour use.

More densely populated countries, such as Taiwan and India, can accommodate increases in their agricultural population and labour force mainly by increasing the intensity of labour used on land already in highly labour-intensive uses. Most of these countries have averted decreases in output per worker largely through technical improvements, land development (as by irrigation and drainage), and increased capital investments (*Foreign Agricultural Economic Report No. 27*, 1965, 63-65).

GENERAL SETTING OF KENYA

The Human Resource

Kenya's population was estimated at 13 million in 1973. During the last population census in 1969 Kenya's population was estimated at 10.9 million, increasing at an accelerated rate of 3.3 per cent annually. Non-Africans represent approximately

2 per cent of the total. This group consists primarily of Europeans who numbered 40,593 (0.4 per cent) in 1969; Asians, 139,037 (1.3 per cent); and Arabs, 27,886 (0.2 per cent) (*Kenya Population Census*, 1969, Vol. I). A significant characteristic of Kenya's demographic make-up is that 50 per cent of the population are under 16 years of age. There are about 49 people per square mile (Table 4.1). Over 75 per cent of the total population is dependent on agriculture. Kenya's agricultural production by commodity, values and indices of total agricultural and food production over the past decade is shown in Appendix Table 1.

The great majority of Africans are farmers: most do some cash cropping in addition to subsistence farming. Asians are engaged mainly in marketing, distribution, and transportation. Most Europeans are in businesses, the professions, farming, and public services (Singleton, 1974, 8).

The principal tribes are Kikuyu (20 per cent of Kenya's total population), Luo (14 per cent), Luhya (13 per cent), Kamba (11 per cent), Kisii (6 per cent) and Meru (5 per cent) (Table 4.2).

In 1960, about 45 per cent of wage and salary earners were employed in the agricultural sector; in 1965, 35 per cent, and in 1970, 29 per cent, a decline of about one-third during the decade. The number of persons employed in nonagricultural occupations increased by about 36 per cent from 1960 to 1970. The number employed in the public services sector increased nearly 54 per cent, and the number in services, 67 per cent. Manufacturing also showed substantial gains, 17 per cent (Table 4.3).

TABLE 4.1

KENYA: POPULATION BY SEX, AREA, AND DENSITY FOR ALL PROVINCES, 1969 (number)

Province	Male children	Male adults	Total Male	Female children	Female adults	Total Female	Total	Per cent of total	Density per sq. mile	Square miles
Central	539,013	574,660	1,113,673	532,538	538,722	1,071,260	2,184,933	19.9	406	5,377
Coast	216,279	266,772	483,051	206,806	254,225	461,031	944,082	8.6	29	32,172
Eastern	495,354	428,321	923,675	481,550	502,076	983,626	1,907,301	17.4	31	61,830
North-eastern	67,043	66,685	133,728	54,812	57,217	112,029	245,757	2.2	5	48,890
Nyanza	564,858	482,395	1,047,253	539,920	534,872	1,074,792	2,122,045	19.5	435	4,876
Rift Valley	562,760	576,724	1,139,484	538,613	532,192	1,070,805	2,210,289	20.3	32	68,581
Western	366,867	274,650	641,517	360,096	326,685	686,781	1,328,298	12.1	416	3,195
Total	2,812,174	2,670,207	5,482,381	2,714,335	2,745,989	5,460,324	10,942,705	100.0	49	224,921

Source: *Kenya Population Census, Vol. I, 1969. Statistics Division, Kenya Ministry of Finance and Economic Planning, Nairobi,* 1970.

TABLE 4.2

SEX AND PERCENTAGE DISTRIBUTION OF KENYA'S POPULATION
BY MAJOR TRIBE, 1969

Tribe	Male	Female	Total	Per Cent
Kikuyu	1,091,413	1,110,219	2,201,632	20.1
Luo	763,080	758,515	1,521,595	13.9
Luhya	723,071	730,231	1,453,302	13.3
Kamba	592,889	604,823	1,197,712	10.9
Kisii	356,730	344,949	701,679	6.4
Meru	276,325	277,931	554,256	5.1
Mijikenda	255,508	265,012	520,520	4.8
Kipsigis	237,578	233,881	471,459	4.3
Nandi	131,001	130,968	261,969	2.4
Turkana	107,249	95,928	203,177	1.9
Other tribes	838,086	805,828	1,643,914	15.0
Population Non-African	109,451	102,039	211,490	1.9
Total	5,482,381	5,460,324	10,942,705	100.0

Source: *Kenya Population Census, Vol. I, 1969. Statistics Division, Ministry of Finance and Economic Planning, Nairobi,* 1970.

TABLE 4.3

KENYA'S LABOUR FORCE BY SECTOR, 1960, 1965, AND 1970[1]

Sector	1960		1965		1970	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
Agriculture and Forestry	271,800	44.5	202,400	34.9	183,700	28.5
Mining	5,000	0.8	2,300	0.4	2,900	0.4
Manufacturing	52,300	8.6	52,100	9.0	61,300	9.5
Construction	21,100	3.5	8,700	1.5	17,000	2.6
Transportation and Communications	14,800	2.4	12,000	2.1	16,500	2.6
Commerce	39,100	6.4	46,500	8.0	39,800	6.2
Services	45,200	7.4	67,400	11.6	75,300	11.7
Public Services[2]	161,400	26.4	188,200	32.5	248,000	38.5
Total	610,700	100.0	579,600	100.0	644,500	100.0

[1] Data are for wage and salary earners.

[2] Includes workers in the Kenya Government, parastatal bodies, local government, EAC General Fund Service, railways and harbours, post and telecommunications, East African Airlines Corporation, and cargo and handling services.

Source: *Economic Survey, 1971, Kenya Ministry of Finance and Economic Planning, Nairobi,* 1971.

Kenya has a number of social problems with long-range economic implications including unemployment, rapid population growth, housing shortages in urban areas, and the flight of people from rural areas to cities. The unemployment situation became so acute in 1970 that the Government negotiated a one-year agreement with the Federation of Kenya Employers and the Central Organisation of Trade Unions under which the Government and the employers increased their staffs by 10 per cent while the unions made no new wage demands. But of the 230,000 people who registered for employment under the programme, only 36,200 entered jobs.

During 1960-70, the number of towns with populations above 2,000 increased from 34 to 40. The urban population in 1969 was approximately 1.1 million, or 10 per cent of the total (*Kenya Population Census*, 1969, Vol. I). The African urban population has increased substantially during the past 10 years. The 4 largest cities are Nairobi, 510,000 in 1969; Mombasa, 247,000; Nakuru, 47,000; and Kisumu, 33,000. Because of rapid population growth, these towns have required increases in personnel involved in administrative, social and commercial services.

Measures taken by the Kenya Government to alleviate the pressing problem of reducing unemployment are outlined in the *Report of the Select Committee on Unemployment*. At a general level unemployment can be reduced through: (1) raising the output of the economy and hence creating jobs; (2) ensuring that increases in output are streamlined to the most labour intensive means feasible; and (3) reducing the gap between rural and urban living standards by raising the rural incomes and bringing essential amenities to the rural population (*Report of the Select Committee on Unemployment*, 1970, 24).

A substantial part of future urban growth will probably come from an increase in the number of women and children in the towns as the African urban population becomes more and more permanent. For several years there has been an influx of rural young men, many with a primary education, but little in the way of urban skills. Stopgap measures are being used to absorb some of these unemployed, and long-range plans have been made to employ others. However, urban (or nonagricultural) employment opportunities are not likely to grow fast enough to absorb the increasing numbers of rural migrants (Singleton, 1974, 9).

Approximately 15,000 Europeans are employed in the professions or in business management positions in Kenya. Even the displacement of these people by Africans would take up only a small proportion of the thousands who are entering the job market each year. Therefore, it is the agricultural sector (and agribusiness) which must largely be relied on to provide jobs and reduce underemployment. Further, an increase in the number of trained farmers and farmworkers is essential to obtaining higher agricultural output and improvement in the quality of agricultural products (Singleton, 1974, 9).

Food Consumption

Food consumption in Kenya during 1964-66 averaged 2,216 calories daily (Table 4.4). By 1975, it may reach 2,560 calories. Kenya is generally self-sufficient in food measured by caloric intake. Important food deficits are sugar and vegetable oils.

TABLE 4.4

KENYA'S FOOD BALANCE, 1964-66 AVERAGE.[1]

Produce	Production	Imports	Exports	Total	Total	Per capita per year	Per capita per day
	1,000 metric tons				1,000 metric tons	Kilograms	Calories
Wheat	137	10	40	107	66	7.0	70
Corn	1,242	88	3	1,327	979	104.5	1,031
Sorghum and millet	237	nil	nil	237	232	24.7	232
Rice, milled	11	3	2	12	12	1.3	13
Oats	1	nil	nil	1	nil	nil	nil
Total cereals	1,628	101	45	1,684	1,289	137.5	1,346
Cassava	600	1	nil	601	391	41.7	125
Sweetpotatoes	453	nil	nil	453	276	29.5	76
Potatoes	193	1	7	187	106	11.4	22
Pulses	270	12	10	272	222	23.7	221
Other vegetables	250	3	1	252	226	24.1	14
Bananas	283	nil	nil	284	256	27.3	53
Pineapples	27	nil	7	20	11	1.2	1
Other fruits	35	1	nil	nil	32	3.4	4
Sugar	52	70	nil	112	112	11.9	126
Meat[2]	203	nil	16	187	187	20.0	107
Fish	20	1	nil	21	19	2.1	6
Vegetable oils[3]	6	19	3	22	11	1.2	28
Milk[4]	610	2	19	593	330	35.2	70
Fats[5]	10	7	3	14	7	.7	17
							[6]2,216

1 Based on midyear 1965 population of 9,365,000. Excludes alcoholic beverages. Total "utilization" reflects extraction rates for grains as follows: wheat, 74 percent; corn, sorghum, and millet, 90 percent. Trade for corn includes grain equivalent of meal. Extraction rate for raw sugar is 94 percent.

2 Carcass weight. Beef, veal, mutton, lamb, and pork.

3 Oil equivalent of edible oilbearing seeds including copra and palm kernels.

4 Cow, sheep and goat milk. Production excludes the amount fed to young stock. Trade and consumption include the whole milk equivalent of imported canned, powdered, and dried milk.

5 Includes butter, animal fats, lard and shortening, tallow, and ghee

6 Total caloric intake.

Source: *Food and Agriculture Organisation of the United Nations, Food Balance Sheets, Rome,* 1967.

Cereals account for approximately three-fifths of the caloric intake and starchy foods -- sweetpotatoes, potatoes, cassava, and bananas -- account for about one-eighth. Consumption of sugar, although relatively low, is at about average for East Africa. Maize is the most important single food consumed in Kenya. Fresh fruits and vegetables are of minor significance, and consumption of fats and oils is also relatively small. Consumption of milk and meat (excluding poultry and pork) is relatively high. Fish consumption is unusually low. Among Africans, tribal taboos keep production and consumption of eggs very low (Singleton, 1974, 47-48).

Demand for wheat flour and livestock products is rising and -- with further economic development and urbanisation, accompanied by rising incomes and levels of living -- will further increase substantially. On present trends, Kenya might have to import some additional food items to meet internal demands. The cost of such food imports will result in a drain upon foreign exchange which is sorely needed in the Kenyan economy.

POPULATION BUILD UP OF THE HIGH DENSITY BELT

Urban Centres

The urban population centres in the surrounding area are the social and economic foci of population. A number of these centres are located within a 10, 20, and 30 mile radius of Mwea (Fig. 4.1). The proximity of Thika, Fort Hall, Embu, and Nyeri to Mwea acts as a powerful social magnet for the Mwea population.

The railway infrastructure has been fundamental to the development of urban population centres and industrial opportunities. The railway is also fundamental in the movement of manpower and goods in the area (Fig. 4.1). Soja (1968, 29) writes:

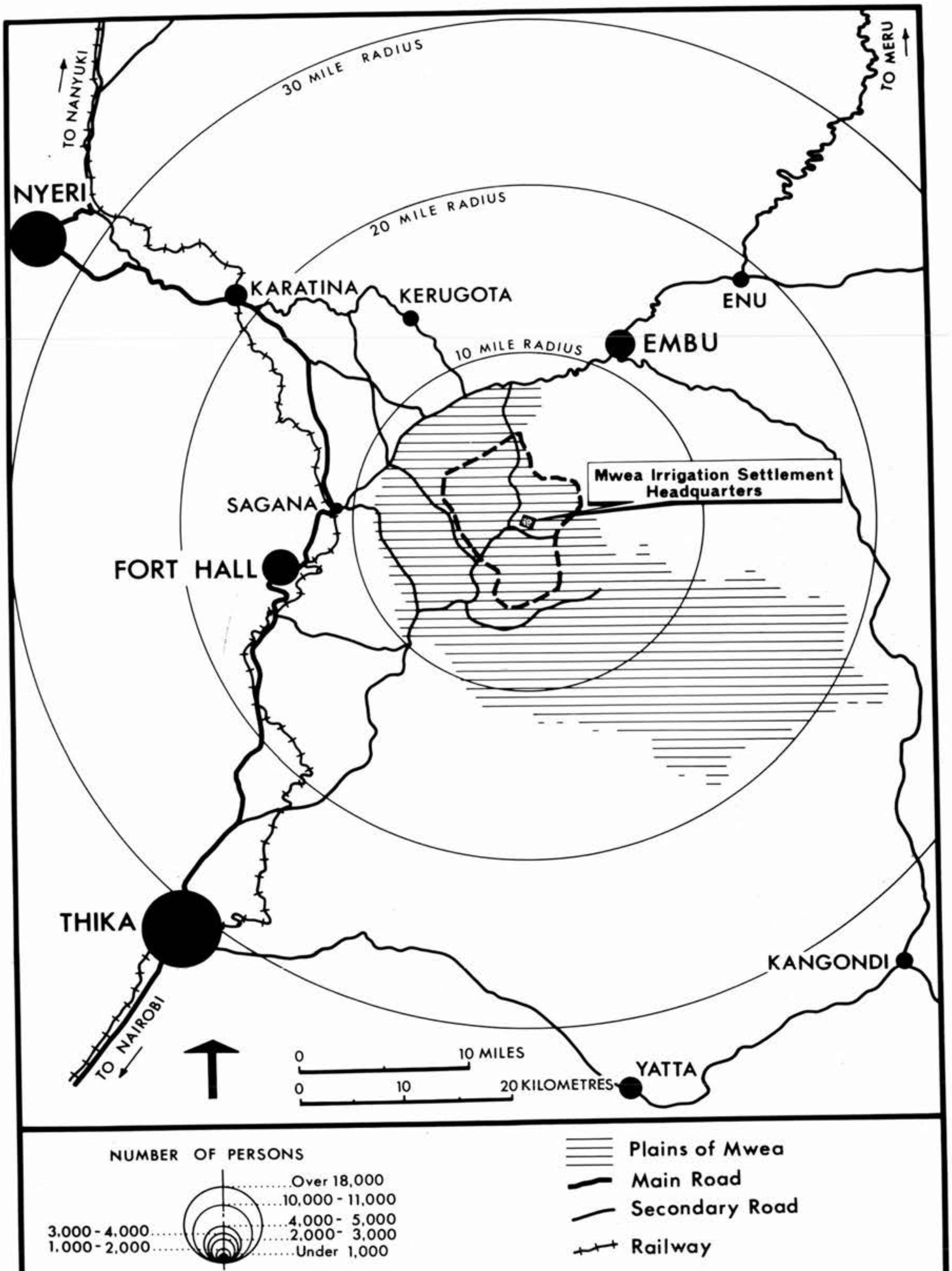
> The railways established the general urban pattern of Kenya, fostering the growth of important centres at key points along their route. The even spacing of these centres reflects the weak influence of local economic factors in initial urban growth for nearly all were within 100- to 125-mile jumps from one another.

The road network is a means of long distance movement of people. It is a major factor in the direction of flow of population. Nucleated villages are attracted by the development of roads. Evolving trunk line connections by roads have been greatly influenced by the pattern which the rail communications established. Farm-to-market roads in the surrounding High Density Belt Area are of prime importance to enable smallholders to bring their products to local markets.

D.R.F. Taylor (1969, 492) writes:

> The construction of a network of all-weather feeder roads would give a very high return for investment in a relatively short space of time and would stimulate the growth of the whole economy in the plateau to such an extent that it would rapidly become self-generating. The continuing development of the Kikuyu Plateau is vital to Kenya's economic and political future. It is hoped that the Kenya Government will be able to find sufficient funds to build the adequate feeder roads necessary for further economic growth.

Products from smallholder farms in the area are usually transported to local markets by means of headload, but sometimes by



THE HUMAN MAP

FIG. 4·1

cart, bicycle, or animals on the hoof. From the local markets to processing and higher-order marketing centres, transportation is mainly by truck and rail. Some products are trucked for long distances to the nearest railhead (Fig. 4.1) or processing centre. The construction of farm-to-market roads, perhaps more than any other single factor, will make it feasible for subsistence farmers to bring their produce from rural areas to the local market place (Singleton, 1974, 50-51).

Table 4.5 shows the changes in the population of the urban centres between 1962 and 1969. Table 4.5 also shows that there has been a substantial increase in the population of Thika and Nyeri since 1962. This is the result of agribusiness and light industrial development in these urban centres. Embu's population declined by 1,285 over the period as a result of better opportunities elsewhere, particularly in the Thika and Nyeri areas. The 4 largest towns in the area are located within a 30 mile radius of Mwea in the High Density Belt of the Aberdare Range and the southeastern slopes of Mount Kenya (Fig. 4.1).

There are many small urban towns and villages dispersed throughout the High Density Belt. The towns of Embu and Nyeri, situated at distances of 20 and 40 miles respectively from Mwea, are connected with Mwea by an excellent tarmac road. From Mwea to Fort Hall, a distance of approximately 20 miles, a dirt road serves the area. From Embu to Meru unimproved roads serve the area -- the high and low road (Fig. 4.1). The Thika-Nyeri tarmac road is in excellent condition.

TABLE 4.5

URBAN CENTRES OF POPULATION IN THE HIGH DENSITY BELT, 1962 AND 1969

Urban Centres	1962	1969
Thika	13,952	18,387
Nyeri	7,857	10,004
Meru	5,389	4,750
Fort Hall	4,250	4,475
Embu	5,213	3,928
Kitui	2,520	3,071
Karatina	2,350	2,436
Kerugoya	1,059	1,938

Source: *Kenya Census of Population*, 1962 and 1969.

In the urban areas, particularly Thika, Fort Hall, and Nyeri, employment opportunities have been considerably augmented by the development of agribusiness. Large-scale pineapple and sisal plantations are located in the Thika-Fort Hall area. In this belt of very high rural population densities, the population pressure on the land is intense. The magnitude of this situation may be expected to encourage the migration of people into large towns seeking jobs which do not exist.

Drift Effect of Population Movements

There are two drifts of population in the High Density Belt: (1) the movement of landless unemployed, underemployed, and/or unemployable relatives and friends into the area; and (2) the movement of the educated youth out of the area to seek jobs in urban centres. Both movements are dynamic and sustained.

The economic activity in the High Density Belt pulls people into the area like a magnet. The affluent families take on the responsibility of caring for relatives or friends. I observed that this situation in the up-country is often encouraged by the affluent group, who generally do not object because this provides them with a source of cheap labour to do all the menial tasks on the *shambas*.

The High Density Belt enjoys, by the standards of rural Kenya, comparative affluence. Some of the reasons are: (1) high rainfall area between 5,000 to 7,000 feet; (2) money to be made by growing cash crops; (3) all-weather roads, serving as arteries of transport; (4) proximity to Nairobi; and (5) the highlands to the north, which serve as a source of employment on large dairy farms and also as an area for squatters.

Between the 1962 and 1969 Population Census there has been a substantial increase of people in the High Density Belt. The following are some of the reasons for this phenomenal increase: (1) economically a relatively viable and affluent area based on cash crops (coffee, tea, pyrethrum) production; (2) the excellent tarmac road extending from Nairobi to Nanyuki -- a major artery of transport; (3) the railway used to transport heavy and bulky products; (4) an increase in the use of lorries in the area; (5) private vehicles which operate as taxis; and (6) an increase in the use of mini-buses, bush buses, and the *matatu*, or "happy taxis" which operate throughout the area as major means of communication. The "stationary" *matatu* operates from a fixed terminal. The fare is negotiated with the driver on each trip. "Mobile" taxis, on the other hand, operate on a particular route at a fixed rate per person, and are thus more popular with the public. The former provide a greater personal service, in terms of dropping passengers as near as possible to their destination, than is provided by official public transportation (*International Labour Office*, n.208).

Districts of the High Density Belt

The heavy population concentration in the districts of the High Density Belt, in the up-country, is shown in Table 4.6.

The High Density Belt, encompassing these 7 districts, is often referred to as Kikuyuland. This is the home area of the Kikuyu people and where the majority of Kikuyu still live. These districts are of vital importance as major sources of hired and/or casual labour supply needed by the tenants of Mwea during the critical harvesting and transplanting periods.

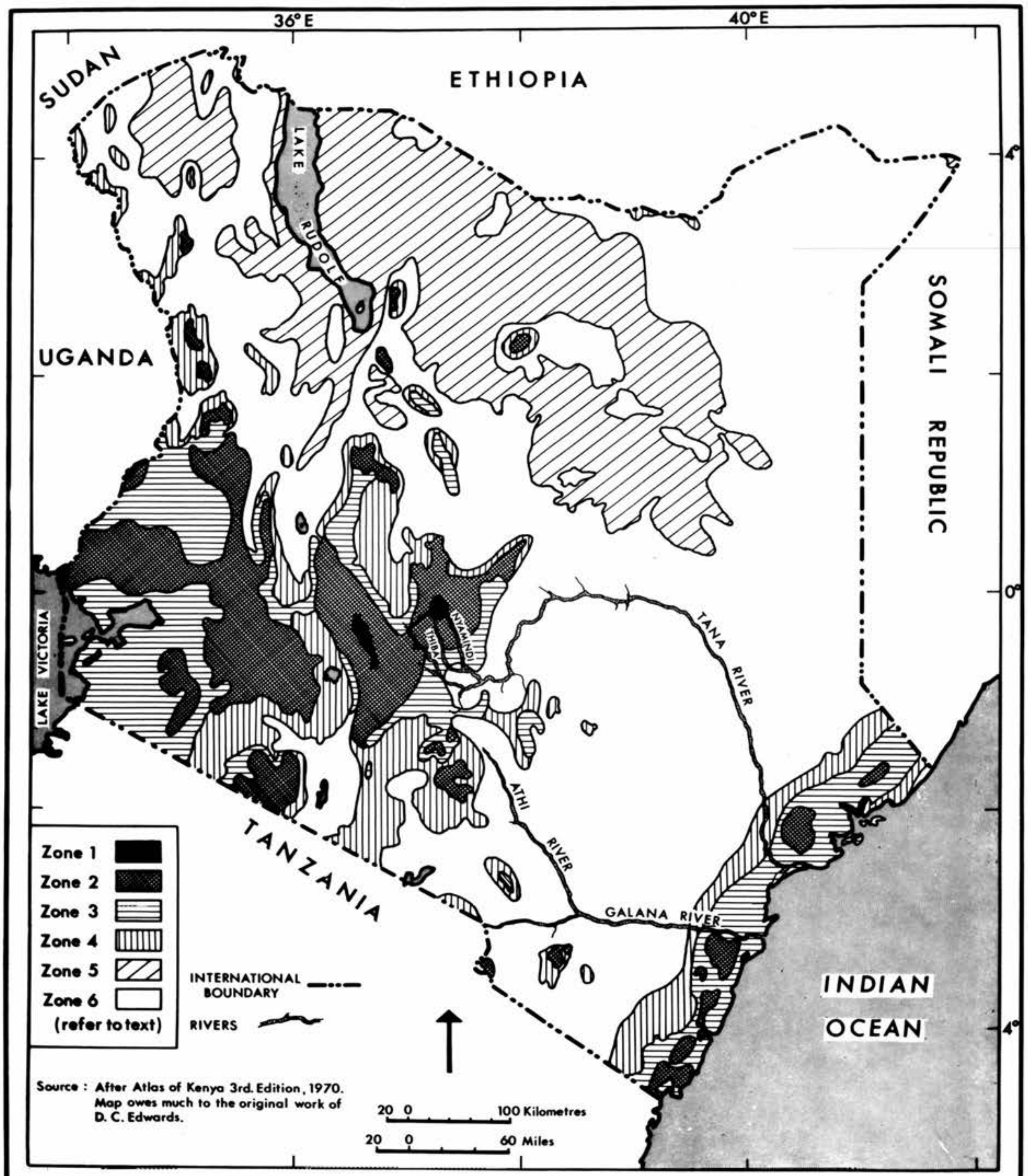
TABLE 4.6

POPULATION OF DISTRICTS IN THE HIGH DENSITY BELT, 1969

Province and District	Male	Female	Total
Central Province			
District			
Kiambu	235,293	240,283	475,576
Kirinyaga	105,478	111,510	216,988
Muranga	208,947	236,363	445,310
Nyeri	172,266	188,579	360,845
Eastern Province			
District			
Embu	85,852	93,060	178,912
Meru	293,412	303,094	596,506
Kitui	161,406	181,547	342,953

Source: *Kenya Census of Population*, 1969.

The High Density Belt forms a dense chain or "rope effect" on the eastern and southern foothills of the Aberdare Range and Mount Kenya. A similar High Density Belt extends from Nairobi to Embu. The varied and involved topography of the area, ranging from elevated plain or forest to valley or mountain, results in a wide variety of climatic and ecological patterns (Fig. 4.2) with marked changes occurring in relatively short distances. The eco-climatic zones are sub-divided according to topography and soil to give the desired ecological land units (Fig. 4.2). Eco-climatic zones have been subdivided into



ECOLOGICAL POTENTIAL OF KENYA

FIG. 4·2

ECO-CLIMATIC ZONES OF KENYA*

ZONE I Afro-Alpine Climate
(climate governed by latitude not moisture)

Moorland and grassland or barren land, at high altitude above the forest line; of limited use and potential, except as water catchment and for tourism.

ZONE II Equatorial Climate
(Humid to dry sub-humid moisture index not less than -10)

Forests and derived grasslands and bushlands, with or without natural glades. The potential is for forestry (with local wildlife and tourist development) or intensive agriculture, including pyrethrum, coffee and tea at the higher altitudes. The natural grassland, under intensive management for optimum production, supports one stock unit per 1-1½ ha. dependent on grassland type. (Ground water forests occur under climates drier than dry sub-humid.)

ZONE III Dry Sub-Humid to Semi-Arid
(Moisture index -10 to -30)

Land not of forest potential, carrying a variable vegetation cover (moist woodland, bushland or "savanna"), the trees characteristically broad-leaved (e.g. *Combretum*) and the larger shrubs mostly evergreen. The agricultural potential is high, soil and topography permitting, with emphasis on ley farming. Areas under range-use are still extensive and under close management their stock-carrying capacity is high, at less than 2 ha. per stock unit.

ZONE IV Semi-Arid
(Moisture index -30 to -42)

Land of marginal agricultural potential, carrying as natural vegetation dry forms of woodland and "savanna" (often an *Acacia-Themeda* Association) or derived semi-evergreen or deciduous bushland. This is potentially productive rangeland -- usually less than 4 ha. per stock unit -- limited mainly by the encroachment of woody species. The more open country with a high density of wildlife constitutes a valuable tourist asset.

ZONE V Very Arid
(Moisture index -51 to -57)

Rangeland of low potential, the vegetation being dwarf shrub grassland, or a very dry form of bushed grassland with *Acacia reficiens* subsp. *misera,* often confined to water courses and depressions with barren land between. Perennial grasses (e.g. *Chrysopogon aucheri* are localized within a predominantly annual grassland; productivity is confined largely to unreliable seasonal flushes and grazing systems must be based on nomadism. The populations of both wild and domestic stock are restricted severely by the environment.

ZONE VI Arid
(Moisture index -42 to -51)

Land only very locally suited to agriculture, the woody vegetation being dominated by *Commiphora, Acacia* and allied genera, mostly of shrubby habit. Perennial grasses such as *Cenchrus ciliaris* and *Chloris roxburghiana* can dominate, but succumb readily to harsh management; more than 4 ha. is required per stock unit. Wildlife is important, particularly where dry thorn-bushland predominates. Burning requires great caution but can be highly effective in bush control.

* Explanation of Fig. 4.2 Ecological Potential of Kenya.

Source: Based on *Atlas of Kenya, 3rd Edition*, 1970.

geomorphological divisions (landscapes); the ecological land units then represent individual sites within the landscapes, described by reference to position and soil type.

The High Density Belt contains much of Kenya's most productive soils, some of its most densely populated districts and a major agricultural area. Rainfall is usually reliable and adequate, and temperature ranges are conducive to culture of coffee, tea, pyrethrum, maize, legumes, and bananas (Singleton 1974, 3).

Since Kenya straddles the equator, differences of climate are caused mainly by variations in altitude. Seasonal changes in temperatures in Kenya are only slight, much less than changes from day to night.

Soils in the area form a mosaic of many types, depending on climate, topography, parent material, vegetation, and effects of weathering over time. There is an altitudinal zonational effect (due to differences in altitude) throughout the belt of temperature, rainfall, and soil which is reflected in the crop combinations grown. The population pattern of this densely contoured belt has been greatly influenced by: (1) cash crop production (coffee, tea, and pyrethrum); (2) excellent soils for farming; (3) farm registration; and (4) employment opportunities.

The High Density Belt has some of the highest densities in Kenya which are a-typically large with some areas ranging from 1,500 to 2,000 people per square mile. Most of the people in the High Density Belt have, on average, approximately one-acre plots where they grow a cash crop and subsistence crops. The principal subsistence crops grown are maize, beans, pulses, potatoes, and bananas.

Farm Registration

A significant movement in the hinterland of Kenya over the past decade has been the registering of farms and awarding title to land in African areas. The impact of this trend was tellingly described to me at a conference in August 1973, by an East African Agricultural Specialist of the British High Commission in Nairobi:

> At present, approximately 600,000 African farmers have title to land in Kenya. By having title to land, they are then in a position to use the land as collateral and purchase bicycles, cars, motorcycles, radios, sewing machines, etc. The title to the land is used as collateral against the loans to purchase consumer goods. Another significant trend is the amalgamation of many smallholder African farms into co-operative farms. This trend is spreading fast in the Highlands and Rift Valley Areas. Smallholder African farms are increasing in size; some farms are as large as 120 acres. Land grabbing, by Africans, in a position to do so, is continuing at an accelerated rate. Many African politicians own large farms in the Rift Valley, Central, and Eastern Provinces. They now have a position of absentee landlords and have hired African workers farming their land. These absentee landlords are rapidly replacing the former European land owners who owned vast acreages of excellent farm land in Kenya.

GENERAL SETTING OF MWEA

During my field research survey I gradually became aware that from a geographical and socio-economic point of view Mwea may be divided into two distinct parts -- Mwea and Tebere Sections forming one part, and Thiba, Wamumu, and Karaba Sections the other (Fig. 4.3). After the first 3 months of field work I became very conscious of this distinct dichotomy. It is like living in two different settlements.

The great immediacy for Mwea is time. Certain issues have been left unresolved too long and call for rapid -- indeed overdue -- attention. There is at present a viable economy and an affluent society at Mwea, where living standards have risen sharply over the past decade.

The ability of people to adapt to and utilise the physical environment varies in space and time. Light is being cast upon such things as the introduction of various crops, past movements of population, and patterns of settlement (Prothero, 1972, 8).

D.F. Owen (1972, VI) summarises:

> The basic requirements of man are the same as those of other organisms, and although man may attribute special properties to himself which he believes set him apart from other animals, it is possible to place man in an ecological setting and to examine his interactions with the environment ... I firmly believe that attempts to solve the numerous problems that have been created must come from within Africa itself: a peasant farmer in Mali has just as much right to determine his destiny as a business man in London has to determine his.

The key question is: has man, through the use of a package mix of technology, established an advantageous balance with the environment at Mwea? This balance is now threatened

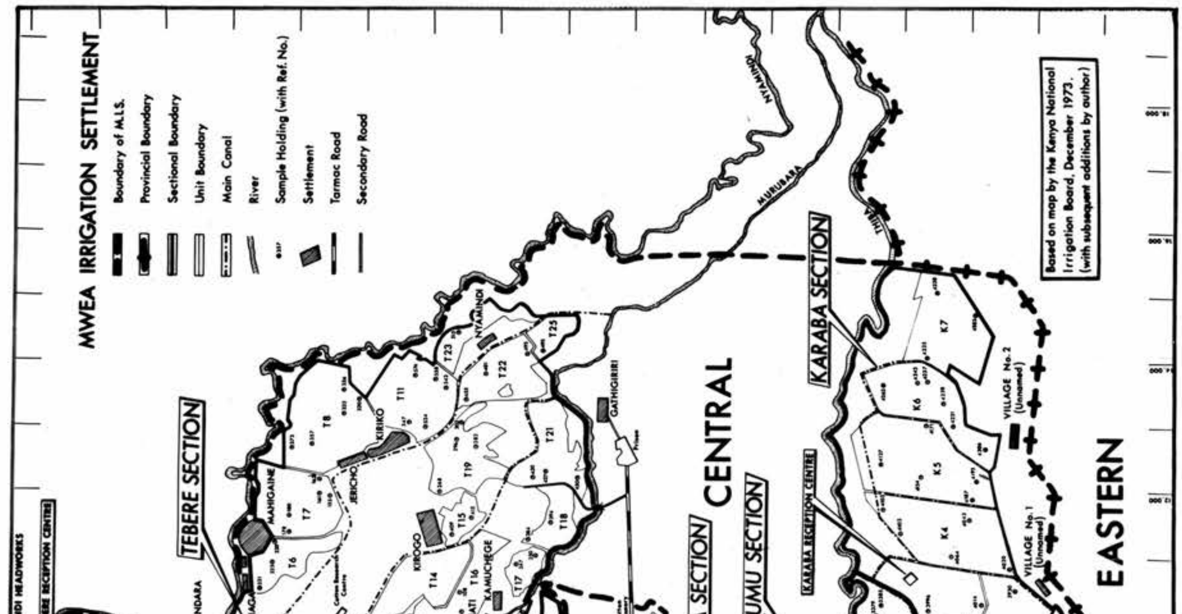

MWEA IRRIGATION SETTLEMENT
Boundary of M.I.S.
Provincial Boundary
Sectional Boundary
Unit Boundary
Main Canal
River
Sample Holding (with Ref. No.)
Settlement
Tarmac Road
Secondary Road
TEBERE SECTION
MWEA SECTION
THIBA SECTION
WAMUMU SECTION
KARABA SECTION
CENTRAL
EASTERN
NGUKA SWAMP
Based on map by the Kenya National Irrigation Board, December 1973. (with subsequent additions by author)
2 MILES
2 KILOMETRES

FIG. 4·3

by the rapid population build up in Kenya as a whole, in the wider regional setting of the Mwea, and on the Settlement itself. There is also the fear of over-expanding the area of paddy production beyond the limits of the capability of the water and soil resources in the Area. Has the Management of the MIS over-reacted due to economic and political motives? The Kikuyu tenants think primarily in terms of the cash payout they receive at the end of the season from the paddy crop. Paddy production has brought economic affluence to Mwea. But it has also created serious socio-economic problems. The Kikuyu response to an inherent desire for money, self-betterment, and a desire for a better life style for his children are all important.

Historical Background

Before 1900 the Wild Plains of Mwea, which include the land between the Tana and Thiba Rivers (Fig. 3.4), did not attract much settlement. However, population pressure in the more favoured neighbouring areas -- in the up-country of the Aberdares and Mount Kenya -- resulted in some pre-irrigation migration into the Mwea-Tebere Area during the twentieth century. Ephemeral and peripheral settlement was primarily confined to the lighter red soils of the ridges, where uncontrolled grazing and cultivation gave rise to considerable soil erosion after 1930. The colonial situation was transformed by political developments in the early 1950's when the Mau Mau Emergency focussed attention on the need for immediate action to find useful and constructive work for several thousand detainees who were held under the Mau Mau Emergency regulations.

From October 1952 to December 1956, the Mau Mau Emergency continued. The conflict was subdued, but the underlying idea of independence from Britain intensified, culminating in full recognition and elevation of Kenya to the status of an independent member of the British Commonwealth on December 12, 1963.

The Mau Mau Movement also had far-reaching implications for the agricultural development of Kenya. Of the contributing causes of the Mau Mau revolt, the following are the most pertinent: (1) the unequal spatial distribution of physical resources in the country; (2) the cultural frustrations of the African tribes; and (3) the ever-widening impact of the European "occupation" in the highlands. Among the Mau Mau Movement's specific goals were to push forward a restructuring of the existing pattern of land use and settlement, consolidation of fragmented plots of African farms, African ownership of land with a title, introduction of agricultural development schemes, introduction of settlement schemes, and formulation of 5-year development plans. Pursuit of these goals was the underlying force which ultimately set the stage for an independent Kenya (Singleton, 1974, 2).

A small pilot irrigation project had been started at Tebere in 1951. Earlier still, in 1949, rice trials had been started in the Nguka Swamp Area of Mwea (Fig. 4.3). Experiments had indicated that irrigated paddy could be successfully grown on the black cotton soils during the "short rains" season when temperatures and sunlight were clearly adequate for the achievement of good yields (de Wilde, 1967, 224).

Thus the Mwea came into being in 1953 as a response to pressing political and social problems.

R. Chambers (1967, 125-6 writes:

> With the arrival of the first Manager, the emergence of the scheme as an entity was taken a step further. The three ALDEV Works Supervisors already in the area now worked under him, forming a nucleus of staff which was soon expanded. In May 1955 an Assistant Manager was recruited, and in November an Accountant. The local committee, known as the Mwea-Tebere Irrigation Scheme Committee (M.T.I.S.C.), began to function. The labour resources available increased as five more camps were constructed in 1955. Soon after his arrival the Manager introduced a new dimension by starting to prepare land for irrigation. The Nguka Swamp was drained, partly to reduce malaria and the papyrus which grew on it was burnt because it was a hide-out for Mau Mau. The Manager then began to lay out one-acre fields and to grow rice. In the conditions of haste, confusion and inexperience which prevailed, physical achievements fell far short of targets, and expenditure was high. By mid-1956 recorded expenditure already totalled £173,000, but by the end of the year the achievement in land preparation was only 589 acres. However, the headworks for the Nyamindi inlet for the Tebere Section had been completed by an outside contractor, water use experiments and crop trials were in progress, and the scheme had begun to exist as a seasonal agricultural process through the cultivation of paddy rice, which in 1956 was sold for a revenue of £7,000. The scheme had come to be not just information, surveys, and plans, but also altered land, a small organisation and a farm in production.

Chapters 2 and 3 have already indicated that Mwea has not had the chequered history that characterised the evolution of

Perkerra. From the beginning it was possible to grow a highly lucrative crop -- rice -- the more so because the combination of moderate temperatures and a high degree of insolation made for unusually high yields. It was possible to devote the entire irrigated area to the cultivation of rice, partly because the tenants, though previously not accustomed to either producing or consuming rice, found this cereal a quite palatable food (de Wilde, 1967, 222). It should be kept in mind that rice is a completely new crop to tenants coming into Mwea. There is no local tradition of irrigation in the Mwea Area.

Preparation for the Mwea was limited and little was known concerning rainfall reliability, river flow variations, pest and disease hazards, or soil response to irrigation. Moreover, the labour force of political detainees showed little enthusiasm for the project. An irrigation headworks was constructed on the Nyamindi River in 1956 to serve the Tebere Section. Inevitably, progress was less rapid than some had hoped and by the end of 1957 the irrigable area of Mwea was only 850 acres. Additionally, major problems had been encountered in attempts to irrigate the red soils in the Tebere Section, where high infiltration rates resulted in a very uneven distribution of irrigation water. On the other hand, paddy cultivation on the black cotton soils was progressing favourably. The labour situation was improving as detainee labour was phased out and considerable experience had been gained which was later to prove useful.

It is important to stress that the timing of the development of Mwea was determined by the availability of the Mau Mau labour and not by the completion of any prior studies of the technical and economic feasibility of the project. Mwea, in fact, started from scratch! In general, during the early stages of development Mwea suffered from a lack of adequate preparatory work (de Wilde, 1967, 222).

The detainees who came to the Plains of Mwea were primarily Kikuyu. The origin of the landless detainees, who were eventually to become permanent tenants, was predominantly from Kiambu, Rift Valley, Nyeri, Muranga, Embu, and Kirinyaga Districts. Elspeth Huxley (1961, 204) vividly describes the early Mwea landscape:

> Then we came suddenly to a patch of squares, as if we had an aerial view of the Red Queen's chessboard. The landscape had been laid out with a ruler, it was patterned with black and green rectangles, streaked by lines and dotted with neat toy compounds ... This was the Mwea-Tebere irrigation scheme, lying on the plains south-east of Mount Kenya ... its origins lay in finding work for Mau Mau detainees to do. Men came from the Sudan to run it ... Technically, it is sound; the question is, what can be grown at a profit?

In many ways, the foundation had been laid for the future expansion which took place after 1959. With the expansion another headworks was constructed on the Thiba River to serve the Mwea Section. Since then the irrigable area has steadily increased and during the 1972/73 season 11,698 acres were under paddy cultivation (Fig. 1.2).

The lack of hydrological data and a comprehensive soil survey are important handicaps to the development of future extensions of the Mwea Area. The accelerated rate of developing irrigable areas in recent years has made water a critically limiting factor.

The Mwea Development has mitigated some of the thorny land shortage problems among the Kikuyu peoples. There were 3,020 tenant farmers in the Mwea during the 1972/73 season. The sole criterion for admission to tenancy is landlessness and most tenants are of local origin.

The philosophy of Mwea over the past two decades is to settle landless Africans on land which has been provided with drainage and irrigation and which is capable of intensive production. The current philosophy of the Mwea Management, since 1970, is that landless tenants will be admitted into the MIS only from Kirinyaga District. At present there are over 2,000 peasants from Kirinyaga District waiting to become tenants in the MIS.

During 1973, a law was enacted by the Kenya Government making it possible for women to obtain an annual licence as tenant farmers in the MIS. From my field enquiry I observed that women (guardians) do in fact make good paddy farmers, given direction and proper supervision from the Field Assistant and the members of the Field Extension Staff.

Land is rented under annual licences, automatically renewable provided tenants show reasonable competence in their farming. Unsatisfactory tenants may have their tenancies terminated but such tenants have been very few and only 151 were evicted between 1960 and 1973, a surprisingly small number considering the method of admission to the Scheme.

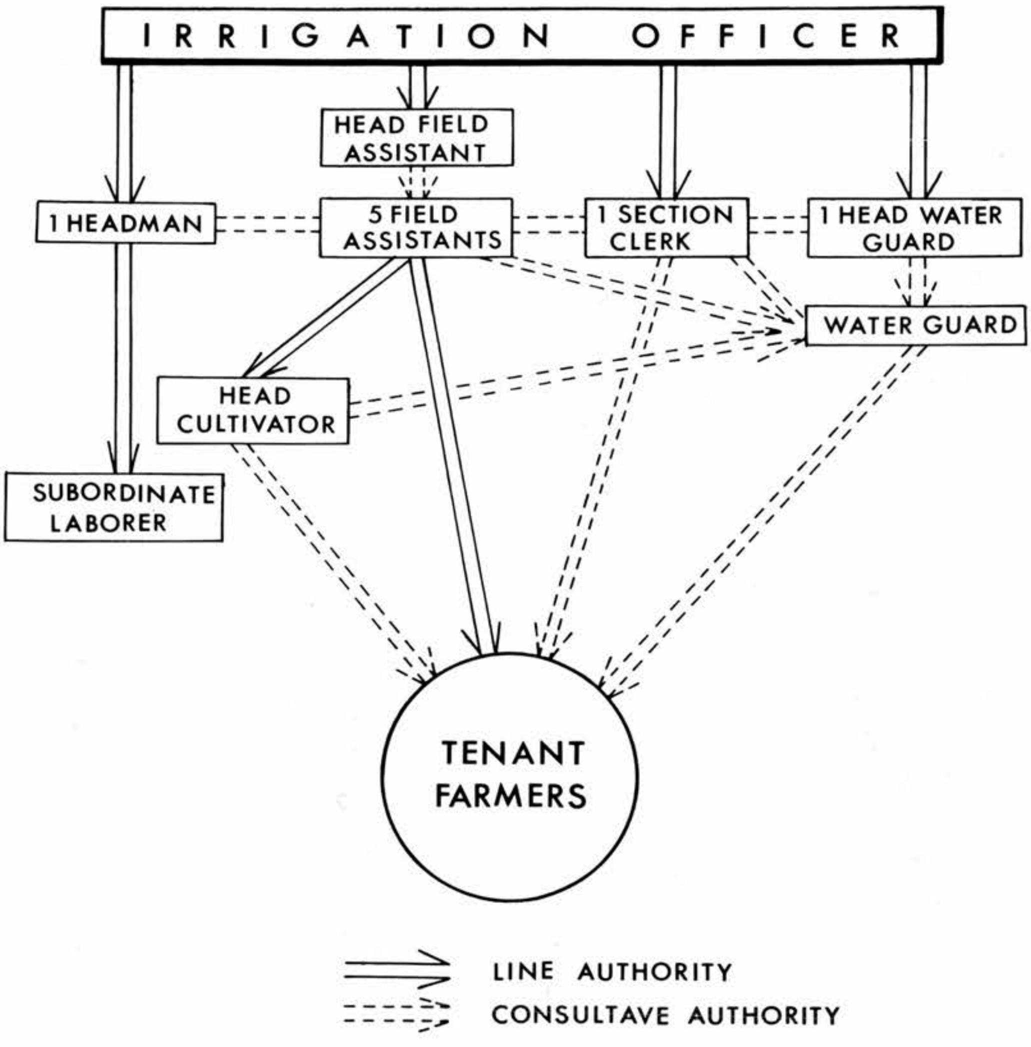
The termination of tenant licences to farm in the Mwea, since the promulgation of the Irrigation Rules in 1960, has resulted primarily from the following misdemeanours: persistently bad paddy husbandry over a number of years has resulted in 47 per cent of the terminations; prison sentences of more than 6 months for crimes of violence have accounted for 12 per cent of tenant dismissals from the Settlement; and the remaining 41 per cent were attributable to tenants deserting the Scheme. The majority of desertions were the result of poor initial selection of the tenant. The inability of the tenant to adjust to the hierarchical structure of Mwea, which results in his developing interests outside the Scheme, leads to the paddy holding's being neglected and being finally abandoned (*National Irrigation Board Annual Report*, 1972-73, 8).

Strict measures are necessary to restrict the spread of malaria, bilharziasis, ascariasis and amoebic diseases among the tenants and their families who perform much of their work in habitats favourable to the vectors of these diseases.

Hierarchical Structure

The Mwea is under a hierarchical structure (Fig. 4.4) with close supervision exercised over the tenants. The Management is able to maintain authority under the *Trust Land Irrigation Areas Rules*, 1963 (Appendix I) over the economic activities of the tenants. I observed a growing problem concerning

ORGANISATION CHART, IRRIGATION SECTION LEVEL



Source : Field Enquiry, 1973

FIG. 4·4

tenants who earn sufficient income from their paddy output to become involved in various types of business enterprises in the villages and elsewhere off the Scheme and consequently give less time and attention to their paddy holdings. This is serious. Tenants are under the close supervision of the Field Assistants (Fig. 4.4) who are directly responsible to the Irrigation Officer in each Section (Fig. 4.4), who in turn is directly responsible to the Manager.

A system of managerial control, together with a complete package of the necessary input factors, has been established over the years with very successful results. The tenant is not only provided with drainage and irrigation, but the Mwea organisation supplies field extension services, fertilisers, insecticides, herbicides, mechanical cultivation, transport, storage and drying facilities, marketing channels, and credit. All factors of production, being under one administrative umbrella, are easily obtainable by the farmer with a minimum of bureaucratic delay and are available when needed. At the same time, due to the intimate relations between the Field Extension Staff and the credit side of the organisation, the risk of bad debts is greatly minimised, thus avoiding one of the most frequent defects of smallholder settlement schemes (Giglioli, 1970, 307).

Hornby (1973, 259) summarises the success of Mwea as follows:

> The Mwea is particularly impressive because it is effectively utilising land previously regarded as of little value for cultivation and because of the inauspicious circumstance in which

> it began. Reasons for its successful development would seem to include the suitability of the black cotton soils for irrigated cultivation, the reliable Kenyan 'home' market for rice created by import restrictions, the financial incentives for any tenant who works effectively, the happy blend of individual responsibility for some parts of the work, and efficient management organisation of other parts and the strict control which the management is able to maintain ... over the economic activities of the tenants.

Population Structure and Distribution

The population build up in Mwea is a serious matter: at the 1962 census Mwea's population was 14,484; at the 1969 census there were 22,804 people living in the Settlement, a substantial increase of over 60 per cent during the 7 year period (Table 4.7). At present the population is estimated at approximately 25,000 people including tenants, families, relatives, and hired and/or casual workers living in 34 villages in the 30 square mile area of the MIS.

The population pressure on the land is a very serious problem. Many young men and women out of primary and secondary schools are looking for jobs which are not available. I observed that there was a considerable number of young men in their teens who have dropped out of school and are roaming the villages of the MIS looking for any type of work; but nothing is available. They are not interested in becoming paddy farmers and look upon paddy farming as inferior work. This leaves a volatile element, and law and order are difficult to control. Many of the older tenants complained to me of the increasing number of thefts in the villages.

TABLE 4.7

MWEA IRRIGATION SETTLEMENT POPULATION BY AGE, SEX, AREA, AND DENSITY, 1969

Villages	Total	Male	Male Children	Female	Female Children	Density per sq. mile
Karaba	1,238	710	282	528	262	47
Thiba	3,609	2,074	923	1,535	876	84
Nguka	3,155	1,673	861	1,482	826	136
Kiuria	1,550	817	416	733	413	156
Kiarakongo	5,616	2,900	1,422	2,716	1,376	262
Gathigiriri	3,275	2,024	723	1,251	689	86
Mahingaine/Kiaga	2,339	1,213	658	1,126	613	95
Mathanguta	2,022	1,071	510	951	510	254
Total	22,804	12,482	5,795	10,322	5,565	920

Source: *Kenya Census of Population*, 1969, 6.

The population build up is also acute in the contiguous High Density Belt in the eastern foothills of the Aberdare Range and on the southern and eastern slopes of Mount Kenya. The High Density Belt is located within a radius of 20 to 30 miles from the centre of the MIS (Fig. 4.1). The population pressure on the land poses a formidable problem throughout the High Density Belt. Progress under these pressing conditions of over-population, unemployment, and underemployment of landless people depends to a great extent on the present, proposed, and potential irrigation settlement schemes in the area. Possibly a new spatial balance in this area is in the making with the potential development of the Upper Tana Catchment Area (Fig. 2.8). Attention has been given to the relationship between man's cultural and socio-economic attainments in the area and his changing appraisals of natural and human resources. Modern techniques and technological innovations used in the MIS are increasing the power of man to alter the ecological equations.

Family Structure and Transition of Life Style

The family structure of Mwea has gone through a major transitional change over the past 2 decades. The life style of the tenants has also involved challenging adjustments -- not least psychological. The tenant farmer has experienced a trans-location, when his traditional livelihood was set aside and when he has had to adapt to a new life style as a tenant farmer, subjected to close supervision under a hierarchical organisation. This is a severe transformation. The tenant no longer has his individuality and independence; farming is no longer accomplished in a traditional manner. Settlement farms are different, too: families at Mwea live in villages; they are allocated a small plot and build a house. They are given an advance to purchase materials to construct the house. Advances are paid back to the MIS Management, out of the tenant's payout, during the first 3 years. Land for cultivation is now allocated by the Management, not chosen by the tenant. Paddy holdings are located in an assigned section of the Settlement. In summary, the tenant's life style has been abruptly changed from a peasant to a tenant farmer specialising in paddy production.

The transitional period takes from one to two years in order to make the necessary adjustments in the mode of life as a tenant in a controlled irrigation settlement. From a psychological point of view, the tenants try to rationalise that the monetary returns from their paddy production will compensate for all the discomforts and unease of departing from the traditional way of life.

P.S.T. Mirie, General Manager, National Irrigation Board, outlined to me his philosophy of the tenant responsibility:

> Nothing is free at Mwea. The tenants have to work for what they receive. The tenant is charged for everything he receives from the management. He receives the social amenities provided by the management. After the tenant is allocated his four acre holding, then he is on his own to be a successful, mediocre, or unsuccessful paddy farmer.

It was observed that the Mwea Management provides the tenant and his family with a bare minimum of social amenities and services. The social sector has been, and is, in a state of benign neglect. The population build up in the villages and the pressure on the land is increasing annually. Essentially, the tenant's livelihood and survival depend on how well he farms his paddy holding.

Unemployment and underemployment, particularly of young men and women, in the MIS are thorny problems. The young people with some primary and secondary education want an office job that seldom exists and then only on a temporary basis. They do not want to work on the paddy farms. But the landless peasant from Kirinyaga District in the up-country is eager to become a tenant at Mwea. His objective is to make money and have food to eat. I have heard tenants remark many times, "Mwea is my daily bread".

During a conference in May 1973 with Mr. John Stemp, Chief Agriculturalist, National Irrigation Board, he remarked:

> One has to look at the human factor in its own context at Mwea. Mwea is a classic example of the cliche, 'Nothing succeeds like success'. The landless peasants in the up-country of Kirinyaga District personally see the success at Mwea and are motivated by what they see and want to join the scheme. They see the success and want 'the package deal'. 'Money talks at Mwea!' You have to demonstrate to the future tenant farmer in a tangible and visible way. If they see Mwea as a success, then they will believe it. The potential tenant is motivated by the possibility of earning 3,000 Kshs. per year plus the tangible amenities he sees on the settlement, eg. bicycles, radios, more food to eat, good clothing, housing, schools, etc. He is immediately motivated because he wants the same things. However, after the tenant is brought into the scheme then the initial breakthrough of integrating him into the hierarchical system is the difficult job.

Size of Family

The older tenants in the Mwea and Tebere Sections often have more than one wife and more children than families in the other sections of the settlement. They wanted to have more people to help them with transplanting and harvesting the paddy crop.

However, this tendency of the older tenants to have large families increases the farmer's expenditures, particularly for food, clothing, and school fees. It is also difficult to feed all members of a large family and relatives sufficiently. Protein consumption has declined steadily over the years. Malnutrition continues to plague a substantial percentage of the children. Home demonstration agents are greatly needed to assist the women in Mwea in planning diets, budgets, and introducing new foods particularly with high protein content to build up the body structure.

In many cases in Mwea it was not possible for the tenant to increase his income from off-farm work. Only 5 per cent of the tenants from my sample survey had off-scheme jobs. Jobs are scarce in the area. It was observed that in some cases there were other people living permanently in the households. These people were generally relatives, friends, or hired workers from up-country. The average family size in Mwea was 7 people. The size of family varied from one person to as many as 18 people. Over 60 per cent of the sample tenants had 5 children, 30 per cent up to 8, and the remainder more than 10. Approximately 75 per cent of the sample tenants had one wife, 14 per cent were married to 2 wives, about 3 per cent to 3 wives and 8 per cent had no wife. I observed that many of the young tenants in the 25-30 age group are satisfied with one wife and 3 children. They are interested in family planning. Their long-term objective is to educate their children through primary and secondary school. Their major expenditures are used for the household and to educate their children. The more extensive the education of the young tenant farmers, particularly in the Thiba and Wamumu Sections, the less was the incentive to have large families. The cost of educating children in Mwea is increasing. On average, about 75 per cent of the children, older than 7 years, attend primary school; approximately 20 per cent attend secondary school. Total school attendance in the MIS was about 95 per cent.

Bicycles, cars, radios, sewing machines, and household equipment are good indicators of the social and economic status of a family. From my sample survey, approximately 60 per cent of the tenants owned one bicycle or more, 20 per cent owned a radio, 5 per cent owned a sewing machine, 1 per cent owned a car, and 70 per cent had an *mbati** roof on their house.

Trade-Off Effects of Mwea

The employment generated by Mwea has been substantial and the economic growth impact on the surrounding area significant. From an economic point of view Mwea has been highly successful. During the 1960's and early 1970's the Scheme expanded substantially (Figures 1.1, 1.2, and 1.3). This was the result of the increased capability and expertise of the Field Extension Staff and the skilled entrepreneurial ability of the Management. The capability of Mwea as a vehicle for generating employment or job creating is

* A roof made of corrugated iron sheeting.

impressive by any standard.

The trade-off effects of Mwea are: (1) high population absorbing capacity, and (2) employment generating capability. These aspects have been displayed dramatically at Mwea over the past decade. In appraising any irrigation proposal the ability of the project in question to absorb population and generate employment deserves careful investigation and appraisal before a decision can be made whether or not to implement the project.

E.G. Giglioli (1970, 1) comments on the role of irrigation in Kenya:

> It is difficult at the present stage of knowledge of the irrigable potential in Kenya to quantify the role that will be played by irrigated settlement in the overall agricultural picture of the future. While there are clear indications that a very considerable expansion of the existing area under irrigation will undoubtedly take place, the country is still in the stage of assessing possibilities and weighing alternatives. The high settlements, together with the fact that most of the irrigable potential is located in thinly populated areas of low productivity, are very attractive features to any agricultural country faced with a rapid expanding population.

The evolution of Mwea in terms of volume of paddy production, yield per acre, acres cropped, number of families settled, and average income per family from paddy production is shown in Figures 1.1, 1.2, and 1.3.

Montague Yudelman (1964, 144-5) stresses the importance of research in the process of change:

> Without adequate applied research, the consequences of changed agricultural

> methods will remain an open question until after the new methods have been adopted by producers. By that time the damage to resources may be very great. Despite the need for research, enough is known so that output could be raised appreciably if producers would adopt changed techniques of production. In the past the process of inducing producers to do this has been slow ... Change tends to disrupt social organisation and may require new types of inputs ... Up to the present time less than one third of the producers have been persuaded to adopt improved techniques. If there is to be any appreciable increase in African agricultural output, the process has to be accelerated.

PROCESS OF CHANGE

Traditional Kenyan agriculture is characterised by low agricultural output, low yields per acre, and small farm plots. A major problem facing the agricultural sector is to try to keep pace with the rising demands of a growing population. The population pressure on the cultivable land is an ever pressing problem. There exists a high man-land ratio in the heavily populated cash crop and subsistence areas of the High Density Belt. Economic and agricultural development means an improvement and change of agricultural practices and technology.

C.E. Kellogg (1963, 1-2) describes with perception the future role of technology and agricultural research in the process of change:

> As agriculture develops, the complexity of its technology grows. The natural soils are greatly modified, chemically, physically, and biologically; water is controlled; improved genetic types of

> plants and animals are selected and bred for specific areas; and methods are worked out for soil, plant, and animal production. Success on any one field or farm depends on having the correct combination of practices. New research and technology and new industries to serve agriculture have pushed up the agricultural potentials even more than production has increased. That is, the gap between the potential production from our soils and current food production continues to widen. Although the total land area of the world is essentially fixed, the part of it suitable for cropping is highly flexible. The acres of soil used for crops at any time depend upon need (or economic demand), the state of the agricultural arts, transport, other facilities and services, and the skills and financial resources of the cultivators. The effectiveness of rain water, and of most irrigation water, can be greatly increased with improved practices. Much unused stream water can be impounded for irrigation. Low-cost methods for removing salt from sea water may lead to further expansion of arable acres.

The particular economic equilibrium represented by traditional agriculture is fundamentally based on the state of the arts underlying the supply or reproducible factors of production, the state of preference and motives underlying the demand for sources of income, and the period of time during which these two states remain constant. In the case of the state of the arts the following *ex post* specifications are essential, the agricultural factors that farmers employ have been used by them and their forebears for a long time and none of these factors meanwhile has been altered significantly as a consequence of learning from experience. Nor have any new agricultural factors been introduced. Thus what is known by farmers about the factors they use has been known by farm people in the community for one or more generations. For a long time nothing new has been learned either from trial and error or from other sources (Schultz, 1965, 30-31).

A change in the mix must take place in the structure of the traditional sector. This would result in a breakdown of an equilibrium which the farmers have achieved within their physical and economic milieu. To break this equilibrium, a set of new scientific factors has to be introduced.

Recently many have emphasised the critical need of large amounts of chemical fertilisers in the developing countries. The need is very great. But fertilisers are economically effective only if the correct kinds and amounts are used for the local kinds of soil and if the other practices required for good harvests are used at the same time. Similarly one cannot expect full benefits from any other single practice. The results of irrigation or terracing without good engineering designs and without fertilisers, a responsive variety, and pest control are bound to be disappointing.

Failure to grasp the vital principle of developing combinations of practices that take full advantage of the interactions is the greatest present technical handicap to agriculture in the developing countries (Kellogg, 1963, 964).

Interactions in agriculture must be consciously sought. When missed, people can be seriously misled. Survey-type interviews with farmers have suggested that those using a single practice, such as fertiliser or improved varieties, have 20 to 50 per cent higher yields than other farmers. But commonly only a part of the increase can be credited to the one practice. Farmers who have adopted one improved practice usually have used other unidentified good practices that also contribute to the better result (Kellogg, 1963, 964).

Population Absorption and Unemployment

The 2 principal impediments to a rapid realisation of improved living standards in Kenya are the limited nature of the resource base and the inability of the people to utilise efficiently those resources that do exist.

With a current population growth rate of well over 3 per cent per year and a declining death rate, Kenya is faced with the prospect of over 15 million people by 1980 and about 30 million by the end of the century. To assure the country of a continued high standard of living, the economy must grow at a higher rate than the population (Ominde, 1968, v).

The major casual factors of unemployment in Kenya are:

(1) Rapidly increasing population which is exerting increasing pressure on limited supply of land, non-reclamation of semi-arid and arid land and other inputs. The consequences of this have been relatively low levels of incomes and increasing levels of migration of people from the rural areas to the urban areas.

(2) The relatively high levels of wage and other incomes in the urban areas which have acted as a further inducement for the people to migrate from rural areas to the towns.

(3) The relatively high levels of wage and other incomes

in the urban areas have come about partly as a result of increase in labour productivity, but also as a result of the trade union activities. Apart from attracting people from the rural to the urban areas, the rapid increase in wages has induced employers to seek more labour-saving and capital-intensive operating techniques. This factor has reduced the ability of the economy to offer an adequate number of jobs.

(4) The nature of technology employed in many of the industrial processes in Kenya is capital-intensive. The high capital-intensity in Kenya's industrial process is because of relatively high costs of labour in relation to capital, but also is the very nature of modern technology. The industrial technology currently in use in Kenya is almost wholly imported, and it tends to be capital-intensive because it is geared to the needs of the industrial countries whence the goods are imported.

(5) The rapid increase in school enrolment and output since independence. Theoretically an increase in school enrolment and output should not result in increased unemployment. In Kenya's context, however, the school curricula are such that they do not provide the school-leavers with immediately applicable skills after leaving school. In recent years, therefore, the problem of the unemployed school-leavers has become a major issue.

(6) Agricultural policies in Kenya which have discouraged high output of agricultural produce. For example, poor marketing and pricing systems in both domestic and export markets, lack of manufacture and processing of finished products from agricultural produce, etc.

(7) Failure on the part of the Government to implement all projects approved by the National Assembly (*Report of the Select Committee on Unemployment*, 1970, 3).

J.C. de Wilde (1967, 31) elaborates on the problems faced by the subsistence economy in Kenya, and the difficulty of a large majority to make the transition from purely subsistence farming to a market economy:

> The progress that has undeniably been made has, as yet, left untouched the great majority of African farmers and pastoralists who still, on the whole, produce little more than what is required for their bare subsistence. It is noteworthy that the development of production for the market by the larger or more progressive farmers has apparently not taken place at the expense of production for subsistence. In other words, cash cropping has in large part been grafted on to a subsistence economy.

Population absorption and employment have been and are likely to remain common objectives of irrigation projects in Kenya and Africa South of the Sahara in general. During the 1950's African population absorption as an objective was of great importance where African overpopulation was perceived as a political threat to European settlement. The Mwea history and development during this period is an excellent example.

A detailed analysis of the historical evolution of Mwea and, in particular, the organisational and administrative background to the Settlement is provided in *Settlement Schemes in Tropical Africa* by R. Chambers, 1969.

The problem of resettling Africans displaced for various reasons, and the problems of resettlement of populations displaced by irrigation projects during the past 2 decades have been analysed by many writers too numerous to discuss here. An excellent appraisal of various irrigation development schemes in Africa is provided in *Agricultural Development in Tropical Africa, Vol. II, The Case Studies,* by J.C. de Wilde, 1967.

Most recently there has been increasing concern in Kenya with the related problems of employment and social equity. One of the major recommendations of a Select Parliamentary Committee on unemployment and underemployment in Kenya, which reported in 1970, was urgent expansion of irrigation projects, increasing labour intensiveness and reducing budgeted tenant incomes so that more families could be settled on irrigation settlements (*Report of the Select Committee on Unemployment,* 1970, 1).

The expansion of irrigation schemes is seen as a major means of increasing employment in Kenya. The NIB estimates that there are over four jobs created for each hectare of land irrigated. According to the 1970-74 Development Plan, only 6,000 hectares of land have been irrigated out of an estimated potential of over 160,000 hectares. In other words, less than 4 per cent of the employment potential of irrigation has yet been exploited. Organised irrigation settlement is a recent phenomenon in Kenya. It was started in response to the political pressures generated by the Mau Mau Emergency. But unemployment is also an emergency. It should be treated with the same seriousness and urgency.

The *Report of the Select Committee on Unemployment* (1970, 19) states:

> The early irrigation schemes were labour-intensive in both the construction phase and in operation. Recently there has been a shift from labour-intensive to capital-intensive technology in scheme construction, and also from higher-density to lower-density schemes. These changes should be reversed. The target family income on the schemes, which was K£ 100 at the beginning of the 1960's but has since risen to K£ 150 should be reduced back to K£ 100 so that more people can be accommodated.
>
> These problems stated above are substantially sharpened in their relevance to Kenya by the irrigation potential of the country. It is important to keep in mind that technology, crop labour requirements, size of holding, processing, marketing, and the tenant family structure are among the variables which might substantially affect the population supported by any irrigation project.

SUMMARY

The aim of this chapter has been to examine the social and economic development of Mwea and the surrounding area. An attempt has been made to discuss the socio-economic factors which influence the development of smallholder farming. The role of economic and social infrastructure has been appraised within the context of irrigation development in Mwea.

The most critical problem facing Mwea and the High Density Belt within the 10, 20, and 30 mile radius is the mounting population pressure on the land. Also facing Mwea and the High Density Belt is the swelling number of unemployed, underemployed, and unemployable. Jobs are not available for the increasing number of jobless young people in the area with primary and secondary education. Also a matter of great concern is the increasing number of landless peasants in the up-country. In Kirinyaga District there are perhaps as many as 20,000 landless peasants. Only a very few can be given tenancies at Mwea. It is hoped that many of these landless people will be absorbed on the land in peripheral areas through a more intensive use of agricultural resources.

The population density problems in the area will have to be analysed and reappraised in the light of new developments. An analysis of the internal movements and evolution of changes in the population structure in the area is urgently needed. It is becoming more and more evident that it is not solely economic, but also socio-economic situations in the rural areas, which underlie the drifts of population migrating in and out of the area. One way out of this vicious circle is by developing irrigation schemes as a vehicle for population absorption and intensive crop production. The relevance of detailed study of Mwea is paramount. The major thrust of the field survey is directed toward using Mwea as an example of the social and economic desirability of smallholder farming under organised irrigation. Emphasis will be placed in later chapters of this thesis on how far Mwea has been extended and the impact on the future environment of Mwea. The facts of the field enquiry will be shown in detail in subsequent chapters.

CHAPTER 5

QUESTIONNAIRES, METHODOLOGY, AND SAMPLING TECHNIQUES

BACKGROUND

This chapter concerns one of the most important phases of the thesis. It is germane to elaborate on the various aspects of the questionnaires, methodology, and the sampling techniques used in the field survey work. It is also relevant to elaborate on some of the problems involved in constructing and designing the two questionnaires used in the field survey; the techniques used in interviewing the tenant farmers and the Field Extension Staff; and the response of the tenants and the Field Extension Staff to the questionnaires. After careful appraisal and analysis of the study, it was decided that two questionnaires would be used in this comprehensive field work. One questionnaire was designed for interviews with the Mwea tenant farmers and the other questionnaire was designed specifically for the Field Extension Staff. These two field questionnaires were the major research tools used in the survey work. The two questionnaires are found in the pocket of the thesis.

The design of the questionnaires was of major importance and encompassed a period of 6 months of trial and error. The number of questions was kept to a workable minimum so that essential and relevant information could be obtained. I was particularly fortunate to have had the advice and wise counsel of E.G. Giglioli, former General Manager and founder of the National Irrigation Board, 1966-72, and former Manager of Mwea, 1959-66, to review and comment on the two questionnaires. I was fully responsible for the questions used on the final questionnaires.

This field research survey was conducted from May 15 - September 15, 1973, at the Mwea Irrigation Settlement, Kerugoya, Kenya.

ASSUMPTIONS

The tenant farmer survey consisted of a 10 per cent random sample of the approximately 2,500 tenants at Mwea. The tenant farmer survey involved my personally interviewing 250 tenant farmers - 50 from each of the 5 sections.

The objectives of the tenant farmer questionnaire were to obtain from each farmer interviewed relevant information about his land and paddy production, current paddy practices, labour requirements, production costs, problems in producing and harvesting paddy, personal information, personal expenditures, household structure, home possessions, personal reaction to being on the scheme, and his social and economic background.

The Field Extension Staff survey involved my personally interviewing each of the 50 members of the MIS Field Extension Staff including Irrigation Officers, Head Field Assistants, Field Assistants, Head Water Guards and Water Guards in each of the 5 sections of the MIS. I had a 100 per cent response from the questionnaires. Not one person refused to be interviewed or answer all of the questions presented from the questionnaires. This outstanding response went far beyond my expectations.

Prior to my going to Kenya I was apprehensive about some of the questions involving the tenants' personal money expenditures and personal income. I was also sceptical about receiving answers to provocative and poignant questions concerning the operations of Mwea and the Management, such as found in Question 14, Section VIII, Personal Reactions. I was amazed to find out that the farmers were willing to express detailed information on their personal expenditure as found in Question 5, Section VIII. In fact, after conducting the pilot survey, I had to alter Question 5 to show this breakdown of personal expenditure. I was also surprised to find a detailed and comprehensive breakdown of major costs in paddy farming in the MIS for all of the farmers. These records were maintained in the Central Records Office of the MIS. These are firm and hard figures which represent some of the best statistical data on any scheme in Africa over a period of the past 15 years.

In Section V, Personal Information about the Farmer, Question 8 had to be altered to read, "Have you ever gone to school?" rather than "What was the highest grade you completed in school?"

One of the major alterations in the farmer questionnaire was in Section III, Labour and Finance, concerning a breakdown of man days involving the various operations during the season. Being able to obtain this information added measurably to the detail involving man days of work during the paddy season. This question was expanded to include a breakdown of 7 categories (see questionnaire in pocket of thesis). Additional alterations included Questions 8 and 9.

The Field Extension Staff survey involved my personally interviewing the 50 members of this particular survey. The response was excellent with no one refusing to answer any questions and there was complete co-operation. Any prior apprehension on my part was dispelled. I received complete co-operation from the NIB General Manager and his staff; the Mwea Manager and his Administrative and Field Extension Staffs; the Irrigation Officers, Head Field Assistants, and Field Assistants of each MIS Section; however, above all, the Mwea tenant farmers gave me their total co-operation. Without this co-operation it would have been practically impossible to conduct this comprehensive field survey and receive this excellent response. The Irrigation Officers in each section were extremely co-operative and followed through with my planned programme of interviews of the tenant farmers and Field Extension Staff in each particular section. I informed each Irrigation Officer a fortnight in advance concerning the names and farm numbers of the farmers and the particular Field Extension Staff members to be interviewed on a specific date (Fig. 5.1).

14 MAY Mon. CON. WITH GEN MGR, P.S.T. MIRIE, NIB & STAFF	21 MAY Mon. CON. WITH MGR, SIMON KINAI & ASST MGR, JOHN KIMANI OF MIS INTRO. TO INTERP./ENUM., CHARLES KIHARA	28 MAY Mon. FIELD SURVEY THIBA SECTION INTER. HFA & FA OF H-20 & FARMERS IN H-20 2054, 2062, 2096	4 JUN. Mon. INTER. FA & FARMERS IN H-7 2651 VISITED HOLDINGS 2654, 2695 WITH ALKAL. OBSER. WEEDING OP. IN HOLDING 2407	11 JUN. Mon. INTER. FA & FARMERS IN H-7 2670, 2666 WORKED ON THIBA SECTION FIELD MAP	18 JUN. Mon. VISITED WITH IO ABAN. HOLDINGS IN THIBA SECTION UNITS H-2, H-4, H-18 & H-20 (56 ACRES WITH ALKAL.)
15 MAY Tue. Do	22 MAY Tue. BEGAN PILOT SURVEY INTER. 2 FA, PETER NDEGE & KIBUCHI KARIRA	29 MAY Tue. INTER. FA & FARMERS IN H-3 2381, 2390, 2391, 2407, 2417 SURV. UNIT INTER. GUARDIAN	5 JUN. Tue. INTER. FA & FARMERS IN H-8 2725, 2734, 2744, 2747, 2750 CON. WITH MGR & ASST MGR OF HIG	12 JUN. Tue. INTER. FA & FARMERS IN H-4 2763, 2772, 2782, 2787, 2805 SURV. UNIT	19 JUN. Tue. FIELD SURVEY WAMUMU SECTION INTER. IO & HFA INTER. FA FOR W-1 BERNARD MWAURA, JOINED TEAM AS ENUM.
16 MAY Wed. Do	23 MAY Wed. PILOT SURVEY INTER. HC & 5 MIS TENANT FARMERS	30 MAY Wed. INTER. FA & FARMERS IN H-5 2501, 2510, 2513, 2510, 2519 SURV. UNIT INTER. GUARDIAN	6 JUN. Wed. INTER. FA & FARMERS IN H-1 2325, 2333, 2335, 2346, 2352, 2355, 2360 SURV. UNIT SAMUEL NJENGA/ENUM	13 JUN. Wed. WORKED ON THIBA SECTION FIELD MAP INTER. WG IN H-5 & H-8 INTER. HWG	20 JUN. Wed. INTER. FARMERS IN W-1 3103, 3126, 3135, 3142, 3157 SURV. UNIT
17 MAY Thu. Do	24 MAY Thu. Do	31 MAY Thu. INTER. FA & FARMERS IN H-18 2101, 2113, 2114, OBSER. ROTAVATION OF HOLDING 2407, SURV. MAIN CANALS, DRAINS & FEEDERS	7 JUN. Thu. INTER. FA & FARMERS IN H-2 2433, 2436, 2448, 2464, 2482 SURV. UNIT	14 JUN. Thu. VISITED WITH IO HOLDINGS WITH EVIDENCE OF ALKAL. H-7 2693 H-18 2089, 2090, 2115	21 JUN. Thu. CONT. INTER. FARMERS IN W-1 3120, 3121, 3144, 3167, 3168 INTER. GUARDIAN
18 MAY Fri. Do	25 MAY Fri. INTER. IO & HFA OF THIBA SECTION	1 JUN. Fri. INTER. FA & FARMERS IN H-19 2148, 2152, 2161, OBSER. LEVELLING OP. IN HOLDING 2391	8 JUN. Fri. INTER. FA & FARMERS IN H-6 2611, 2622, 2638, 2644 VISITED HOLDINGS 2608 & 2346	15 JUN. Fri. VISITED WITH IO HOLDINGS WITH HIGH ALKAL. H-3 2381 H-6 2591, 2594 H-7 2684 THRO' TO 2695 H-8 2703	22 JUN. Fri. INTER. FA & FARMERS IN W-2 3200, 3225, 3257, 3262, 3291 SURV. UNIT
19 MAY Sat.	26 MAY Sat.	2 JUN. Sat. VISITED HC & HOLDING 2513 IN H-5	9 JUN. Sat.	16 JUN. Sat.	23 JUN. Sat. CONT. INTER. FARMERS IN W-2 3241, 3279, 3300, 3214
20 MAY Sun.	27 MAY Sun.	3 JUN. Sun.	10 JUN. Sun.	17 JUN. Sun.	24 JUN. Sun.

25 JUN. Mon INTER. FA & FARMERS IN W-3 3358, 3379, 3385 SURV. UNIT	2 JUL. Mon. INTER. FA & FARMERS IN W-6 3615, 3646, 3666, (JOHN WAINAIHA JOINED TEAM AS ENUM.) 3636, 3648, 3659, 3662, 3685, 3689 SURV. UNIT	9 JUL. Mon. WORKED ON WAMUMU SECTION FIELD MAP	16 JUL. Mon. SURV. MWEA RICE MILLS LTD., INTER. WITH MGR & STAFF	23 JUL. Mon. INTER. FA & FARMERS FOR T-2, T-5, T-6, T-13 T-2 142, 144 T-5 1, 14, 49 T-6 231, 230, 225 T-13 92, 94 SURV. UNITS	30 JUL. Mon. WORKED ON TEBERE SECTION FIELD MAP AUTHOR SURV. ABAN. (RED SOILS) UNITS T-2, T-3, T-4, T-9, T-10, T-12, T-15
26 JUN. Tue. CONT. INTER. FARMERS IN W-3 3313, 3319, 3341, 3362 ANALY. TENANTS REC. IN MIS HQ. INTER. GUARDIAN	3 JUL. Tue. VISITED WITH IO HOLDINGS WITH HIGH ALKAL. W-3 3375, 3386, 3412, 3413 W-6 3414, 3422, 3423, 3430, 3431, 3430, 3448, 3455, 3461, 3467, 3476	10 JUL. Tue. ANALY. TENANTS REC. IN MIS HQ. FRANCIS MWANGI, JOINED TEAM AS ENUM.	17 JUL. Tue. FIELD SURVEY TEBERE SECTION INTER. IO & HFA INTER. FA FOR UNITS T-15, T-16, T-17, T-19 INTER. FARMERS T-15 409, 415 INTER. GUARDIAN	24 JUL. Tue. TOOK PHOTOS IN UNITS T-17, T-18, T-20 SURV. ALKAL. & ABAN. HOLDINGS IN TEBERE SECTION WITH IO	31 JUL. Tue. ANALY. TENANTS REC. IN MIS HQ.
27 JUN. Wed. INTER. FA & FARMERS IN W-4 3450, 3459, 3468 SURV. UNIT ANALY. TENANTS REC. IN MIS HQ.	4 JUL. Wed. VISITED WITH IO ABAN. HOLDINGS IN WAMUMU SECTION UNITS (162 ACRES DUE TO EXCESS ALKAL.)	11 JUL. Wed. ANALY. TENANTS REC. IN MIS HQ.	18 JUL. Wed. SURV. UNITS T-15, T-16, T-17, T-19 INTER. FARMERS IN UNITS T-16 108, 123 T-17 247, 250 T-19 268, 282, 296, 302	25 JUL. Wed. INTER. FA & FARMERS FOR T-10, T-20, T-21 T-18 384, 394 T-20 602, 603, 627, 650, 663 T-21 420, 427, 450 PHOTOS. SURV. UNITS	1 AUG. Wed. Do
20 JUN. Thu. CONT. INTER. FARMERS IN W-4 3415, 3454, 3488 INTER. FA & FARMERS IN W-5 3518, 3540, 3588 SURV. UNIT	5 JUL. Thu. Do	12 JUL. Thu. WORKED IN NIB, NAIROBI: ANALY. FIELD MAPS, INFOR & DATA INTER. NIB CHIEF AGRICULTURAL SPECIALISTS	19 JUL. Thu. INTER. FA & FARMERS FOR T-11, T-22, T-23, T-25 T-11 534, 543, 547, 558, 574 T-22 455, 481, 493 T-23 515 T-25 495 SURV. UNITS	26 JUL. Thu. VISITED WITH IO HOLDINGS WITH EVIDENCE OF ALKAL. T-6 145, 147 T-7 244, 245, 247 T-8 312, 316, 318	2 AUG. Thu. LEFT FOR MOMBASA/MALINDI
29 JUN. Fri. CONT. INTER. FARMERS IN W-5 3508, 3539, 3564, 3583 INTER. GUARDIAN	6 JUL. Fri. VISITED THIBA & NYAMINDI HEADWORKS WITH MIS ASST MGR GEOFFREY NGARE, JOINED TEAM AS ENUM.	13 JUL. Fri. CON. WITH GEN MGR OF NIB & CHIEF IRRIGATION ENGINEER.	20 JUL. Fri. INTER. FA & FARMERS FOR T-7, T-8 T-7 155, 161, 163, 178, 180 T-8 320, 326, 357, 373 SURV. UNITS	27 JUL. Fri. CONT. HOLDINGS WITH EVIDENCE OF ALKAL. T-19 262, 260, 270, 280, 281, 295, 296 T-20 648, 647, 656, 657, 658, 661	3 AUG. Fri. Do
30 JUN. Sat. SAFARI TO MARSABIT TO VIEW SOLAR ECLIPSE	7 JUL. Sat.	14 JUL. Sat. Do	21 JUL. Sat.	28 JUL. Sat. VISITED WITH IO ABAN. HOLDINGS IN TEBERE SECTION UNITS T-5, T-6, T-8, T-17, T-19, T-20 (120 ACRES DUE TO EXCESS ALKAL.)	4 AUG. Sat. Do
1 JUL. Sun.	8 JUL. Sun.	15 JUL. Sun.	22 JUL. Sun.	29 JUL. Sun.	5 AUG. Sun.

6 AUG. Mon. FIELD SURVEY MWEA SECTION INTER. IO & HFA INTER. FA FOR UNITS M-7, M-8, M-11, M-12 SURV. UNITS	13 AUG. Mon. INTER. FA & FARMERS FOR M-5, M-9, M-10 M-5 1524, 1556, 1564 M-9 1804, 1813 M-10 1827, 1831, 1841 SURV. UNITS	20 AUG. Mon. FIELD SURVEY KARABA SECTION INTER. IO & HFA PHOTO. SECTION INTER. FA FOR K-1 & SURV. UNIT HRUM KINYANJUI JOINED TEAM AS ENUM.	27 AUG. Mon. INTER. FA & FARMERS IN K-5 4154 4127 4171 4187 4195 SURV. UNIT	3 SEP. Mon. SPENT WEEK AT MIS HQ., ANALY. TENANTS REC. & WORKING ON FIELD MAPS	10 SEP. Mon. SPENT WEEK AT NIB, NAIROBI, REVIEWING RECORDS, MAPS & REPORTS
7 AUG. Tue. INTER. FARMERS IN M-7 1582, 1584 M-8 1596, 1603 M-11 1849, 1853 M-12 1769, 1774, 1865, 1886 INTER. GUARDIAN W-3	14 AUG. Tue. INTER. FA & FARMERS FOR M-16, M-17 M-16 1993, 2017, 2020 M-17 2204, 2208, 2219, 2249, 2251, 2267, 2298 SURV. UNITS	21 AUG. Tue. INTER. FA & FARMERS IN K-1 3733 3741 3719 3752 3717 3731 3747 [illegible] 3742 3748 3764 3779 3804 3801 3811 3812 INTER. GUARDIAN	28 AUG. Tue INTER. FA & FARMERS IN K-6 4206 4228 4237 4243 4263 4221 SURV. UNIT	4 SEP. Tue. Do	11 SEP. Tue. Do
8 AUG. Wed. INTER. FA & FARMERS FOR M-1, M-2, M-3, M-4 M-1 1617, 1641, 1650 M-2 1657, 1670 M-3 1745 M-4 1697, 1703, 1714, 1727 SURV. UNITS	15 AUG. Wed. VISITED WITH IO HOLDINGS WITH EVIDENCE OF ALKAL. M-8 1590, 1600, 1601, M-9 1802, 1805 M-1 1637, 1647 M-2 1657 M-3 1745, 1753, 1755	22 AUG. Wed. INTER. FA & FARMERS IN K-2 3850 3892 3830 3885 3897 3851 3868 3932 SURV. UNIT	29 AUG. Wed. INTER. FA & FARMERS IN K-7 4283 4325 4328 SURV. UNIT	5 SEP. Wed. Do	12 SEP. Wed. Do
9 AUG. Thu. INTER. FA & FARMERS FOR M-13, M-14, M-15 M-13 2304, 2302 (PHOTO OF PLANNING A NURSERY) 2323, 2299 M-14 1918, 1936, 1942, 1945 M-15 1950, 1956 SURV. UNITS	16 AUG. Thu. VISITED WITH IO HOLDINGS WITH HIGH ALKAL. M-4 1693, 1716, 1722, 1766, 1767, 1760, M-12 1774, 2216 M-13 2302, 2304, 2309	23 AUG. Thu. WORKED ON KARABA SECTION FIELD MAP VISITED MWEA RICE MILLS LTD. OP. CON. WITH H. DAY, MGR	30 AUG. Thu. VISITED WITH IO HOLDINGS WITH EVIDENCE OF ALKAL.	6 SEP. Thu. Do	13 SEP. Thu. Do
10 AUG. Fri. WORKED ON MWEA SECTION FIELD MAP AUTHOR SURV. MWEA SECTION WITH MGR AUTHOR MET MR. SHEERER OF I.L.A.C.O.	17 AUG. Fri. VISITED WITH IO ABAN. HOLDINGS IN MWEA SECTION UNITS M-3, M-7, M-11, M-13 (140 ACRES DUE TO ALKAL.) ANALY. TENANTS REC. IN MIS HQ.	24 AUG. Fri. INTER. FA & FARMERS FOR K-3, K-4 K-3 4014 3977 3064 3956 3958 3945 3996 K-4 4105 4103 4084 4043 4020 SURV. UNITS	31 AUG. Fri. VISITED WITH IO ABAN. HOLDINGS IN KARABA SECTION (400 ACRES DUE TO EXCESS ALKAL.)	7 SEP. Fri. Do	14 SEP. Fri. Do
11 AUG. Sat.	18 AUG. Sat.	25 AUG. Sat.	1 SEP. Sat.	8 SEP. Sat.	15 SEP. Sat. LEFT NAIROBI FOR LONDON/EDINBURGH
12 AUG. Sun.	19 AUG. Sun.	26 AUG. Sun.	2 SEP. Sun.	9 SEP. Sun.	NOTES

NIB = NATIONAL IRRIGATION BOARD
MIS = MWEA IRRIGATION SETTLEMENT

GEN MGR = GENERAL MANAGER
MGR = MANAGER
ASST MGR = ASSISTANT MANAGER
IO = IRRIGATION OFFICER
HFA = HEAD FIELD ASSISTANT

FA = FIELD ASSISTANT
HC = HEAD CULTIVATOR
HWG = HEAD WATER GUARD
WG = WATER GUARD

ABAN. = ABANDONED
ALKAL. = ALKALINITY
CON. = CONFERRED
CONT. = CONTINUED
INTER. = INTERVIEWED

ENUM. = ENUMERATOR
INTERP. = INTERPRETER
OBSER. = OBSERVED
OP. = OPERATION
SURV. = SURVEYED

THE CONDUCT OF THE ENQUIRY

SOURCE : BY AUTHOR

FIG. 5·1

PROCEDURE

I developed a calendar of operations (Fig. 5.1) to maintain and exercise control of the date, time, and place of each interview throughout this 4 month survey. The 50 farmers sampled and interviewed from each of the 5 sections were selected from the numerical listing of the farms in the Central Records Office in the MIS. The tenant farmers were selected at random from a table of random numbers (*The Cambridge University Statistical Series)*.

Each interview was conducted separately and apart from any other members of the Field Extension Staff or tenant farmers. The tenant farmers were interviewed by my interpreter and myself (Photo. 5.1).

I also used the services of a team of 5 enumerators who stayed with me for approximately 9 weeks during the field survey; one member left after the first 6 weeks to return to teaching in a primary school in Sagana.

The first 2 weeks were used to conduct a pilot survey; 5 tenant farmers and 2 Field Extension Staff personnel were interviewed during this survey. It was after this pilot survey that the questions were altered or deleted. This was perhaps one of the most important aspects of the initial operations and is vital in conducting similar field surveys.

After the first month it became apparent that it was necessary to add 5 additional enumerators to the staff to meet the target date for the completion of the field survey. Each

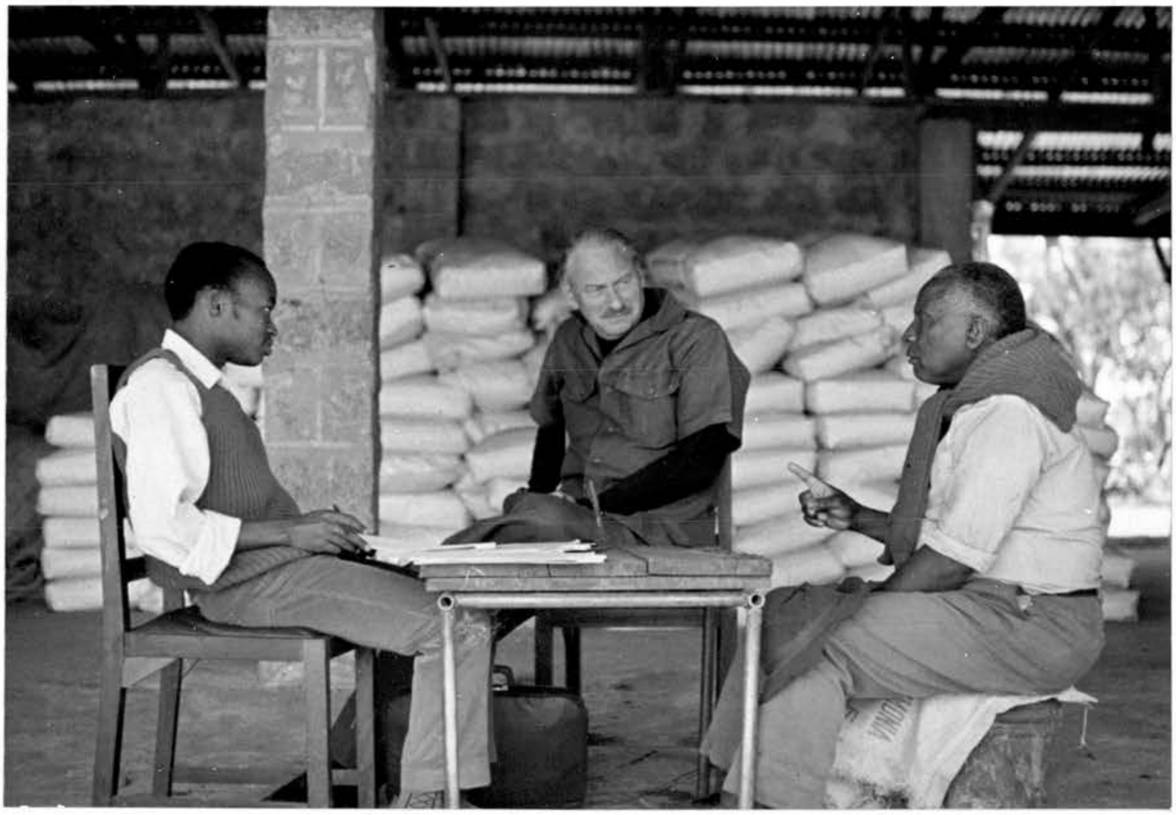


PHOTO. 5.1: CONDUCTING A TYPICAL FIELD ENQUIRY WITH A TENANT FARMER AT MWEA

The author is in the centre of the photograph and the interpreter/enumerator is on the left. The tenant farmer being interviewed was a former Mau Mau detainee who has been at Mwea since 1955. In the background are stacks of bags of fertiliser which are supplied on contract by the West German Government on the Kreditanstalt für Wiederaufbau Agreement. The West German Government is assisting the Kenya Government in the development programme at Mwea.

enumerator was trained by my Research Assistant and myself for a fortnight prior to joining the team. This technique proved invaluable in the course of events to come. All interviews of tenant farmers were conducted in Kikuyu. Some of the tenant farmers could speak and understand some English. All interviews which I conducted with the Field Extension Staff were in English. However, in each case, the person interviewed was greeted in Kikuyu or Swahili, never in English! Quite clearly it would have been an advantage for me to have had a working knowledge of Kikuyu. The lack of direct knowledge and a facility of the Kikuyu language was a limiting factor in how much I could probe into specific questions during an interview. I spoke Swahili as often as possible. All interviews were planned a fortnight in advance so as not to interfere with the daily functions of the scheme; more important, not to disrupt the tenant farmer's schedule on his paddy holding. On many occasions, during the interviews, I would give the tenant farmer a cigarette or Coca Cola; this tended to put the farmer at ease and break the ice. After the interview I would always thank the farmer in his native language for his time and co-operation. Each of the farmers and the Field Extension Staff members interviewed expressed the feeling that I was interested in his problems and gave assistance toward solving them. Before each interview my interpreter would state briefly the purpose of the interview, authorisation, and that what was said would be kept in strict confidence as to individuals and specific, sample holdings.

In performing any field survey work, particularly in

Africa, it is imperative to seek a high degree of empathy with the farmers being interviewed. One realises very quickly that much of the information asked is of a personal nature and that unless the confidence of the farmer can first be gained it would be extremely difficult to obtain it. It should be kept in mind that by having the full co-operation of the General Manager of the NIB, the MIS Manager and Management, and the official backing of the Kenya Government, a respondent may be conditioned, psychologically, to a degree of reticence in answering fully sensitive questions because of the fear that the answers given may be used against the respondent at some future time and impair his status on the scheme. However, this feeling was not apparent as I personally made it abundantly clear that at no time would his name be mentioned and that all of the information given would be kept in strict confidence with non-attribution to anyone. Nevertheless, this psychological aspect is a limitation in conducting a comprehensive survey of this magnitude.

The format of the questionnaires offered me several advantages: (1) it gave me considerable flexibility in the field survey operation, for example I could begin my questions at any section of the questionnaire according to the mood of the tenant being interviewed; however, in most cases I started the questionnaires from the beginning; (2) it made the interviews as informal as possible; (3) it minimised the amount of writing done in the field by including as many anticipated answers as possible; (4) it presented questions in a sequential and logical order so as not to confuse the farmer; and (5) it facilitated transcribing the data from the questionnaires on 80-column cards for data processing on the IBM 370-155 computer. This necessitated having a selection of codifiable anticipated answers and space for unexpected responses. The layout of the questionnaires was compact with a minimum of paper used. The blank page on the back of the front covers was used for additional notes and field sketches. The questions were structured in a terse and concise form.

PROCESSING OF DATA

The data from the farmer questionnaires were processed on the IBM 370-155 computer at the Edinburgh Regional Computing Centre, Edinburgh, Scotland. The computer programme used was *The Statistical Package for Social Sciences* (SPSS system) devised by Nie, Bent and Hall. This study furnishes the Pearson correlations for performing the correlation analysis in this thesis. The variables which were considered for this analysis were obtained from the farmer questionnaires. The data selected included aspects of farm income, expenditure, hired man days, labour inputs, size of farm, types of fertiliser used, non-farm jobs, major agricultural and harvesting problems, district of origin of the tenant farmer, age of farmer, marital status, length of tenure at Mwea, educational level, total household members, total size of family (blood ties), number of household members working on the holding, farm management techniques, and social and economic characteristics of the farmers' background.

In total there are 20 independent variables which are numbered and listed in Appendix IV. Inter-correlations are assumed to exist between the dependent and independent variables. The results of the correlation analysis used provide a single summary statistic describing the strength of association between two variables: in this case, the dependent variable is paddy yield per holding, and the independent variables are selected from the field enquiry (Appendix IV). The correlation coefficients determine the degree of covariation existing between the dependent and independent variable. The matrix of correlation coefficients and level of significance of selected variables is shown in Appendix IV. The interpretations of the 20 independent variables are dependent upon the degree of relationship which exists between yield per holding as the dependent factor, and each selected independent variable.

EVALUATION

Some of the lessons learned from this study are: (1) that such an enquiry must have the authorisation from the Kenya Government, Provincial Officer, District Commissioner, General Manager of the NIB and the Manager of the MIS before starting such a programme of field research; (2) that it is vital to have an interpreter and enumerators who have had previous experience with agricultural and population census work; (3) that it is extremely important to have a clear and concise questionnaire structured so as to obtain necessary information for the study; and (4) that it is vital to run a pilot programme for a fortnight before beginning the field survey. In this way questions may be altered, or added, to make the interviews more meaningful.

From my personal experience, I found that by constructing a calendar of operations (Fig. 5.1), I was able to have control over the entire field survey at all times. Also, by having duplicate copies of this calendar of operations for the Manager and the Assistant Manager of the MIS they were completely cognizant at all times of the status of my field work. However, it should be kept in mind that there will be differences in the stress of answers from respondents due to the particular time of the season when the interview is taking place. The tenant farmers' problems will appear different according to the particular time during the season when the interview is being conducted (Fig. 5.1). I conducted my interviews during the May to September period which covered all the operations of the paddy productive cycle, with the exception of harvesting. Thus, conducting an interview at a certain point of time in the paddy production cycle may be viewed as a limitation in the field survey. The questionnaire must be structured with a high degree of flexibility so one could begin at any section according to the particular situation. Another lesson to learn is that the interpreter should be selected, if possible, in advance and should be a very competent and experienced individual in agriculture. The interpreter plays a key role in the total field research programme. It is important to structure questions in a lucid and terse form in order that they may have a degree of continuity. Questions of income and expenditures were asked after the confidence and respect of the respondent were obtained so that he had little or no reluctance in replying to these personal questions. It was observed that once you gained the respondent's confidence, he was more than willing to reply and assist in clearing up any complex issue. Check questions for reliability were incorporated to verify the respondent's information: for example, in I. 2 and I. 14; III. 1(vii) and III. 7; and III. 8 and VIII. 5(i) 4. It is important to have check questions throughout the questionnaire in order to have reliable information.

The following questions proved to be most useful:

(1) Do you have a soil alkalinity problem on your paddy holding?

(2) What makes a successful paddy farmer?

(3) What was your net income from paddy farming last season?

(4) What income do you get other than from paddy farming?

(5) What investments have you made?

(6) What main items do you spend your money on?

(7) What were your major costs in paddy farming last season?

(8) How many man days did you spend last season in the various phases of paddy operation?

(9) How many days did you spend on non-farm jobs last season?

(10) How much did you spend on hired and/or casual labour last season?

(11) How many people did you hire last season?

(12) How many hired man days of labour did you hire on your holding last season?

(13) Did you hire labour from outside Mwea on your holding last season?

(14) How many days did you spend last season on any other land you may own?

(15) What was your major agricultural problem?

(16) What was your major harvesting problem?

My major suggestions for improving future field research surveys in Kenya are to have: (1) a social psychologist and an anthropologist with experience in Kenya review the questionnaires, question by question, on-the-spot with the individual who is going to conduct the survey; (2) a course in the particular language of the tribe where you are going to conduct your survey, which would prove to be extremely useful; (3) a trip to the country and area to serve as an introduction - in this way the researcher will have an idea what he is faced with and will be able to generate contacts of key personnel in the country in preparation for future in depth field research surveys. It is absolutely vital to have the necessary financial backing from a research organisation well in advance of planning such a comprehensive research programme.

CHAPTER 6

LAND USE AND PADDY PRODUCTION

The material presented in this chapter concerns land use and analyses of the cycle of operations in paddy production. These analyses are based on my intensive field survey work in Mwea, farmer and Field Extension Staff sample questionnaires, interviews with the MIS Administrative Staff, and my personal observations. During my field research work I was able to observe all of the operations in the paddy production cycle with the exception of harvesting. Stress will be placed on the percentage of work accomplished in each phase of the cycle of operations.

LAND USE

The total acreage of Mwea is approximately 30,000 acres, consisting of about 14,000 acres of black cotton soils, used for irrigated paddy production, and 16,000 acres of red soils, with the fertile areas (approximately 2,000 acres) allocated to the tenants for subsistence crops, primarily maize, beans, and peas. The red soils are also allocated to the spatial needs of the 34 villages (Photo. 6.1) in the Settlement. Approximately 850 acres of the red soils are allocated to tenants of the Mwea and Tebere Sections (Fig. 4.3) for non-irrigated cultivation of cotton. The red to reddish-brown volcanic loam soils are located on the higher

PHOTO. 6.1: A TYPICAL DIRT ROAD LEADING INTO NGUKA VILLAGE, MWEA SECTION

The villages in Mwea are located primarily on the high-lying typography. The red soils are allocated to the spatial needs of the 34 villages in the Mwea Irrigation Settlement. These roads are the main means of communication between the villages.

land and lower ridges of the Mwea Area.

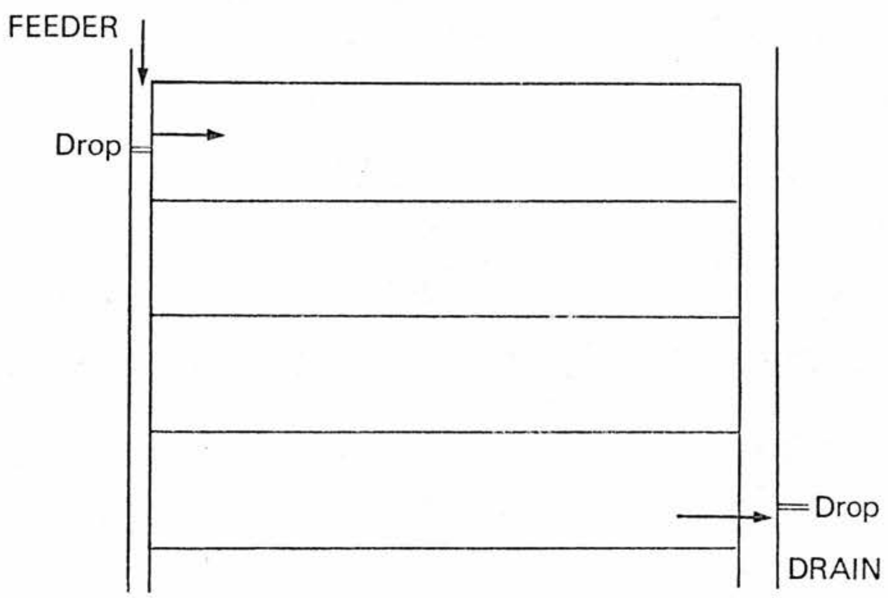
The primary determinants of land use in Mwea are water and soil. Land potential in the MIS Area may be modified by improved drainage, improved cultural practices, good crop husbandry and crop hygiene, and the use of agricultural inputs, such as fertilisers, improved varieties of seed, insecticides, herbicides, and the use of *boma* manure. During the 1972/73 season there were 11,698 acres of black cotton soils under paddy cultivation. An extension of 2,000 acres (Karaba Section) of black cotton soils was added to the MIS during the 1973/74 season (Fig. 4.3). The use of the black cotton soils is based directly on the present canal system of the MIS, linked to the Headworks on the Thiba and Nyamindi Rivers (Fig. 4.3).

The major factors affecting land use in the MIS are: (1) availability of an adequate water supply to satisfy the demands of 12,100 acres under irrigated paddy cultivation; (2) impact of the trend toward increased alkalinity of black cotton soils and the accelerated abandonment of areas due to excessive alkalinity; (3) lack of an adequate supply of hired and/or casual labour during the peak periods of labour demands at harvesting and transplanting; (4) inability of many farmers to mobilise their household labour to help with the many tasks involved during the paddy cycle of operations; and (5) the increasing population build up in the area and the concomitant increase of population pressure on the limited land area.

Paddy production uses a substantial amount of water. The Mwea was designed and constructed to be in perfect balance for proper water flow in a manner similar to the intricate construction of a spider's web. Thus, if you alter or change one or more parts of the system, this unavoidably affects the whole system. A case in point is the Karaba Section.

At Mwea, the typical drainage pattern for an individual holding is a separate inlet and outlet to each holding, in order to simplify water control.

IRRIGATION HOLDING LAYOUT



Paddy under irrigation requires close control of water levels; this is imperative if high yields are to be obtained. For example, I noted that on a paddy holding a soil level variation of just a few inches can make a considerable difference in yields. The irrigation engineers who created the Mwea Irrigation System were fully cognizant of this delicate balance. R. Chambers states it has been agreed by experienced irrigation engineers that there is more irrigable land in Kenya than there was water to irrigate it. A prime consideration in designing an irrigation system must be economical use of water. The most economical way to apply water in Mwea was by running it down drains or furrows. In order to ensure even application of water on the holdings, these furrows should lie on planes, the system being known as "the incline plane system of irrigation" (Chambers, 1967).

Water in sufficient quantity and available at the correct time is vital to the Mwea Operation. Other factors having a limiting effect on land use in Mwea are: maintaining a botanically disease-free area for paddy production; entrepreneurial expertise of the Field Extension Staff; maintaining available marketing channels and a market for rice; and higher productivity through the use of improved seed varieties.

Future developments in irrigation and land use in the Mwea are very closely tied to success in soil and water conservation. There is increasing need for the MIS Management to carry out programmes of water and soil conservation. It is also imperative for the MIS Management to assess the impact of spreading alkaline conditions in each section, unit, and holding in the MIS. Looking ahead, alkalinity and the shortage of water will be major constraints to maintaining the current high paddy yields and production.

Cultivation of paddy is organised on individual tenant holdings. Basically, each holding consists of 4 acres of paddy divided into 4 equal parts. Within each holding is a permanent nursery of 1/6th of an acre from which seedlings are transplanted on the remainder of the holding. Seedlings grow for 4 weeks before being transplanted, around the end of August, in time for the short rains; the paddy crop matures in about 5 months altogether. Experiments with a long rains crop have produced yields only 60 per cent as high as those of the short rains season. A possible explanation of this difference in yield is because of low temperatures and lack of an adequate amount of sunshine for proper tillering of the grains during the long rains ripening period. The MIS Management, through trial and error, decided that such yields are not worth the extra effort and organisational problems involved in double-cropping of paddy.

The *International Land Development Consultants* (1971, 35-36) elaborate on the problem of double-cropping of paddy in the Mwea as follows:

> Experience on the MIS has shown that the main season for growing rice is August/September to January/February in view of the favourable temperatures and amount of solar radiation in the months of November, December and January, being 575, 651, and 658 cal./cm^2/day respectively. The main crop is harvested in December - March.
>
> Sindano - the only rice variety used for commercial planting so far - requires about 120 days to mature after transplanting. Hence, transplanting must be done between mid-August and the end of September. In view of the water requirements of this crop an extended transplanting period would be desirable. This is, however, hardly possible, since the mid-August transplanting corresponds with the mid-December harvesting at the end of the rains and the last transplanting date corresponds with the onset of the rains in March.

> So far, little experience has been gained with the rice growing in the off-season. At Mwea it has been observed that Sindano yields far less in the off-season than in the main season. This may be attributable to the lower solar radiation in the months of May, June and July of 547, 479, and 380 cal./cm^2/day respectively combined with daily temperatures which then tend to be below optimum.

Pests and paddy diseases have posed few serious problems at Mwea. On occasion, paddy crops have suffered from the depredations of Quelea birds, but aerial spraying has prevented major difficulties. Control measure have also been successful against other pests such as moth borer and leaf miner.

Field cultivation is carried out by a fleet of 24 tractors. Mechanical cultivation (rotovation or "puddling") is efficient and also ensures that the paddy crop is planted on schedule, thereby normally giving better yields. Weeding, reaping, threshing, and winnowing are all carried out by hand by the tenants and their families. Many tenants employ hired and/or casual labour to help with these tasks. On average, the cost of hired and/or casual labour during the 1972/73 harvesting operations was 70 Kshs. per acre. This use of hired and/or casual labour is important since it alleviates the severe unemployment situation in the Central and Eastern Province of Kenya. Seeds and fertilisers are obtained through the MIS Management Organisation. Processing of paddy takes place in the Mwea Rice Mills Ltd., which began operations in January 1968 and has been enlarged substantially during the last 6 years. Mwea Rice Mills Ltd. is jointly owned by the NIB and the Mwea tenants, with a 60 per cent and a 40 per cent ownership respectively. The entire paddy production is sold by the NIB to the Maize and Produce Marketing Board.

During the 1973/74 season there were 3,020 tenant farmers living in Mwea. The tenants were located in the following five Sections: Tebere 624; Mwea 593; Thiba 634; Wamumu 563; and the newly formed Karaba Section 606.

The sole criterion for admission to tenancy in Mwea is landlessness. Most of the tenants are of local origin and come from the nearby Kirinyaga District. Land in the Mwea is obtained under annual licenses, automatically renewable, provided the tenants show reasonable competence in their paddy operation. Unsatisfactory tenants may have their tenancies terminated.

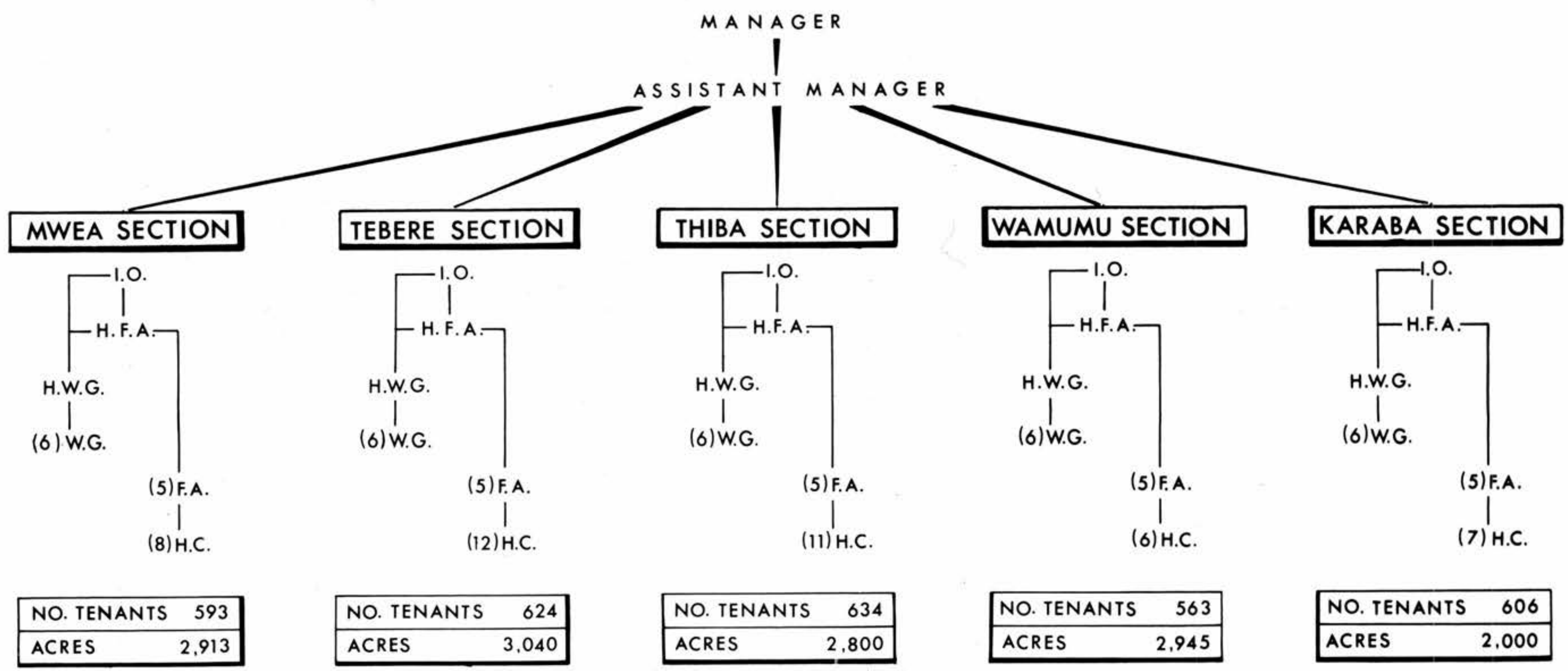
Mwea is a hybrid of plantation agriculture and successful smallholder farming under centralised control and close supervision. Mwea started from scratch in 1955. It is important to keep in mind, from a historical point of view, that Mwea went directly to a cash crop agriculture without going through the sequential process from subsistence to a market agriculture. Mwea has been extremely successful over the past decade because of a high degree of expertise and management, discipline, and close supervision. In short, this is what differentiates Mwea from other Settlement Schemes. Through vertical and horizontal integration Mwea has associated the farmers to the processing of paddy. It has also associated the tenants to the milling process and gives the tenant an additional income as a shareholder in the Mwea Rice Mills Ltd. Dividends are passed to the tenants as shareholders in the Mwea Rice Mills Ltd. Mwea is an example of the efficiency of centrally directed agriculture. The availability of water and the excellent black cotton soils set the stage for irrigation.

The standard field size is one acre, surrounded on four sides by bunds between 3 and 4 feet in height (Photo. 3.1) and bordered on two sides by quite deep drains or furrows. The holdings are rectangular, with a width to length ratio 1:4 and water courses are at right angles to the long axis of the field. The black cotton soil on which the paddy is grown is a grumosol, which is moderately permeable to water. No crop rotation is practised on the irrigated tracts of the scheme.

CYCLE OF OPERATIONS IN PADDY PRODUCTION

The field operations of the MIS are characterised by a division of work between the Management, Field Extension Staff, and the tenants (Fig. 6.1). All phases of paddy production are under close supervision of the Field Assistants (Photo. 6.2). Each Field Assistant has approximately 600 acres and 150 tenant farmers under his direct supervision. The impact of the Field Assistant on the tenants under his direction is considerable. During the survey I became very conscious of the importance of the Field Assistants in the effectiveness of the tenants' output and efficiency of paddy production. There are 5 Head Field Assistants and 25 Field Assistants in the Mwea Operation (Fig. 6.1). I personally interviewed all Head Field Assistants and Field Assistants at Mwea; all these individuals could speak English

ORGANISATION STRUCTURE IN MWEA IRRIGATION SCHEME 1973/74 SEASON



I.O. = Irrigation Officer, H.F.A. = Head Field Assistant, H.W.G. = Head Water Guard, W.G. = Water Guard, F. A. = Field Assistant, H.C. = Head Cultivator.

(Nos. shown in brackets = number in post)

Source: Field Enquiry, 1973

FIG. 6·1

PHOTO. 6.2: MEETING WITH AN IRRIGATION OFFICER AND FIELD ASSISTANT AT A TENANT'S HOLDING, THIBA SECTION

The author is discussing paddy farming problems with the Irrigation Officer and Field Assistant.

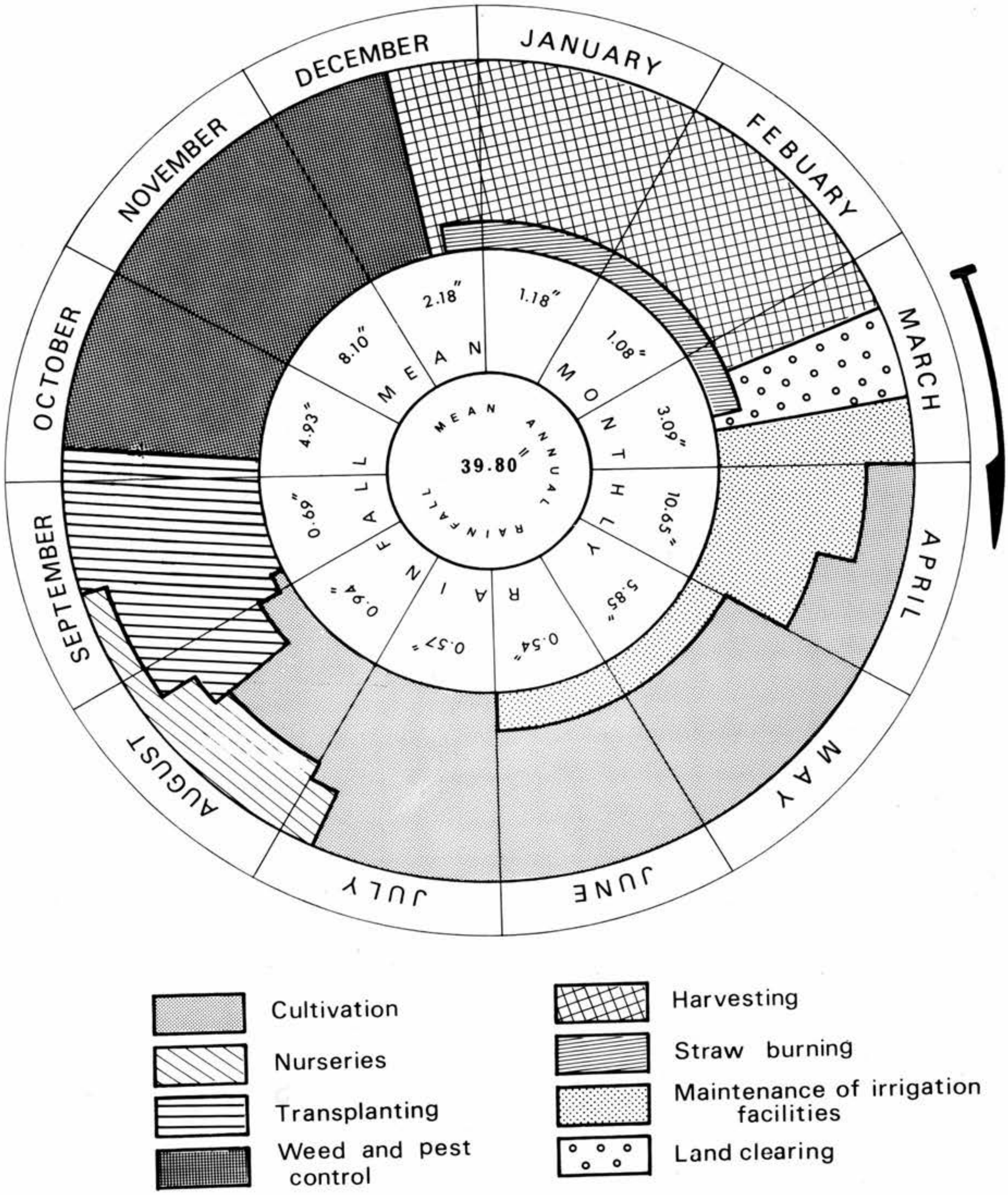
Tenants are under the close supervision of the Field Assistants who are directly responsible to the Irrigation Officer in each section. The Field Assistant plays a key role in the daily operation of the Mwea.

A banana tree appears on the left. Bananas are an important fruit in the tenants' diet, and clusters of trees grow in certain areas in the Settlement.

adequately.

The Gezira Scheme in the Sudan was initially used as a prototype for Mwea. The production and marketing of paddy in the MIS are characterised by a hierarchical superstructure and a division of work between the Management and the tenants. Figure 6.2 shows a schematic calendar of paddy operations during the season. On average, there are approximately 150 days during the year when the tenant is free of paddy farming work. There are 2 critical periods in the cycle of operations when great pressure is placed on the tenant, his family, and his labour force - the harvesting and transplanting operations.

Mechanisation, the use of tractors for rotavation, makes it possible for the MIS Management to perform field operations simultaneously on an established, organised, and programmed basis. Thereby all major operations, such as transplanting and harvesting, take place at approximately the same time period. Therefore, within the mechanised operations cycle, the tenants are constrained to carry out synchronically the successive operations of: maintenance, cultivation, preparing nurseries, sowing seeds, tending nurseries, transplanting seedlings, weeding, scaring off birds, pest control, harvesting, threshing, bagging the paddy, and straw burning. Thus through mechanisation, the harvesting and transplanting operations of the paddy cycle are synchronised. By synchronising the periods of paddy land use and production all operations take place during separate periods of the cycle of operations (Fig. 6.2). The MIS Management performs the following operations: (1) using tractors for rotavation in field preparation;



CYCLE OF OPERATION AND ANNUAL PADDY PRODUCTION

(Source :- Mwea Irrigation Settlement)

FIG. 6·2

(2) transporting the bags of paddy from the holding to the Reception Centres; (3) drying, cleaning, measuring the moisture content, and weighing the paddy at the Reception Centres; (4) transporting the bags of paddy, which are ready for milling, from the Reception Centres to the Mwea Rice Mills Ltd.; and (5) cleaning and maintaining the two major canals.

All other tasks are the responsibility of the Mwea tenants which include: (1) cleaning and maintaining the unit feeders, main and minor drains; (2) preparing the paddy holdings for rotavation after the harvest is completed; (3) preparing the nursery and the seedling beds; (4) transplanting the seedlings from the nursery to the paddy holdings; (5) weeding the paddy holdings; and (6) harvesting the paddy.

First phase of cycle - Maintenance of paddy holding

The work performed during this phase is the sole responsibility of the tenant. The Field Assistant is responsible for seeing that the tenant performs these tasks in a satisfactory manner. On average, a total of 48 man days are allocated to this phase of work (Fig. 6.2). The principle tasks performed are: (1) maintaining feeder drains (8 man days); (2) maintaining the drain site (12 man days); (3) cleaning the holding (16 man days); and (4) performing communal tasks (12 man days). After straw burning is completed (Fig. 6.2), the tenants of each section clean and restore the feeders and the bunds of their holdings so that the flow of water from the drains will not be impeded. This is good crop hygiene in paddy farming and is directly related to good yields.

The tenants clean their paddy holding of extraneous materials by straw burning. This is essential for cleaning the fields of weeds and other undesirable materials. The question arises: why burn the straw? Why not plough it under as a mulch to help rejuvenate the soil? Through trial and error at Mwea it has been proved that if the straw were to remain on the field to serve as a mulch, this would then require two cultivations. It would also be necessary to use heavy equipment to cultivate the fields. This would tend to upset the level of the field and also encourage pot holes.

The tenants also perform communal tasks involving cleaning and installing unit feeders, major and minor drains, and cutting weeds off the banks and bunds. The Head Cultivator is responsible for the communal tasks of each section. The work during the maintenance phase is performed during half of March and occupies about 25 days in April and 10 days in May and June (Fig. 6.2). During March to May the MIS Management has the canals cleaned and repaired by labourers from the Thiba Works Camp.

Second phase of cycle - Mechanical cultivation

The mechanical cultivation programme starts at the beginning of April and terminates in September. Hence the tractor rotavation (Photo. 6.3) work is spread out over a period of 5 months (Fig. 6.2). From May to July 90 per cent of the work in the MIS is connected with rotavating paddy fields in each of the 5 sections based on an established schedule of operations announced well in advance by the MIS Management.

PHOTO. 6.3: TRACTOR ROTAVATION

The process of "puddling" the black cotton soils under four inches of water by using a hydraulic rotavator attached to the back of a Massey-Ferguson 135 tractor. In the foreground is located a nursery bed with ratoon sprouts and weeds.

Tractor rotavation starts at the beginning of April and terminates in September. The daily output of rotavation per tractor was 1.46 hectares in 1973. There are 24 tractors equipped with rotavators in the Mwea.

It was observed that the normal vegetative cover of the paddy fields at the time of cultivation consists of a mixture of ratoon sprouts of the former crop, together with some grasses and sedges. The average height of the vegetation is from 1 to 2 feet at this time of the year. Straw from the previous harvest is spread and burned, as it has been found otherwise to impede operations by wrapping around the rotavator. The field is flooded to a depth of 4 inches before rotavation begins (Photo. 6.3). Control of depth is most important. Too little water leads to impeding the rotavator, filling in the tractor wheel treads and bogging down of the tractor in the muck. An excess of water reduces the mixing effect of the rotavator and impedes adequate incorporation of the vegetation in the "puddling" process. Optimum results are obtained by restricting the period of time the land is flooded prior to cultivation to not more than 72 hours. Submergence for longer intervals causes serious bogging down of tractors. The success of the rotavation operation depends basically on the propelling effect of the rotavator (Photo. 6.3). The tractor would be quite incapable of pulling the dead weight of the hydraulic rotavator through the heavy and wet black cotton soil. To obtain the maximum propulsion from the rotavator, the field has to be in optimum condition, with a minimum of sink holes and loose soil which cause the tractors to become bogged down. I observed that on several different occasions when the tractors were stuck in the muck and unable to move, the driver continued to try to drive the tractor and rotavator out of the muck and mire. This was impossible. After 10 minutes of this nonsense the clutch can burn out. If he had been properly trained in preventive maintenance a driver would have notified the Irrigation Officer of the Section of the need for another tractor to pull him out. This would have saved the tractor for another job. There is great need for a tractor training programme for drivers in the MIS.

Access to the area of work in the MIS is by the interfield access roads (Photo. 3.2). These roads are constructed of crushed stone, from the nearby rock quarry, mixed with the black cotton soil. Interfield roads are very rugged and dangerous; they often have rock outcrops protruding, or hidden in the grass. These roads are also extremely dangerous when wet as vehicles may skid quite easily. However, interfield roads, located between 2 drains, are capable of carrying 4 wheel drive vehicles throughout the paddy season. From my personal experience I found that when the black cotton soils or the red soils are wet they are extremely slippery and very dangerous to drive on without a 4 wheel drive Land Rover. All fuel and service vehicles use these interfield access roads. Tractors move into the paddy fields by crossing the drains on portable bridges. The latter are also used to move over the bunds. The bridges are constructed of 3 inch x 2 inch angle-iron and are 10 feet long and 2 feet wide. Cross members are 9 inches apart. When in use in the field the bridges weigh about 200 pounds and can be moved easily by 6 tenants. A pair of bridges is required for water channels and 2 pairs for getting over bunds, one for ascent and one for descent. The MIS Manager stated that experience has shown that a tractor fleet of 6 tractors constitutes the optimum working unit. Larger fleets are too widely spread out for proper supervision and smaller numbers of tractors used are overloaded with administrative and service overhead costs. There are 24 tractors equipped with rotavators in the MIS.

Rotavation of the fields begins in early April and is completed by mid-September (Fig. 6.2). Preparation of the paddy fields is done by hydraulic rotavators which are mounted on the back of Same and Massey Ferguson-135 tractors (Photo. 6.3). During the 1972/73 season the daily output of rotavation per tractor was 1.46 hectares (Table 6.1).

TABLE 6.1

MWEA IRRIGATION SETTLEMENT: MECHANICAL CULTIVATION STATISTICS 1960/61 - 1972/73

Season	Tractors number	Production Total Hectares	Production Mean ha./ Tractor/Day
1960/61	6	637	-
1961/62	11	2,005	2.15
1962/63	11	1,977	2.26
1963/64	11	2,227	1.79
1964/65	13	2,169	1.28
1965/66	15	2,486	1.18
1966/67	18	2,837	1.61
1967/68	18	3,170	1.44
1968/69	18	3,441	1.53
1969/70	19	3,788	1.51
1970/71	23	4,311	1.38
1971/72	24	4,660	1.42
1972/73	24	4,766	1.46

Source: *National Irrigation Board Annual Report*, 1974

The tenants must be in their fields during the mechanical cultivation phase to perform certain tasks by hand, such as hauling the metal bridges used in moving the tractors from field to field.

Third phase of cycle - Levelling

After the rotavation operation, the fields are levelled by use of a long spiked board and the use of 4 oxen to pull the levelling board over the entire field (Photo. 6.4). It is the tenants' job to level the rotavated fields in such a way that the water-level is the same throughout the paddy field. Levelling is a very important and necessary operation in crop hygiene and paddy production. On average, the operation of levelling the paddy holding takes approximately 24 man days of work. The cost of levelling varies between 30 - 40 Kshs. per acre. The paddy fields are kept under 4 inches of water (Photo. 6.4), which tends to inhibit the growth of weeds. However, I observed that without systematic weeding maintenance the ratoon sprouts and weeds begin to show within 5 to 6 weeks.

Fourth phase of cycle - Preparation of nursery

Permanent, individual nurseries of 1/6th of an acre are constructed in each holding in the MIS (Photo. 6.5). Nurseries are cultivated manually with hoes and rakes. This task of nursery preparation is made easier when the nursery is covered with 2 to 3 inches of water. The nursery is then levelled with a long board in a meticulous manner similar to levelling wet concrete (Photo. 6.6). A thin film of water is left on the surface

PHOTO. 6.4: LEVELLING A PADDY FIELD

After rotavation, the fields are levelled by means of a long spiked board, and four oxen are used to pull the levelling board over the entire field. It is the tenant's job to level the fields, after "puddling", in such a way that the water level is the same throughout the field. Levelling is very arduous work and is a highly important and necessary operation. It is essential to obtaining good yields.

PHOTO. 6.5: A TYPICAL PADDY NURSERY WITH SEEDLINGS, MWEA SECTION

The nursery is planted in early July and transplanting of the seedlings takes place in mid-August. Permanent individual nurseries of 1/6th of an acre are constructed in each holding in the Mwea Irrigation Settlement. The nursery is divided by four separate strips which can be seen in the photograph as faint horizontal lines across the nursery. The tenants use the strips as paths to approach the nursery without having to trample on the seedlings.

PHOTO. 6.6: A TENANT'S WIFE LEVELLING THE NURSERY IN PREPARATION FOR SEEDING

The nursery occupies a corner of the paddy holding; it is cultivated manually with hoes and rakes. The nursery is then covered with a two inch film of water and levelled with a long board in a meticulour manner. This is a very important operation before broadcasting the pre-germinated seed. The Irrigation Officer from the Tebere Section is inspecting the levelling operation.

before systematically broadcasting the seeds. The tenant receives from the MIS Management 40 pounds of seed per acre 3 days prior to sowing. The seed is grown by the Mwea designated seed propagators, i.e., tenants who have been selected by the MIS Management. The seed propagators obtain their seed from the Mwea Research Station (Fig. 4.3).

It is important to note that the seed is broadcast in the nursery in a very systematic manner and is sown in four separate strips (Photo. 6.5). Each strip can be approached from 4 sides without having to trample on the seedlings (Photo. 6.5). All operations in the nurseries are carried out from the bunds or from the unsown strips between the 4 seeded areas. Dividing the nursery into 4 sections (Photo. 6.5) makes it easier for the tenant to plant all his fields evenly. Shortage of seedlings happens only rarely. Sixty pounds of ammonium sulphate is blended with the top layer of the soil in the nursery before broadcasting the seed. The seed is pre-germinated and is sown systematically through a thin film of water of about one inch on the surface of the nursery bed. Water is added repeatedly and with care as it is needed. While growth of the seedling continues the water level of the nursery must be raised but the seedlings must never be covered. The first 2 - 3 weeks is a critical period in the life of the seedlings. Small seedlings particularly are in great danger from large birds, namely Herons, Crested Cranes, and Egrets, walking in the nursery, and small birds, primarily ducks, that eat the young seedlings. Seedlings are ready for transplanting after 4 to 5 weeks, depending on the prevailing weather. Dull, overcast skies, with occasional showers, for the first 10 days, followed by bright, sunny weather for the remainder of the time in the nursery, has proved the most effective climatic combination. Nurseries are sown between the end of July and as late as mid-September.

On average, preparation and planting of the nursery and care of seedling beds requires approximately 30 man days of labour. During August about 60 per cent of all the work in the MIS is directed to the nurseries. In September about 10 per cent of the work effort is devoted to nurseries (Fig. 6.2).

Fifth phase of cycle - Transplanting

Transplanting the seedlings is performed about one month after sowing the seeds in the nursery (Fig. 6.2). The transplanting task is one of the most important and demanding operations in the paddy cycle. It is imperative that transplanting be performed very quickly, generally well within a fortnight. Just before transplanting begins, a dressing of 112 pounds of superphosphate (40 - 42 per cent P_2O_5) and 112 pounds of 40 per cent ammonia sulphate ($(NH_4)_2(SO_4)_2$) is broadcast on each acre of the holdings. Trials from the Research Station have shown significant results from such a rate of fertilisation and the response from tenant holdings has been substantial. It was observed that a considerable number of tenants in the Mwea and Tebere Sections apply *boma* manure (Photo. 6.7) obtained from farm contacts in the up-country. The MIS does not provide *boma* manure or transport it to the Settlement Area. Since the nearest source of *boma* manure is

PHOTO. 6.7: A TENANT FARMER HAULING BOMA MANURE TO HIS HOLDING

Most of the high-yielding tenants at Mwea use boma manure to rejuvenate the soils of their holdings. This manure is obtained from up-country near the Mwea; and, on average, increases yields from 5 to 10 bags per acre.

located about 20 miles from the Mwea, the logistics of moving large quantities required for even a small basic dressing of 2½ tons per acre are considerable. However, the interviewed tenants who use this manure receive, on average, an increase of 5 to 10 bags of paddy per acre. The use of this manure is indeed worthwhile in the Mwea and Tebere Sections.

The transplanting operation, on average, requires 70 man days to complete. The average cost of hired and/or casual labour to help perform this task was 50 Kshs. per acre in 1973. Transplanting begins after mid-August and is completed by the end of September (Fig. 6.2). Approximately 20 per cent of the total work performed in August is transplanting; however, over 90 per cent of the work performed in September is devoted to transplanting. I observed that because of the considerable number of hours needed for transplanting, the tenants' household labour force is mobilised for this assembly-line type of work. Many tenants use hired and/or casual labour to assist the family force in speeding-up the task (Photo. 6.8). All local primary and secondary schools are closed during the transplanting period. Trials at the Mwea Research Station have shown that the Sindano variety responds well to close spacing. The trials indicated that optimum results were obtained using single plants per hole at a spacing of 6 inches. The MIS recommended planting distance for the tenant is 4 inches by 4 inches. Experience at the MIS has shown that whatever recommendation is made the tenant tends to make his own personal interpretation. The 4 inch spacing is

PHOTO. 6.8: A TYPICAL TENANT'S FAMILY TRANSPLANTING SEEDLINGS

The seedlings are obtained from a contiguous nursery. Transplanting requires approximately 10 days to complete a 4-acre holding with paddy seedlings which are planted 4 inches apart. Transplanting is one of the critical periods in the paddy production cycle. Most of the tenants use hired and/or casual labour to perform this task as well as all the available members of the household. During the transplanting operation the schools are closed so that the children can help with transplanting the seedlings.

advocated in the hope of getting the 6 inch spacing which is really wanted. Transplanting takes place at a water-level in the field of about 2 inches (Photo. 6.8). The seedlings are pressed only far enough into the soil to get a firm foothold. All seedlings are planted in a systematic alignment across the one acre fields by use of a string, which serves as a guide for planting. Four days after transplanting, the water-level in the fields is raised slightly to about 3 inches. Care is taken not to float out the new plants. Once the plants are well established, water in the fields is raised to a depth of between 4 to 6 inches and maintained at this level for the remainder of the growing period. It was observed that in properly levelled fields water was not allowed to stagnate; a very gentle, nearly imperceptible trickle from the feeder to the drain is maintained throughout the paddy crop's life. The discipline and distribution of water is entirely in the hands of the MIS Water Staff. The fields are drained when a majority of the panicles have bent over. The flowering of the paddy takes place about 2 months after transplanting the seedlings.

It is important to note that when fresh water is supplied to the fields from the drains it often brings new salts and also lowers the temperature of the water in the fields. This is particularly important during the growing months of November/December. Also if the short rains during October/November are above normal in amount, then water must be drained off from the fields accordingly. Periodically, excessive short rains destroy the tillering of the plants and produce a resultant drop in paddy yield and output.

Scaring and beating birds off the nursery, and later the transplanted paddy fields, begins in early August and extends into November. In most fields scarecrows are placed to distract birds from invading the nursery and fields.

Sixth phase of cycle - Weeding and pest control

The tenants begin weeding and apply pest control measures about a month after transplanting. If the tenant performs the task of weeding properly and at the correct time then a second weeding task is generally not necessary. The timing of weeding and completing the task as quickly as possible is extremely important at this early stage in the growing cycle. During the weeding operation (Photo. 6.9) the water is not drained off the fields.

Pests which are often found in the fields are leaf sappers, leaf curlers, and different species of the rice stem borer. A 25 per cent solution of DDT is used for spraying once or twice during the growing period to control pests. Chemical pest control is the responsibility of the MIS Field Extension Staff. Weeding and pest control are performed during October continuing into mid-December (Fig. 6.2).

It was observed that during the cultivation period an excess of weed flora and ratoon from the previous crop was very evident in many of the fields (Photo. 6.9). This condition is serious and exists due to dereliction of duty of maintaining good crop hygiene in the fields. I also observed a rapid spread of

PHOTO. 6.9: A TENANT'S WIFE WEEDING A PADDY FIELD

A major drain appears on the right. Weeding is a very important operation in the paddy production cycle and directly affects paddy yields. Proper weeding at specific periods is good crop husbandry and crop hygiene necessary to obtain high yields. The Mount Kenya Range appears in the background. Mount Kenya is the second highest peak in Africa, rising to 17,058 feet.

the spreading weed *Typhanangustifolio* in some of the drains which had not been cleaned properly and also in waterlogged areas. In holdings where the Field Assistant had exercised supervision and discipline weeds were not a problem. Crop hygiene depends on how hard-working the tenants are and how they co-operate with the Field Extension Staff. The Field Assistant is the key factor to the successful operation of the units in the Mwea superstructure. It was observed that a significant factor in controlling weeds in the holding is maintaining the correct water-level of about 6 inches in the fields. If the fields are not covered properly with the required amount of water after rotavation, then weeds and ratoon will grow rapidly (Photo. 6.9). Maintaining the correct water-level in the fields, at all times, is the direct responsibility of the Head Water Guard and the Water Guard assigned to specific units.

Attempts at chemical control of weeds have been disappointing and have proved very expensive. Weeding-out the old ratoon sprouts is an ever-present problem after rotavation.

Sporadic attacks of leaf miner, army worm, and grasshoppers were observed in the nurseries; however, they are controlled effectively by spraying with 25 per cent DDT. The only hazard of any major significance encountered at Mwea has been the Sudan Dioch (*Quelea ethiopica)*. Considerable loss in yield was caused in the 1960 crop. No trouble has been caused by the Sudan Dioch bird since destroying their breeding grounds in Tanzania in the 1960's. In general, the Mwea is a disease-free area for paddy production.

Seventh phase of cycle - Harvesting

Harvesting is the final and most important phase of the cycle of operations. This task is most critical and important for the tenant as this represents his reward for months of labour during the season.

The harvest cycle begins in late December and is completed by early March (Fig. 6.2). All harvesting is manual. A fortnight before the schedule for harvesting, the water is completely drained off the paddy fields. During the 1972/73 season harvesting began on December 22nd and was completed by March 15th. On average, the harvesting operation requires about three weeks to complete a 4 acre holding with 4 people working full time, or 80 man days of labour. During the past several seasons the MIS tenants have been faced with a severe shortage of available labour during the harvesting operation. This is a very serious problem for the MIS Management. Due to the lack of available labour from up-country, many of the fields had over-dried paddy with a high percentage of broken grains. On average, the tenants pay hired and/or casual labour 70 Kshs. per acre during harvesting.

The tenant cuts his paddy crop with a machete and threshes it by beating the heads on the ground. The grain is manually winnowed in the field and bagged in burlap sacks and placed at the edge of the field. The MIS Management provides transport by lorries to bring the paddy to the Reception Centres. The lorries belong to a company, Kirinyaga Transport Company Ltd., the majority of whose shareholders are tenants in the MIS. The

PHOTO. 6.10: PADDY STORED IN BURLAP BAGS IN THE MWEA RICE MILLS LTD. WAREHOUSE

During the 1972/73 season there were over 350,000 bags of paddy weighing 160 lbs. per bag, stored in the Mwea Rice Mills Ltd. Warehouse located in the Mwea Irrigation Settlement. The current storage capacity of the Mills is 450,000 bags of paddy.

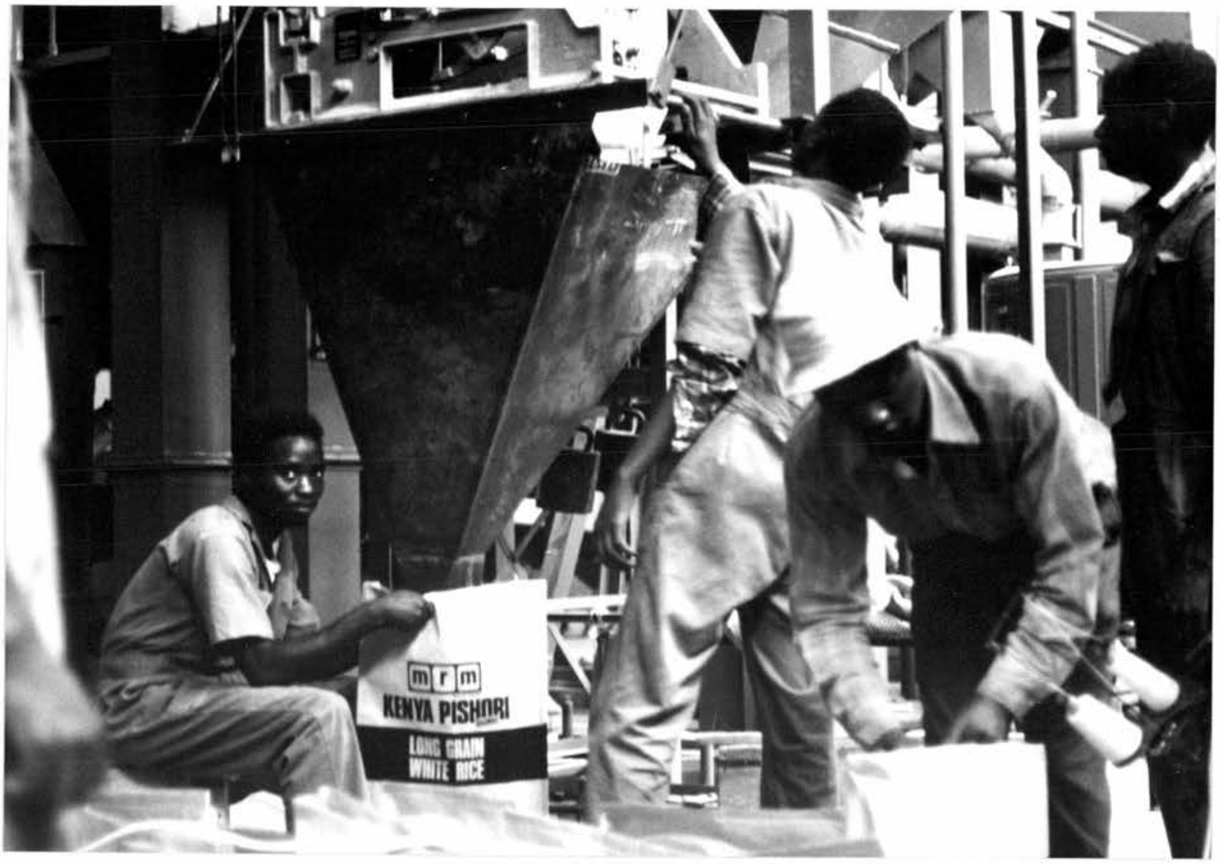


PHOTO. 6.11: BAGGING MILLED RICE AT THE MWEA RICE MILLS LTD.

The major variety of rice grown at Mwea is Sindano. However, during my field enquiry and visit to the Mwea Rice Mills Ltd. I observed that Basmati variety, obtained from the Ahero Scheme, was being milled. During the 1973/74 season the Mwea Management decided to use Basmati variety in the Thiba Section for the first time in the history of Mwea.

tenant loads and unloads his paddy and is present at the time it is weighed at the Reception Centre. The tenant receives a printed slip from the Reception Centre indicating the number and weight of bags he has delivered. The paddy then becomes the responsibility of the MIS Management.

At the Reception Centres all paddy is graded for moisture and rice content. The latter is merely a check to ensure that tenants are using the pure seed issued to them and are not using ratoon seedlings. Every effort is made to get the tenants to cut paddy with a moisture content between 16 and 21 per cent, in order to avoid sun-cracking in the fields. Grain with a moisture content of over 20 per cent is dried in the artificial dryers, the remainder being sun-dried on the concrete drying floors in the Reception Centres.

During the 1972/73 season a total of 200,268 bags of paddy, or 53 per cent of the total received, was sun-dried on the drying floors of the Reception Centres; 4,002 bags, or 1 per cent, was dried artificially; the remaining 46 per cent was received dry from the fields.

After drying, the paddy is cleaned and bagged in burlap sacks, to the standard commercial weight of 160 pounds (Photo. 6.10), with a moisture content of 14 per cent. The grain is then transported from the Reception Centres by lorries to the Mwea Rice Mills Ltd. for milling (Photo. 6.11), and then shipped by lorries to the Maize Marketing Board at Sagana, approximately 12 miles from Mwea, which buys all the Mwea milled rice at a Government guaranteed price. All the labour involved in drying and bagging the paddy and transport is supplied by labour contractors, paid by the bag by the tenant. The MIS Field Extension Staff is responsible only for technical jobs and supervision. This has been found to be the most economical and efficient way of dealing with the handling of the paddy crop.

SEASONAL OPERATIONS OF MWEA MANAGEMENT

The normal operations of the MIS Management are carried out throughout the year with an organisation of labourers, technicians, and administrative staff (Table 6.2) as to the maintenance of tractors, rotavators, mechanical equipment, improvements and repairs to the inter-field roads, bridges, canals and drains. The Field Extension Staff members and tractor drivers are also employed on a permanent basis by the MIS Management.

The MIS provides the tenant with seed, fertiliser, insecticides, twine, and burlap bags. All of these inputs are charged at cost plus handling to the tenants. Similarly, charges are made for services, such as mechanical cultivation and crop handling. In addition to paying for these inputs and services the tenant is charged an annual water rate of 200 Kshs. per acre. The rate covers the cost of indirect services such as the maintenance of canals, building structures, roads, and the administrative overhead of the MIS.

All charges are debited to the tenant's account and collected from the proceeds of his crop. The incidence of bad debts in the MIS has been exceedingly small over the years.

TABLE 6.2

MWEA IRRIGATION SETTLEMENT: STAFF ESTABLISHMENT, 1973/74

Senior Staff		Junior Staff	
Manager	1	Head Field Assistants	5
Assistant Manager	1	Field Assistants	25
Accountant	1	Clerks	17
Irrigation Officers	5	Pest control clerk	1
Work Superintendent	1	Artisans	11
Senior Foremen	2	Mechanics	5
Senior Technical Assistant	1	Chargehands	4
		Tractor supervisors	4
		Drivers	27
		Weir Recorder	1
Total Senior Staff	12	Total Junior Staff	100

Subordinate Staff		Extension Junior Staff	
Head Water Guards	5	Levellers	2
Water Guards	30	Clerk	1
Watchmen	18	Drivers	19
Headmen	6		
Sweepers	7		
Labourers	40		
Tractor Mechanics	2		
Total Subordinate Staff	108	Total Extension Junior Staff	22

Grand Total: 242

CHAPTER 7

AGRICULTURAL RESEARCH AND FIELD EXTENSION STAFF AT MWEA

AGRICULTURAL RESEARCH

The Research Station at the MIS is located in the Thiba Section, Unit 2 (Reference Map). The major research effort at the Research Station is concentrated, to a large extent, on the search for suitable and higher-yielding replacements for the Sindano rice variety, the standard variety used in the MIS. Of the 11 varieties of rice seed tested during 1973, 9 have higher yields than Sindano including 3 IRRI* selections. Most of the high-yielding varieties have an appreciably longer maturation period than Sindano and in many cases an inferior grain quality. However, at least two of the promising IRRI selections have given characteristics which compare favourably with Sindano.

An interesting research finding was made during 1973 concerning the use of nitrogen fertiliser. If it is applied in a split dressing, then the second application should be made 42 days after transplanting. This coincides with panicle development of the paddy; trial results with Sindano variety indicate that this timing will result in the most efficient use of nitrogen in terms of boosting grain rather than straw yields. In addition to

* International Rice Research Institute

experimentation with rice varieties, experimentation with soya beans was started as an alternative crop, or possibly for use in rotation with paddy. The initial results are encouraging with soya bean yields in excess of 2 tons per hectare.

In addition to agronomic studies, the Research Station continues to be responsible for producing the foundation Sindano seed required by the MIS paddy crop together with the supervision of the bulking of Basmati seed for one section in the Mwea and the Ahero and Bunyala Schemes. Spacing and fertiliser trials on rice continue to be an important function at the Research Station.

C.E. Kellogg (1962, 5-6) writes:

> Every productive hectare of arable soils in the world has at least four basic conditions, resulting from either custom or planning. If the practices for any one are neglected we can expect little from practices that may take care of the others. And each unique kind of soil requires a unique combination of practices for the best results. These four basic conditions are:
>
> A balanced supply of plant nutrients for high yields. For economical results, chemical fertilizers are nearly always necessary to supplement the supplies of one or more of the nutrients within the soil and of those contributed by compost, crop residues, manures, and green manures. At least some chemical fertilizers are needed on nearly all arable soils, and they are especially critical in the tropics.
>
> Adequate moisture in the rooting zone of the soil when the plants need it, without the waterlogging that deprives roots of air. An ideal soil holds abundant water and lets the excess drain on through. Few soils have a combination of characteristics and associated climate for ideal water control. Some need

shaping, diversions, or terraces (bunds) for runoff control; some need irrigation; others need drainage; and many need a combination of two or more of these.

A variety of crop (or varieties of several crops in rotation or in mixed culture) adapted to the environment and with the genetic potential to respond to the most favourable arable soil that it is practicable to develop.

Protection of plants (and of animals for which the crops may be grown) against pests and other hazards.

Some potential arable soils also need protection from the sea, mountain torrents, runoff from heavy rains, floods, and high winds.

Recently great emphasis has been given to the critical role of chemical fertilizers in food production in the newly developing countries. The need is very great. But fertilizers are economically effective only if, (1) the correct kinds and amounts are used for each local kind of soil and, (2) the needed practices to meet the other requirements for good harvests are adopted at the same time. Nor will irrigation be successful unless a good job is done of shaping the surface and of avoiding water-logging, and of meeting the other three conditions.

Experimentations

In significant experiments in 1973 at the Research Station, 49 varieties of rice were tested to determine their yield potential (Table 7.1). The rice varieties included were all varieties whose seeds were bulked during 1973 at the Research Station. In this experiment, there were 20 rice varieties which had higher yields than Sindano. During 1974 more research will be directed on IR 665-29-2, IR 579-48-2, and IR 22. These rice

TABLE 7.1

MWEA IRRIGATION SETTLEMENT RESEARCH STATION,
RICE VARIETY TRIALS, 1972/73

Variety of Rice	Yield in kg./ha. Grain	Straw	Grain/ Straw Ratio	Grain 1000 grams	Growing Period Days
Taichung Native 1	8,250	5,861	.71	26.2	167
IR 532-1-33	7,977	6,415	.80	23.5	178
Sindano 0/606	7,900	9,231	1.17	23.7	178
IR 665-29-2	7,893	7,722	.98	29.4	178
Afaa Mwanza 1/159	7,860	9,812	1.25	29.7	178
Afaa Kilombero 0/906	7,707	10,917	1.42	28.2	178
IR 20	7,617	7,259	.95	20.7	170
Kahago 1/146	7,463	9,537	1.28	28.8	178
IR 8	7,453	7,450	1.00	31.0	178
YRL 1	7,443	5,844	.79	26.7	151
IR 579-48-2	7,413	5,564	.75	22.0	154
Kilombero	7,410	9,993	1.35	26.8	178
Afaa Kilombero 2/214	7,363	12,195	1.66	28.4	178
Afaa Mwanza 0/746	7,310	8,914	1.22	29.5	178
IR 12-178-2-2	7,203	6,447	.90	22.2	178
Milfor 6 (2)	7,177	6,185	.86	29.8	167
IR 790-28-6	7,170	5,661	.79	24.1	167
IR 822-347	7,170	5,934	.83	24.8	163
IR 661-1-140-3-2	7,143	7,345	1.03	28.2	178
Sindano	7,120	5,833	.82	26.8	151
IR 532E-527	7,040	5,795	.82	22.7	178
Afaa Mwanza 1/104	6,987	10,683	1.53	28.2	178
IR 52-18-2	6,960	6,126	.88	21.4	178
Introduction 1/324	6,953	12,186	1.75	27.7	181
IR 773A1-36-21-1	6,953	7,553	1.09	18.7	178
IR 22	6,943	5,850	.84	23.7	157
IR 5	6,847	8,024	1.17	26.8	178
IR 589-66-2	6,513	6,297	.97	25.6	154
Radin Goi	6,473	6,164	.95	24.8	160
IR 154-61-1-1	6,440	5,083	.79	20.5	167
IR 878B2-62-2	6,313	6,733	1.07	28.3	178
Yonechino	6,153	4,108	.67	27.4	136
Bule Belle	6,097	5,056	.83	23.5	151
Afaa Kilombero 1/196	5,947	10,991	1.85	30.3	181
Demesara Creole 2/100	5,897	6,866	1.16	28.2	163
IR 579-163-2	5,857	5,017	.86	23.3	167
Basmati 217	5,510	7,394	1.34	21.2	151
IR 661-1-127-3-1	5,483	6,207	1.13	23.5	178
SML 128/4	5,477	7,372	1.35	27.8	191
Fujiminori	5,470	5,283	.97	26.4	138
SML 242	5,460	9,843	1.80	29.8	191
Makarafuu	5,460	6,499	1.19	27.6	158
Lindi Safari	5,417	11,017	2.03	21.1	178
SML 140/10/4	5,097	9,473	1.86	29.5	191
Afaa Mwanza 1/133	4,957	10,197	2.06	26.5	178
Shimokita	4,847	3,602	.74	25.9	134
S.M.L. Jemerim	4,770	11,176	2.34	31.6	191
S.M.L. Apura	4,727	11,941	2.53	29.9	191
S.M.L. 140/5	4,423	9,829	2.22	28.6	191

Source: *Mwea Irrigation Settlement Research Station, Thiba Section, Unit 2, Experimental Results 1972/73 season*, p.12, July 1973.

varieties have good grain characteristics, except IR 665-29-2, and have yields significantly higher than the Sindano variety, now being used on four sections at Mwea. Basmati 217 is used in one section of Mwea on an annual rotating basis. Planting Basmati 217 in the Mwea is a new development which was started during the 1973/74 season.

Another significant experiment conducted at the MIS Research Station was in crop rotation. In Table 7.2, rice and soya bean yields for both short and long rains seasons and net income per hectare are indicated.

TABLE 7.2

MWEA IRRIGATION SETTLEMENT RESEARCH STATION, ROTATION TRIALS, 1972/1973

Treatments		Yields in kg./ha.		Annual net income[2] in
Short Rains	Long Rains	Short Rains	Long Rains	Kshs./ha.
Rice followed by dry fallow		6,506	-	2,355
Dry fallow followed by Rice		-	2,711	515
Rice followed by Rice		6,723	2,876	3,056
Rice followed by wet fallow		7,182	-	2,683
Wet fallow followed by Rice		-	3,081	694
Rice followed by Soya beans		7,375	2,684[1]	3,705
Soya beans followed by Rice		960[1]	3,085	418

1 Soya bean yields

2 For rice and soya bean production costs were 800 Kshs. and 950 Kshs. respectively.

Price for rice and soya bean = 48.5 Kshs. and 70 Kshs. per kg.

Source: *Mwea Irrigation Settlement Research Station, Thiba Section, Unit 2, Experimental Results 1972/73 season*, p.14, July 1973.

The optimum treatment was rice in the short rains season followed by soya beans in the long rains season which gave the highest yields of 7,375 kilograms per hectare and an income of 3,705 Kshs. per hectare. It is interesting to note (Table 7.2) that rice grown after wet fallow gave an increase in yield of 676 kilograms per hectare over rice grown after dry fallow during the short rains season.

Although the MIS Research Station has developed good experimentations over the past several years, its efficiency is greatly hampered by a severe shortage of qualified senior research personnel. A staff of only four is available for research work. At present the Research Station is operating without a Chief Agronomist to conduct needed experimentations. Also continuity of research work is jeopardised by the fluctuations in availability of overseas research personnel, many of whom spend only a few years in Kenya.

C.E. Kellogg (1962, 6-7) writes:

> The total research effort in tropical agriculture is woefully inadequate to bring forth its great potential. Research is now only a fraction of that in temperate regions. Many of the existing tropical research stations are working along narrow lines, even on a single function. The need is for general research stations with good staffs in all lines, including the social sciences, and provisions for soil surveys and related field research. Competent staff at such stations can receive and make full use of the basic principles and research methods already available from the advanced countries. Farming systems can be developed and tested that take full advantage of the principle of interactions - systems that combine soil, crop and

> livestock practices for the several kinds of soil. In this way the developing countries can adapt these principles and methods to their own local environments.
>
> An excellent beginning along the most advanced lines had been made by INEAC (L'Institut National pour l'Etude Agronomique du Congo) in the Republic of the Congo, and many great improvements have been put into effect. The results apply, of course, to similar tropical soils elsewhere. A failure of this system of advanced research institutes to move forward would be an agricultural tragedy for cultivators on similar soils everywhere.
>
> To establish advanced general research stations requires the solution of difficult problems of financing and recruitment -- especially recruitment. Good results can be expected only from research workers highly skilled in the basic sciences of agriculture who are able to work in the field as well as in the laboratory and on experimental plots.
>
> Badly as the general research stations are needed, some time must elapse before many new ones can be fully staffed and providing the needed results. Soil surveys, exploratory studies of existing agriculture, and the field testing of promising new combinations of practices can be organised quickly, provided the difficult problems of recruitment and training are solved.

This poignant statement by C.E. Kellogg on the need for advanced general research stations, and trained research personnel in the basic sciences of agriculture, is still as valid today as 12 years ago when it was written.

There is great need for a viable research organisation at Mwea to carry out extensive research work on different varieties of rice and alternative crops to ascertain the crop varieties best suited to the Mwea ecological and soil conditions.

FIELD EXTENSION STAFF AND TENANT DISCIPLINE AT MWEA

The reputation and success of the MIS continues to attract the public, drawing a steady stream of visitors, both local and overseas. During 1973 a total of 1,107 people visited Mwea. In discussing Mwea's increasing attraction to visitors, R. Chambers, in his book *Settlement Schemes in Tropical Africa*, stated:

> The benefits of such visits are not calculated, but it would be surprising if irrigation developments in other countries in Africa, and perhaps even outside Africa, were not affected. In the field of complex, disciplined settlement projects, it does not seem an exaggeration to suggest the Mwea model or organisation was beginning to supplement the Gezira and Moshav models which had been dominant in Africa earlier.

A total of approximately 3,500, formerly landless, families is accommodated on about 14,000 acres of irrigated rice land at Mwea during the 1973/74 season, in an area that, prior to development, supported no permanent population. The 1969 population census estimates that Mwea provides a livelihood for over 18,000 people. In view of the increasing importance of settlement schemes in general, and irrigated settlements in particular, it is necessary to examine the MIS Field Extension Staff and the disciplinary framework which have made success at Mwea possible.

The existence of Mwea is governed by the *Trust Land Ordinance (Irrigation Areas) Rules, 1963* (Appendix I). These rules are very comprehensive and entail 8 pages of fine print.

Provision is made for crop and water discipline, and the penalties for non-observance are spelled out. The rules are particularly detailed on matters relating to cropping practices, water control, absentee ownership, and disposal of the paddy crop. The MIS Management has 3 disciplinary tools to deal with recalcitrants. These are, in order of increasing severity: (1) written warnings, (2) prosecution, and (3) termination of licence. Warnings are issued to spur a slow and lazy tenant along and, in more serious cases, to admonish a tenant when his general conduct imperils his future on the Settlement. Prosecutions are reserved for serious infractions of the rules or for recidivism. All prosecutions are carried out before an African Court, with power to impose fines and/or terms of imprisonment. Termination of the licence is the last recourse. The rules lay down an elaborate procedure to prevent arbitrary action by the MIS Management. The tenant has the right of appeal to the Ministry of Agriculture, whose decision is final. Seventeen tenants had their licences terminated during 1973. Since the promulgation of the Irrigation Rules in 1963 a total of 151 licences have been terminated. Under the terms of his licence a tenant may nominate a successor to take over his holding in the event of his death. The nomination must be approved by the African Court, to ensure that the family's interests are safeguarded under Customary Law. The MIS Management has the right to refuse to accept a nomination, in which case the matter is once again referred to the Court. The succession provisions of the rules are an essential factor in lessening tenant antipathy to the annual nature of the licence.

They give the tenant an element of family continuity and go a long way towards demonstrating the fact that security of tenure is guaranteed to a good paddy farmer and to his descendants. No sub-division of the holding is permitted.

As of 1970 all tenants admitted to the MIS are Kikuyu from Kirinyaga District only. This is a severe form of discrimination which has an impact in the neighbouring Eastern Province and on other tribes in the surrounding area. No tests of agricultural aptitude or ability have ever been carried out. Selection of tenants is done by the Clan Committee in Kirinyaga District from the landless element within each particular clan. During my field enquiry there were over 2,000 applications from landless peasants wanting to be tenants at Mwea.

E.G. Giglioli (1965, 202-203) states:

> Experience at the Mwea has shown that a man of between 35 and 40 years of age, with one or more wives and adolescent children makes the best tenant. Such a man is physically capable, with his family, of handling four acres of transplanted rice and has enough mental maturity to appreciate the potentialities of his holding. Very young men are usually single and immature and frequently run into trouble through lack of help or lack of character. Old men cannot cope physically with the work.
>
> The method of tenant selection has not given the Settlement a representative sample of the population. Selection has been limited to the disinherited and the Clan Committee have a very human tendency to unload on the Settlement the less desirable members of their communities. Rice is a completely new crop to the incoming tenant and there is no local tradition of irrigation. From the point of view of both technical knowledge and human resources the Mwea started from scratch.

> The Settlement was no better off in terms of staff organisation. Development took place during the Mau Mau Emergency when the staff resources of the Department of Agriculture at all levels were stretched to the limit. There was no local pool of experience in either Settlement or rice agronomy to draw on. Most of the staff gained their knowledge on the job and the organisation of staff evolved over the years by a process of trial and error. The development phase of the Settlement ended in mid-1960, the rules were promulgated in late-1960 and the staff organisation crystallised in its present form in mid-1961.

The basic organisational unit of the Mwea is a section of 2,400 acres of irrigated paddy, supporting 600 tenant families (Fig. 6.1). Each tenant is allocated a 4 acre holding. The section is sub-divided into a number of units. The size of a unit is determined by topography and varies from a minimum of 32 acres, with 8 tenants, to a maximum of 320 acres, with 80 tenants (Reference Map). It is important to keep in mind that from the point of view of agricultural management, a unit is handled as a single field, as each unit depends on its own water intake point. Tenants live in the 34 villages (Photo. 7.1) dotted throughout the Mwea. Every effort is made to keep tenants from the same unit in one village (Photo. 7.2), and to locate the village in such a way that no tenant has to walk more than 2 miles to reach his holding. Most of the tenants own bicycles and journey back and forth from their house and their holding. The tying of villages to units greatly facilitates the field extension effort, which is based on a unit approach.

Experience over the years at Mwea has shown that an area

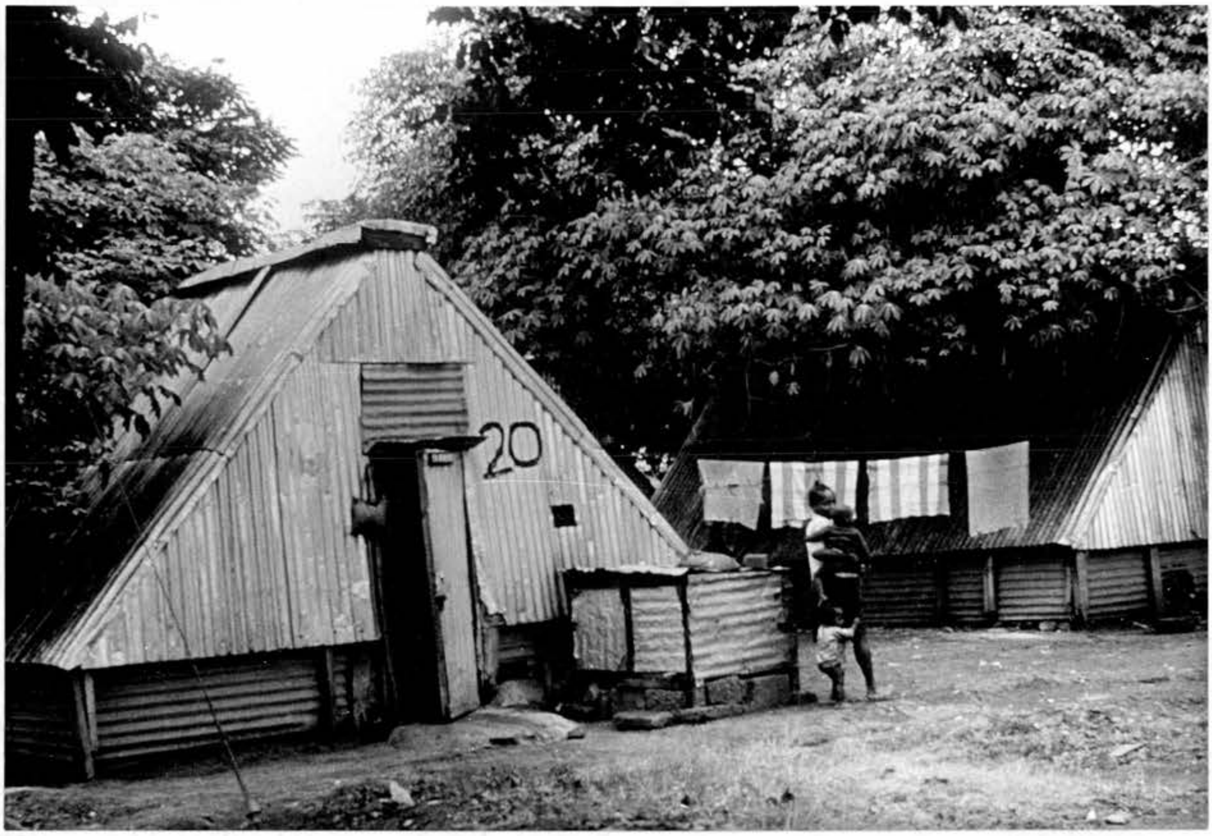


PHOTO. 7.1: THIBA VILLAGE: CORRUGATED IRON HUTS USED FOR HOUSING

These huts were originally used during the Mau Mau Insurrection to house the detainees in 1954, when six camps were set up at Mwea. The Mau Mau Emergency continued in Kenya from 1952 to 1956. At present these corrugated iron sheeting huts are used as homes by the tenants from the Thiba Section.

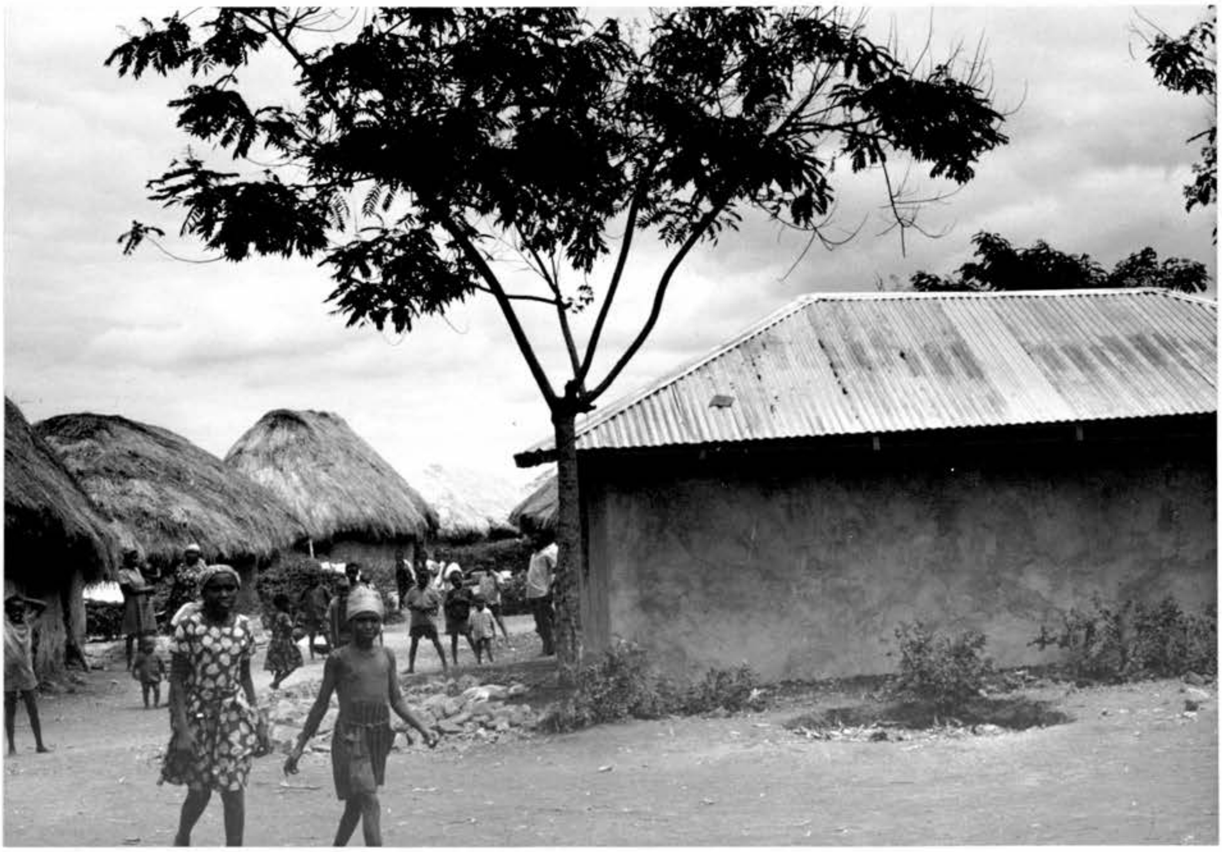


PHOTO. 7.2: NGUKA VILLAGE: A TYPICAL VILLAGE SCENE AT MWEA

Two different types of house construction are shown. On the left, thatched-roofed huts, and on the right an mbati roof. Housing is in very short supply at Mwea and the population build up is a very serious problem.

of 2,400 acres is the optimum size for a section (Fig. 6.1). Each section must be equipped with a Reception Centre to handle the drying, weighing, and temporary storage of paddy. An area of more than 2,400 acres makes transport of the crop from the field difficult, as distances become excessive. The administrative and supervisory burden involved in 2,400 acres of tenant-grown, transplanted paddy is about the maximum that one man can efficiently handle. The loss of control on larger acreage is quickly apparent. Figure 4.4 shows the current staff establishment of a section in the MIS.

The Irrigation Officer is in direct charge of all activities in the section (Fig. 4.4), and is responsible for implementing the agricultural policy laid down by Management and for the carrying out of the Irrigation Rules. He organises and carries out the system of field extension meetings, held periodically in every unit, which is the basic feature of the Settlement's educational effort. The Head Field Assistant aids the Irrigation Officer in all his responsibilities (Fig. 4.4).

The day to day supervision and education of the tenant is in the hands of the Field Assistants. Each Field Assistant is responsible for 150 tenants, spread out over 600 acres. This has been found to be the optimum number of farmers for a Field Assistant to deal with. Smaller numbers result in idleness and larger numbers involve the Field Assistant in uneconomic amounts of time spent getting from one farmer to another. The Field Assistants are provided with motor-cycles for their work. The Field Assistant attends all field extension meetings held by the

Irrigation Officers and supplements them with smaller field meetings of his own. He is encouraged to keep in close contact with all village activities and to become a well-known and trusted person. During my field enquiry, it quickly became apparent that the Field Assistant is the key man in the Field Extension Staff. All of the phases of the cycle of operations revolve around the Field Assistant.

In the past, and at present, the Field Assistant is the most important single factor in unit yield per acre in the MIS. These men are generally recruited from the ranks and trained on the Settlement. During my field survey I personally interviewed all of the Head Field Assistants and Field Assistants. The most vital trait which I discerned is leadership. In the MIS, leadership means the ability to get the farmers to perform their tasks, follow instructions, and maintain good cultural practices. There is no one source from which Field Assistants are recruited. Several of these men were former tenants and Head Water Guards before joining the Field Extension Staff. All of the Field Assistants have a knowledge of English, which is required in order to keep records. Technical knowledge is not considered essential, as a Field Assistant only has to be familiar with a few simple facts of transplanted paddy and these can be quickly acquired. The overriding factor is leadership and personality, i.e. the ability to get along with the farmers.

All water control is in the hands of the MIS Water Staff. A tenant is not allowed to interfere in any way with the water availability in his fields. The Irrigation Officer establishes the watering programme after consultation with the Head Field Assistant, Field Assistants, and the Head Water Guard and his Water Guards who are responsible for execution. The Head Water Guard is in charge of the main section intake from the Irrigation Headworks and supervises the water movement in the individual units. The Water Guard's work calls for a considerable amount of travelling in the MIS Area, and he is equipped with a motor-cycle. Each Water Guard is in charge of between 400 and 500 acres (Fig. 6.1), the amount varying according to the size of the units making it up. He regulates the quantity of water going into a unit and feeds or drains individual holdings as required. It was observed that best results were obtained by keeping the Water Staff completely separate from the Field Extension Staff. This arrangement helps water economy by making the Irrigation Officer make the decision, rather than leaving it to the more parochial point of view of the Field Assistants. Water Guards are expected to be literate in English and are trained during a 6 month probationary period by attachment to a serving Water Guard.

The last link in the chain of command between the Manager and the tenants is constituted by the Head Cultivator (Fig. 6.1). The Head Cultivator is a tenant, selected by the Irrigation Officer for his farming and leadership qualities from a panel of 3 candidates submitted by the Head Field Assistant and Field Assistants. He is paid a small monthly allowance and acts as a prototype of good farming for his colleagues in the same unit. The number of Head Cultivators is dependent on the number of units in a section (Fig. 6.1). The Head Cultivator helps the Field Extension Staff to organise communal work such as cleaning of the feeders and drains, sets the pace for the timely inception of all operations, and is the vehicle through which new techniques are demonstrated. The Head Cultivator also has the valuable role of keeping the Field Extension Staff in touch with tenant thinking at grass root level.

The MIS hierarchical organisation (Fig. 6.1) which has been described provides a channel for the downward dissemination of the Management's instructions (Fig. 6.1). However, a parallel flow in the other direction is obtained through the Tenant Liaison Council and the Tenants' Advisory Committee. Each section has a Tenant Liaison Council, consisting of all the Head Cultivators in the section and an elected representative from every village in the section. The elected member must be a tenant chosen by tenants. Tenure is for two years. Meetings are held once a month and are presided over by the Irrigation Officer. All the Field Extension Staff from the MIS and all the local village headmen, appointed by the MIS Management, attend by invitation. The Tenant Liaison Council deals with cropping programmes and all difficulties and grievances of a local nature. Each Tenant Liaison Council elects five of its members to the Tenants' Advisory Committee. The Tenants' Advisory Committee also meets once a month under the chairmanship of the MIS Manager and is attended by the Assistant Regional Government Agent, the Locational Chief and all the MIS Field Assistants. The Tenants' Advisory Committee deals with broad issues affecting the MIS;

any changes in MIS policy or cropping programmes are always discussed, in the first place, in the Tenants' Advisory Committee before being put into operation by the MIS Field Extension Staff. These bodies have functioned very well and have been singularly free from agitators. On the whole, a very useful and constructive type of man has been sent by the tenants to both the Councils and the Committee (Giglioli, 1965, 204).

CHAPTER 8

THE ECONOMIC SETTING AT MWEA

This chapter is based primarily on my field enquiry. It must be kept in mind in assessing the economic setting of Mwea that the NIB has a monopoly over all rice production in Kenya. The *Summary of Tenants Accounts* is the basic document for all major business transactions between the Mwea Management and the tenant. The *Summary* includes both credits and debits which take place between the tenant and the Mwea Management.

The power keys which developed the socio-economic structure of Mwea were: (1) available water supply; (2) excellent black cotton soils; (3) expertise in managerial leadership; (4) availability of hired and/or casual labour from surrounding area; (5) good climatic conditions for paddy cultivation; (6) botanically disease-free area for paddy production; (7) no displacement of people or tribes from the area; (8) no serious agronomic problems; (9) close supervision of tenants by the Field Extension staff; and (10) disciplinary control of tenants by the Mwea Management.

H.S. Piquet (1974, 2-4) elaborates on the importance of understanding the interaction of economic, physical, biological and psychological forces which operate within a physical environment:

> This is not to say that governments must follow a *laissez-faire* economic policy. What it does say is that in pursuing any

> and all policies they must take these forces into account and work in harmony with them. These five economic axioms are: (1) self-interest, (2) demand and supply, (3) value imputation, (4) proportionality, and (5) time-discount.
>
> Although the first of these axioms -- self-interest -- is primarily psychological, it is so important that it is included as an economic axiom.
>
> Associated with these economic axioms are certain physical, biological and psychological principles which constitute a matrix within which economic activity functions. First, is the physical law of diminishing returns. Second, are the basic biological urges of survival, namely, the satisfaction of hunger, the provision of shelter, and sex. Third, are a number of psychological principles, including group conformity and conspicuous consumption.
>
> All of these axioms, or principles, economic, physical, biological and psychological, operate within a physical environment of resources that are useful to man, such as air, water, climate, and the current state of science and technology. Equally important are the size, composition, growth and distribution of population.
>
> They also operate within an institutional environment -- legal, social and economic -- that prevails at a particular time and place and which changes through time.
>
> ... This is not to imply that all that one has to do is to understand the meaning and ramifications of the five axioms to solve all economic problems. It is not that simple. It does assert, however, that unless the axioms are understood there is a strong probability that attempts by governments to solve economic problems will aggravate them and even lead to confusion, if not disaster.

LABOUR AND FINANCE

Practically all the MIS tenants use hired and/or casual labour during the critical harvesting and transplanting periods.

These tasks must be carried out as quickly as possible. Labour is also employed for weeding during the growing season. During my field enquiry the following questions were asked: What were your major agricultural problems last season? What were your major harvesting problems last season? From the field enquiry over 90 per cent of the sample tenants stated that their major problems were obtaining hired and/or casual labour when needed and the lack of an adequate labour supply. On average, hired and/or casual labour was paid the following rates during the 1972/73 season: harvesting 70 Kshs. per acre; transplanting 50 Kshs. per acre; levelling with oxen 40 Kshs. per acre; weeding 20 Kshs. per acre. Table 8.1 shows that the mean number of hired and/or casual man days of labour used by the sample tenants on their paddy holdings was 171 man days during the 1972/73 season on the different operations in the cycle of paddy production. The significance of Table 8.1 shows the great dependency of the tenants for hired labour in order to carry out their paddy operations. Over 55 per cent of the sample tenants used between 101-200 man days of hired and/or casual labour on their holding during 1972/73. 30 per cent of the tenants used between 201-300 man days of hired and/or casual labour during the 1972/73 season.

TABLE 8.1

MEAN MAN DAYS OF HIRED AND/OR CASUAL LABOUR USED
ON PADDY HOLDING, 1972/73

No. of Man Days	No. of Tenants	Per cent
Under 50	4	1.8
51 - 100	22	10.2
101 - 150	68	31.3
151 - 200	53	24.4
201 - 250	53	24.5
251 - 300	11	5.0
301 and over	6	2.8
Total	217	100.0

Mean	171.332	Maximum	719.000
Standard error	5.147	Median	157.875
Standard deviation	75.813	Variance	5,747.637
Skewness	2.583	Range	719.000

Table 8.2 shows that during the 1972/73 season the mean number of hired and/or casual labour used by the sample tenants was about 19.

TABLE 8.2

MEAN NUMBER OF HIRED AND/OR CASUAL LABOUR USED BY SAMPLE TENANTS ON PADDY HOLDINGS 1972/73.

Range	No. of Sample tenants	Per cent
0 - 5	7	3.2
6 - 10	22	10.2
11 - 15	51	23.5
16 - 20	74	34.2
21 - 25	31	14.3
26 - 30	16	7.3
31 and over	16	7.3
Total	217	100.0

Mean	18.931	Maximum	141.000
Standard error	8.792	Median	17.842
Standard deviation	11.669	Variance	136.176
Skewness	5.588	Range	141.000

Table 8.2 shows that approximately 50 per cent of the sample tenants used between 16-25 labourers to assist them with their paddy production tasks.

Table 8.3 shows that during the 1972/73 season the mean expenditure for hired and/or casual labour used by the sample tenants was 674 Kshs. Approximately 50 per cent of the sample tenants spent between 601-800 Kshs. for hired labour.

TABLE 8.3

MEAN EXPENDITURE FOR HIRED AND/OR CASUAL LABOUR BY SAMPLE TENANTS, 1972/73

Expenditure (Kshs.)	No. of Tenants	Per cent
0 - 500	49	22.6
501 - 600	22	10.1
601 - 700	54	24.9
701 - 800	52	24.0
801 - 900	19	8.7
901 - 1,000	11	5.1
1,001 and over	10	4.6
Total	217	100.0

Mean	674.470	Maximum	1,725.000
Standard error	14.534	Median	661.563
Standard deviation	214.099	Variance	45,838.230
Skewness	0.836	Range	1,725.000

Hiring labour represents a major personal expenditure, annually, by the Mwea tenants. The largest personal expenditure for labour by the sample tenants was 1,725 Kshs. (Table 8.3).

Table 8.4 reveals that during the 1972/73 season at Mwea the mean number of man days used in performing all of the operations in the paddy production cycle was 354 man days. Harvesting and transplanting, the most critical tasks in the cycle of operations, required, on average, 157 man days or 45 per cent of the total man days used.

TABLE 8.4

MEAN MAN DAYS SPENT ON SAMPLE HOLDING PERFORMING CYCLE OF OPERATIONS DURING 1972/73 SEASON

Cycle of Operations	Man days	Per cent
Maintenance of irrigation facilities	61.48	17.4
Preparation of paddy fields	34.75	9.8
Planting and care of seedling beds	38.67	10.9
Transplanting seedlings	73.47	20.8
Weeding and insent control	61.65	17.4
Harvesting paddy	83.78	23.7
Total	353.80	100.0

Mean	353.797	Maximum	653.000
Standard error	3.153	Median	348.333
Standard deviation	46.440	Variance	2,156.718
Skewness	1.606	Range	389.000

The Chief Agriculturalist of the National Irrigation Board stated to me during a conversation:

> The key to the success of the Mwea has been the fact that most of the tenants can afford to hire labour to help with the heavy work involved in the paddy production cycle, particularly during the critical harvesting and transplanting periods. But if their labour supply dries up, then the Mwea tenants are in serious trouble. The tenants have become too dependent upon hired and/or casual labour to perform their different tasks. There also exists a high degree of absenteeism in the Mwea with tenants leaving their paddy holdings for long

> periods of time. On average, the Mwea tenant farmer is involved approximately six months of the year with paddy production and the other six months with off-scheme activities. The tenant, on average, works directly on his paddy holding, approximately 80 days during the year. He has a lot of free time to himself, but generally fails to budget his time or money properly. He has a lot of lost time spent visiting neighbours and relatives on and off the scheme. He is not where he should be, on his paddy holding.

From the field enquiry it was observed that the sample tenants had, on average, 118 days free of paddy farming per season at Mwea. It was also noted that these sample tenants, on average, spend only 5 days working outside the scheme. It was observed that the tenants fail to utilise their free time on constructive activities. Most of the free time is spent visiting neighbours on the scheme and relatives in the up-country. I found many tenants loitering around the villages and drinking *pombe* in the numerous pubs in the villages at Mwea. This valuable time could be used in performing irrigation maintenance work on their holding. The failure of the NIB to provide a vocational training programme for the tenants, during their free time, is a great oversight. There is urgent need for a vocational training programme to be established at Mwea.

During the 1972/73 season the MIS had a record paddy crop with an average of 36.8 bags per acre. However, the broken grain content of the paddy was the highest ever recorded, approximately 30 per cent. This high percentage of broken grains was the result of paddy cracking in the field under heavy insolation and the concomitant inability to obtain hired and/or casual labour to help harvest the paddy at this critical period. During the harvesting period it is extremely important to harvest the crop quickly and transport it to the mill at a 14 per cent moisture content to avoid broken grains. If the moisture content is less than 14 per cent, then the probability of a high broken grains content in the paddy is very great. The more broken grains the less profit to the farmer from his crop.

Table 8.5 illustrates the schedule of prices for rice in Kenya under the *Price Control (Rice) Order, 1972* (Appendix III) Approximately 70 per cent of the MIS paddy crop is milled out as Grade II (containing less than 20 per cent broken grain by weight) Sindano Rice which brought an Ex-Mill price of 141.85 Kshs. per 100 kg. bag. In comparison to Grade II Sindano Rice the Ex-Mill price for Sindano Rice with over 20 per cent broken grains was 89.20 Kshs. per 100 kg. bag. The Ex-Mill price for Basmati (Pishori) Rice was 223.45 Kshs. per 100 kg. bag. Kenya Basmati (Pishori) Grade II Rice is a long, slender grain white rice which is popular in the diets of the Asian population in Kenya. High quality Basmati rice is in great demand by the hotels and game park lodges. Figure 8.1 illustrates a recently designed cover by the Mwea Rice Mills Ltd. General Manager used in the popular 20 kg. net bag. Table 8.5 also shows the wholesale and retail prices of these rice varieties.

The success of the MIS as an economically viable scheme with high average yields per acre and high average income to the farmers may be in serious jeopardy in the future if the farmers continue to rely so heavily on uncertain hired and/or casual labour

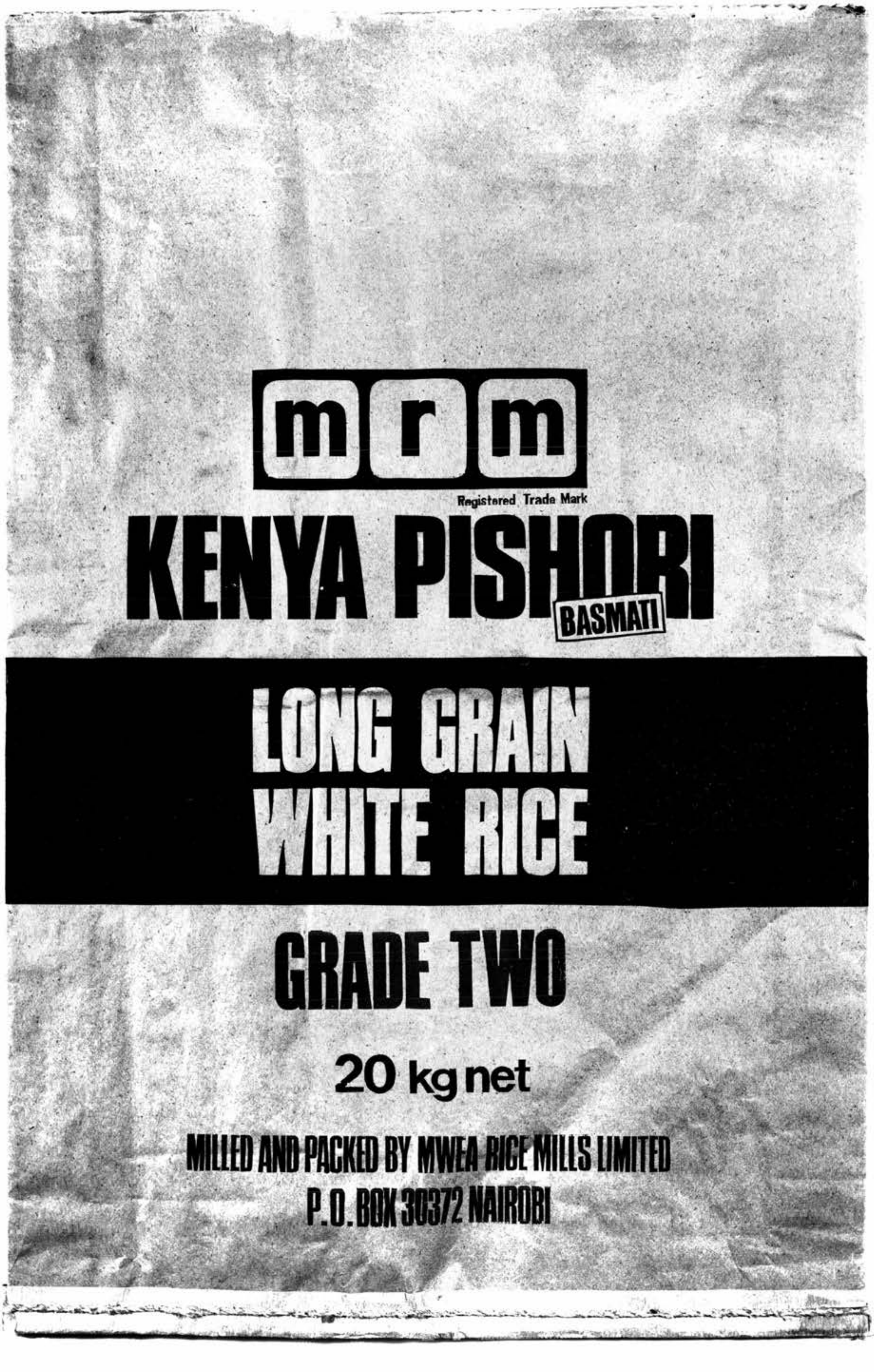

mrm
Registered Trade Mark
KENYA PISHORI
BASMATI
LONG GRAIN
WHITE RICE
GRADE TWO
20 kg net
MILLED AND PACKED BY MWEA RICE MILLS LIMITED
P.O. BOX 30372 NAIROBI

FIG. 8·1

supply to perform their tasks.

TABLE 8.5

KENYA SCHEDULE OF RICE PRICES, 1973

Rice Varieties	Sales Ex-Mill 100 kg	Ex Wholesalers incl. cost of bag 100 kg	Maximum Retail price to consumers incl. cost of bag 1 kg
	Kshs.	Kshs.	Kshs.
Sindano Rice, East African Rice			
(a) Grade I containing less than 10 per cent broken grain by weight	151.85	159.35	1.75 *
(b) Grade II containing less than 20 per cent broken grain by weight	141.85	149.35	1.65 *
(c) Broken Sindano Rice containing more than 20 per cent broken grain by weight	89.20	96.25	1.10 *
Basmati Rice, Local or imported			
(a) Basmati Rice containing not more than 20 per cent broken grain by weight	223.45	231.35	2.50 *
(b) Basmati Rice containing more than 20 per cent broken grains by weight	89.20	96.25	1.10 *

* All parts of Kenya except where otherwise indicated.

Source: *Kenya Gazette Supplement No. 75*, 26 January 1973, pp. 12 and 13.

Table 8.6 shows the average size holding of the sample tenants during the 1972/73 season was 4.4 acres.

TABLE 8.6

NUMBER AND PERCENTAGE OF SAMPLE TENANTS FALLING INTO VARIOUS ACREAGE GROUPS, 1973

Acres	Tenants	Per cent
4.00	160	64.0
4.01 - 4.50	20	8.0
4.51 - 5.00	40	16.0
5.01 - 5.50	11	4.4
5.51 - 6.00	12	4.8
6.01 - 6.50	2	0.8
6.51 - 7.00	2	0.8
7.01 and over	3	1.2
Total	250	100.0

Mean	4.4392	Maximum	90.000
Standard error	0.519	Median	37.978
Standard deviation	8.209	Variance	67.388
Skewness	2.139	Range	79.000

The relative affluence of the Mwea tenants may be evaluated by noting that the annual basic wage in the surrounding area is approximately 600 Kshs. per year. In comparison, on average, during the 1972/73 season the net income of a tenant in the Mwea was 3,680 Kshs.

The Mwea was originally planned and designed on the basic assumption that a tenant should clear 2,000 Kshs. per year from his holding. At the present time he has almost doubled this amount over a period of 14 years, although, of course, inflation has had a similar toll as elsewhere in Kenya. Approximately 20,000 formerly destitute people are now usefully engaged, at a reasonable standard of living and life style, and are now contributing a considerable amount of taxation to the government and the NIB. The mean length of tenure of the sample tenants was approximately 7.5 years at the Mwea (Table 8.7). The median of 6.8 years is the more meaningful statistic in this case.

TABLE 8.7

LENGTH OF TENURE IN MWEA IRRIGATION SETTLEMENT
BY SAMPLE TENANTS, 1973

No. of years in MIS	Tenants	Per cent
Less than 1	33	13.2
1 - 2	29	11.6
3 - 4	40	16.0
5 - 6	19	7.6
7 - 8	22	8.8
9 - 10	19	7.6
11 - 12	15	6.0
13 - 14	51	20.4
15 - 16	14	5.6
17 and over	8	3.2
Total	250	100.0

Mean	7.448	Maximum	21.000
Standard error	0.346	Median	6.833
Standard deviation	5.479	Variance	30.015
Skewness	0.188	Range	21.000

Hired and/or casual labour is desperately needed. During the transplanting period the tenant measures the tasks; one acre has 50 tasks. The cost for each task, during transplanting, is one shilling, thus the total cost per acre is 50 Kshs. or 200 Kshs. for a 4 acre holding.

The cost of hired and/or casual labour from the up-country has been increasing over the past several years. During my field enquiry many of the tenants discussed the cost of hired and/or casual labour:

> When the people in the villages and surrounding areas of the up-country have a good harvest of maize and beans, and therefore plenty to eat, then they are not interested in working at the Mwea during the heavy work periods of harvesting and transplanting. The cost of hired and/or casual labour is 75 Kshs. per acre when there exists a scarcity of labour. However, if there is a poor harvest in the up-country and labour is plentiful then labour is available at 50 Kshs. per acre. Therefore, the wages for hired and/or casual workers from up-country vary substantially from season to season according to the vagaries of weather and the success of the harvest in the surrounding area.

A socio-economic transition is taking place within the Mwea structure. In recent years a different type of tenant farmer is coming into the Settlement. The young tenant's objective is to make as much money as he can, and as quickly as possible, from his holding. On average, he will hire a minimum of outside labour to help him with his operation.

The following payments are charged by the MIS Management to the tenants: (1) Cost of water (@ 200 Kshs. per acre annually);

(2) cost of rotavating fields; (3) cost of seeds, fertilisers, etc.; (4) cost of burlap bags (@ 5 Kshs. per bag); (5) cost of transporting paddy to Reception Centres and the Mwea Rice Mills Ltd.; (6) a tax or "cess" @ 1.50 Kshs. per dry bag of paddy); and (7) an annual development loan repayment fee to the West German Government, KFW[1] Loan (@ 20 Kshs. per acre). Table 8.8 shows the average major costs incurred by the sample tenants during the 1972/73 season.

TABLE 8.8

MEAN MAJOR COSTS OF PADDY PRODUCTION
BY SAMPLE TENANTS, 1973

Item	Cost Kshs.	Per cent
Water	903.23	43.4
Ploughing and levelling	177.37	8.5
Seeds, fertiliser, etc.	407.30	19.6
Bags	30.31	1.5
Transporting paddy to Reception Centre	224.14	10.8
Cess (tax) at 1.50 Kshs. per dry bag of paddy	245.16	11.8
Repayment of KFW loan (20 Kshs. per acre)	94.01	4.4
Total	2,079.52	100.0

Mean	2,079.520	Maximum	4,840.000
Standard error	32.281	Median	2,044.500
Standard deviation	474.427	Variance	225,080.688
Skewness	1.090	Range	3,332.000

1 The development programme of Mwea is being assisted with a West German Government Loan through the Kreditanstalt für Wiederaufbau (KFW).

The mean cost of paddy production for the sample farmers was 2,080 Kshs. in 1973 (Table 8.8). The striking statistic in Table 8.8 is the substantial cost for water that the tenant has to bear. The average cost of water for the sample tenants was 903 Kshs. representing 43 per cent of the total cost of paddy production. Seeds and fertilisers represented 407 Kshs., or about 20 per cent of total costs.

TENANT INCOME

The tenant's net income in the Mwea is calculated from the *Summary of Tenants Accounts* by deducting from gross income the charges and services rendered by the MIS Management to the tenant during the paddy season. The average net income of the sample tenants was 3,925 Kshs. during 1973 (Table 8.9). The range of sample tenant net incomes from their holdings is shown in Table 8.9.

The wide dispersion of tenant incomes is the result of a myriad of factors which will be analysed in Chapter 9. The net income of the tenant depends to a great extent on his personal effort, drive, ambition, and management ability as a paddy farmer. Close supervision by the Field Assistant plays a key role in the tenant's efficiency. The net income received by the tenants does not include the cost of any hired and/or casual labour. The farmer's labour is also included in the calculation of net income. The tenant's net income does not take into account any additional income derived from other work and/or investments. Each tenant retains approximately 10 bags of paddy for home consumption with an estimated value of 350 Kshs. (@ 22 Kenya cents per pound).

TABLE 8.9

SAMPLE TENANTS BY VARIOUS CLASSES OF NET INCOME
FROM PADDY HOLDING DURING 1972/73 SEASON

Net income (Kshs.)	No. of Tenants	Per cent
Under 2,000	6	2.8
2,000 - 2,500	25	11.5
2,500 - 3,000	24	11.0
3,000 - 3,500	38	17.6
3,500 - 4,000	37	17.0
4,000 - 4,500	34	15.7
4,500 - 5,000	19	8.7
5,000 - 5,500	11	5.1
5,500 - 6,000	6	2.8
6,000 - 6,500	6	2.8
6.500 - 7,000	3	1.4
7,000 and over	8	3.6
Total	217	100.0

Mean	3,925.562	Maximum	9,659.000
Standard error	95.345	Median	3,717.250
Standard deviation	1,404.526	Range	8,385.000
Skewness	1.243		

The 10 bags of retained paddy is considered by the MIS Management as representing the value of the farmer's labour input during the season. This method of payment in paddy has promoted the use of paddy as a staple food in the Mwea (Photo. 8.1). I observed that about 75 per cent of the sample tenants have a preference for rice over other foods in their diet. The farmer and his household eat substantial quantities of rice daily (Photo. 8.2).

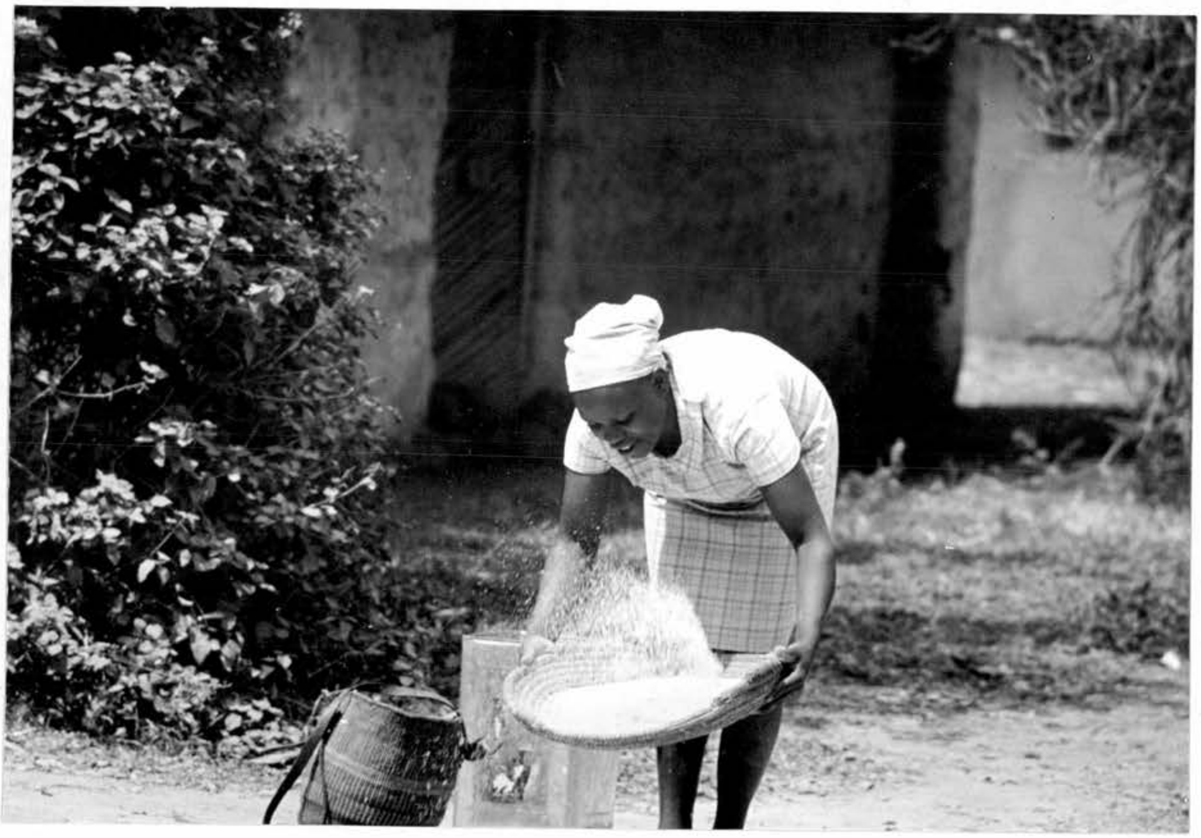


PHOTO. 8.1: WINNOWING PADDY IN PREPARATION FOR COOKING, NGUKA VILLAGE, MWEA

Over 80 per cent of the tenants interviewed preferred to eat paddy over other grains. On average, the farmers retain 10 bags of paddy for household use at Mwea. Food comsumption in Kenya has been estimated at 2,300 calories daily.

PHOTO. 8.2: A TENANT'S CHILDREN USING A MORTAR AND PESTLE TO PREPARE THE PADDY FOR WINNOWING

After the paddy is beaten, it is placed in basket-woven fibre trays. The children assist in many of the household duties and also perform various tasks on the paddy holding involving weeding, transplanting, scaring birds from the nursery and from the young seedlings in the field. They also assist in threshing and bagging during harvesting.

I discerned a serious problem concerning tenants who have been at the Mwea over a period of years and who earn sufficient income from paddy production. Many of these tenants become absentee farmers involved in business enterprises in the villages of the Settlement and off the scheme. These absentee tenants give less attention to their holdings. They generally leave the responsibility of paddy farming to their wives and children, but they receive the pay-out at the end of the season. This often results in inefficiencies of production and lower yields on a considerable number of good paddy holdings. The price paid to the tenants for their paddy was 22 Kenya cents per pound during the 1972/73 season. The tenants are paid an advance in January and the final payment is made in May of each season. The advance is used by the tenant to pay for hired and/or casual labour during harvesting in December to March. The amount of the January advance is based on the tenant's yields of the previous season. The advance is recorded in the *Summary of Tenants Accounts* as a debit to be deducted from the tenant's gross income at the pay-out in May of each year.

Tenant Investments

Most of the sample tenants received some income from the following sources: one, or more, of (1) as shareholders in the Mwea Credit Co-operative Society;* (2) as shareholders in the Mwea Consumers Co-operative Society; (3) as an owner or part owner in a villag

* which has a 40 per cent interest in Mwea Rice Mills Ltd.

business, e.g. a pub, restaurant, grocery store, taxi company, a *matatu*, bicycle shop, shoe store, etc.; (4) as a shareholder in the Kirinyaga Transporters Ltd. (a trucking company with a fleet of lorries which has a contract agreement with the MIS Management to transport paddy from the fields to the Reception Centres and then to the Mwea Rice Mills Ltd.); (5) as a shareholder in a large co-operative farm in the highlands; (6) as an owner of a small farm outside the Settlement; (7) as an owner of oxen used for contract levelling of paddy holdings (@ 40 Kshs. per acre during the 1972/73 season); (8) as a cotton producer on the Mwea red soils (average income from cotton production is 200 Kshs. during a good season); and (9) as a hired and/or casual labourer on other paddy holdings.

Approximately 90 per cent of the sample tenants have, on average, 500 Kshs. deducted annually from their payout by the MIS Management for the purchase of shares in the Mwea Credit Co-operative Society. The objectives of the MIS Management are twofold: To build up a substantial cash flow in the Mwea Credit Co-operative Society so that the National Irrigation Board can use it as collateral for development purposes, and make it possible for the tenant to become a partner and shareholder in the Mwea Rice Mills Ltd. The tenants receive a 3 per cent dividend annually. For example, the Mwea Rice Mills Ltd. was constructed through a KFW Loan, with the backing of these funds. The NIB has 60 per cent ownership of the Mwea Rice Mills Ltd.; the Mwea tenants have the remaining 40 per cent ownership (Appendix V, Table 3). Table 8.10 shows a breakdown of some of the most important expenditures by the sample tenants. The mean personal expenditure by the sample tenants was 3,187 Kshs.

TABLE 8.10

MEAN MAJOR PERSONAL EXPENDITURES BY SAMPLE TENANTS, 1973

Item	Expenditure Kshs.	Per cent
Educating children	803.80	25.2
Helping relatives	137.01	4.3
Fixing house	75.62	2.4
Hiring labour	674.47	21.2
Beer expenditure	315.53	10.0
Transportation[1] expenditure	92.13	2.9
Food purchase	460.00	14.4
Fuel purchase	138.12	4.3
Refreshments[2]	91.43	2.9
Contingencies	44.54	1.4
Clothing purchases	333.87	10.5
Other purchases	17.14	0.5
Total	3,186.63	100.0

Mean	3,186.629	Maximum	7,820.000
Standard error	73.556	Median	3,075.000
Standard deviation	1,081.044	Range	6,650.000
Skewness	1.066		

1 Does not include transporting paddy to Reception Centre

2 Includes coffee, tea, milk, soda, Coca Cola, etc.

Most of the tenants borrow from the Mwea Credit Co-operative Society during the transplanting period in August to September, in order to pay hired and/or casual labour. The interest rate on loans is 7 per cent annually. In some cases the tenants' investment in the Mwea Credit Co-operative Society represented between 15 to 20 per cent of their net income. This investment by the tenants may be viewed as a form of forced savings, controlled by the NIB. During my field enquiry I asked the question: What income do you get, if any, as a shareholder in the Mwea Credit Co-operative Society? Most of the tenants gave an answer but many were not certain of the amount they had invested in the Mwea Credit Co-operative Society. The NIB and the MIS Management had not explained to the tenants what they were investing and their dividend rate. Approximately 20 per cent of the sample tenants have purchased shares in the Mwea Consumers Co-operative Society.

The most important expenditure was educating children -- this item represented 804 Kshs. On average, annual school fees are 300 Kshs. for a child attending primary school; 600 Kshs. for secondary school; and 50 Kshs. for a child attending nursery school. Food expenditure represented 460 Kshs. Hiring labour represented

675 Kshs. Beer expenditure represented 316 Kshs. Beer and *pombe* consumption in the Mwea is substantial! After the pay-out at the end of May, pubs in the main villages, with licences to sell alcoholic drinks, are filled with swarms of tenants. There is a high incidence of drunkenness in Mwea.

Transportation expenditures are closely associated with the ownership of bicycles. The bicycle is the most important mode of transport in the Mwea. The number of bicycles in the Mwea area is considerable. About 75 per cent of the tenants own one or more bicycles. Bicycle shops are located in the main villages. Expenditures on bicycles include the cost of repair and maintenance as well as the purchase price. The bicycle in the Mwea represents an important status symbol and is one of the first purchases a tenant makes. Psychological factors, including group conformity and conspicuous consumption, are relevant in this situation. People from up-country who visit the Mwea are impressed by this display of affluence. The bicycle is ever present and a symbol of the life style of the tenants. Other important expenditures include clothing purchases, 334 Kshs., fuel purchases, 138 Kshs., and helping relatives, 137 Kshs.

CHARACTERISTICS OF THE HOUSEHOLD

The tribal and historical background of the tenancy at Mwea, which is predominantly Kikuyu, has a significant influence on ability to perform as a paddy farmer at Mwea. However, it must be kept in mind that rice is a completely new crop to the incoming tenant; there are no traditions of irrigation at Mwea or in

Kenya. D.R.F. Taylor (1969, 492) writes:

> The farmers of the Kikuyu Plateau have the skill and ability to farm well. There are many, as in most agricultural communities, who are backward and conservative but most are quick to realise the commercial benefits of a new crop or variety and to utilize it. ... The majority of the people wish to improve their farms and are ready and willing to learn. The agricultural skills of many leave much to be desired but there is considerable latent potential in a people who, using only a digging-stick, grew sufficient food to support an agricultural population density of 100-200 per square mile prior to any contact with more advanced farming techniques.
>
> ... Agricultural finance is being made available on an increasing scale, especially by the commercial banks, from whom the small-holder can now borrow as he can offer his land as security.

This description of the historical background of the Kikuyu farmer offers a valuable yardstick for evaluation of the farmer's household at Mwea.

The character, composition and size of the household are key factors which help to explain the complex role of the household in the farming system at Mwea. Stress will be placed on the following: What should be within a family's own competence for labour demands at Mwea? What size and type of family can best meet the demands of the paddy production tasks at Mwea? What can the farmer and his household do for themselves at Mwea?

The age of the farmer, length of tenure, district of origin, acceptance of a different life style, level of education, attitude toward work, and willingness to follow instructions and close supervision are prime factors which shed light on understanding the farmer and his household at Mwea. The household consists of those people living in the house of the tenant. The tenant's immediate family consists of his blood ties and his wife or wives.

From the sample survey, 90 per cent of the tenants interviewed were male, 10 per cent female. During 1973 a Government act made it possible for women to become tenant farmers at Mwea. I noted that there were only 5 per cent of the sample tenants who were guardians. These guardians are in charge of the household (Photo. 8.3) and the holding and operate the farm equally as well as the tenant farmer. When the heir becomes of age (at 18) he takes over the holding.

It was observed in the survey that 75 per cent of the sample tenants had one wife, 14 per cent two wives and 3 per cent had three wives; 8 per cent were bachelors or widowers. The wives at Mwea perform the major tasks in the paddy production cycle, particularly in transplanting seedlings, harvesting, weeding, and caring for the seedlings beds. In fact, women play a major role in paddy production at Mwea. They also perform all the household tasks. Thus they play a key role in the success of Mwea which is all too often overlooked. The manner in which they help organise the household functions and co-operate with the tenant has an important psychological effect on the cohesiveness of the household-

D.R.F. Taylor (1969, 468) writes:

> Cultivation by hand was, and still is, virtually the only method of working the land, with much of the work being done by women. There seems to have been a fairly well-defined division of labour. Women

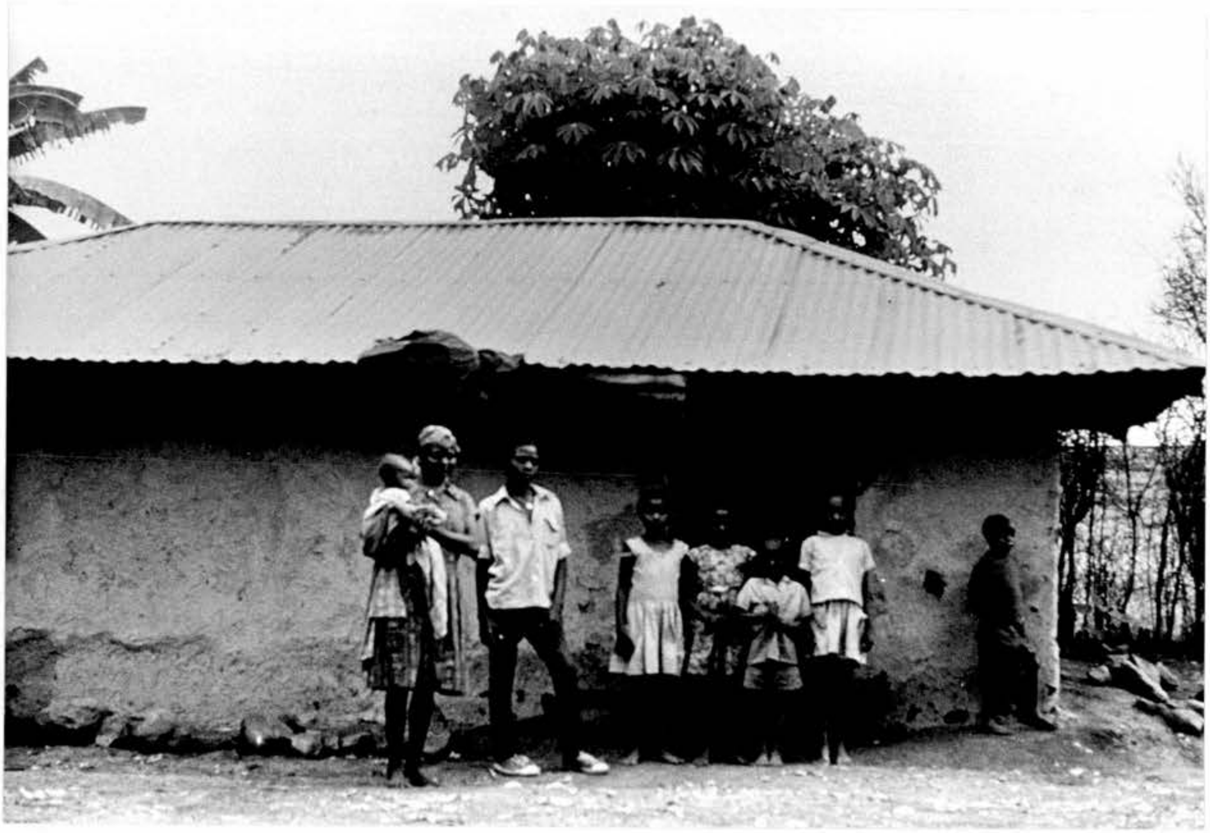


PHOTO. 8.3: A TYPICAL TENANT FARMER'S FAMILY IN FRONT OF A HOUSE WITH AN MBATI ROOF

The wife is a guardian who took over the farm operations when her husband died in 1972. During my field enquiry I interviewed 15 guardians who were performing all of the tasks of tenant farmers. During 1973 a law was enacted by the Kenya Government, making it possible for women to obtain an annual licence as tenant farmers in the Mwea Irrigation Settlement.

> were responsible for the collection of firewood, fetching water from the stream, various domestic duties and food storage. In the fields they were responsible for planting crops, weeding the land, harvesting, threshing and winnowing.
>
> Men were responsible for the rearing and milking of cattle and most of the work connected with the livestock. Breaking virgin land and the care of certain crops such as tree crops and most perennials were the special concern of men.

Table 8.11 shows that over 47 per cent of the sample tenants are between 30 - 49 years of age. However, 36 per cent of the sample tenants were 50 and over. The mean age of the tenants sampled was 37.32 years of age (Table 8.11).

TABLE 8.11

SAMPLE TENANTS BY AGE GROUPS, 1973

Age group	Number of tenants	Per cent
Under 20	7	2.8
20-29	35	14.0
30-39	66	26.4
40-49	52	20.8
50 and over	90	36.0
Total	250	100.0

Mean	37.32	Maximum	60.00
Standard error	0.074	Median	38.27
Standard deviation	1.170	Variance	1.370
Skewness	0.417	Range	60.00

Table 8.12 shows that the Kirinyaga District is the major source of Mwea tenants. 76 per cent (190) of the sample tenants 'came from thence'; and NIB promulgated a law in 1972 that only tenants from the Kirinyaga District can come into the Mwea in the future.

TABLE 8.12

PERCENTAGE OF SAMPLE TENANTS COMING FROM DIFFERENT DISTRICTS, 1973

District	Tenants	Per cent
KISII	2	0.8
NAKURU	2	0.8
KERICHO	2	0.8
NYANDARUA	1	0.4
NYERI	16	6.4
KIRINYAGA	190	76.0
KIAMBU	26	10.8
MURANGA	9	3.6
EMBU	1	0.4
Total	250	100.0

Standard error	0.114	Maximum	29.000
Standard deviation	1.800	Median	23.037
Skewness	-5.813	Variance	3.241

THE FARMER'S HOUSEHOLD

The mean number of persons per household was 7.50 (Tables 8.13 and 8.14). On average, the tenant's family (the total blood ties) in the sample households was 6.16 consisting of

3.19 males and 2.97 females (Tables 8.15 and 8.16). The maximum number of male and female blood ties in the household of the sample tenants was 14 and 9 respectively (Tables 8.15 and 8.16).

TABLE 8.13

TOTAL MALE MEMBERS IN HOUSEHOLD OF SAMPLE TENANTS, 1973

Range	No. of males in household	Per cent
0-1	45	18.0
2-3	107	42.8
4-5	63	25.2
6-7	21	8.4
8-9	12	4.8
10 and over	2	0.8
Total	250	100.0

Mean	3.336	Maximum	14.000
Standard error	0.136	Median	2.991
Standard deviation	2.158	Variance	4.658
Skewness	1.087	Range	14.000

TABLE 8.14

TOTAL FEMALE MEMBERS IN HOUSEHOLD OF SAMPLE TENANTS, 1973

Range	No. of females in household	Per cent
0-1	26	10.4
2-3	80	32.0
4-5	83	33.2
6-7	38	15.2
8-9	14	5.6
10 and over	9	3.6
Total	250	100.0

Mean	4.168	Maximum	11.000
Standard error	0.150	Median	3.904
Standard deviation	2.375	Variance	5.642
Skewness	0.731	Range	11.000

TABLE 8.15

TOTAL MALE BLOOD TIES IN HOUSEHOLD OF SAMPLE TENANTS, 1973

Range	No. of male blood ties in household	Per cent
0-1	53	21.2
2-3	103	41.2
4-5	62	24.8
6-7	20	8.0
8-9	10	4.0
10 and over	2	0.8
Total	250	100.0

Mean	3.192	Maximum	14.000
Standard error	0.138	Median	2.811
Standard deviation	2.178	Variance	4.742
Skewness	1.093	Range	14.000

TABLE 8.16

TOTAL FEMALE BLOOD TIES IN HOUSEHOLD OF SAMPLE TENANTS, 1973

Range	No. of female blood ties in household	Per cent
0-1	70	28.0
2-3	92	36.8
4-5	60	24.0
6-7	17	6.8
8 and over	11	4.4
Total	250	100.0

Mean	2.972	Maximum	9.000
Standard error	0.134	Median	2.788
Standard deviation	2.122	Variance	4.501
Skewness	0.729	Range	9.000

The head of the household at Mwea is generally the tenant. Usually he is married to one or more wives, who take care of their own children. It was observed that each wife works independently in her household. These households form the basic social units at Mwea. In many of the families the children have grown up, particularly in the Mwea and Tebere Sections, and have left Mwea. Unable to find permanent employment in the urban centres, they have to be supported by their families, without doing any productive work for the household. The smaller families often have permanent hired labourers lodging with them at 16 Kshs. per month, plus board and lodging. When a tenant has two or more wives, which frequently occurs at Mwea, one wife looks after the children to free others for work in the fields. Most of the work load at Mwea is carried by women. I noted that the women have to collect heavy loads of firewood from miles away and it is usual to see women trudging the paths with back-breaking burdens. They also transport water for household use in big tin drums from a nearby river or an irrigation furrow or drain. The washing is also done in these rivers, furrows and drains. In addition, women do the cooking and care for the children. Most of the work on the holdings, too, is done by the women. The tenants help with the paddy cultivation and direct operations, but I noted that great differences exist between the households of the drags and those of the high-yielding tenants. Some of the tenants, particularly the high-yielding ones, take an active part in paddy cultivation tasks. However, I noted a considerable number try to evade these responsibilities in any manner and way possible.

The ability to mobilise the children in the household of working age - over age 10 - to work on the paddy holding is of major importance to the farmer, particularly during the harvesting, transplanting, and weeding periods of the paddy production cycle. The low-yielding tenants rely heavily on their household labour to assist them with various tasks of paddy production. Tables 8.17 and 8.18 show that the mean number of males and females in the household, over age 10, working on the holding was 1.40 and 1.70 respectively.

TABLE 8.17

NUMBER OF MALES IN HOUSEHOLD OVER AGE 10
WORKING ON SAMPLE HOLDING

No. in household working on holding	Males	Per cent
0	76	34.4
1	52	23.5
2	49	22.2
3	28	12.7
4	7	3.2
5	6	2.7
6 and over	3	1.3
Total	221	100.0

Mean	1.407	Maximum	7.000
Standard error	0.096	Median	1.163
Standard deviation	1.423	Variance	2.024
Skewness	1.071	Range	7.000

TABLE 8.18

NUMBER OF FEMALES IN HOUSEHOLD OVER AGE 10
WORKING ON SAMPLE HOLDING

No. in household working on holding	Females	Per cent
0	49	22.2
1	68	30.8
2	49	22.2
3	29	13.1
4	16	7.2
5	6	2.7
6	2	0.9
7 and over	2	0.9
Total	221	100.0

Mean	1.701	Maximum	9.000
Standard error	0.102	Median	1.404
Standard deviation	1.520	Variance	2.310
Skewness	1.307	Range	9.000

Over 34 per cent of the males and 22 per cent of the females in the household fail to work on the paddy holding. Many of these children are in primary school and are only available to work full time on the holdings during the vacation period which coincides with the critical transplanting operation. The non-availability of this valuable source of labour presents a serious problem to the farmer. The farmer's only alternative is to try to find hired and/or casual labour in the Settlement or in the up-country during the critical harvesting and transplanting periods. I noted that children between 5 and 10 years old contribute to the household labour supply by helping with transplanting, weeding, and scaring birds from the young seedlings.

Many of the older children between 16 to 20 years are employed part time or seeking employment elsewhere and only sleep at home. The mean number of children between 16 and 20 years per household was only 0.69 (Tables 8.19 and 8.20). Many of the children between 16 and 20 years, with a primary school certificate, consider it beneath their dignity to work on the paddy holding. They are seeking office jobs which seldom exist.

TABLE 8.19

TOTAL NUMBER OF MALE CHILDREN BETWEEN 16 TO 20 YEARS OF AGE IN HOUSEHOLD OF SAMPLE TENANTS, 1973

Range	No. of male children 1 to 20 years of age in household	Per cent
0-1	221	88.4
2-3	27	10.8
4 and over	2	0.8
Total	250	100.0

Mean	0.428	Maximum	4.000
Standard error	0.049	Median	0.0
Standard deviation	0.769	Variance	0.591
Skewness	1.916	Range	4.000

TABLE 8.20

TOTAL NUMBER OF FEMALE CHILDREN BETWEEN 16 TO 20 YEARS OF AGE IN HOUSEHOLD OF SAMPLE TENANTS, 1973

Range	No. of female children 16 to 20 years of age in household	Per cent
0-1	233	93.2
2-3	16	6.4
4 and over	1	0.4
Total	250	100.0

Mean	0.260	Maximum	4.000
Standard error	0.041	Median	0.0
Standard deviation	0.647	Variance	0.418
Skewness	2.820	Range	4.000

Tables 8.21 and 8.22 show the total number of adults in the tenant's household working on the sampled holdings. The mean number of adults working on the sample holdings was only 0.90. This *prima facie* evidence clearly illustrates the great need at Mwea for hired and/or casual labour to perform the heavy work during harvesting and transplanting.

TABLE 8.21

TOTAL MALE ADULTS IN HOUSEHOLD WHO WORK ON THE HOLDINGS OF SAMPLE TENANTS, 1973

Range	No. of male adults who work on holdings	Per cent
0-1	212	84.8
2-3	35	14.0
4 and over	3	2.8
Total	250	100.0

Mean	0.540	Maximum	4.000
Standard error	0.054	Median	0.0
Standard deviation	0.860	Variance	0.739
Skewness	1.642	Range	4.000

TABLE 8.22

TOTAL FEMALE ADULTS IN HOUSEHOLD WHO WORK ON THE HOLDINGS OF SAMPLE TENANTS, 1973

Range	No. of female adults who work on holdings	Per cent
0-1	231	92.4
2-3	18	7.2
4 and over	1	0.4
Total	250	100.0

Mean	0.356	Maximum	4.000
Standard error	0.043	Median	0.0
Standard deviation	0.686	Variance	0.471
Skewness	2.170	Range	4.000

Tables 8.23 and 8.24 show the average number of the tenants own children of working age working on the holding: the mean number of children of working age was only 1.98.

TABLE 8.23

TOTAL NUMBER OF TENANTS' MALE CHILDREN OF WORKING AGE IN HOUSEHOLD WORKING ON HOLDING, 1973

Range	No. of male children of working age in household	Per cent
0-1	173	69.2
2-3	67	26.8
4-5	7	2.8
6 and over	3	1.2
Total	250	100.0

Mean	1.048	Maximum	11.000
Standard error	0.086	Median	0.627
Standard deviation	1.364	Variance	1.861
Skewness	2.338	Range	11.000

TABLE 8.24

TOTAL NUMBER OF FEMALE CHILDREN OF WORKING AGE IN HOUSEHOLD WORKING ON HOLDING, 1973

Range	No. of female children of working age in household	Per cent
0-1	181	72.4
2-3	60	24.0
4-5	8	3.2
6 and over	1	0.4
Total	250	100.0

Mean	0.928	Maximum	7.000
Standard error	0.078	Median	0.0
Standard deviation	1.240	Variance	1.537
Skewness	1.379	Range	7.000

Tables 8.25 and 8.26 show that the mean number of male and female children in the sample tenant's household was 3.09 and 2.87 respectively.

TABLE 8.25

TOTAL MALE CHILDREN IN HOUSEHOLD OF SAMPLE TENANTS, 1973

Range	No. of male children in household	Per cent
0-1	52	20.8
2-3	110	44.0
4-5	58	23.2
6-7	23	9.2
8-9	5	2.0
10 and over	2	0.8
Total	250	100.0

Mean	3.096	Maximum	14.000
Standard error	0.131	Median	2.729
Standard deviation	2.067	Variance	4.272
Skewness	1.195	Range	14.000

TABLE 8.26

TOTAL FEMALE CHILDREN IN HOUSEHOLD OF SAMPLE TENANTS, 1973

Range	No. of female children in household	Per cent
0-1	73	29.2
2-3	96	38.4
4-5	55	22.0
6-7	16	6.4
8-9	9	3.6
10 and over	1	0.4
Total	250	100.0

Mean	2.872	Maximum	11.000
Standard error	0.132	Median	2.700
Standard deviation	2.092	Variance	4.377
Skewness	0.853	Range	11.000

This statistic clearly illustrates that it is not the size of the household that matters but the ability of the tenant to organise, co-ordinate, and utilise the labour supply within his household.

Tables 8.27 and 8.28 illustrate the number of male and female children who work on the sample holdings. The mean number of male children working on the holding was 1.57; the mean number of female children was 1.44.

TABLE 8.27

TOTAL MALE CHILDREN WHO WORK ON HOLDINGS OF SAMPLE TENANTS, 1973

Range	No. of male children working	Per cent
0-1	132	52.8
2-3	92	36.8
4-5	20	8.0
6-7	5	2.0
8 and over	1	0.4
Total	250	100.0

Mean	1.568	Maximum	10.000
Standard error	0.100	Median	1.360
Standard deviation	1.575	Variance	2.479
Skewness	1.340	Range	10.00

TABLE 8.28

TOTAL FEMALE CHILDREN WHO WORK ON HOLDINGS OF SAMPLE TENANTS, 1973

Range	No. of female children working on holdings	Per cent
0-1	143	57.2
2-3	83	33.2
4-5	21	8.4
6 and over	3	1.2
Total	250	100.0

Mean	1.436	Maximum	9.000
Standard error	0.094	Median	1.160
Standard deviation	1.491	Variance	2.223
Skewness	1.181	Range	9.000

Tables 8.29 and 8.30 show the number of male and female children who do not work on holdings of the sample tenants; the mean number of male and female children not working on holdings was 1.48 male and 1.38 female.

TABLE 8.29

TOTAL MALE CHILDREN WHO DO NOT WORK ON HOLDINGS OF SAMPLE TENANTS, 1973

Range	No. of male children who do not work on holdings	Per cent
0-1	140	56.0
2-3	84	33.6
4-5	25	10.0
6 and over	1	0.4
Total	250	100.0

Mean	1.480	Maximum	7.000
Standard error	0.090	Median	1.250
Standard deviation	1.418	Variance	2.010
Skewness	0.850	Range	7.000

TABLE 8.30

TOTAL FEMALE CHILDREN WHO DO NOT WORK ON HOLDINGS OF SAMPLE TENANTS, 1973

Range	No. of non working female members in households	Per cent
0-1	154	61.6
2-3	76	30.4
4-5	16	6.4
6 and over	4	1.6
Total	250	100.0

Mean	1.376	Maximum	7.000
Standard error	0.091	Median	1.086
Standard deviation	1.443	Variance	2.083
Skewness	1.301	Range	7.000

LEVEL OF LIVING OF TENANT AT MWEA

The following information was noted from the field enquiry, illustrative of the degree of affluence at Mwea. 69 per cent of the sample tenants own an *mbati* roof (corrugated iron sheeting) (Photo. 8.3); 57 per cent own one bicycle; 18 per cent have one or more radios; 69 per cent own a sewing machine and only 1 per cent own a car.

I was interested in obtaining the psychological attitude of the tenant toward the Settlement. One of the questions posed was "Are you living better?" 75 per cent of the tenants said "Yes" but the work was harder, more demanding, with less leisure and more worry. The general impression was that the respondent felt that he was subjected to too many demands for the remuneration received from paddy production; but he had no alternative and no place to go. Therefore, it is imperative for the tenant to adjust his life style to Mwea and dismiss his former way of life.

The Tenant's attitude toward Farming at Mwea

The following question was asked of respondents: "In your opinion, what makes a successful paddy farmer at Mwea?" 66 per cent stated the effective use of labour. Other reasons were: good Field Assistant; can save and invest money; and a good Manager. But it was unanimous that working hard and practising good crop husbandry and hygiene on the paddy holding were perhaps the most important factors.

The following question was also asked: What determines good paddy yield? The response was: 47 per cent of the sample tenants stated that working hard and good crop cultural practices was the most important factor; 20 per cent responded that the use of *boma* manure was an important factor; 13 per cent stated that planting early was a contributing factor; and 10 per cent stressed the importance of proper levelling of the fields and periodic weeding.

I observed that livestock were found in each of the sections and were often roaming within the paddy fields unattended. Of the sample tenants, 82 per cent own livestock at Mwea. Unattended livestock can become a very serious problem in the operation of paddy production. There is a great need to have livestock controlled within the Settlement.

It is abundantly clear from the field enquiry data that it is not so much the size of the family or household that matters but how well the tenant organises and trains his potentially adequate labour force to perform the tasks of the paddy production cycle.

CHAPTER 9

DIAGNOSES

This chapter represents a culmination of the field enquiry and research survey conducted at Mwea during the 1972/73 season. The major objectives in these analyses are to bring to light significant factors which have interacted to make the Scheme viable. However, behind the facade of success and affluence, there are severe constraints to continuing stability and future development. Stress will be placed on subjective evaluations based on field observations and substantiated by statistical analysis. An attempt is made to ascertain the socio-economic factors which have differentiated successful, average, and below average farmers at Mwea. The Scheme operations during the 1972/73 season are analysed closely. Emphasis is placed on analysing the social and economic desirability of smallholder farming under organised irrigation in Kenya, combined with efficient production, marketing, and processing functions. Primary emphasis is placed on the geographic, economic, and sociological aspects of successful development. The relationships in incomes, production, and consumption during the 1972/73 season are delineated from regression analyses. Variability of paddy production results from: (1) technological changes particularly in capital/labour ratios and structures; (2) topographic conditions; (3) soil variability;

(4) effectiveness of the Management and Field Extension Staff; (5) willingness of the tenant farmers to change their productive life styles; and (6) climatic and ecological differences.

Social change and social organisation in economic growth and efficiency are analysed. This brings into focus underlying geographic, economic, and social trends and patterns of development which are continuing to take place during the 1973/74 season. The major thrust of this chapter is a comparison of the most successful farmers with those farmers who are unsuccessful. In considering the quality and comprehensive nature of the field enquiry, yield per holding has been selected as the most satisfactory indicator of the measure of success of the sample farmers in the MIS. The information in the Mwea Headquarters, Central Records Office, on the *Summary of Tenants Accounts* is recorded as paddy yield per holding.

The variables which were considered for this analysis are obtained from the farmers' questionnaire. Those selected include aspects of net income, labour input, size of holding, farm expenditures, man days of labour, size of household, length of tenure, and social and economic characteristics of the tenant and his household (Appendix IV). The 20 independent variables used in this analysis are listed in Table 9.1.

The criterion of paddy yield per holding as the best indicator of success is for the following reasons: (1) Mwea is the major rice Scheme in Kenya and is concerned only with paddy production and increasing yields. Mwea is a unique Scheme in a unique setting. The major objective and thrust of the MIS

Management and the Field Extension Staff is directed toward annual increments. (2) Yield per holding is the most precise and sound data measurement available. Precise measurements of paddy weight are taken at each Reception Centre, at 14 per cent moisture content. (3) Yield data are used by the MIS Management and the Field Extension Staff themselves as a measure of the degree of efficiency or success of the paddy farmer.

TABLE 9.1

LIST OF VARIABLES

1. Net Income from paddy farming
2. Size of paddy holding
3. Total personal expenditures
4. Total cost of hired labour
5. Amount of fertiliser used on paddy holding
6. Total number of man days of hired labour
7. Increase in paddy acreage
8. Total income from other sources than paddy farming
9. Length of tenure of farmer at MIS
10. Total man days on paddy holding (hired, farmer, and household)
11. Size of tenants' household
12. Size of family (blood ties)
13. Total number of females in the household
14. Total number of man days spent on non-farm jobs
15. Total number of working members of household
16. Total number of working members over age 10 in household
17. Age of tenant
18. Total number of man days tenant is free of paddy farming
19. Major costs of paddy farming
20. Soil alkalinity problem on holding

A systematic form of analysis was made of three specific categories selected in the field on an *ad hoc* basis to separate successful farmers (the upper 25 per cent), average farmers (50 per cent), and below average farmers (25 per cent).

Throughout this work major consideration has been given to the importance of the human factor in the overall success of Mwea. During the field enquiry some of the pertinent human factors observed were: (1) attitudes of the tenants towards farming; (2) degree of experience in farming; (3) efficiency of the tenant in his operations; (4) diligence and enthusiasm for work; (5) sincerity of effort; and (6) capability of the individual. Working hard on the holding was the most important measure according to the sample farmers. Many of the older farmers stressed the importance of using *boma* manure to rejuvenate their soils. Good productive soils, without evidence of alkalinity, generally produce excellent yields with good cultural practices. However, soils with evidence of alkalinity tend to have lower yields regardless of the diligence and experience of the farmer.

SPATIAL PATTERNS AT MWEA

All too often social scientists fail to recognise the spatial aspects of their studies, as well as time differentials and the display of areal variations and interactions which have important implications for comprehensive research. One of the major objectives of this work is to demonstrate the relevance of spatial aspects at Mwea, which affect the success of the Scheme.

Such analysis involves the challenges not only of space itself, but also of change, adaptive capabilities of the people, and the desire to utilise the best from both the past and present systems of organisation. Spatial aspects of Mwea's success are related to time, environment, ecology, geography and the people of the Area.

The land area for paddy production at Mwea is restricted. In many instances holdings have been abandoned and large acreages have been lost due to excessive alkalinity in the soils. Soil tests by the NAL indicate that the area for expansion or use at Mwea is also firmly limited (Leyder, 1969). Water for irrigation is a further restriction on development at Mwea. It has been estimated that there is enough water to irrigate 12,100 acres of paddy under cultivation, but beyond this limit a calculated risk is involved (Duckett, 1966). R. Golkowsky (1969) in fact limits the area to 11,500 acres as the maximum to be used for paddy cultivation. Golkowsky (1969, 30, 101) elaborates:

> Auf Grund der bis 1967 durchgeführten Bodenuntersuchungen erscheinen noch etwa weitere 4000 acres schwarzen Bodens im Süden Mweas geeignet, in den bewässerten Reisanbau einbezogen zu werden.
>
> ....
>
> Aus projektbetriebswirtschaftlicher Sicht wäre eine Steigerung der extra-fields sinnvoller als eine offizielle Flächenausdehnung. Grenzen sind der Flächenerweiterung jedoch gesetzt durch die Knappheit von Bewässerungswasser und geeignetem Land. Wie schon berichtet, wird Wasser der Faktor sein, der nur eine Reisanbaufläche von 12 000 acres gestattet.

Golkowsky estimates that there is enough water at Mwea for 12,000 acres under paddy cultivation and adequate black cotton soil for 11,000 acres of paddy production. Water and soil, he points out, become limiting factors for any expansion of Mwea. Beyond these limits there is a high calculated risk involved. Golkowsky was aware of these restrictions in 1968, when the Mwea consisted of only 7,000 acres under paddy cultivation (the Mwea, Tebere and Thiba Sections). The Wamumu and Karaba had not been developed.

There is a distinct spatial dichotomy in the geographic setting of the Mwea. The two distinct parts are: (i) the higher Mwea and Tebere Sections; (ii) the lower Thiba, Wamumu and Karaba Sections. It is like living in 2 different settlements. The geography is different, the environment is different, the ecology is different, the people are different, the villages are different, and life style is different. Tenants are assigned to a particular holding and are given a plot for a house in a nearby village. This creates a specific spatial pattern. The older tenants tend to cluster together and associate with others of their age and group; the younger tenants do likewise. Age groupings are in any case a strong influence among the Kikuyu and often more powerful than blood ties. The spatially patterned bio-social cohesive force is a mix of cultural, social and physical influences, which pull these age groups together in a strong way. Man in many ways has created his own ecological environment at Mwea. Over the past 2 decades, the environment has been transformed. Human occupancy has changed substantially and is reflected in the income levels, techniques and life styles of the tenants of the different Sections.

The Reference Map in the back pocket of this work displays the spatial relationships between the high, average and low-yield groups.

Table 9.2 illustrates the distribution of sample farmers in the MIS by introducing three categories: low (LYG), average (AYG) and high-yielding groups (HYG). It shows the number of farmers in each category and length of tenure at Mwea. The Thiba Section, the most viable in the MIS, has a median of 6 years for the LYG and a median of 7 years for the HYG. The Thiba Section had only 4 farmers in the LYG during the 1972/73 season. However, there were 30 farmers in the AYG near the yield threshold which was used to define the high-yielding group. The HYG in the Thiba Section had 16 farmers during the 1972/73 season. This analysis of the Thiba Section is a significant element in the field enquiry. It is interesting to note from Table 9.2 that the highest median length of tenure is found in the Mwea and Tebere Sections. A striking feature of this table appears in the Wamumu Section where there is only one farmer in the HYG. The Karaba Section was under construction during the 1972/73 season. Clearly length of tenure at Mwea is an important factor in tenant performance. However, the vital aspect is the positive attitude of the farmer toward paddy farming and hence his willingness to adhere to the discipline of good crop cultural practices.

The spatial consequence of soil alkalinity at Mwea is profound. In contrast the high-yielding groups in the Mwea have the larger paddy holdings, which contribute to greater production, and are an important spatial element of the measure of success at Mwea.

TABLE 9.2

FREQUENCY DISTRIBUTION OF SAMPLE TENANTS IN LOW, AVERAGE, AND HIGH-YIELDING GROUPS, MWEA IRRIGATION SETTLEMENT, 1973

MWEA SECTION PERFORMANCE 1972/73 SEASON

Sample Group	Number of Tenants in Group	Length of Time on Scheme (years)	Median (years)
Low-yielding Group (72 - 120)*	15	14 - 1	12
Average-yielding Group (121 - 170)*	21	-	-
High-yielding Group (171 - 320)*	14	21 - 9	13

TEBERE SECTION PERFORMANCE 1972/73 SEASON

Sample Group	Number of Tenants in Group	Length of Time on Scheme (years)	Median (years)
Low-yielding Group (72 - 120)*	8	16 - 9	14
Average-yielding Group (121 - 170)*	19	-	-
High-yielding Group (171 - 320)*	23	18 - 4	14

THIBA SECTION PERFORMANCE 1972/73 SEASON

Sample Group	Number of Tenants in Group	Length of Time on Scheme (years)	Median (years)
Low-yielding Group (72 - 120)*	4	7 - 5	6
Average-yielding Group (121 - 170)*	30	-	-
High-yielding Group (171 - 320)*	16	13 - 5	7

WAMUMU SECTION PERFORMANCE 1972/73 SEASON

Sample Group	Number of Tenants in Group	Length of Time on Scheme (years)	Median (years)
Low-yielding Group (72 - 120)*	21	5 - 1	3
Average-yielding Group (121 - 170)*	28	-	-
High-yielding Group (171 - 320)*	1	4	4

KARABA SECTION PERFORMANCE 1972/73 SEASON

Sample Group	Number of Tenants in Group	Length of Time on Scheme (years)	Median (years)
Low-yielding Group (72 - 120)*	5	0 - 2	2
Average-yielding Group (121 - 170)*	45	-	-
High-yielding Group (171 - 320)*	0	-	-

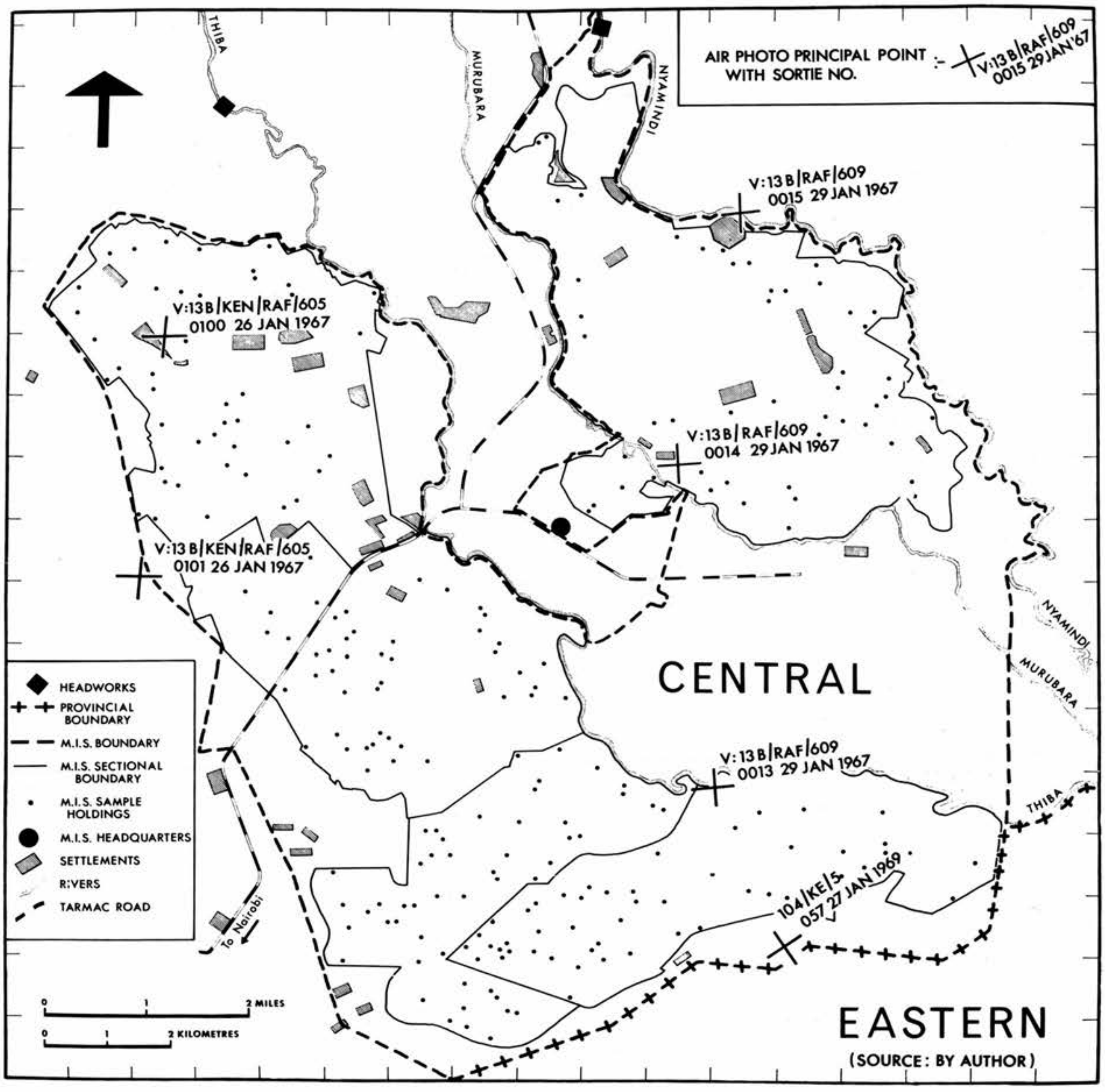
* Bags of paddy

Figure 9.1 shows the air photo coverage of the Mwea. Air photography of Mwea was performed in January 1967 by the RAF. A partial air photo coverage of the southern part of Mwea was made by the Hunting company in January 1969. Figure 9.2 illustrates the major geographic features in the area covered by air photo 0014. It is apparent that air photos provide a valuable tool for study and a basis for interpretation of soils, display of spatial and cultivation patterns, areas of habitation, and trends in the movement of people. Stereoscopic analysis, combined with field survey work, was used for interpretation and analysis of geographic, economic, and social phenomena in the Mwea. The evidence of soil alkalinity in Mwea is clearly seen on the air photo, and the evidence of abandoned land is also observed.

Section-by-Section Analysis of Spatial Aspects

1. Mwea Section

The Mwea Section is the oldest in the MIS. It was initiated in 1954. The first operation was to drain the Nguka Swamp (Reference Map). Nyamindi Headworks were constructed in 1956 and the Thiba Headworks were constructed in 1957. The Mwea was originally a grazing area for Kikuyu herdsmen. Wild life was plentiful throughout the area during the early days. Six camp sites were established during the Mau Mau Insurrection in the Mwea-Tebere Area. It was noted from my field enquiry that some of the original Mau Mau Detainees became tenant farmers and are still on the Scheme. Topographically, the Mwea Section is located in the relatively higher-lying area of the Scheme.



AIR PHOTO COVERAGE OF M.I.S., 1973

FIG. 9·1

COMMENTARY ON FIGURE 9.2

V13B/RAF/609/0014

Scale 1:25,000

1. The white specked areas show clear evidence of soil alkalinity. A lot of mottled areas (alkali soils) are found in Unit T-20.

2. An example of maize and beans growing on the red soils in Mwea.

3. Harvesting of paddy is in progress. Harvested areas appear as white and unharvested areas are black. The paddy fields form a chevron type of pattern.

4. The white dots, likened to a pattern of smallpox, are sites of old thatched huts where fires have been going for a long period of time. The wood ash from the charcoal fires has left soda ash deposits - a form of alkalinity of the soils.

5. Open scrub vegetation intermixed with subsistence plots. When the subsistence plots are abandoned scrub vegetation developed on this area.

6. Unharvested paddy along the feeder drains. The land is too wet to begin harvesting.

7. Villages in the Mwea

   Some of the villages are laid out in a planned manner. Mahigaine Village in the Tebere Section, Units T-6 and T-7, was built in 3 concentric circles. There is considerable habitation in the villages and housing is in short supply.

8. The airstrip at Mwea

   The former Manager of Mwea used this airstrip regularly, particularly from the NIB office in Nairobi.

9. The MIS Headquarters and Administrative Centre

10. MIS Prison

11. Thiba River

FIG. 9· 2

At present the Mwea Section consists of 2,913 acres under paddy cultivation. Significant environmental factors related to the performance in the Mwea Section are the effect of the Nguka Swamp Area of 2,000 acres, which has resulted in waterlogged conditions in the fields contiguous to the Swamp. This has resulted in lower yields in the northern part of the Mwea Section. Also, the prolonged poor drainage conditions in this Section have resulted in lower yields. It is interesting to note that topographically the Mwea Section is split into 2 distinct parts by a steep escarpment. This is a specific spatial characteristic of the Section. Because of the escarpment the 2 parts have developed separately rather than as a whole.

2. Tebere Section

This is the largest Section in the MIS, consisting of 3,040 acres. It came into operation for the first season in 1955, with 300 acres under paddy cultivation. Paddy irrigation was begun on the red soils. This initial operation was a complete failure and the red soils were thereafter abandoned because they did not have the high capacity for water retention so necessary for paddy cultivation. After experimenting with the red soils, it was decided to use the black cotton soils for paddy cultivation under irrigation. This proved to be successful. Spatially, the belt of abandoned red soils split the Tebere Section into 2 separate and distinct parts (Reference Map). This dichotomy is similar to the escarpment effect in the Mwea Section and has a similar impact on the environment and development of the Section.

The Tebere Section is located on the higher-lying basin area of the MIS and has the highest percentage of red soils in the Settlement. The communicating roads on the high, undulating areas are made of no more adequate materials than these red soils themselves. When it is dry they are powder and fineness, with clouds of red dust noticeable as you travel throughout the Section. However, when the red soils are wet, they become so slippery that only a 4-wheel drive vehicle may be used, if that! From a spatial point of view, the high and low-yielding groups are randomly dispersed throughout the Section (Reference Map). It is interesting to note that in the 1972/73 season, the highest-yielding tenant (in Unit T-18), with 321 bags of paddy from his holding, and the lowest-yielding tenant (in Unit T-20), with 80 bags from his holding, were both located in the Tebere. I noted that there were more dark brown textured soils in the Tebere than in any other Section in the MIS. These soils are satisfactory and good paddy yields are obtained with good cultural practices. Soil alkalinity is found in different parts of the Tebere; however, high concentrations of alkali soils are found in Unit T-20.

a) Profile of tenant from LYG (No. 602, Unit T-20)

The major problem of the low-yielding tenant is evidence of soil alkalinity on his holding. This situation has become progressively worse over the past 3 seasons. For example, in 1970/71, 129 bags of paddy, 1971/72 100 bags, and currently 80 bags is a typical diminution in yield, characteristic of the LYG in the different Sections in the Settlement. A substantial decline in yields has taken place seasonally due to accelerated alkalinity, without remedial action by the MIS Management. This tenant has been at Mwea since 1963. His major agricultural problem was seasonal lack of labour and lack of money, or credit. His major harvesting problem was, once again, lack of labour during harvesting. This tenant is over 50 years of age and from the Kirinyaga District. He has 2 wives and 7 children: 3 male and 4 female. Four are in primary school; one older child does not work on the farm, as he has a business of his own. Thus it is his 2 wives and 2 children only who assist on the paddy holding. During the 1972/73 season he hired 13 labourers (at the cost of 500 Kshs. -- his highest expenditure) to help with harvesting and transplanting. He had 100 days free of farming during the 1972/73 season, which could have been used in maintaining his irrigation facilities and preparing his paddy fields. However, he spent most of that time drinking *pombe* and visiting friends in the Settlement and in the up-country.

b) Profile of tenant from HYG (No. 394, Unit T-18)

This tenant has shown a substantial increase in yield from his holding, from 230 bags in 1970/71, to 288 bags in 1971/72 and 321 bags in 1972/73. He has 7 acres under paddy cultivation, representing 3 extra fields. This tenant has no soil alkalinity problems. Moreover, he is innovative: he obtains *boma* manure from the up-country to rejuvenate his holdings, utilises good cultural practices and works hard on the holding. He has 2 acres of cotton on the red soils and receives extra income at the rate of 1.30 Kshs. per kg. Last season he hired 29 people to assist with work on the holding, particularly during transplanting and harvesting. His expenditure on labour was 920 Kshs., representing his second highest expense. He has 2 wives and 15 children; 4 in primary, 1 in secondary, and 1 in nursery school. His major personal expenditure (2100 Kshs.) is educating his children. Four children help with work on the paddy holding, mostly weeding, transplanting and scaring birds off the nursery. He also has 2 labourers living in the household as permanent members. He has made investments in the Mwea Credit Co-operative Society, the Mwea Consumer Co-operative Society and on his 2-acre cotton farm. The only problem he mentioned in response to questioning was a slight attack of leaf miner on his paddy holding. He has been in the Settlement for 12 years and comes from the Muranga District.

3. Thiba Section

Located on the flat plains of the Settlement, it encompasses an area of 2,800 acres. Spatially, it represents the most compact area in the Settlement. Most of the tenants living in this Section are between 30 and 40 years of age: the prime of their life as paddy farmers. This Section is perhaps the most flourishing and progressive in the Settlement. During the 1972/73 season, the Thiba Section had the highest yields in the MIS: 38.7 bags per acre. The soils in this area are black cotton. However, alkalinity problems appear in various parts of the Section (Fig. 3.6). Some of the holdings have shallow soils. One of the interesting characteristics of the tenants in this Section is displayed by the AYG, a considerable number of whom are pushing on the threshold of the high-yielding group. It was noted that with better organisation and administration by the Irrigation Officer, many of these tenants would be in the high-yielding group. I noted that the Irrigation Officer had been recently appointed, and had little experience in paddy farming under irrigation. The Head Field Assistant and Field Assistant were actually running this Section, and were the key reason for its success. Many of the Field Assistants had been trained by a former Manager of the Settlement during the 1959/66 period. The MIS Management certainly cannot afford to fail in this viable Section! The Thiba Section has, in fact, all the necessary characteristics for success; however, the human factor will be the deciding issue.

4. Wamumu Section

Located in the low-lying basin of the Settlement, Wamumu occupies an area of 2,945 acres. Over 160 acres have been recently abandoned in Unit W-6 (Fig. 3.6), because of excessive soil alkalinity. There are also 68 acres in Units W-3 and W-4 which have evidence of alkali soils. Spatially, the LYG is clustered in Units W-3, W-4 and W-5 (Reference Map). These spatial conditions, resulting from the presence of alkalinity, render the Section vulnerable. There exists a significant contrast in the topography and ecological conditions in this Section, in comparison to the higher-lying Mwea and Tebere Sections. I noted that there was a serious lack of management and coordination here. The Irrigation Officer had been recently appointed; the

Head Field Assistant and the Field Assistants were managing the Section. The Head Field Assistant was the most experienced of the Field Extension Staff that I met at Mwea. He has been there since 1958. The MIS Management has contracted the services of ILACO Consultants on an annual basis. ILACO has attempted to solve the spreading alkalinity problem in the Wamumu Section, but has not yet succeeded. ILACO has used gypsum and flooding techniques on the 160 acres of alkali soils on 6 different occasions. However, there is still no paddy grown on these soils. There is basically an environmental contrast here to the other Sections, which is significant. Are the Kenya Government and the NIB getting value for money spent on high consultancy fees?

5. Karaba Section

This is the lowest-lying area in the Settlement. This flat-bottomed basin is the most recent Section to be added to the MIS and encompasses an area of 2,712 acres. I noted that there is a marked drop in the terrain on leaving the Wamumu. From a spatial point of view, it is significant that an estimated 300 - 400 acres already have evidence of high alkalinity, particularly in Units K-3 and K-4. This is reflected in the clustering of the LYG (Fig. 3.6). It is expected that this 300 - 400 acres will have to be abandoned in the 1974/75 season. During the 1973/74 season, 400 acres were abandoned, due to excessive soil alkalinity in Units K-5, K-6 and K-7. These Units failed to raise a paddy crop in 1973/74, in spite of several attempts at re-planting (*Mwea Irrigation Settlement, Quarterly Report*, Oct.-Dec. 1973, 4). This soil alkalinity problem which affects the Section is possibly correlated with the physiographic features in the area: waterlogged soils, poor drainage, the friability of the soil, and the fact that these soils cannot be rotavated under water, hence dry rotavation has to be performed. Has Mwea another Wamumu experience at Karaba? Is the Karaba a total failure, resulting from implementation based on political reasons? Has implementation been done without planning? Will the drag of the Karaba destroy the balance of Mwea? These are provocative issues which the MIS Management is now called upon to face.

CORRELATION ANALYSIS

The Statistical Package for the Social Sciences (SPSS) system devised by Nie, Bent, and Hull used in this study furnishes the Pearson correlation for performing correlation analysis which was run on the IBM 370/155 computer at the Edinburgh Regional Computing Centre (ERCC) during May - August 1974.

The SPSS programme was used to produce scattergrams and correlation coefficients from ordinal data of the sample survey. It also provides tests of the level of significance and has the capability of producing matrices from the SPSS system.

The results of the Pearson correlation provide a single summary statistic describing the strength of association between 2 variables: in this case the dependent variable is paddy yield <u>per holding</u> and the independent variables are selected from the field enquiry (Table 9.3). The correlation coefficients determine

TABLE 9.3

LIST OF VARIABLES -- CORRELATION WITH PADDY YIELDS

Variable		All tenants group	Low-yielding group	Average-yielding group	High-yielding group
210	Net income from paddy farming	.86	.23	.46	.85
007	Size of paddy holding	.78	.11	.37	.75
174	Total personal expenditure	.76	.25	.47	.65
062	Total cost of hired labour	.68	.28	.20	.63
020	Amount of fertiliser used on paddy holding	.64	.05	.15	.71
064	Total number of man days of hired labour	.55	.33	.11	.54
010	Increase in paddy acreage	.51	.16	.08+	.11
New Var 41	Total income from other sources than paddy farming	.40	-.08	.02	.44
084	Length of tenure of farmer at MIS	.38	-.04	.16	.22
New Var 1	Total man days on paddy holding (hired, farmer, and household)	.34	.06	.08	.65
New Var 9	Size of tenant's household	.34	-.26	.37	.22
New Var 10	Size of family (blood ties)	.30	-.21	.34+	.19
101	Total number of females in the household	.28	-.27	.38+	.10
058	Total number of man days spent on non-farm jobs	.24	.15	.15	.35
063	Total number of working members of household	.23	.33	.13	.38
New Var 8	Total number of working members over 10 in household	.20	-.40	.20+	.13
090	Age of tenant	.18	.09	.03+	.09
059	Total number of man days tenant is free of paddy farming	.05	.12	.15	.11
New Var 26	Major costs of paddy farming	-.17	.17	-.09+	-.10
222	Soil alkalinity problem	-.48	-.30	-.34	.99

All correlations are significant at 2 standard errors.

\+ These variables are not significant at the 95 per cent confidence level.

the degree of covariation existing between the dependent and independent variable. The matrix of correlation coefficients is shown in Appendix IV. Some of these independent variables are doubtless intercorrelated; however, taken separately, they indicate relationship to yield.

Synthesis and Interpretation of Variables

The following interpretations of the 20 independent variables (Table 9.3) are dependent upon the degree of relationship which exists between yield per holding as the dependent factor, and each selected independent variable.

Factors affecting the High-yielding Group

The 8 independent variables with correlations greater than .50, in the HYG, are regarded as the most important factors influencing paddy yield and offer individual explanations of the degree of success of the HYG (Table 9.4). This approach and interpretation is systematic in that it illustrates that a number of interrelated factors exist and interact in Mwea.

The highest coefficient, .99 relates to the nature, condition, and variability of the soil. The HYG generally has no soil alkalinity problems. However, this is not the case for the other groups (Table 9.3). Evidence of soil alkalinity exists in varying degrees for each of these groups. An inverse relationship is indicated by the negative coefficients for variable 222 (Table 9.3). Evidences of alkalinity exist in the different sections of the Mwea. It is not surprising that variable 210,

TABLE 9.4

LIST OF VARIABLES -- CORRELATION WITH PADDY YIELDS OF THE HIGH-YIELDING GROUP

Variable		Correlation Coefficient
222	Soil alkalinity problem	.99
210	Net income from paddy farming	.85
007	Size of paddy holding	.75
020	Amount of fertiliser used on paddy holding	.71
174	Total personal expenditures	.65
New Var 1	Total man days on paddy holding (hired, farmer, and household)	.65
062	Total cost of hired labour	.63
064	Total number of man days of hired labour	.54
New Var 41	Total income from other sources than paddy farming	.44
063	Total number of working members of household	.38
058	Total number of man days spent on non-farm jobs	.35
New Var 9	Size of tenant's household	.22
084	Length of tenure of farmer at MIS	.22
New Var 10	Size of family (blood ties)	.19
New Var 8	Total number of working members over age 10 in household	.13
010	Increase in paddy acreage	.11
059	Total number of man days tenant is free of paddy farming	.11
101	Total number of females in the household	.10
090	Age of tenant	.09
New Var 26	Major costs of paddy farming	-.10

net income has the second highest coefficient, .85 (Table 9.4); this closely linked variable has a direct relationship to yield. This close association between high yield and high net income is, of course, predictable. Variable 007, size of paddy holding, .75 is one of the best indicators of yield and net income. The average size of holding for the HYG was 5.5 acres compared to 4 acres for the low-yielding group. The proportion of net income obtained from the sale of paddy is substantial compared to the average and low-yielding groups. The larger the holding, the greater the likelihood that the tenant's net income will also be larger. Other variables which increase with the size of holding are New Var 1, total man days on holding, .65, variable 062, total cost of hired labour, .63, and variable 064, total number of man days of hired labour, .54.

Table 9.4 reveals the profile of the high-yielding group in Mwea. The human factor plays a major role in the efficiency of the high-yielding group. In this group the tenants utilise their scarce resources efficiently and effectively. They employ the factors of production-land, labour, capital, and entrepreneurship -- at an optimum level. Uppermost, the HYG organise and utilise their labour supply effectively. They manage their own family resources by training the members of the household to be effective workers in the various tasks of the paddy production cycle. They make excellent use of fertiliser and apply it systematically at critical programmed periods. They are innovative and quick to seize an opportunity to increase their yields. For example, they obtain *boma* manure at optimum times during the growing season from the up-country to rejuvenate the soils of their holdings. On average, yields are increased from 5 to 10 bags per acre. Above all, they practice good crop husbandry and hygiene. Psychologically, they are attuned to paddy farming; they enjoy paddy farming and its remunerations. They are adjusted to the new life style at Mwea. They are eager to improve their performance, attempt new farming techniques, and to increase yields, and net income. Many of those in the HYG have permanently hired and trained labour living within their household. They are well organised and have a sufficient supply of efficient hired and/or casual labour experienced in paddy farming to assist them in their operations. Many of the workers are hired regularly, particularly during the heavy work periods of harvesting and transplanting. It was also observed that success in Mwea is often related to length of tenure (Table 9.3). The HYG which has been at Mwea from 5 to 10 years has developed a high degree of efficiency and expertise in paddy farming. They are often the farmers who have the larger holdings (Table 9.3), receive more return from their inputs, and have a high morale and motivation for paddy farming. Moreover, these farmers of the HYG utilised their income from other investments to improve their paddy holdings (Table 9.3).

The high degree of efficiency displayed by the HYG was a significant finding of the field enquiry. These farmers are successful because they are good managers and have displayed considerable business acumen. It was apparent that the optimum use of their labour supply is the result of training these workers efficiently over a long period of time. They are effective workers. Much of the hired and casual labour is contracted over a long period of time. This is rarely the case among the low-yielding group.

Mwangi Kabugi, Head Field Assistant in the Wamumu Section, states:

> The labour problem at the peak times of transplanting and harvesting is serious and becoming worse each year. There should be a circulation of labour technique introduced into the different sections of the Mwea to relieve the serious labour shortage problem which exists during peak periods. People from up country just don't want to do the heavy work in the paddy fields at transplanting and harvesting periods.
>
> In 1967 there were signs for the first time that a labour problem existed in the Mwea. Each season the labour problem has become worse and now it is acute. With the addition of the Karaba Section, the labour problem will be substantially increased. In order to alleviate this problem, to some extent, the paddy fields should be planted at intervals of one week apart so that the harvest will not come in at the same time. This may be a partial solution to the acute labour problem at Mwea.

The key to the success of the HYG is its efficiency of paddy production and entrepreneurship. Other factors enhancing the high-yielding group are that: (1) they train their labour supply to be efficient and effective during the critical harvesting and transplanting periods; (2) they integrate labour into their households on a permanent basis; (3) they are able to face the impact of inflation and increased cost of labour; (4) they have acquired additional money from outside sources and investments;

and (5) they budget their money and time.

The age of the farmer has very little impact on yield. The length of tenure is more important in its association with yield than the age of the farmer (Table 9.3).

Factors Affecting the LYG

This is an attempt to present a profile of the tenants in the LYG in Mwea. Analytically this can be done by an evaluation of the correlation coefficients of the particular variables having the greatest impact, indicative of the poor performance of the group.

The most striking aspect of Table 9.5 concerns the 7 independent variables with negative correlation coefficients ranging from -.04 to -.40 in the low-yielding group. These variables may be regarded as the most significant factors affecting paddy yield and reflect individual explanations of the poor performance of the low-yielding group. The inverse relationships, which are indicated by the negative coefficients, show a degree of poor performance of the low-yielding group. The lowest coefficient, -.40 (Variable New Var 8) reflects the inability of the LYG to mobilise members over age 10 in their household to work on the paddy holding (Table 9.5). The next lowest negative coefficient, -.30 (Variable 222) refers to the accelerating soil alkalinity problem in Mwea. Problems of soil alkalinity are found primarily on the holdings of the low-yielding group. However, evidences of soil alkalinity problems also appear in the average-yielding group. Variable 101 reflects the number of females in

TABLE 9.5

LIST OF VARIABLES -- CORRELATION WITH PADDY YIELDS OF LOW-YIELDING GROUP

Variable		Correlation Coefficient
064	Total number of man days of hired labour	.33
063	Total number of working members of household	.33
062	Total cost of hired labour	.28
174	Total personal expenditures	.25
210	Net income from paddy farming	.23
New Var 26	Major costs of paddy farming	.17
010	Increase in paddy acreage	.16
058	Total number of man days spent on non-farm jobs	.15
059	Total number of man days tenant is free of paddy farming	.12
007	Size of paddy holding	.11
090	Age of tenant	.09
New Var 1	Total man days on paddy holding (hired, farmer, + household)	.06
020	Amount of fertiliser used on paddy holding	.05
084	Length of tenure of farmer at MIS	-.04
New Var 41	Total income from other sources than paddy farming	-.08
New Var 10	Size of family (blood ties)	-.21
New Var 9	Size of tenant's household	-.26
101	Total number of females in the household	-.27
222	Soil alkalinity problem	-.30
New Var 8	Total number of working members over age 10 in household	-.40

the household; the correlation coefficient is unusually low: -.27. I observed that in many instances the women were burdened by household tasks when they had unusually large families. Hence they were unable to help the tenant on the holding. Variable New Var 9, size of tenant's household, has a correlation coefficient of -.26. It is not surprising that this variable has such a high inverse relationship to yield. I observed that it was extremely difficult for the LYG tenants to mobilise the members of their household to perform the tasks in the paddy production cycle. Variable New Var 9 reveals a significant finding in this study: it is not the size of the family that matters, but the ability of the tenant to organise, co-ordinate and train the members to perform the various tasks on the paddy holding. This is one of the reasons why the tenants are dependent upon hired labour to help them with their operations, particularly the heavy work involved in harvesting and transplanting. Variable New Var 10, size of family (blood ties), has a coefficient -.21 which illustrates the inability of the tenant in the LYG to utilise the members of his immediate family. Total income from other sources than paddy farming (Variable New Var 41), with a coefficient -.08, illustrates the inability of the low-yielding group tenants to obtain income from other employment. Supplementary jobs are scarce at Mwea and there is a high degree of unemployment in the Settlement. Length of tenure of farmer at the MIS (Variable 084) has a coefficient -.04. This coefficient is unusually low because it reflects the new tenants coming into the Karaba. If the Karaba had not been included in this field enquiry, in all likelihood this coefficient would have been much higher.

It is also necessary to evaluate some of the highest coefficients in the low-yielding group. The highest coefficients, .33, relate to total number of man days of hired labour (Variable 064) and total number of members of household (Variable 063). The first illustrates the need of the low-yielding group for hired labour to help with the paddy operations. Total cost of hired labour (Variable 062) has a coefficient of .28. This is not surprising, since the LYG hire labour whenever possible. Total personal expenditures (Variable 174), coefficient .25, shows that the low-yielding tenants have high personal expenditures which are used to maintain the household: food, clothing, fuel, relatives, etc. Net income from paddy farming (Variable 210), with a coefficient .23 represents a significant statistic, as shown in Table 9.3. The coefficient for the LYG is substantially lower than the AYG coefficient .46, and the HYG has a substantially higher income from the paddy holding than the other two groups.

The low-yielding group is to a high degree dependent on hired and/or casual labour, which may or may not be available. Regardless of the size of the household, the LYG is unable to mobilise it to perform the required tasks. They fail to budget their money properly, and I noted that they are chronically in debt throughout the season. For example, by the end of July, they have often spent all of their income from the seasonal May payout and must receive an advance from the Mwea Credit Co-operative Society in order to pay for labour to assist them in the transplanting operation. Likewise, in January of each season, many require an advance payment from the MIS Management in order to pay for labour to perform the all-important harvesting operation. This advance is deducted from the gross income at the final payout in May.

This profile of the LYG clearly illustrates that they are inefficient paddy farmers, and fail to use their land, labour and capital effectively. The LYG with large families are often burdened with extra expense; in fact, in many instances the size of the household of the LYG acts as a hindrance to their efficiency and output. Poor cultural practices and the neglect of the paddy holding over long periods of time by tenants in the LYG are other major causes of low yield.

I became conscious of the importance of seasonal grouping of farmers and the impact on yield per holding; farmers who plant early have, on average, higher yields than those who plant late.

The Field Assistant plays a key role in the paddy production cycle and supervises the farmers' operations. It was apparent that, without the close supervision of the Field Assistants, yields would drop off substantially for the low and average-yielding groups. The importance of an adequate number of trained Field Assistants of a high standard is manifest, and note should be taken of Mwangi Kabugi's statement:

> The main reason why the new tenants come to Mwea is for money! They have high expectations of receiving good yields and money at the end of the first season. Nothing could be

> further from the truth. There is a great difference between the new tenant coming into Mwea and the old-established tenant. The Field Assistant is the heart of the system at Mwea -- everything evolves around him. However, the Field Assistant's wage is low and he has not had an increase in wages since 1965; this situation has resulted in a state of low morale of the Field Assistants and the Field Extension Staff in the Mwea. The Field Assistant's wage has not been increased to meet the rising cost of living. I will not be here next year if I can find something better!

Mwangi Kabugi, Head Field Assistant of the Wamumu Section, is the most experienced member of the MIS Field Extension Staff, and was trained over a period of years by a former Manager, E.G. Giglioli.

The MIS Management needs to carry out disciplinary measures against many of the negligent farmers in the low-yielding group. Absenteeism, failure to maintain holdings, poor cultural practices, and failure to comply with crop time-tables are some of the major factors which have resulted in low yields. A time and frequency schedule and close supervision exercised by the Field Assistant will result in good husbandry and will increase paddy output substantially.

Shortages of water during the growing season will necessitate stretching out irrigation schedules. This is a serious problem.

Synthesis of Group Variables at Mwea

This phase of the analysis concerns an evaluation of the selected variables (Table 9.3). An attempt will be made to evaluate the performance of each group in comparison to the all tenants group in the sample survey. Clearly, the most important variable in its relationship to yield is 210, net income from paddy farming. This is not surprising, since net income is closely linked with yield, and in fact has a direct relationship to yield. Size of paddy holding (Variable 007) is directly related to yield and net income. The high-yielding group has substantially larger holdings compared to the other groups, therefore the net income obtained from the sale of paddy is considerably greater. The highest coefficients appear in certain Variables because a substantial number in the AYG (particularly from the Thiba Section) are on the threshold of the high-yielding group. Total cost of hired labour (Variable 062) illustrates the ability of the HYG to invest in hired and/or casual labour by contrast with the inability of the low-yielding group. This offers an explanation for the relatively high coefficient .68 in the all tenants group illustrating the dependency of the tenants on hired and/or casual labour. Amount of fertiliser used on paddy holding (Variable 020) clearly relates to the comparative amount of acreage in each of the groups. The high-yielding group on average has 5.5 acres, compared to 4 acres for the low-yielding group. The .64 coefficient for the all tenants group indicates that many of the tenants in the high and average-yielding groups have extra fields. Tenants in the LYG have only 4 acres. Total number of man days of hired labour (Variable 064) illustrates the need and use of hired and/or casual labour by both the low and high-yielding groups. This is reflected in the coefficient .55

in the all tenants group. An increase in paddy acreage (Variable 010) shows a coefficient of .51 for the all tenants group. The high and average-yielding groups have extra fields, in contrast to the low-yielding group. The total number of working members of the household (Variable 063) has a coefficient .23 in the all tenants group which reflects the very low coefficient in the average-yielding group. Total man days on paddy holding (Variable New Var 1) shows a substantial difference between the HYG, coefficient .65 and the low and average-yielding groups with coefficients of .06 and .08 respectively. The coefficient .34 for the all tenants group reflects the total number of man days on the paddy holdings in the high-yielding group.

I observed that a considerable number of tenants in the LYG spend a substantial amount of time on the red soils and neglect their paddy holding. This time might be seen as fruitfully spent in, for example, cotton cultivation; but experience shows that the effort of attempting to produce a cash crop from the red soils, in view of the vagaries of the weather, involves a calculated risk, and that tenants would be wiser to use their free time improving their paddy holdings.

E.G. Giglioli states:

> The cotton crop, grown by the rice farmers on 254 acres of non-irrigated red soils, yielded 201,574 pounds of seed cotton, with an average yield of 794 pounds per acre. The gross value of the crop totalled K£4,848, giving a net return per farmer of K£12. In terms of the amount of labour absorbed and the inevitable neglect of the rice holdings, dry-land cotton growing is

> probably a waste of time for the Mwea farmer. (*National Irrigation Board Annual Report 1968-69*, p.16).

This is certainly so. The average Mwea farmer would be wise to concentrate his resources and efforts on good rice husbandry and hygiene practices which would result in substantial increases in paddy yields and net income.

CHAPTER 10

CONCLUSIONS AND PRESCRIPTION FOR THE FUTURE

The objectives of this study were fourfold: (1) to find out why the Mwea is a successful smallholder organised irrigation settlement; (2) to find out what factors make a successful paddy farmer at Mwea; (3) to ascertain the spatial and environmental constraints of future development of Mwea itself; and (4) to find out if the Mwea experience and success can be duplicated elsewhere in a similar irrigated scheme in Kenya.

The primary aim of this concluding chapter is to pull together all of the findings of the field research and enquiry and appraise Mwea from the point of view of a successful organised smallholder irrigation scheme. Primary emphasis is placed on geographic, economic, sociological, and environmental aspects of successful development. The major thrust of this analysis is directed toward using Mwea as an example of successful smallholder farming in Africa combined with efficient production, marketing, and processing functions.

THE PROFILE OF SUCCESS AT MWEA

Mwea is in fact a hybrid of plantation agriculture and successful smallholder farming under centralised control and close supervision. The scheme started from scratch in 1955.

Since then Mwea has become the most highly sophisticated and successful rice scheme under organised irrigation in Africa. On average, it has produced 3 tons of paddy per acre, thus ranking with the highest paddy producers in the world. This certainly argues a real measure of success.

The power keys responsible for this success are: (1) an available and adequate water supply; (2) good black cotton soils; (3) a high degree of expertise in managerial leadership; (4) disciplined tenants; (5) close supervision of farmers by Field Assistants. Mwea was developed from the crises of the Mau Mau Insurrection and out of the necessity of using landless, unemployed, Kikuyu. There was not, then, an initial careful screening of tenants for specific skills and aptitudes, and this makes the achievement the more impressive. However, the success of Mwea is continually being tested. It is necessary to erase the blackboard of the past and analyse the socio-economic conditions of Mwea as they exist now and to try to see what lessons they can provide for the future. One must keep in mind that an organised irrigation system is a complex entity that may be compared to a spider's web.

"SPIDER'S WEB EFFECT"

If such a sophisticated engineering project, designed on the principles of hydrological engineering, is altered in ways that conflict with the design, is over-strained in use, or is permitted to degenerate by neglect, then it will revert to a state of disequilibrium, analogous to a spider's web being pulled at one end, so that every strand in the web is affected. It is when these inter-relationships in an irrigation system are not understood and appreciated properly, and when political actions disregard these crucial factors, that problems are created. Success brings further problems. There are few men in Kenya with the ability to manage an organised irrigation scheme. There is very great need for a highly trained and pragmatic Manager at Mwea, and many obvious arguments for his being a national of the country. One of the keys to the success of Mwea is the fact that the tenant can afford to hire his labour. However, if the hired labour supply dries up then the tenants are in deep trouble, as most members of their immediate families will not readily work for them.

Moreover, Mwea is an hierarchical organisation, with centralised control, committed to hydraulic agriculture. Paddy production uses a substantial amount of water. The Mwea irrigation system was designed and constructed to be in perfect equilibrium for proper water flow.

An important technical issue involves the adequacy of the Mwea water system to supply 14,000 acres of paddy under irrigation and the failure to maintain the proper flow of water throughout the system, particularly in the main drains and the feeder drains. The related risks of increasing salinity of the soils due to leaking bunds, waterlogged conditions and poor crop husbandry and crop hygiene, particularly by the low-yielding tenants are serious problems facing Mwea. Field observations revealed increases in siltation of drains and feeders throughout the Mwea system.

There is a striking imbalance at Mwea created by the Management, the low morale of the Field Extension Staff, and lack of tenant initiative, particularly among the low-yielding group.

Moreover, at the political level, this centralised control over the operations and planning at Mwea poses real issues between Mwea and the NIB and between Mwea and Nairobi.

CHANGING DEMOGRAPHIC CONTEXT

The demographic context of Kenya has changed drastically over the last decade. At present the population is approximately 13.5 million, increasing at well over a 3 per cent annual rate. The national picture of Kenya is changing dramatically. Over 3,500 formerly landless families are accommodated on Mwea's 14,000 acres. By using the sample survey figure of 6 people per family, Mwea is currently directly supporting approximately 21,000 people, excluding employees and their families. In addition, over 500 permanent jobs have been created, as well as a substantial amount of work for hired and/or casual labour at peak periods of harvesting and transplanting. The Mwea Area was practically uninhabited prior to irrigation. A striking finding in this study is the high population absorption capacity as an attractive feature of Mwea. This is particularly important for a country like Kenya, faced with demographic pressure, a paucity of natural resources and limited amounts of naturally high-potential land.

Significance of the Tenantry

The development of irrigation schemes, all of which had their inception in the early 1950's, was only one aspect of the major progress of agricultural improvement undertaken in response to the pressures generated by the Mau Mau Emergency. During this period there was no tradition or experience in irrigated cropping to draw on, no experience in hydrological engineering or available agriculture expertise. Also, very little thorough research had been done on irrigation possibilities in Kenya. Under these conditions planning was reduced to an *ad hoc* basis. Irrigated agriculture came first to Mwea and acted as a catalyst in the development of the Area. But the human factor has played a major role in the development of Mwea since its first conception. The capability of the tenant himself is the major variable affecting output. His ability to hire and train labour, organise the necessary tasks to be performed in the paddy production cycle, and plan and budget his income and expenditures properly is critical. Those tenants who are inefficient and fail to plan and budget their money become a drag on Mwea. I observed that the effect of the Field Assistant on paddy yields and tenant performance is profound. Generally speaking, paddy yields are closely associated with the performance of the Field Assistant and the degree of close supervision which he exercises. Without his close supervision, paddy yields at Mwea would drop off sharply.

What factors have an important bearing on the tenants' performance at Mwea? What type of tenants make the best farmer?

What factors contribute to a successful paddy farmer at Mwea? These questions are complex in nature but germane to the analyses. Some of the factors which affect paddy yield were described at length in Chapter 9, with the following summary conclusions:

1. Attitude of the farmer towards work: whether the farmer is willing to exercise extra effort to obtain good yields, practice good crop husbandry and hygiene, and, uppermost, co-operate with the Field Assistant. The human factor at Mwea is of major concern in evaluating success.

2. Age of the tenant: it was noted that the younger tenants aged 25-35 are generally the best farmers. They work hard and follow the instructions of the Field Assistant implicitly. For their effort these farmers are given extra fields.

3. Size of the family household (blood ties): it was observed that the major problem facing the tenant is the ability to mobilise his family to help him with the different tasks in the paddy production cycle. It is this -- not the size of the family in mere numbers -- that matters. The degree of success in mobilising the family labour varies greatly among the tenants.

4. Level of education: it was noted that the level of education of the tenant does not matter too much in obtaining good yields.

5. Amount of hired and/or casual labour used on the paddy holding: there is considerable demand for hired and/or casual labour during harvesting and transplanting. However, the lack of labour now and in the future is a major problem facing Mwea.

6. Condition of soils: it was observed that the high-yielding group have excellent soil and maintain it properly. Many use *boma* manure to rejuvenate their soil which increases yields substantially. However, the low-yielding group is often encumbered with soil alkalinity problems, waterlogging conditions, poor drainage conditions and leaking bunds. In fact, this is a cause and effect relationship: careless irrigation practices by the low-yielding group at Mwea have led to a rapid spread of alkalinity of soils within that Area.

7. Time of planting: it was observed that the farmer who plants early, on average, receives higher yields than those who plant late, *mutatis mutandis*. However, at Mwea each unit in a particular section is designated a time to plant and this is done on a rotation basis.

The Household

The head of the household at Mwea is generally the tenant. Usually he is married to one or more wives, who take care of their own children. It was observed that each wife works independently in her household. These households form the basic social units at Mwea. In many of the families the children have grown up, and have left Mwea, particularly in the Mwea and Tebere Sections. Unable to find permanent employment in the urban centres, they have to be supported by their family, without doing any productive work for the household on the scheme. The smaller, resident families often have permanent hired labourers lodging with them who are paid 16 Kshs. per month in cash, plus board and lodging. When a tenant has two or more wives, which frequently occurs at Mwea, one wife looks after the children to free others for work in the fields. Much of the overall work load at Mwea is carried by women. I noted that the women have to collect heavy bundles of firewood from miles away and it is usual to see women trudging the paths with back-breaking burdens. They also transport water for household use in big tin drums from a nearby river or an irrigation furrow or drain. The washing is also done in these rivers, furrows and drains (and this creates a health hazard). In addition, women do the cooking and care for the children. Most of the work on the holdings, too, is done by the women. The tenants help with the paddy cultivation and direct operations, but I noted that great differences exist between the households of the drags and those of the high-yielding tenants. Some of the tenants, particularly the high-yielding ones, take an active part in paddy cultivation tasks. However, I noted that a considerable number try to evade these responsibilities in any manner and way possible.

Health Conditions

The inadequacy of the provision of a domestic water supply at Mwea is a critical problem. The problem of water hygiene is serious. I noted that no real effort has been made to take care of the water consumed by the people. There is urgent need for a water-purification system at Mwea.

The increase in the incidence of bilharziasis, ascariasis, malaria, and amoebic diseases is debilitating and causes a loss in the tenant farmer's efficiency. There is great need for remedial action by the NIB to correct the spreading effect of bilharziasis and ascariasis. These diseases result in a debilitating effect on children, youth and tenants at Mwea and tend to destroy their health and ability to do good work. There is a relatively high incidence of malnutrition in children in the MIS (as Korte indicates on p. 19 of his full-scale study of nutrition and disease: *Report on the Nutrition Survey Conducted on the Mwea-Tebere Irrigation Scheme*, 1967). The NIB and MIS Management must face up to these social problems confronting the people at Mwea. The status of health of the population at Mwea should be of prime concern and have high priority in future plans. The social and medical costs necessary to bring about the desired amenities: sanitation, water purification, medical facilities, education and housing should be absorbed by the substantial profits made by the NIB from the Mwea Scheme. In the past, these profits have been used to prop up the other irrigation schemes in Kenya, namely Ahero, Perkerra, Galole, Bunyala and Yala Swamp.

Population Build Up

Population build up at Mwea has been increasing at an alarming rate. This has resulted in intense population pressure on the limited land area. Population has almost doubled over the past 10 years. The concentration of population may be seen on air photo (Fig. 9.1), which illustrates the high density of population in the villages at Mwea.

Labour Problem.

The lack of hired and/or casual labour at the critical periods of harvesting and transplanting is now an acute problem at the Mwea and has been exacerbated by the addition of the Karaba Section. The apathy and the affluence of the tenants have helped to create this problem. For example, the tenants depend too heavily on hired and/or casual labour to perform their major tasks, particularly transplanting and harvesting. This is a vulnerable situation. If the supply of labour from the up-country dries up, what will happen to the Mwea? As illustrated and backed by statistical data in the field enquiry, many of the tenants in the low-yielding group are unable to mobilise their household labour. This is a serious problem.

Training and Vocational Programmes

I noted during my field survey that there was a total absence of any training programme for the Field Extension Staff, new tenants, or a vocational programme for the tenants. This is an appalling situation, because the tenants could utilise their substantial amount of free time (on average 150 days a year) in pursuing other interests, particularly cottage industries. I observed that the only vocational training school in existence in the area was in the Gathigiriri Prison (Reference Map).

Social Trend

Many of the young tenants are not inclined to have 2 or 3 wives, because of economic reasons. The costs of taking care of a large family have increased considerably at Mwea: the cost of food, clothing, and of sending the children to school. Thus, it is economically not feasible for many of the young tenants to have more than one wife.

TECHNOLOGY AND YIELD

Low yields per acre also reflect the under-utilisation of the labour force. An increase in the input of labour and in labour efficiency would raise yields, even without technological innovation or any additional investment, except work. Much of any such increase in input should be directed to better use of existing technology -- toward improving the land, toward constructing works for water conservation and distribution, toward building more and better farm-to-market roads and toward improving inadequate amenities in the villages (Myrdal, 1974, 178).

Technological innovations can certainly improve yields. However, at Mwea, better crop husbandry and crop hygiene would increase yields 20 - 30 per cent without additional inputs of fertiliser, improved seeds, technology, etc. Creating the possibilities and incentives for a farmer to work more, to work harder and more efficiently, and to invest whatever he can save to improve his land, is of vital importance for the future of Mwea.

LACK OF SOCIAL AWARENESS

Social Conditions in the Mwea Setting

In approaching the problem of social conditions at Mwea, it is fair to ask the following: Can the Management of Mwea and the NIB continue to ignore the critical and deplorable social conditions in the Area? How long can this benign neglect (lack of sanitation, clean drinking water, housing, education facilities, proper nutrition, etc.) continue at Mwea? How long can the General Manager of the NIB and the Manager of the MIS continue to neglect these deteriorating social conditions at the expense of subsidising and supporting the other unsuccessful irrigation schemes in Kenya? How long can the Mwea Management ignore the need for social changes and prompt action in the face of an intense population build up at Mwea? These issues contain the seeds of a potentially explosive situation. Some of Mwea's major social problems are summarised below.

1. The lack of sanitation facilities is deplorable.
2. A water purification plant is long overdue. There are over 14,000 acres of water, and yet not a clean drop to drink.
3. The lack of housing for the tenants and their families is, in many sections, critical.
4. The population build up in the area is intense.
5. Medical facilities to take care of the increasing population are deplorably inadequate. Outbreaks of diarrhoea in the area are common. Bilharziasis, malaria, ascariasis, and amoebic diseases are widespread. During my field enquiry the Irrigation

Officer of the Thiba Section was ill with bilharziasis on several occasions and it was impossible for him to perform his duties. This was true also of many of the Field Assistants. This condition brings about inefficiencies in paddy production for the Sections and the Scheme. Malnutrition of the young children is prevalent throughout the Settlement. This is due principally to the lack of protein in their diet.

6. Vocational facilities to train people in other lines of endeavour when they are not working on the paddy holdings are seriously lacking.

7. A training programme for new members of the Field Extension Staff who play such a vital role in the paddy production at Mwea is greatly needed.

8. The lack of educational facilities for an increasing number of children entering primary and secondary schools.

9. The lack of social amenities for the tenants and their families.

10. The high degree of unemployment of a growing number of young teenagers, not out of primary school. It was observed during my field survey that there were many teenagers roaming the villages looking for jobs which were not available. However, when I questioned some of these teenagers about working on paddy farms their answer was "we would rather do without, than work on a paddy farm; that is below our dignity!"

THE FAILURE OF THE KARABA SECTION AND THE FUTURE OF MWEA

The addition of the Karaba Section exacerbates the contemporary water, soil alkalinity, and labour problems of Mwea. The success of Mwea has itself created problems for the future.

Unfortunately, the Karaba Section represents a drag on the whole Scheme. The future of this Section, as well as the impact of its failure, present a precarious situation for the Mwea Management. The patterns of spatial development in Mwea show two specific and distinct groupings of tenants: the high-yielding group is generally well-distributed throughout the Thiba, Tebere and Mwea Sections. The Wamumu Section offers a clear spatial pattern of decline, resulting from spreading soil alkalinity, lack of organisation of the Field Extension Staff, an inexperienced Irrigation Officer, inadequate supervision of the tenants by the Field Assistants and lack of discipline and leadership.

Bottlenecks of Implementation

At Mwea, as is often the case in other areas of Africa South of the Sahara, projects are implemented very quickly without prior in-depth planning, generally based on political motives, and if planned in-depth at all, planned after they have been put into effect. The capacity to implement plans, particularly in the context of human geography, and in the form of men and women capable of executing funded plans, is rare. Finance is one problem, implementation of plans another problem, but in between those proper planning itself is a major problem.

Irrigation, unlike purchasing lands in the highlands to extend the Million Acre Scheme, is a favourite field for givers of aid. Provided a feasible long-term plan is produced, finance need not prove a major constraint. The irrigation development plan at Mwea is financed with a West German Government loan through the Kreditanstalt für Wiederaufbau (KFW). For example, the 2,000 acre Extension of the Karaba was financed by a West German loan, as were the construction of the new MIS Headquarters, and the tarmac road construction throughout the Mwea Area. One of the major bottlenecks in implementing an organised irrigation scheme is obtaining the necessary expertise in managerial ability, hydrological engineering, civil engineering, agricultural economics, and agronomics. Expertise in these disciplines is often in short supply. Currently Mwea is without an Irrigation Engineer to maintain the irrigation system in the Settlement. During my field enquiry the Chief Agronomist, head of the Research Station, left his position and returned to his home in India. This vacancy has yet to be filled at Mwea. Also the Chief Mechanic in the Machinery Department decided to leave Mwea and move to South Africa. His position at present is being filled by an African with little experience in managing a workshop. Each of these examples results in inefficiencies and bottlenecks in increasing production and yields at Mwea. However, at the same time social and demographic problems are pressing. The NIB decided to expand the Mwea Area through the Karaba Extension of 2,000 acres. This is a classic case of problems breeding problems. The following comments of the former General Manager of the NIB are relevant to the question of the feasibility of expansion of irrigation schemes in Kenya:

> As the areas of higher population growth coincide with the home territories of the largest, most educated, and most politically dynamic tribes in Kenya, it is easy to foresee considerable and

increasing pressure developing in the near future for a very substantial acceleration in the rate of irrigated development.

The question then arises whether the present organisation structure of irrigated settlement could handle a greatly expanded programme assuming that the development was planned and rational and not a spasmodic process of politically motivated casual programmes. There is every reason to believe that the Board's organisation could cope effectively with an orderly and substantial expansion of the operational sector of its activities. The main requirement would be adequate forewarning to produce the necessary flow of trained operational personnel.

On the development side, the picture would be far less rosy. The maximum acreage developed in one year by the Board has put nearly unbearable strain on the Board's resources. The near total lack of irrigation engineers, surveyors, draftsmen, and heavy plant maintenance personnel, and the tiny number coming out of training institutions represent very severe constraints on a rapid expansion of irrigation.

Pending a drastic change in training policy and apparatus, which are beyond the Board's control, the only short term answer is to rely very heavily on consultants and contractors. Both are inherently expensive, and can be exorbitantly so in the absence of a strong and technically competent control organisation which is firmly anchored in the national framework. The creation of such a control unit within the Board is a prime prerequisite to any expanded programme of irrigation development.

(E.G. Giglioli, former General Manager, Employment Incomes and Equality, International Labour Office, 1972, 419-420).

Spatial and Environmental Patterns

Man has created his own ecological environment at Mwea. There are many places in Mwea where man has left his mark in the Scheme's 20-year history of success through trial and error. Over this time-span of human occupancy, Mwea has changed substantially and this change is reflected in the spatial aspects of the levels, techniques, and modes of life of the tenants. Some of the following spatial characteristics are thought noteworthy: (1) the amount of land available for paddy cultivation is severely limited; (2) the spread of soil alkalinity in the different sections of Mwea is a serious and protracted problem, as there will be less land for paddy cultivation in the future at Mwea if this spread continues at its present rate; (3) the Karaba Section Extension of 2,000 acres has been added.

This intensive pressure on the land results in an unbalanced relationship with the environment; thus the environmental balance at Mwea is now threatened by the rapid population build up in what is so far a successful but overpopulated and insanitary settlement scheme. Other associated problems are the limited amount of available water for paddy production under irrigation, the lack of an adequate interested labour supply during the critical periods of harvesting and transplanting. A significant spatial characteristic at Mwea is the difference in the size of the paddy holdings. On average the high-yielding farmers, an elite group at Mwea, have the larger holdings and the highest yields per acre. Many of the high-yielding tenants have been selected by the Mwea Management as seed growers to supply the Scheme with seed and also to supply the Ahero Scheme with seed. These seed growers receive a substantially higher price per bag of paddy than the normal farmers. They practice good crop husbandry and hygiene, and are hard workers who are well organised, and efficient and successful paddy farmers. Looking ahead, it seems imperative that the tenants and the Mwea Management obtain increased yields out of Mwea's limited land area. This will have to be accomplished through innovation, technology, improved rice varieties, improved crop husbandry and crop hygiene practices, intensive paddy production, close supervision by the Field Assistants and strict disciplinary measures enforced by the Management and the Field Extension Staff.

Population Absorption and Employment Patterns

Population absorption and employment have been and are likely to remain common objectives of irrigation projects in Kenya and all of Africa. Where overpopulation is perceived as a political threat to stability, absorption capability becomes of great importance. Understandably, there is increasing concern in Kenya for the problems of unemployment and underemployment. Urgent expansion of Kenya's irrigable areas as a means of increasing labour intensiveness has been given priority. Through irrigation schemes it is assumed that more families could be settled on small yet profitable landholdings. These problems have relevance and credence. Politically, Kenya is very attractive for expansion. It is anticipated that the Lower Tana

Basin could possibly absorb many of Kenya's landless job-seekers. The NIB has estimated that this area could settle approximately 750,000 people on a small section of a District, now supporting only 50,000 people at a poor subsistence level. Instead, they can envisage 250,000 acres carrying 750,000 people. Ideally, then, there might be 3 jobs created for every acre of land irrigated. Of course, these extrapolations and forecasts of the Lower Tana Basin's irrigation potential have been influenced by the phenomenal success at Mwea. At Mwea the NIB projects that a population of over 21,000 is being absorbed or supported by Mwea. The total number of people whose livelihood is derived from Mwea and from the economic changes it has generated including man-year equivalents for hired labour on a monthly basis is substantial. Other employment created by Mwea includes the Field Extension Staff, administrative staff, employees of the Mwea Rice Mills Ltd., and cotton ginnery workers. On average, a family of 6 is supported by each holding at Mwea; hence the population supported by Mwea during the 1973/74 season was well over 21,000 people, including the tenant and his household.

It is important to bear in mind that technology, crop labour requirements, size of holding, processing, marketing, and the tenant's household, therefore, are among the variables which substantially affect the population supported by any irrigation project. The employment generated by Mwea has been substantial and the economic growth impact on the surrounding area significant. From an economic point of view, Mwea has been a success, although its social successes are rather few. During the 1960's and early

1970's Mwea improved substantially through the capability and expertise of the Management and trained Field Extension Staff. The capacity of Mwea as a vehicle of employment-generating, or job-creating is impressive by any standard. The high population-absorbing and employment-generating capability of irrigation has been displayed dramatically at Mwea.

In appraising any irrigation project the ability of the scheme to absorb population and generate employment deserve in depth investigation and appraisal before a decision can be made whether or not to implement the project. Also of critical importance is the need of assessing the availability and cost of hired and/or casual labour to cover the critical labour peaks — harvesting and transplanting -- which are of growing concern. The ability of the scheme to attract hired and/or casual labour for seasonal labour peaks is vital. An essential consideration in pre-investment appraisal of an irrigation project should be the population supporting capacity of the area in question without an irrigation project. Often the obvious facts appear not so obvious after all. Finally, in the design of an irrigation project, population-support and employment-generating capability must be considered in relation to the size of holdings in the project. Projected tenant incomes are of vital importance in the overall appraisal of any project at any time. Each of these factors, in turn, has to be appraised in comparison with future anticipated opportunities and income levels in the aggregate economy and with alternative technologies on the particular scheme.

The importance of the role of the agricultural geographer in research in tropical fields is pointedly described by Coppock (1969, 9-10):

> Since agriculture is the most common and widespread of the ways in which man gets his living and since geographers are primarily concerned with his varied impact on the earth's surface, it might be supposed that a considerable proportion of geographical research would be devoted to the study of agricultural geography. Yet this is not the case and, while it is true that geographical journals contain many descriptive articles and that descriptions of agriculture often bulk large in elementary textbooks, few substantive works have appeared in this field and no adequate methodology or body of theory has yet been devised.
>
> It seems likely that a major cause of this neglect is the difficulty, which stems largely from the nature of available data, of undertaking worthwhile and intellectually rewarding investigations in this field by comparison with those which are possible in other branches of geography, a view which is supported by the fact that the proportion of agricultural articles in geographical journals is declining. This explanation seems even more plausible in tropical Africa where many of the investigations which have been undertaken by geographers have either been in physical geography, where the ground itself provides all necessary data, or in the study of communications, industries and settlement, for which material is both more accessible and more manageable.
>
> Despite these problems, a strong case that geographers should pay more attention to tropical agriculture can be made, on both practical and academic grounds. In the foreseeable future it is likely that agriculture will continue to occupy a leading place in the economies of African countries and, both out of academic self-interest and as responsible citizens, geographers ought to play a part in economic development by employing their skills in describing and understanding the existing use of agricultural resources

> and so contributing to the planning of their more effective exploitation; for the geographer's concern with total environment, both physical and human, and his training in methods of reconnaissance survey are very appropriate in countries in tropical Africa, whose problems are often too urgent to wait on detailed inquiries by many specialists.
>
> In any case, the distinction between academic and practical should not be overstressed; a better theoretical understanding of the location of agricultural production may be expected to increase geographers' ability to predict the likely results of proposed changes and so make a more effective contribution to the planning process and, conversely, the investigation of the agricultural consequences of, say, the construction of new communications may lead to improvements in theory. In this respect, the tropics offer opportunities which are not so readily available in the developed world; the existence of large numbers of peasant farmers, operating on a small scale in an environment with few external links and a relatively simple economic climate and yet subject to radical and rapid change, offers the nearest approach to laboratory conditions that the social scientist is likely to find.

Suggestions for further Research on Mwea

A number of suggestions for extensive research on Mwea have been mentioned in the various chapters of this thesis. However, first, the methodology established in this study may be applied to other organised irrigation schemes in Kenya by changing the parameters used in the thesis. The trade-off effects of the remarkable success at Mwea may be aptly applied in the future to other irrigable and non-irrigable areas in Kenya and Africa South of the Sahara.

Further research aspects stimulated by this thesis include:

1. A sharper contrast in depth of Mwea with other organised irrigation schemes in Kenya, namely Ahero, Bunyala, Perkerra, Galole, and Yala Swamp. Also to probe further into the question of why Mwea is successful and the other schemes are not.

2. An in-depth study of malnutrition and diseases at Mwea and how they impede paddy production.

3. A comprehensive soil survey and analysis of Mwea.

4. An analysis of the water balance and hydrological problems at Mwea.

5. An investigation of soil alkalinity problems at Mwea and the application of anti-alkalinity methods.

6. An environmental ecological and spatial study of Mwea.

7. An input - output analysis of energy requirement and consumption and its impact on the ecological balance at Mwea.

8. An investigation of family planning aspects at Mwea including the family attitude toward success and toward each other.

9. Research into vocational training programmes and training of the Field Extension Staff and future tenants.

10. Research into the use of further mapping techniques using SYMAP and CAMAP programmes applied to the Mwea base map in this thesis.

These are only a few of the aspects of further research on Mwea. Mwea is a dynamic Scheme in a changing equilibrium which should be studied and researched at different points in time.

MWEA AS THE SPRINGBOARD AND THE PROTOTYPE

Since its beginnings in 1955, Mwea has become the most highly sophisticated and successful smallholder rice scheme under organised irrigation in Africa. On average, it produces 3 tons of rice per acre, thus ranking with the highest rice producers in the world. It must be remembered that rice is a completely new crop to the incoming tenant, and there is no local tradition of irrigation. The factors which have brought about this phenomenal success were: (1) available water supply; (2) excellent black cotton soils; (3) expertise in managerial leadership; (4) availability of hired and/or casual labour from the surrounding area; (5) good climatic and environmental conditions for paddy cultivation; (6) botanically disease-free area for paddy production; (7) no major displacement of individuals or tribes from the Plains of Mwea; (8) no serious agronomic problems; (9) close supervision of tenants by Field Assistants; and (10) disciplinary control of tenants by the Mwea Management. What were the contributing factors which have brought about success at Mwea? Why is Mwea important to Kenya? What were some of the major findings from this intensive field research at Mwea? These are provocative questions which deserve considerable reflection and thought. Mwea is still the most successful irrigated rice scheme in Africa. However, under the facade of success are found serious and deteriorating conditions. An attempt will be made to state succinctly some of the major findings of this work.

Inefficiency in Paddy Production

It was observed during the survey that a substantial number of inefficient paddy farmers with low yields should, if efficiency is to be the yardstick, be promptly replaced by new tenant farmers who are motivated and have the capability to work as successful farmers. This is, of course, not always practicable. Inefficiencies of production are losses to the Mwea Management, the NIB, and to the tenants. Mwea was designed to intensify paddy production and to provide holdings for 3,600 farmers and their families. Irrigation settlement schemes in densely-settled low income areas should be encouraged because they offer good prospects of improving the levels of living for the people. One of the aims of this work is to indicate the conditions which are necessary to duplicate, or at least to some extent, emulate the Mwea success in other irrigable areas of Kenya.

Water and land resources are in themselves obviously valuable; however, technical assistance, entrepreneurship, and close supervision of tenants especially by a trained Field Extension Staff are not always too obvious but are nonetheless vital for the success of any organised irrigation scheme. The control of water and conservation of the soil should be constantly assessed and recognised as important. The trade-off effects of an organised irrigation scheme such as Mwea are profound. However, a prerequisite to the successful planning of an organised irrigation scheme is the establishment of a long-term policy and an in depth feasibility study as to what crop or crops are most suited to the topography, soil, ecology, social and economic conditions of the area. It should be kept in mind that long-term development plans and finance are not necessarily sufficient to guarantee implementation and success of any irrigation scheme. The success of Mwea was due to many factors, but management and close supervision by the Field Extension Staff were particularly vital. The complex range of administrative, legal, social, technical, and financial problems associated with smallholder irrigation schemes require sound and effective policies by a strong executing agency with dynamic and innovative leadership. In looking ahead, the main thrust of the NIB's irrigation policy should be directed toward the development of the irrigable areas in Kenya already discussed in detail in Chapter 2.

The NIB is at present the planning, constructing, and operating agency for irrigation development in Kenya. If viewed primarily in the light of the past performance of Mwea, proposed and potential organised irrigation development schemes, particularly in the Upper and Lower Tana River Basins, appear realistic for the future. However, the capacity to implement plans, particularly in the human context, and to acquire the services of capable and experienced personnel to execute funded plans presents a major problem. Finance is obviously an initial problem. But inadequate management and inexperienced personnel are posing serious, immediate and long-term problems. Foreign countries are more inclined to give aid for irrigation than for other varieties of agricultural development. Essentially, organised irrigation projects are complex undertakings. It is in the supervision and management of these projects that bottlenecks appear in implementation. From my field experience it is quite apparent that, to an outsider, an organised scheme like Mwea seems easy to supervise and control. This hidden complexity is masked by difficulties of management and administration of a sophisticated organised irrigation settlement. However, regardless of the past success of Mwea, the present and the future for such schemes rest on a high degree of managerial ability. Mwea is an example of a hierarchical organisation. Technology and engineering aspects are also complex and require considerable expertise. A major prerequisite of any scheme is to obtain the best highly trained operational personnel for organised irrigation schemes. At present the NIB relies too heavily on outside consultants and contractors to direct irrigation schemes in Kenya. In employing outside consultants, Kenya should consider the efficacy of such expenditure. Is the Kenya Government getting value for money? An established training programme in an organised irrigation scheme is essential to maintain a high degree of close supervision of the farmers. The proposed procedure for developing future organised irrigation settlements in Kenya should be based on in-depth feasibility studies, the use of Mwea as a prototype for future developments, and the acquisition of highly trained managerial, technical, and engineering personnel.

There is need for greater intensity of agriculture in Kenya, similar to the Mwea Scheme. Rice is a high value crop, and high-yielding. Mwea is economically successful and sound. It represents a hope for the development of smallholder agriculture in Kenya. Mwea also provides an example for other irrigable areas in Kenya and for other African countries. Essentially, the methods of farming in Kenya are inadequate and lack intensive forms of agriculture, particularly for smallholders. Thus there is great need to place priority on intensive agriculture production in Kenya.

Profile of Success

What factors contribute to a successful paddy farmer? This is basically a human problem. However, the following points emerged from the field enquiry: length of tenure gives experience and training, and develops the capability and potential of the farmer. Age of the farmer appears to have a slight effect on paddy yields. Up to the present, education has not been significant as far as paddy yields are concerned. Previous farming experience may be helpful to some extent, but is not essential. The ability of the tenant to adjust to the organisation and operate efficiently under the direction of the Field Extension Staff, to follow instructions implicitly and to work hard, is of utmost importance. His success stems primarily from a mental maturity enabling him to appreciate the potentialities of his holding. He needs to mobilise his household to perform the major tasks in the paddy production cycle. It is not so much the size of the household that matters, but the ability of the tenant to utilise this labour.

One of the most striking findings from this study of Mwea is the extremely wide range of net incomes among the tenants. All of the tenants have an allocation of 4 acres of land when they are brought into the MIS. However, the social structure, attitudes of the farmer toward work, the size of his family and his ability to adjust to an hierarchical organised system under close supervision, may be considered as factors affecting income distribution. Malnutrition among the children, and widespread disease must also be recognised as exceedingly debilitating.

Despite the fact that the tenant dislikes the hierarchical organisation at Mwea, which inevitably curtails his freedom, the Mwea Management is nevertheless transforming his life style in return for his services. As E.G. Giglioli points out, the human factor plays a major role in the success of Mwea:

> I do not believe that all schemes go through the same stages of development. The success of a scheme is not inevitably due to its organisational structure. A scheme is made successful by the individuals who make it so and not by the organisation.

What is past is prologue. The future of Mwea is now! The destiny of the tenants and Management is their choice and responsibility.

APPENDIX I

THE TRUST LAND (IRRIGATION AREAS) RULES

CHAPTER 288

THE TRUST LAND ORDINANCE

(Rev. 1963) Amendments CAP. 288

First Schedule of Ordinance

Additions of Crown land to land units made under section 48 *in* 1962 *(L.N.s* 133, 333, 515, 516, 517, 518 *and* 573 *of* 1962*) are omitted as being of limited application, in view of the introduction of the new Constitution.*

The Trust Land (Kaimosi) Rules under Section 65

Rule 7 -

Insert "to the District Commissioner" after "pay" in paragraph 1 (*a*) and *add* two new paragraphs as follows --

(3) The District Commissioner shall pay all fees received by him under paragraph (1) (*a*) of this rule to the African District Council of Nandi.

(4) The District Commissioner may in his discretion remit or reduce any fee prescribed in the Second Schedule to these Rules in any individual case of hardship or for any other good reason.

Add to marginal reference to the heading to these Rules "L.N. 107/1962".

Rules under section 65

Delete the Trust Land (Irrigation Areas) Rules (L.N. 410/1959) and *substitute* the following new Rules --

THE TRUST LAND (IRRIGATION AREAS) RULES

L.N. 535/1962

1. These Rules may be cited as the Trust Land (Irrigation Areas) Rules, and shall apply to such areas of the Special Areas as the Minister may, by notice in the Gazette, declare to be irrigation areas.

2. In these Rules, except where the context otherwise requires --

"African court" means the African court having jurisdiction in the area;

"area" means any area declared to be an irrigation area under rule 1 of these Rules:

"authorized dependant" means, in relation to a licensee, his father and mother, wives and such of his children as are unmarried and under the age of eighteen years;

"committee" means an irrigation committee appointed under rule 3 of these Rules:

"holding" means that part of an area specified in a licence;

"licence" means a licence granted under rule 4 of these Rules;

"licensee" means any person to whom a licence has been granted, and includes any person who succeeds a licensee under rule 7 of these Rules;

"manager" means such person as may from time to time be appointed by the Minister to be in charge of an irrigation area.

3. (1) The Minister may appoint a committee for any area, such committee to be known as an irrigation committee, to be responsible for advising the manager on the general administration of the area in accordance with Government policy.

(2) Such committee may either be the District Agricultural Committee of the district in which the area is situate or may be composed of such members as the Minister may appoint after consultation with the Provincial Agricultural Committee of the Province in which the area is situated.

4. Any person who resides in, carries on business in, or occupies any part of the area or grazes any stock thereon shall, unless he is the holder of a valid licence granted to him under these Rules by the manager with the approval of the committee or is the authorised dependant of such licensee, be guilty of an offence.

5. (1) Every licence shall be in the form in the First Schedule to these Rules, and shall be prepared in duplicate; the original shall be given to the licensee and the duplicate shall be retained by the manager.

(2) The manager shall maintain a register in which he shall enter the name of every licensee, the number of his holding and the names of his authorized dependants.

(3) The manager shall also maintain a separate register in which he shall enter the name of any successor nominated by the licensee under rule 7 of these Rules, together with the number of the holding in respect of which the successor has been nominated.

6. Before issuing a licence, the manager shall --

(a) cause these Rules to be read and explained to the licensee in a language which he understands;

(b) give the licensee a copy of these Rules; and

(c) obtain from the licensee, in the form in the Second Schedule of these Rules, a receipt for the Rules, an acknowledgement that he understands them and an undertaking to observe them.

7. (1) A licensee may, at any time after the date of being granted a licence, nominate, in writing to the manager, another person to succeed him as licensee in the event of his death; and a licensee may at any time, in writing to the manager, revoke or alter any such nomination which may have been made by him:

Provided that no person nominated as successor may succeed until he has attained the apparent age of eighteen years; if he has not reached that age his guardian under customary law may, within one month of the licensee's death, and with the approval of the manager, appoint a person to act on his behalf until the successor is of age.

(2) No person nominated as a successor may succeed without the approval of the committee.

(3) The authorized dependant of a deceased licensee may, within thirty days of his death, appeal to the African court against the nomination under paragraph (1) of this rule, of a successor.

(4) The authorized dependant may --

(a) where a licensee dies without having nominated a successor in accordance with paragraph (1) of this rule; or

(b) where, under paragraph (3) of this rule, an appeal to the African court against the nomination of a successor has been successful,

within one month of the death of the licensee or one month after the determination of the appeal, as the case may be, nominate, in writing to the manager, a successor who must be approved by the African court.

(5) In the event of --

(*a*) no person being appointed within the time prescribed in the proviso to paragraph (1) of this rule; or

(*b*) no person being nominated within the time prescribed in paragraph (4) of this rule; or

(*c*) any person nominated or appointed under this rule failing to accept such nomination or appointment or failing to assume the responsibilities inherent in such nomination or appointment within a period of three months from the death of the licensee; or

(*d*) no successor being acceptable to the committee.

the holding shall be deemed to have been vacated, the licence in respect of such holding shall terminate, and a fresh licence may be granted in accordance with rules 5 and 6 of these Rules.

(6) In the event of a holding being deemed to have been vacated in terms of paragraph (5) of this rule --

(*a*) the manager may make provision for the cultivation of any such holding and where appropriate recover the costs from the incoming licensee; and

(*b*) in accordance with rule 23 of these Rules reasonable compensation may be paid to the authorized dependant of a licensee in respect of any improvement to the holding effected by the licensee.

8. (1) Every licence shall be granted subject to the following conditions --

(*a*) a licensee shall devote his full personal time and attention to the cultivation and improvement of his holding and shall not without the permission in writing of the manager, allow any other person to occupy his holding or to cultivate it on his behalf;

(*b*) a licensee shall maintain the boundaries of his holding in a manner satisfactory to the manager;

(*c*) a licensee shall maintain at all times his holding and all field feeder and drainage channels to the satisfaction of the manager;

(*d*) a licensee shall maintain to the satisfaction of the manager all irrigation channels and works on or serving his holding;

(*e*) a licensee shall cultivate his holding to the satisfaction of, and in accordance with the crop rotation laid down by, the manager and shall comply with all instructions given by the manager relating to the cultivation and irrigation of his holding;

(*f*) a licensee shall comply with all instructions given by the manager with regard to good husbandry, the branding, dipping, inoculating, herding, grazing or watering of stock, the production and use of manure and compost, the preservation of the fertility of the soil, the prevention of soil erosion, the planting, felling, stumping and clearing of trees and vegetation and the production of silage and hay;

(*g*) a licensee shall not hire, cause to be hired, or employ stock or machinery for cultural operations other than stock and machinery owned by the manager, without prior approval, in writing, from the manager;

(*h*) a licensee shall not absent himself from the area for longer than one month without prior approval, in writing, of the manager.

(2) Any licensee who fails to comply with the conditions specified in paragraph (1) of this rule shall be guilty of an offence.

(3) Any licensee who refuses, or without reasonable excuse fails, to comply with any of the conditions of this rule shall, in addition to any penalty that may be imposed under paragraph (2) of this rule, be liable to have his licence terminated, subject to confirmation by the committee, by the manager.

9. (1) A licensee shall pay to the manager, on demand, such rates in respect of water and other services in respect of his holding as shall be calculated in accordance with rates prescribed by the Minister from time to time.

(2) The whole or part of any rates prescribed under paragraph (1) of this rule may be varied or remitted by the Minister, either generally or in any particular case, in his absolute discretion.

10. (1) The manager may allocate to a licensee a house to be occupied by him within the area, or may permit a licensee to erect his own house.

(2) In either event it shall be the duty of the licensee to maintain his house and precincts to the satisfaction of the manager, and if the manager is dissatisfied with the condition of the house or precincts he may give written notice to the licensee of the repairs which he considers necessary and specify a reasonable time within which they must be completed.

(3) If the licensee fails to complete such repairs within the time specified and to the satisfaction of the manager, the manager may cause such repairs to be carried out and may recover the cost thereof from the licensee.

(4) The Licensee may not occupy any house other than that allocated to him without prior permission, in writing, from the manager.

(5) A licensee shall not construct buildings or other works of any kind on his holding or elsewhere in the area without the prior consent, in writing, of the manager. In the event of his having erected a structure or building without such consent, the manager may direct, in writing, that the structure be removed and the land returned to its original state. If the licensee fails to comply with this direction within one month, the manager may enter the building or structure for the purpose of demolition. Any expenses incurred by the manager for the removal of the building or structure may be recovered from the licensee.

11. (1) If a licensee is sentenced to imprisonment for a term of six months or more, his licence may be terminated forthwith.

(2) If a licence is terminated under paragraph (1) of this rule, a successor may be nominated or appointed in accordance with rule 7 of these Rules.

12. The manager shall have power to order the destruction of any crops planted in contravention of his instructions or of the provisions of these Rules and to recover the expenses incurred from the licensee. No compensation shall be payable in respect of crops so destroyed.

13. If, in the opinion of the manager, it would be beneficial to a licensee's crops or to all the licensees in the area to cultivate by machinery, or to apply fertilizers, or manure, or to treat any crops or stocks in any way to protect them against disease, pests, or damage of any kind, then the manager may do so and recover the costs thereof from the licensee or licensees.

14. As soon as each crop has been harvested the licensee shall deliver it, other than such portion as he may wish to retain for his own consumption and that of his authorized dependants living with him, to the manager at a collecting station to be appointed by the manager, or shall otherwise dispose of it in accordance with the instructions of the manager.

15. (1) The manager may when necessary, collect, process and market the crops delivered to him under rule 14 of these Rules and may arrange for the sale of such crops, in which event he shall give the licensees details of the sales of all such crops as soon as possible.

(2) The manager shall not be obliged to keep or sell the crops of individual licensees separately.

16. (1) A licensee shall not keep on his holding any stock other than those specified in his licence and shall declare to the manager annually the natural increase in such stock and shall comply with any instructions issued by the manager as to their disposal.

(2) A licensee who fails to comply with the provisions of paragraph (1) of this rule, or with any instructions issued by the manager thereunder, shall be guilty of an offence, and where any additional undeclared stock is found in the possession of a licensee within the area, the manager may order a licensee to remove such additional stock from the area forthwith.

(3) If a licensee fails to remove his additional stock in accordance with an order to that effect given by the manager under paragraph (2) of this rule, the manager may confiscate and sell such additional stock paying the proceeds thereof, less any expenses incurred by such confiscation and sale, to the licensee.

17. (1) If, in the opinion of the manager, a licensee has been negligent in the use of his land, the use of irrigation water or the cultivation of his crops, the manager may direct him to take such steps as the manager may specify to remedy the effects of such negligence, and, in the event of a licensee failing to comply with any such directions, the manager may take such measures as he considers necessary to safeguard the crop and to preserve the holding and irrigation water, and may recover the costs of any such measures from the licensee.

(2) If a licensee is absent owing to illness or any other reason, the manager may take such measures as he considers necessary to safeguard the crop and to preserve the holding and irrigation water, and may recover the costs of any such measures from the licensee.

18. A licensee shall not permit any of his stock to be upon any part of the area which is closed to stock or to cause damage to any crops or water installations or communications or other property, and shall be liable to pay the cost of the repair of any damage so caused.

19. (1) Any licensee who wilfully or negligently causes damage or causes to be damaged any road, bridge, or culvert within the area shall be guilty of an offence.

(2) The manager may, where such damage has been caused by a licensee repair any such damage and shall recover the cost of the repairs to such damage from the licensee.

20. The manager may deduct from the proceeds of the sale, under rules 15 and 16 of these Rules, of any crops or stock belonging to a licensee --

(*a*) the costs or expenses incurred by the manager--

(i) in the making of provisions for the cultivation of any holding under rule 7(6)(*a*) of these Rules;

(ii) in the removal of any building or structure or repairs carried out to any house under rule 10 of these Rules;

(iii) in the destruction of any crops under rule 12 of these Rules;

(iv) in providing manure, fertilizers, insecticides or any agricultural operations under rule 13 of these Rules;

(v) in the collecting, processing and marketing of crops under rule 15 of these Rules;

(vi) in remedying the negligence or safeguarding crops or preserving the holding under rule 17 of these Rules;

(vii) in repairing any damage cuased by stock under rule 18 of these Rules;

(viii) in repairing damage under rule 19 (2) of these Rules; and

(*b*) any amount due for rates payable under rule 9 of these Rules, any outstanding amount of any advance made to such licensee for the purpose of the cultivation, irrigation or other improvement of his holding, and such charges as may be agreed to by the Minister on the recommendation of the committee.

21. Any person who causes any motor vehicle to be driven within the area over any road other than a public road within the meaning of the Public Roads and Roads of Access Ordinance unless he is in possession of a permit issued by the manager, and unless he complies with all conditions made on such permit by the manager, shall be guilty of an offence.

22. (1) Where the manager is satisfied that a licensee has failed to comply with any of the provisions of these Rules or with any instructions given thereunder or under any other law for the time being in force, he may serve a notice in writing on the licensee requiring him to comply with the said provisions, instructions or rules within such time as is specified in the notice.

(2) If the licensee fails within such time to comply with the requirements of such notice, the manager may, by notice in writing, call upon the licensee to show good cause, by a date specified in the notice, why his licence should not be terminated.

(3) If the licensee fails to show good cause as aforesaid to the satisfaction of the manager, the manager may, with the approval of the committee, give notice in writing to the licensee requiring him to remove himself, his dependants and his stock from the area within a period specified in such notice.

(4) A licensee who is given notice under paragraph (3) of this rule may, within twenty-eight days of such notice, appeal in writing to the Minister whose decision shall be final.

(5) If there is no appeal, the licence shall be deemed to have terminated on the date specified in the notice.

(6) If there is an unsuccessful appeal, the licence shall terminate on such date as the Minister may specify.

(7) Any person whose licence has been terminated under this rule and who fails to comply with the terms of the notice given him shall be guilty of an offence.

23. Where any licence is terminated in accordance with any of the provisions of these Rules, a board consisting of the manager and one representative of both the outgoing and the incoming licensees, shall assess the amount, if any, due to the outgoing licensee or his dependants in respect of capital and labour expended by him in improving the holding, and the manager shall make arrangements for the payment of such amount by the incoming licensee within such time as the manager considers reasonable.

24. The manager shall have power, in the event of any emergency, to order all licensees to undertake emergency repair work in any part of the area, and any licensee who refuses to obey any such order by the manager shall be guilty of an offence.

25. Subject to the provisions of rules 7, 8, 11 and 22 of these Rules, every licence shall be valid for a period of one year and from year to year thereafter, but may be terminated at any time --

(*a*) by the licensee giving to the manager six months' notice in writing of his intention to surrender his licence;

(*b*) by the manager, on the instruction of the Minister, giving to the licensee 12 months' notice in writing of his intention to terminate the licence.

26. Any person who —

(*a*) unlawfully interferes with the flow of irrigation water in canals or the opening or closing of control gates within the area;

(*b*) makes unlawful use of irrigation water by taking irrigation water out of turn or otherwise;

(*c*) refuses to permit the authorized passage of irrigation water across his holding;

(*d*) wilfully damages or obstructs canals or control works; or

(*e*) refuses to accept or drain off irrigation water when required to do so,

shall be guilty of an offence

27. (1) Any person who is guilty of an offence under these Rules shall be liable to a fine not exceeding two thousand shillings or to imprisonment for a term not exceeding two months, or to both such fine and such imprisonment.

(2) Where any person is convicted of an offence under rule 4 or rule 22 (7) of these Rules, the court may, in addition to any penalty which it may impose, authorize any administrative officer or police officer to cause such person, together with his dependants and property, if any, to be removed from the area.

FIRST SCHEDULE (r. 5)

The Trust Land (Irrigation Areas) Rules

Licence No. ....

.... son of ....

of the .... district of the ....

Province, is hereby authorized to occupy holding No. ....

of the .... irrigation area for the

period from the................ day of .... 19 .....

to the .... day of .... 19 .....

and from year to year thereafter unless sooner terminated in accordance with the provisions of the above Rules, and to keep thereon not more than the following number of stock --

.... bovines

.... sheep

.... goats

.... mules

.... donkeys

.... *(other stock)*

subject to the conditions prescribed by the above Rules.

Dated this .... day of .... 19 ......

....
Manager

In accordance with rule 6 of the above Rules, I have caused the Rules to be read and explained to the above named licensee in the .... language, which he understands.

....
Manager

SECOND SCHEDULE (r. 6)

I, ... son of ....

of the .... district of the.................

Province, hereby acknowledge receipt of a copy of the Trust Land (Irrigation Areas) Rules. I have had these Rules explained to me and I fully understand them and I undertake to observe them and to pay all sums of money payable to me.

....
Signature or thumb-print of licensee

....
Witness

....
Date

AREAS DECLARED TO BE IRRIGATION AREAS UNDER RULE 1 OF THE ABOVE RULES

Delete the marginal references "L.N. 106/1960" and "L.N. 418/1960" and *substitute* "L.N. 536/1962".

APPENDIX II

THE IRRIGATION ACT, 1966

Act of Parliament No. 13 of 1966

Date of Assent: 11th March, 1966
Date of Commencement: By Notice

ARRANGEMENT OF SECTIONS

Part I -- Preliminary

Section

Part IV -- Financial

16 - Cess
17 - Establishment and operation of general fund and other funds, and investment of funds.
18 - Board's powers with regard to receipt of moneys.
19 - Borrowing powers of Board.
20 - Special application of revenues.
21 - Accounts.
22 - Audit.
23 - Annual report.

Part V -- General

24 - Board to appoint advisory committees
25 - Protection of Board, etc., from liability.
26 - Appeals.
27 - Regulations.

SCHEDULE -- Constitution of Board and other matters relating to Board.

An Act of Parliament to provide for the development, control and improvement of irrigation schemes, and for purposes incidental thereto and connected therewith

ENACTED by the Parliament of Kenya, as follows:-

Part I -- Preliminary

1. This Act may be cited as the Irrigation Act, 1966, and shall come into operation on such date as the President shall, by notice in the Gazette appoint.

2. In this Act, except where the context otherwise requires -- "agriculture" and "agricultural produce" shall have the meanings assigned to such expressions in the Agriculture Act;

"Board" means the National Irrigation Board established by section 3 of this Act;

"Minister" means the Minister for the time being responsible for agriculture and animal husbandry;

"national irrigation scheme" means a scheme of irrigation relating to any area of Kenya and designated as a national irrigation scheme by the Minister by notice in the Gazette, in accordance with section 14 of this Act.

Part II -- Establishment and Incorporation of Board

3. (1) There is hereby established a Board, to be known as the National Irrigation Board, which shall be a body corporate having perpetual succession and a common seal, with power to sue and be sued, and capable of purchasing or otherwise acquiring, holding, managing and disposing of any property movable or immovable, entering into contracts, and doing all things necessary for the proper performance of its duties, and discharge of its functions under this Act and any subsidiary legislation made thereunder.

(2) The Provisions of the Schedule to this Act shall have effect as to the constitution, membership, proceedings of, and otherwise in relation to the Board.

(3) The Minister may, subject to the provisions of this Act and on the advice of the Board, by order in the Gazette, amend the Schedule to this Act.

4. (1) The affixing of the seal of the Board shall be authenticated by the signature of the chairman, the vicechairman, or one member of the Board duly authorized by the Board in that behalf, and the signature of the secretary to the Board.

(2) Any document, other than one required by law to be under seal, made by, and any decision of, the Board may be signified under the hand of the chairman, or the vicechairman, or any member of the Board authorized by the Board in that behalf, or the secretary to the Board.

(3) Any document purporting to be a document duly executed or issued or signified under the seal of the Board, or on behalf of the Board in accordance with the provisions of this section, shall be received in evidence, and shall be deemed to be a document so executed or issued or signified, as the case may be, without further proof, unless the contrary is shown.

5. (1) The Board shall be convened by the chairman at least four times in every year.

(2) The chairman may at any time convene a special meeting of the Board, and shall do so within one month of the receipt by him of a written requisition signed by at least three members.

(3) At every meeting of the Board, the member presiding shall have a casting as well as a deliberative vote.

(4) The quorum of the Board shall be eight.

(5) Subject to the provisions of subsection (4) of this section, no act, decision of proceeding of the Board shall be questioned on account of any vacancy in the membership thereof or on account of any defect or failure in the appointment of any of its members.

6. (1) The Board may appoint and employ a secretary and such other officers and servants as may be necessary or desirable for the efficient conduct and operation of the Board.

(2) The Board may establish and make contributions to a pension, superannuation, provident or medical fund or other contributory scheme for its officers and servants, and may grant pensions, gratuities, retiring allowances, or sickness or injury benefits to any officers and servants, and may require such officers and servants to contribute to any pension, superannuation, provident or medical fund or contributory scheme.

7. The Board may from time to time appoint and employ upon such terms and conditions as it thinks fit any persons or bodies of persons, corporate, or unincorporate, to be its agents for the purposes of this Act and every such agent shall, subject to such limitations as the Board may in each case impose, exercise on behalf of the Board all the powers conferred by this Act or by any subsidiary legislation made thereunder on the Board.

8. The Board may from time to time appoint committees, whether of its own members or otherwise, to carry out such general or special functions as may be specified by the Board.

9. The Board may, by resolution, delegate to any committee, member, officer, servant or agent of the Board the exercise of the powers or the performance of any of the functions or duties which the Board is authorised or required by this Act to exercise or perform, either generally or in any particular case.

10. (1) The members of the Board (other than public officers in receipt of a salary as such) shall be paid out of the funds of the Board such remuneration as the Board with the approval of the Minister, shall determine.

(2) The officers, servants and agents of the Board shall be paid out of the funds of the Board such remuneration as the Board may from time to time determine.

(3) The Board may, in its discretion, refund such travelling and other expenses as may reasonably have been incurred by its members, officers, servants and agents in the performance of their duties under this Act.

11. (1) There shall be an officer of the Board, to be known as the General Manager, who shall be appointed by the Board, subject to the approval of the Minister, and who shall be responsible for the execution of the policy of the Board and for the control and management of its day-to-day business.

(2) The Board shall delegate to the General Manager such of its functions under this Act as are necessary to transact effectively the day-to-day business of the Board of any kind whatsoever, and in particular, and without prejudice to the generality of the foregoing, the Board shall delegate to the General Manager the power, subject to any instructions of a general nature as may be given by the Board --

(a) to control and supervise the acts of all officers, servants and agents of the Board in the matter of executive administration in the whole field of irrigation and in all matters concerning the accounts and records of the Board; and

(b) to dispose of all questions relating to the service of officers, servants and agents of the Board and their pay, privileges and allowances.

12. Every member of the Board who is or is likely to be concerned in, or who participates or is likely to participate in the profits of, any contract with or work done for the Board otherwise than in his capacity as a member of the Board shall, on the matter coming before the Board for consideration, immediately declare his interest therein, and shall, unless the Board otherwise agrees, retire from the meeting, and shall in any case abstain from voting on the matter.

Part III - Functions and Powers of Board

13. In the exercise of its powers and the performance of its functions under this Act the Board shall act in accordance with any general or special directions that may be given to it by the Minister.

14. (1) The Minister may, by notice in the Gazette, designate any area of Kenya to be a national irrigation scheme.

(2) In respect of land other than Trust land in the national irrigation scheme the Minister shall in accordance with the law for the time being relating to the compulsory acquisition of land, take such steps as may be necessary to acquire the right, title or interest in such land and to vest it in the Board for the purpose of this Act.

(3) In the case of the Trust land forming part of a national irrigation scheme the Minister, on behalf of the Board, may take on lease, on terms to be agreed between the Minister and the county council concerned, any Trust land in such national irrigation scheme.

(4) In default of agreement between the Minister and the county council as to the terms of lease under subsection (3) of this section the provisions of section 209 of the Constitution shall have effect.

15. (1) The Board shall be responsible for the development, control and improvement of national irrigation schemes in Kenya.

(2) The Board shall have and may exercise all such powers as are necessary to enable it to perform its functions under this Act and, without prejudice to the generality of the foregoing, the Board shall have power --

(a) to conduct research and investigation into the establishment of national irrigation schemes;

(b) in conjunction with the Water Resources Authority established under the Water Act, to formulate, and be responsible for the execution of, policy in relation to national irrigation schemes;

(c) in consultation with the Minister and the Minister for the time being responsible for finance to raise funds for the development of national irrigation schemes;

(d) to co-ordinate and plan settlement on national irrigation schemes;

(e) to design, construct, supervise and administer national irrigation schemes;

(f) to determine the number of settlers to be accommodated in a national irrigation scheme;

(g) to provide land in national irrigation schemes for public purposes;

(h) to promote the marketing of crops and produce grown or produced on national irrigation schemes and to liaise with organizations responsible for the marketing of agricultural produce;

(i) to provide, either by itself or by agreement with other persons, for the processing of agricultural produce grown or produced on nation irrigation schemes;

(j) to award scholarships and bursaries for the study of irrigation (both in Kenya and elsewhere) or any other subject which the Board considers to be of benefit to the Board.

Part IV -- Financial

16. (1) The Board may from time to time, with the approval of the Minister and the Minister for the time being responsible for finance, by notice in the Gazette, impose either or both --

(a) a cess on all or any agricultural produce grown on a national irrigation scheme;

(b) a cess on all or any agricultural produce processed on a national irrigation scheme:

Provided that any such cess shall only be levied for the purpose of meeting the cost of services provided in the relevant scheme, and for which services no other direct charges are available or payable.

(2) A cess imposed under subsection (1) of this section shall be at such rate and shall be payable to the Board by such persons and at such time (not being earlier than one month after publication of the notice) and in such manner as is specified in the notice and shall be recoverable by the Board as a civil debt due to it from the person by whom it is payable.

17. (1) The Board shall with the approval of the Minister establish a general fund --

(a) into which all moneys received by the Board shall in the first instance be paid, and

(b) out of which all payments made by the Board shall be paid.

(2) The Board may, with the approval of the Minister, establish such other funds as it may deem necessary.

(3) The Board may, with the approval of the Minister, open a banking account or banking accounts to handle such funds as the Board may establish, and may, subject to such conditions as the Minister may impose, invest such of its funds as are not for the time being required for the purposes of its duties and functions under this Act.

(4) The powers of the Minister under subsection (3) of this section shall be exercised with the concurrence of the Minister for the time being responsible for finance and shall, in relation to investments, extend to the amount which may be invested, the nature of the investment, and the terms and conditions thereof, and the Minister's approval may be either general or limited to a particular investment.

18. The Board is hereby empowered to receive and apply --

(a) all funds which may from time to time be provided by Parliament for the purposes of the Board; and

(b) revenue accruing from any cess imposed under section 16 of this Act; and

(c) loans raised under section 19 of this Act; and

(d) any moneys properly accruing to the Board from any other source.

19. (1) The Board may, with the approval of the Minister and the Minister for the time being responsible for finance, borrow by way of overdraft or otherwise such sums as it may from time to time require, for all or any of the following purposes --

(a) the provision of working capital;

(b) the establishment or acquisition of property or undertakings required by the Board for the purposes of this Act;

(c) any other expenditure properly incurred by the Board for the purposes of this Act.

(2) The Board may also obtain by way of advance from the Treasury, and the Treasury may, out of moneys provided by Parliament, advance to the Board moneys for all or any of the purposes referred to in subsection (1) of this section.

(3) The Board shall pay interest on advances under subsection (2) of this section at such rates as the Treasury may fix, and the money so advanced and from time to time outstanding, together with the interest thereon shall, unless the Treasury otherwise agrees, be a first charge on the property, assets, revenues and funds of the Board or of such part thereof as shall be hypothecated to secure such advance, but not upon the property, assets and funds of any pension, superannuation provident or medical fund, or other contributory scheme created in favour of the officers or servants of the Board.

20. (1) The Board shall make proper provision for the renewal of wasting assets, for payments of interest and sinking fund charges where appropriate, and for contributions to such reserve and stabilization funds as may be required.

(2) Any excess of the revenues of the Board for any financial year over the total sums (including sums provided under subsection (1) of this section) properly chargeable by the Board against its revenues for that year shall be applied by the Board in such manner as the Minister, after consultation with the Board, may direct.

21. The Board shall cause to be kept proper books of account, records and vouchers in relation to all its undertakings, funds, activities and property and shall cause to be prepared in respect of each financial year --

(a) trading and profit and loss accounts;

(b) a balance sheet; and

(c) such other accounts as the Minister may require.

22. (1) The Minister shall from time to time appoint one or more members of the professional bodies specified in the Schedule to the Accountants (Designations) Act (hereinafter in this Act referred to as the auditors) who shall annually examine, audit and report on the accounts of the Board.

(2) The Board shall produce and lay before the auditors all books and accounts of the Board, with all vouchers in support thereof, and all books, papers and writings in its possession or control relating thereto, and the auditors shall be entitled to require from all members, officers, agents or servants of the Board such information and explanation as may be necessary for the performance of their duties as auditors.

(3) The expenses of and incidental to the audit shall be paid by the Board.

23. (1) The Board shall, within a period of seven months after the end of each financial year, or within such longer period as the Minister may approve, submit to the Minister a report on its operations during that year, and the auditor's report together with the yearly balance sheet and such other statements of account as the Minister shall require; and the Board shall publish them in such manner as the Minister may specify.

(2) A copy of every auditor's report, balance sheet and other statements of accounts submitted in accordance with subsection (1) of this section shall be sent by the Board to the Controller and Auditor-General, who may at any time examine the accounts of the Board, and shall be entitled to require from the Board and the auditors such further information and explanation as he may consider necessary.

(3) The Board's report, with the yearly balance sheet and such other statements of account as the Minister may deem appropriate together with the auditor's report and any report made by the Controller and Auditor-General shall be laid by the Minister before the National Assembly as soon as possible after it has been submitted to him.

Part V -- General

24. (1) The Board shall appoint an advisory committee in respect of each national irrigation scheme.

(2) The Board shall, with the approval of the Minister, regulate the membership, powers and duties of such advisory committees.

25. No liability shall attach to the Board, its members, officers, agents or servants for any loss or damage sustained by any person as a result of any act or omission done or omitted to be done in good faith and without negligence in the performance or exercise of any duty or power imposed or conferred by or under this Act.

26. Any person agrieved by the revocation by the Board of the appointment of an agent for any purpose under this Act, and who has had his representations thereon rejected in writing by the Board, may within twenty-eight days of such rejection being communicated to him, appeal to the Agricultural Appeals Tribunal established under Part XV of the Agriculture Act, and the provisions of that part (excepting section 195 (2) thereof) shall apply, *mutatis mutandis*, in relation to every such appeal.

27. (1) The Minister may, after consultation with the Board, make regulations generally for the better carrying out of the purposes and provisions of this Act and without prejudice to the foregoing generality, any such regulations may provide for --

(a) the administration and day-to-day control of national irrigation schemes;

(b) the standards of good husbandry and the control of pests and diseases in national irrigation schemes;

(c) the regulation of, and the rates payable for, the use of water on national irrigation schemes;

(d) the control of persons occupying any land comprising or forming part of, a national irrigation scheme, the introduction of, or the control of settlers on such land, the issue by the Board of licences or leases to such persons or settlers, the revocation of such licences and leases, and the terms and conditions which may be attached to such licences and leases:
Provided that different regulations may be made for different national irrigation schemes, and that before issuing any licences or leases in accordance with regulations made under this section the Board shall consult the Commissioner for Lands;

(e) the methods of harvesting, collection, storage, transport, processing, marketing, and sale of produce grown on national irrigation schemes;

(f) the licensing of contractors to perform any function connected with a national irrigation scheme.

(2) Any regulations made under this section may require acts to be performed to the satisfaction of a prescribed authority, may prohibit their performance without the prior approval of a specified authority, and may empower a specified authority to impose conditions.

(3) Any regulations made under this section may be made to apply generally to all national irrigation schemes or to any specified national irrigation scheme or to any specified area or areas thereof.

(4) Any regulations made under this section may provide for such penalty for the breach of any provision thereof, not exceeding a fine of ten thousand shillings and imprisonment for one year as the Minister may think fit.

SCHEDULE (s.3)

Constitution of Board and Other Matters Relating to Board

1. The Board shall consist of the following members --

(a) a chairman who shall be appointed by the Minister;

(b) the Director of Agriculture or a person deputed by him in writing to exercise his functions on the Board;

(c) one representative from each Province in which a national irrigation scheme exists, or is being planned, appointed by the Minister from a panel of not less than three persons associated with irrigation submitted to him by each Provincial Agricultural Board concerned:
Provided that should a Province have no Provincial Agricultural Board the Minister shall appoint a representative for such Province after consultation with persons representing irrigation interests in that Province;

(d) the Director of Water Development or any person deputed by him in writing to exercise his functions on the Board;

(e) the chairman of the Water Resources Authority established under the provisions of the Water Act, or any person deputed by him in writing to exercise his functions on the Board;

(f) the Permanent Secretary to the Treasury or any person deputed by him in writing to exercise his functions on the Board;

(g) the Permanent Secretary for Economic Planning and Development or any person deputed by him in writing to exercise his functions on the Board;

(h) not more than three persons appointed by the Minister, who, in his opinion, have qualities of benefit to the Board.

2. The Board shall elect a vice-chairman annually from among its members.

3. In the absence of the chairman and the vice-chairman from any meeting of the Board the members shall elect one of their number to preside, and such member shall, for the purposes of that meeting, have all the powers and attributes of the chairman.

4. All appointments to the Board and all changes of such appointments shall be notified in the Gazette.

5. The members of the Board appointed under paragraph 1 (h) of this Schedule shall hold office at the pleasure of the Minister.

6. The chairman shall retire at the end of the third year after appointment but shall be eligible for reappointment.

7. Two members appointed under paragraph 1 (c) of this Schedule shall retire annually but shall be eligible for reappointment.

8. The members to retire under paragraph 7 of this Schedule shall be those members who have been continuously longest in office (re-appointment being deemed for this purpose to break continuity of office), and as between members who have been continuously in office for an equal period shall, in default of agreement, be determined by the Board by ballot.

9. Notwithstanding the provisions of paragraphs 5, 6, 7 and 8 of this Schedule, the office of a member of the Board shall, upon declaration by the Minister, become vacant --

(a) if he resigns his office by writing under his hand addressed to the Minister;

(b) on his death;

(c) if he is certified to be insane or otherwise adjudged to be of unsound mind under any law in force in Kenya;

(d) if in the judgment of the Minister he becomes physically or otherwise incapable of discharging his duties as a member, and remains so for a period of forty consecutive days;

(e) if he is absent, without the permission of the Board, from three consecutive meetings of the Board;

(f) if he is adjudged or otherwise declared bankrupt under any law in force in Kenya;

(g) if he is sentenced by a court to a term of or exceeding six months imprisonment.

10. Any declaration by the Minister under paragraph 9 of this Schedule shall be conclusive, and shall not be questioned in any court.

11. On any office becoming vacant under this Schedule the Minister may by notice in the Gazette and, in the case of a vacancy under paragraph 1 (c) of this Schedule, after submission of a panel of persons as provided therein, appoint another member to fill the vacancy, and, except in the case of a vacancy arising under paragraph 9 of this Schedule, may in so doing reappoint the member vacating.

APPENDIX III

THE PRICE CONTROL ACT

(Cap. 504)

IN EXERCISE of the powers conferred by section 5 of the Price Control Act, the Minister for Finance and Economic Planning hereby makes the following Order:-

THE PRICE CONTROL (RICE) ORDER, 1972

1. This Order may be cited as the Price Control (Rice) Order, 1972.

2. The prices specified in Column 2 of the Schedule to this Order are the maximum prices at which the Kenya National Trading Corporation Limited, importers or millers shall sell the commodities specified in Column 1 at the places specified in Column 5 of the said Schedule.

3. The prices specified in Column 3 of the Schedule to this Order are the maximum prices at which distributors or wholesalers shall sell the commodities specified in Column 1 at the prices specified in Column 5 of the said Schedule.

4. The prices specified in Column 4 of the Schedule to this Order are the maximum retail prices at which retailers shall sell the commodities specified in Column 1 to consumers in the areas specified in Column 5 of the said Schedule.

5. All sales of rice by any person shall be subject to the maximum prices, specified in Columns 2, 3 and 4 of the Schedule hereto, when sold in the areas specified in Column 5 of the said Schedule.

6. For the purposes of this Order "wholesale" transaction shall be deemed to be any transaction in which the commodity specified is sold in the quantities specified in Column 3 of the Schedule to this Order regardless of the number of bags sold by any person licensed to carry out wholesale trade and "retailer" means a trader who sells to consumers at the prices specified in Column 4 of the said Schedule.

7. For the purposes of this Order every miller or importer shall be required to pack the goods specified in this Order in either of the quantities specified in Column 2 of the Schedule hereto.

8. The Price Control (Rice) Order 1971, is hereby revoked.

L.N. 255/1971.

Commodities	Ex-Mill, Maize and Produce Board and KNTC Stores or any other importer's store or the nearest Railway Station	Ex-Mill, Maize and Produce Board and KNTC Stores or any other importer's store or the nearest Railway Station	Ex-Distributors or Wholesalers 100 kg. net including cost of bag	Ex-Distributors or Wholesalers 20 kg. net including cost of bag	Maximum Retail Price to Consumer including cost of bag: 100 kg.	20 kg.	1 lb.	½ kg.	1 kg.	Area
	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	
BASMATI RICE, LOCAL OR IMPORTED										
(a) Basmati rice containing not more than 20% broken grain by weight.	223 45	44 70	231 35	46 25	250 00	50 00	1 15	1 25	2 50	All parts of Kenya except where other-wise shown.
	243 45	48 70	251 35	50 25	270 00	54 00	1 25	1 35	2 70	Mandera, Wajir, Mo-yale and Turkana.
	233 45	46 70	241 35	48 25	260 00	52 00	1 20	2 30	2 60	Garissa, Lamu Tana River, Merti, Mar-sabit, Garbatulla and Samburu.
(b) Basmati rice containing more than 20% broken grain by weight.	89 20	-	96 25	-	-	-	50	55	1 10	All parts of Kenya except where other-wise shown.
	89 20	-	114 25	-	-	-	60	65	1 30	Mandera, Wajir, Mo-yale and Turkana.
	89 20	-	104 25	-	-	-	55	60	1 20	Garissa, Lamu, Tana River, Merti, Mar-sabit, Garbatulla and Samburu.
EAST AFRICAN RICE										
(a) Grade I con-taining less than 10% broken grain by weight.	151 85	-	159 35	-	-	-	80	90	1 75	All parts of Kenya except where other-wise shown.
	151 85	-	184 35	-	-	-	90	1 00	2 00	Mandera, Wajir, Mo-yale and Turkana.
	151 85	-	169 35	-	-	-	85	90	1 85	Garissa, Lamu, Tana River, Merti, Mar-sabit, Garbatulla and Samburu.

Commodities	Ex-Mill, Maize and Produce Board and KNTC Stores or any other importer's store or the nearest Railway Station	Ex-Mill, Maize and Produce Board and KNTC Stores or any other importer's store or the nearest Railway Station	Ex-Distributors or Wholesalers 100 kg. net including cost of bag	Ex-Distributors or Wholesalers 20 kg. net including cost of bag	Maximum Retail Price to Consumer including cost of bag 100 kg.	20 kg	1 lb	½ kg.	1 kg.	Area
	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	Sh. cts.	
(b) Grade II containing less than 20% broken grain by weight.	141 85	-	149 35	-	-	-	75	85	1 65	All parts of Kenya except where otherwise shown
	141 85	-	174 35	-	-	-	85	95	1 90	Mandera, Wajir, Moyale and Turkana.
	141 85	-	159 33	-	-	-	80	90	1 75	Garissa, Lamu, Tana River, Merti, Marsabit, Garbatulla and Samburu.
ALL OTHER TYPES	89 20	-	96 25	-	-	-	50	55	1 10	All parts of Kenya except where otherwise shown.
	89 20	-	114 25	-	-	-	60	65	1 30	Mandera, Wajir, Moyale and Turkana.
	89 20	-	104 25	-	-	-	55	60	1 20	Garissa, Lamu. Tana River, Merti, Marsabit, Garbatulla and Samburu

APPENDIX IV

CORRELATION MATRIX AND LEVEL OF SIGNIFICANCE OF SELECTED VARIABLES

Variable		All tenants	Low-yielding group	Average-yielding farmers	High-yielding farmers
210	Net income from paddy farming	0.8644 S=0.001	0.2279 S=0.046	0.4629 S=0.001	0.8490 S=0.001
007	Size of paddy farm	0.7759 S=0.001	0.1122 S=0.205	0.3741 S=0.001	0.7506 S=0.001
174	Total personal expenditures	0.7638 S=0.001	0.2487 S=0.032	0.4684 S=0.001	0.6542 S=0.001
062	Total cost of hired labour	0.6768 S=0.001	0.2775 S=0.019	0.2027 S=0.018	0.6252 S=0.001
020	Amount of fertiliser used on paddy holding	0.6355 S=0.001	0.0539 S=0.347	0.1495 S=0.062	0.7134 S=0.001
064	Total number of man days of hired labour	0.5482 S=0.001	0.3322 S=0.006	0.1142 S=0.121	0.5435 S=0.001
010	Increase in paddy acreage	0.5075 S=0.001	0.1585 S=0.122	0.0830+ S=0.198	0.1142 S=0.206
New Var 41	Total income from other sources than paddy farming	0.3967 S=0.001	-0.764 S=0.288	0.0189 S=0.423	0.4434 S=0.001
084	Length of tenure of farmer at MIS	0.3755 S=0.001	0.0042 S=0.488	0.1582 S=0.052	0.2155 S=0.059
New Var 1	Total man days on paddy holding (hired, farmer, and household)	0.3422 S=0.001	0.0628 S=0.323	0.0781 S=0.212	0.6484 S=0.001
New Var 9	Size of tenant's household	0.3420 S=0.001	-0.2598 S=0.027	0.3682 S=0.001	0.2150 S=0.059
New Var 10	Size of family (Blood ties)	0.2979 S=0.001	-0.2100 S=0.060	0.3428+ S=0.001	0.1866 S=0.088
101	Total number of females in the household	0.2770 S=0.001	0.2738 S=0.021	0.3757+ S=0.001	0.1025 S=0.230
058	Total number of man days spent on non-farm jobs	0.2364 S=0.001	0.1462 S=0.141	0.1529 S=0.058	0.3495 S=0.005
063	Total number of working members of household	0.2306 S=0.001	0.3346 S=0.006	0.1333 S=0.086	0.3816 S=0.002
New Var 8	Total number of working members over age 10 in household	0.2017 S=0.001	-0.3959 S=0.001	0.2006+ S=0.019	0.1274 S=0.179
090	Age of tenant	0.1833 S=0.003	0.0869 S=0.262	0.0256+ S=0.397	0.0934 S=0.251
059	Total number of man days farmer is free of paddy farming	0.0542 S=0.214	0.1171 S=0.195	0.1516 S=0.060	0.1062 S=0.222
New Var 26	Major costs of paddy farming	-0.1696 S=0.006	0.1678 S=0.108	-0.0868+ S=0.188	-0.0959 S=0.245
222	Soil alkalinity problem	-0.4797 S=0.001	-0.2996 S=0.018	-0.3410 S=0.001	0.9999 S=0.000

All correlations are significant at 2 standard errors.

+ These variables are not significant at the 95 per cent confidence level

Statistical Tables

KENYA: PRODUCTION BY COMMODITY AND VALUE OF TOTAL AGRICULTURAL
AND FOOD PRODUCTION, AVERAGE 1961-65, ANNUAL 1964-73

Commodity	Price Weight	Average 1961-65	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973[1]
	Dollars	- - - - - -	- - -	- - -	- - -	1,000 metric tons	- - -	- - -	- - -	- - -	- - -	- - -
Wheat	73	122	144	133	180	243	226	216	177	165	150	135
Rice, paddy	63	19	18	23	22	30	30	34	34	34	40	36
Millet and Sorghum	62	307	320	293	367	380	350	325	350	350	350	350
Corn	49	1,357	1,270	1,270	1,500	1,600	1,600	1,425	1,400	1,500	1,660	1,500
Barley	62	19	12	12	14	7	8	11	12	13	15	16
Oats	68	11	9	8	9	9	9	9	10	10	10	10
Beans, dry	60	31	30	31	31	32	33	25	30	35	35	40
Potatoes	51	193	190	195	195	195	195	200	210	200	220	220
Cotton	500	3	3	4	4	4	4	4	6	6	6	7
Cottonseed	50	6	6	8	8	8	8	8	12	12	9	14
Peanuts, in shell	85	5	4	9	9	11	13	15	13	13	13	13
Sesame seed	130	2	2	2	3	3	3	3	1	1	1	1
Sunflower seed	42	2	1	3	3	4	3	4	2	3	3	3
Castor beans	65	5	5	5	7	4	3	4	3	2	2	2
Pyrethrum flowers, dried	600	9	6	8	9	10	11	7	6	10	14	17
Vegetables	84	152	150	160	165	170	175	180	180	175	185	185
Cashews, in shell	94	6	5	9	10	12	12	18	14	15	22	20
Pineapples	74	17	18	20	25	30	35	35	35	44	50	50
Coffee	915	41	40	52	56	39	48	54	60	60	74	63
Tea	1,082	17	20	20	25	23	30	36	41	36	53	60
Sisal	228	65	68	64	57	52	49	50	44	45	41	58
Sugar, raw	146	39	40	31	51	64	103	117	133	119	106	100
Meats	353	178	187	180	185	210	175	175	177	178	179	180
Milk	69	316	330	340	345	366	372	370	375	380	400	400
Hides and skins	750	24	25	25	25	24	22	22	22	22	23	24
Aggregates of Production		- - - - - -	- - -	Million dollars at constant prices	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
Crops		209.2	206.6	217.2	249.1	244.0	263.3	266.0	275.6	275.1	315.8	309.9
Livestock		102.3	107.6	105.8	107.9	117.4	104.0	103.8	104.9	105.5	108.1	109.1
Total Agriculture		311.5	314.2	323.0	357.0	361.4	367.3	369.8	380.5	380.6	423.9	419.0
Total Food		215.0	216.3	213.3	239.0	262.6	254.4	247.0	247.9	250.8	260.8	251.5

1 Preliminary

Source: *Indices of Agricultural Production in Africa and the Near East, U.S. Department of Agriculture, Economic Research Service, ERS - Foreign 365*, June 1974.

APPENDIX TABLE 2

KENYA: INDICES OF TOTAL AND *PER CAPITA* AGRICULTURAL PRODUCTION, AVERAGE 1961-65, ANNUAL 1962-73 (1961-65 = 100)

	Average 1961-65	1966	1967	1968	1969	1970	1971	1972	1973[1]
Crops	100	119	117	126	127	132	132	151	148
Total agriculture	100	115	116	118	119	122	122	136	135
Total food	100	111	122	118	115	115	117	121	117
Per capita agriculture	100	104	102	100	98	97	94	102	98
Per capita food	100	101	107	100	94	91	90	90	85
Index of population 1961-65 population = 9,473,000	100.0	110.2	114.0	117.8	121.7	126.1	129.7	133.9	138.3

1 Preliminary

Source: *Indices of Agricultural Production in Africa and the Near East, U.S. Department of Agriculture, Economic Research Service, ERS - Foreign 365,* June 1974.

APPENDIX TABLE 3

MWEA RICE MILLS LTD.: MILLING COSTS AND PROFIT, 1971/72 SEASON

	Total 1971 Kshs.	Total 1972 Kshs.	1971 Bags of Paddy Kshs.	1971 Bags of Rice Kshs.	1972 Bags of Paddy Kshs	1972 Bags of Rice Kshs.
(1) Loss on Bags	266,174	461,176	0.81	1.71	1.25	2.70
(2) Total Milling Costs	2,067,060	2,343,680	6.31	13.28	6.36	13.70
Direct	843,940	969,320	2.58	5.42	2.63	5.67
Indirect	1,223,120	1,374,360	3.74	7.86	3.73	8.03
(3) Total Mwea Rice Mills Ltd. costs (1) + (2)	2,333,234	2,804,856	7.13	14.99	7.61	16.39
(4) Revenue from by-products	1,306,075	1,684,974	3.99	8.39	4.57	9.85
(5) Net Mwea Rice Mills Ltd. cost (3) - (4)	1,027,159	1,119,882	3.14	6.60	3.04	6.54
(6) Revenue from Rice	20,260,902	22,254,987	61.90	130.16	60.40	130.07
(7) Cost of Paddy	14,885,791	16,510,236	45.47	95.63	44.81	96.49
(8) Net Mwea Rice Mills Ltd. Profit (Pre-Taxation) (6)-(5)+(7)	4,347,952	4,624,869	13.28	27.93	12.55	27.03

Source: *National Irrigation Board Report*, 1973.

APPENDIX TABLE 4

MAIZE AND PRODUCE BOARD ACCOUNT: MWEA IRRIGATION SETTLEMENT
PADDY CROP, 1972/73 SEASON

Section	Number[1] of Bags Produced	Total value[2] of rice sold to the M & PB	Commission[3] paid by M & PB	Cost of bags[4] charged to M & PB	Total Amount due to National Irrigation Board
		Kshs.	Kshs.	Kshs.	Kshs.
Mwea	99,112	3,607,676	163,534	297,336	4,068,546
Tebere	110,382	4,017,904	182,130	331,146	4,531,180
Thiba	101,352	3,689,212	167,230	304,056	4,160,498
Wamumu	99,672	3,628,060	164,458	299,016	4,091,534
Total	410,518	14,942,852[5]	677,352	1,231,554	16,851,758

1 Number of bags of milled rice delivered to the Maize & Produce Board at Sagana from the Mwea Rice Mills Ltd. in 1972/73.

2 Rate per bag of rice @ 36.40 Kshs.

3 Rate per bag of rice @ 1.65 Kshs.

4 Rate per bag @ 3 Kshs.

5 During the 1972/73 season the Mwea Rice Mills Ltd. sold 410,518 bags of rice to the Maize & Produce Board valued at approximately $2,092,000.

Source: *National Irrigation Board Report*, 1973

compared	Wheat	Rice (Paddy)	Maize	Sorghum-Millet	Barley	Potatoes	Sweet Potatoes-Yams)	Cassava	Soybeans	Dry Beans	Ground-nuts(in shell)	chick-peas	Dry Peas	Cowpeas	
AREA (1000 hectares)															
World**	217,220	134,947	112,910	113,437	82,241	22,466	17,001	9,783	36,182	22,868	18,840	10,150	8,999	3,999	6,395
25 LDCs*	3,546	2,843	5,731	16,689	2,094	146	646	1,003	13	1,370	2,070	377	334	1,457	1,242
Latin America	7,965	6,345	26,788	3,807	1,332	1,126	454	2,563	1,896	6,789	1,208	231	156	-	539
Africa	7,884	3,364	16,700	25,580	5,230	299	3,271	4,942	62	1,807	5,956	556	531	2,992	531
Asia**	44,226	89,669	15,869	40,896	10,168	1,304	1,587	2,249	1,556	8,380	8,480	9,104	946	49	3,512
PRODUCTION (1000 metric tons)															
World**	343,111	307,416	307,796	101,062	152,413	306,445	147,713	92,222	48,291	11,686	18,480	6,670	10,942	1,144	20,981
25 LDCs*	3,237	4,427	5,717	11,228	1,867	823	3,821	7,673	9	996	1,550	205	263	329	4,783
Latin America	11,404	10,740	39,611	7,303	1,403	9,129	4,123	34,819	2,609	4,213	1,455	183	106	-	3,873
Africa	7,156	5,082	19,926	18,349	4,605	2,181	23,414	37,017	45	1,235	4,919	334	398	1,078	1,836
Asia**	51,565	177,560	19,629	22,028	11,945	13,625	15,994	20,123	1,225	3,028	7,584	5,983	787	32	7,699
YIELD (100 Kg/hectare)															
World**	15.8	22.8	27.3	8.9	18.5	136.0	37.0	94.0	13.3	5.1	9.8	6.6	12.2	3.7	3.3
25 LDCs*	9.1	15.6	10.0	6.7	8.9	56.4	59.1	76.5	6.9	7.3	7.5	5.4	7.9	2.3	3.9
Latin America	14.3	16.9	14.8	19.2	10.5	81.0	91.0	136.0	13.8	6.2	12.0	7.9	6.8	-	7.2
Africa	9.1	15.1	11.9	7.2	8.8	73.0	72.0	75.0	7.3	6.8	8.3	6.0	7.5	3.6	3.5
Asia**	11.7	19.8	12.4	5.4	11.7	105.0	101.0	90.0	7.9	3.6	8.9	6.6	8.3	6.5	2.2
AVERAGE COMPOSITION OF MATURE SEEDS (percentage)															
Protein Content	12.2	7.1	9.5	10.0	11.0	2.0	1.9	1.6	37.9	22.1	30.4	20.1	22.5	23.4	22.3
Oil	1.9	1.9	4.3	2.8	2.0	0.1	0.4	0.4	18.0	1.4	47.7	4.3	1.2	1.3	42.9
N-free *** extract	69.9	64.9	71.0	71.7	72.1	17.4	26.7	23.8	24.5	57.3	11.7	54.0	57.0	56.8	10.9

* This corresponds to the list of least-developed countries proposed by ECOSOC and adopted by the United Nations General Assembly, Resolution 2768 (XXVI) of 27 November 1971. The countries included are: Africa - Botswana, Burundi, Chad, Dahomey, Ethiopia, Guinea, Lesotho, Malawi, Mali, Niger, Rwanda, Somalia, Sudan, Uganda, Tanzania and Upper Volta; Asia - Afghanistan, Bhutan, Laos, Maldives, Nepal, Sikkim, West Samoa and Yemen; Latin America - Haiti. The population of these 25 countries is approximately 146,209,000 with the total for the world being 3,722,927, and the 16 African countries total 103,297,000, the 8 Asian countries 33,045,000 and Haiti 4,867,000.

** Does not include the Peoples Republic of China for the cereals and the root and tuber crops, data unavailable.

*** Together with fiber content the nitrogen-free extract constitutes carbohydrates. The N-free extract includes the more soluble or more soluable carbohydrates such as starch, the sugars, the hemicelluloses and the more soluble part of the celluloses and pentosans. Total digestible nutrients constitute nitrogen-free extract, protein, fiber and fat.

[1] Source: *Food and Agriculture Organization Production Yearbook, Vol. 25,* (1971).

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MWEA FARMERS' AND FIELD ASSISTANTS'

QUESTIONNAIRES

Introduction

My name is C.B. Singleton and I am doing postgraduate research at the Centre of African Studies, University of Edinburgh, Edinburgh, Scotland.

I shall be most appreciative if you will answer some questions about your farming, yourself and your household. Anything you tell me will be kept in strictest confidence. Nothing will be told here or outside the scheme about you, or your own farm. Your name will not be mentioned in connection with your answers anywhere at anytime. The information you give me will be used solely by me in my analysis.

From this information I will be able to help you to help yourself, help to direct more money and attention to irrigation development in Kenya, and bring to the attention of other African Countries the impact of the successful irrigation development at Mwea.

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FARMER QUESTIONNAIRE: MWEA IRRIGATION SCHEME: KENYA 1973

Section and Unit [| |] 6-8 Sample No [| | |] 1-4 Card 1 [1] 5

Location X [| |] 9-11 Y [| |] 12-14

Name ______________________________

Address ______________________________

______________________________ VILLAGE [|] 15-16

Date ____________________

Time interview started ____________________ Name of Enumerator ____________________

I. LAND USE AND PRODUCTION

1. How large is your paddy holding?

   ACRES [|] 17-18

2. How much non-irrigated land do you have at Mwea?

   ACRES [|] 19-20

3. How much land do you have outside the scheme?

   ACRES [|] 21-22

4. Has your paddy acreage been increasing since you have been at Mwea?

   No 0
   Yes 1
   D.K. 2

   [ ] 23

5. Have your paddy yields been increasing since you have been at Mwea?

   No 0
   Yes 1
   D.K. ... 2

   [ ] 24

6. How many bags of paddy did you grow last season?

   BAGS [| |] 25-27

7. What variety of paddy do you grow?

   Sindano 1
   Basmati 2
   Hybrids 3
   Other (specify)
   4

   [ ] 28

8. Do you and your household eat any of the paddy you grow?

   Yes - all 0
   Yes - some 1
   No - none 2

   [ ] 29

   If none, why not?

   ....
   ....

   [ ] 30

9. Does all the paddy that you eat come from your own paddy?

   No 0
   Yes 1

   [ ] 31

   If no, where does the paddy come from?

   ....
   ....

   [ ] 32

10. About how much paddy do you eat annually?

    BAGS [|] 33-34

11. What are the most important factors which contribute to good paddy yields?

    [ ] 35

12. How much fertiliser do you receive from the scheme annually?

KGS

[ ][ ][ ] 36–38

13. Do you use fertiliser on your paddy crop?

No 0
Yes ...... 1 [ ] 39

If yes, what fertiliser type(s)?

Ammonia sulphate	[ ]	40
Potassium sulphate	[ ]	41
Super phosphate	[ ]	42
Potash	[ ]	43
Other (specify)	[ ]	44

14. How much cotton acreage do you have?

ACRES

[ ][ ] 45–46

15. What was your cotton yields last season?

BAGS

[ ][ ][ ] 47–49

16. Do you use insecticides on your non-irrigated land?

No 0
Yes ...... 1 [ ] 50

If yes, what types?

....	[ ]	51
....	[ ]	52
....	[ ]	53
....	[ ]	54

17. By what means do you transport your agricultural produce, other than paddy, to and from the field to market?

Human carrier 0
Use of animals 1
Mechanical means ... 2 [ ] 55

II. CURRENT FARMING PRACTICES

1. About how much paddy did you store in your house last season?

BAGS

[ ][ ] 56–57

2. About how much of other crops did you store in your house last season?

BAGS

[ ][ ] 58–59

3. Where do you mainly store your paddy?

House 1
Shed 2
Enclosure 3
Other (specify)
.... 4 [ ] 60

4. Where do you mainly store your other crops?

House 1
Shed 2
Enclosure 3
Other (specify)
.... 4 [ ] 61

5. What makes a successful paddy farmer?

Enjoy paddy farming	[ ]	62
Effective use of labour	[ ]	63
Can make and save money	[ ]	64
Good Field Assistant	[ ]	65
Ability to invest wisely	[ ]	66
Good Manager	[ ]	67
Work hard	[ ]	68
Other (specify)	[ ]	69
....	[ ]	70

CARD 2 [ ][ ][ ][ ][ ] 1-5

III. LABOUR AND FINANCE

1. How many man days did you spend last season in:

MAN DAYS

(i) maintenance of irrigation facilities [ ][ ][ ] 6-8

(ii) preparation of paddy fields [ ][ ][ ] 9-11

(iii) planting and care of seedling beds [ ][ ][ ] 12-14

(iv) transplanting seedlings [ ][ ][ ] 15-17

(v) weeding and insect control [ ][ ][ ] 18-20

(vi) harvesting paddy [ ][ ][ ] 21-23

(vii) non-farm jobs [ ][ ][ ] 24-26

2. How many days did you spend last season on your non-irrigated land on the scheme? [ ][ ] 27-28

3. How many days did you spend last season on any other land (outside the scheme) you may own? [ ][ ][ ] 29-31

4. How many days did you spend last season helping your friends and neighbours with their farm? [ ][ ] 32-33

5. How many days did you spend on non-farm jobs last season? [ ][ ][ ] 34-36

6. About how many days were you free of farming last season? [ ][ ][ ] 37-39

7. How many members of your household, over the age of 10, work on your land?

Male [ ] 40
Female [ ] 41

8. How much did you spend on hired labour last season?

SHILLINGS

[ ][ ][ ][ ] 42-45

9. How many people did you hire last season?

NUMBER

[ ][ ][ ] 46-48

10. How many man days of labour did you hire on your farm last season?

HIRED MAN DAYS

[ ][ ][ ] 49-51

11. Did you hire labour from outside Mwea on your farm last year?

No 0
Yes 1

[ ] 52

IV. GENERAL COMMENTS ON IRRIGATED PADDY

1. What do you consider to be your major agricultural problems last season?

Difficulty of getting hired help when needed [ ] 53

Seasonal lack of labour [ ] 54

Lack of money or credit [ ] 55

Pests, diseases, wild animals [ ] 56

Lack of good land [ ] 57

Other (specify)

.... [ ] 58

.... [ ] 59

No problems [ ] 60

2. What do you consider to be your major harvesting problems last season?

Lack of adequate labour [ ] 61

Lack of money or credit [ ] 62

Other (specify)

.... [ ] 63

.... [ ] 64

No problems [ ] 65

3. Was any of your paddy spoiled in the field by rain last season?

No 0
Yes 1

[ ] 66

4. Was any of your paddy spoiled after harvesting last season?

No 0
Yes 1

[ ] 67

If yes, how?

Rain 1
Rodents 2
Poor storage facilities 3
Other (specify) .... 4 ☐ 68

CARD 3 ☐☐☐☐☐ 1-5

V. PERSONAL INFORMATION ABOUT THE FARMER AND HOUSEHOLD

1. How long have you been a tenant on the Mwea scheme?

YEARS ☐☐ 6-7

2. Who told you about Mwea before coming here? ☐ 8

3. Who operated this farm before you came to Mwea? ☐ 9

4. Why did the farmer leave Mwea? ☐ 10

5. Which District did you come from before coming to Mwea?

DISTRICT ☐☐ 11-12

6. Sex of farmer?

Male 0
Female ...... 1 ☐ 13

7. What is your age?

D.K. 0
Under 20 ... 1
20-29 2
30-39 3
40-49 4
50 and over 5 ☐ 14

8. Have you ever gone to school?

No 0
Yes ...... 1 ☐ 15

9. Which type of primary school did you go to?

Public school ... 1
Missionary school 2
Trade school 3
Other (specify) .... 4 ☐ 16

10. At what level did you stop going to school? ☐☐ 17-18

11. From which school did you get your secondary education?

Public school ... 1
Missionary school 2
Trade school 3
Other (specify) 4
No secondary education .... 5 ☐ 19

12. Why did you stop?

Lack of money ... 1
Seek job in village 2
Lack of interest 3
Other (specify) .... 4 ☐ 20

13. Which certificates or other qualifications did you get from school?

No certificates ... 0
Low agricultural certificate 1
High certificate .. 2
Other (specify) .... 3 ☐ 21

14. Have you been on any training course such as:

No training course 0
Agricultural 1
Trade school 2
Missionary course . 3
Other (specify) .... 4 ☐ 22

15. Which school or training programme are you enrolled in at the present time?

No training course 0
Agricultural 1
Trade school 2
Missionary course . 3
Other (specify) .... 4 ☐ 23

16. What was the principal reason for enrolling?

To earn more money .. 1
Suggested by authority 2
Following example or suggestion by friend 3
For status 4
Suggested by family . 5
Don't know 6
Other (specify) ..... 7 [ ] 24

VI. INFORMATION ABOUT THE FARMERS HOUSEHOLD

1. How many people (other than yourself) are there in your household?

Males [ ][ ] 25-26
Females [ ][ ] 27-28

2. How many of these people (blood ties) are members of your family?

Males [ ][ ] 29-30
Females [ ][ ] 31-32

3. How many of these are wives of yours? [ ] 33

4. How many children (your own, brothers, sisters, etc. children) do you have in your household?

TOTAL NUMBER OF CHILDREN

Males [ ][ ] 34-35
Females [ ][ ] 36-37

(i) How many of these children help you with work on your farm?

Males [ ][ ] 38-39
Females [ ][ ] 40-41

(ii) How many of these children do not work on the farm?

Males [ ][ ] 42-43
Females [ ][ ] 44-45

5. How many are your own children (number)?

Males [ ][ ] 46-47
Females [ ][ ] 48-49

6. How many of your own children are going to school?

Males [ ][ ] 50-51
Females [ ][ ] 52-53

7. How many of your own children are attending these schools?

Primary [ ][ ] 54-55
Secondary [ ] 56
Other (specify) .... [ ] 57

8. How many of your own children are of working age?

Males [ ][ ] 58-59
Females [ ][ ] 60-61

9. How many of your own children help you with work on the farm?

Males [ ][ ] 62-63
Females [ ][ ] 64-65

10. How many of your own children are from 16 to 20 years of age?

Males [ ][ ] 66-67
Females [ ][ ] 68-69

11. Do any of your older children fail to work on your farm?

Males [ ][ ] 70-71
Females [ ][ ] 72-73

12. Why is this?

Don't like farm work .. 1
Lazy 2
Want to work in village 3
Want better status 4
Won't accept direction 5
Other (specify) 6
Indifferent .... 7 [ ] 74

CARD 4 [| | | |] 1-5

13. What kind of work do your wives do on the farm?

Taking care of seedlings	6
Transplanting seedlings	7
Weeding	8
Harvesting paddy	9
Work on non-irrigated crops	10
Other (specify)	11

14. How many adults (other than your wives) are in your household?

Males	12-13
Females	14-15

15. How many of these adults work on the farm?

Males	16-17
Females	18-19

16. How many non-working members of the household are there?

Males	20-21
Females	22-23

VII. HOME POSSESSIONS

1. Do you or anyone in your household have a store mbati roof?

No 0
Yes ...... 1 — 24

2. Does anyone in your household own a radio?

No 0
Yes ...... 1 — 25

3. Does anyone in your household own a sewing machine?

No 0
Yes ...... 1 — 26

4. How many bicycles are in your household? — 27

5. Does anyone in your household own a car?

No 0
Yes ...... 1 — 28

VIII. PERSONAL REACTIONS

1. Do you think that your life is better now that you are in the Mwea scheme?

No 0
Yes 1
D.K. .... 2 — 29

(i) If yes, why?

Making more money	30
Living better	31
More food to eat	32
Buy more things	33
Money for educating children	34
Other (specify)	35
....	36

(ii) If no, in what ways is it not as good?

Under close supervision	37
Work harder	38
More demanding work	39
Less leisure time	40
More worry	41
Other (specify)	42
....	43

2. Do you succeed in saving money?

No 0
Yes ...... 1 — 44

3. Do you save in banking and postal savings facilities?

No 0
Yes ...... 1 — 45

4. Do you have any shares in the Mwea Consumers Co-operative Society?

No 0
Yes ...... 1 — 46

CARD 5 [| | | |] 1-5

5. What main items do you spend your money on?

(i) Personal expenditures

	SHILLINGS	
1 Educating children	[ ]	6-9
2 Helping relatives	[ ]	10-12
3 Fixing houses	[ ]	13-15
4 Hiring labour	[ ]	16-19
5 Beer expenditure	[ ]	20-23
6 Transportation expenses (not including paddy)	[ ]	24-26
7 Food purchase	[ ]	27-30
8 Fuel purchase	[ ]	31-33
9 Refreshments (coffee, tea, milk soda, etc.)	[ ]	34-36
10 Contingencies	[ ]	37-39
11 Clothing purchases	[ ]	40-42
12 Other expenses	[ ]	43-45
TOTAL	[ ]	46-49

(ii) What were your major costs in paddy farming last season (definite) to the Mwea Irrigation Settlement?

	SHILLINGS	
1 Cost of water	[ ]	50-53
2 Cost of ploughing and levelling	[ ]	54-57
3 Cost of seeds, fertiliser, etc.	[ ]	58-60
4 Cost of bags	[ ]	61-63
5 Cost of Transporting paddy to reception centre	[ ]	64-67
6 Cess (tax) 1.50 Kshs per dry bag of paddy	[ ]	68-70
7 Repayment of KFW loan (20 Ksh per acre)	[ ]	71-73
TOTAL	[ ]	74-77

CARD 6 [| | | |] 1-5

6. Do these extra goods/ services make your life better?

No 0
Yes 1

[ ] 6

If yes, how?

Children better educated	[ ]	7
Better house to live in	[ ]	8
More food to eat	[ ]	9
More and better clothes to wear	[ ]	10
More luxuries	[ ]	11
Support for relatives	[ ]	12
Other (specify)	[ ]	13
....	[ ]	14

If no, why?

Less leisure time	[ ]	15
Have to work harder	[ ]	16
Support for dropouts	[ ]	17
Have to support relatives	[ ]	18
Have to support friends	[ ]	19
Other (specify)	[ ]	20
....	[ ]	21

7. What other investments have you made?

Mwea Credit Co-operative Society	[ ]	22
Trucking companies in the area	[ ]	23
Mwea Consumers Co-operative Society	[ ]	24
Other (specify)	[ ]	25

8. What income do you get, if any, other than by selling your crops (including paddy)?

	SHILLINGS	
As shareholders in Mwea Credit Co-op Society	[ ]	26-28
As shareholder in trucking company	[ ]	29-31
As shareholder in Mwea Consumer Co-op Society	[ ]	32-34
From other work you do	[ ]	35-37
From any other businesses you have been connected with	[ ]	38-40
Other (specify)	[ ]	41-43

9. What was your net income from paddy farming last season?

NET INCOME
SHILLINGS

[| | |] 44-47

10. What off-scheme opportunities are available for you?

Agricultural training	☐	48
Schooling	☐	49
Off-scheme job	☐	50
Other (specify)	☐	51

11. Do you own any livestock?

No 0
Yes ...... 1 ☐ 52

If yes, how many?	NUMBER	
Oxen	☐☐	53-54
Cows	☐☐	55-56
Sheep	☐☐	57-58
Goats	☐☐	59-60
Pigs	☐☐	61-62
Poultry	☐☐	63-64

12. Do you have a soil alkalinity problem on your paddy holding?

No 0
Yes ...... 1 ☐ 65

13. Are you a guardian?

No 0
Yes ...... 1 ☐ 66

14. Are there any general comments or questions that you think we should have asked but did not ask? ☐ 67

Thank you very much for your time and co-operation with this enquiry.

Time interview ended ____________________

MWEA FARMERS' AND FIELD ASSISTANTS'

QUESTIONNAIRES

Introduction

My name is C.B. Singleton and I am doing postgraduate research at the Centre of African Studies, University of Edinburgh, Edinburgh, Scotland.

I shall be most appreciative if you will answer some questions about your farming, yourself and your household. Anything you tell me will be kept in strictest confidence. Nothing will be told here or outside the scheme about you, or your own farm. Your name will not be mentioned in connection with your answers anywhere at anytime. The information you give me will be used solely by me in my analysis.

From this information I will be able to help you to help yourself, help to direct more money and attention to irrigation development in Kenya, and bring to the attention of other African Countries the impact of the successful irrigation development at Mwea.

Centre of African Studies,
University of Edinburgh,
Adam Ferguson Building,
40, George Square,
Edinburgh,
Scotland.

FIELD ASSISTANT QUESTIONNAIRE, MWEA, KENYA, 1973

Block ☐ 1 Sample No. ☐☐ 2-3 CARD 1 [1] 4

Location Y ☐☐☐ 5-7 X ☐☐☐ 8-10

Name ______________________

Address ______________________

____

Date ______________________

Time Interview Started ______________________

I. GENERAL COMMENTS

1. What were your farmers' major agricultural problems last season?

Seasonal lack of labour	☐	11
Difficulty of getting hired help when needed	☐	12
Lack of money or credit	☐	13
Lack of good land	☐	14
Pests, diseases, wild animals	☐	15
Other (specify)	☐	16
No problems	☐	17

2. What was their main agricultural problem?

☐ 18

3. What were your farmers' major harvesting problems last season?

Lack of adequate labour	☐	19
Difficulty of getting hired help when needed	☐	20
Other (specify)	☐	21
No problems	☐	22

4. What was their main harvesting problem?

☐ 23

5. On average how much time did your farmers have last season between harvesting the paddy and rotavation?

DAYS ☐☐ 24-25

6. On average how much time did your farmers have last season between transplanting and harvesting the paddy crop?

DAYS ☐☐☐ 26-28

II. LAND USE AND PRODUCTION

1. What main variety of paddy do your farmers grow?

Sindano 1
Basmati 2
Hybrids 3
Other (specify) ... 4

☐ 29

2. What do your farmers do with the bags of paddy they retain in their homes?

Eat	☐	30
Barter	☐	31
Sell	☐	32
Other (specify)	☐	33

3. To whom do your farmers feed their paddy?

Their wives and children	☐	34
To others in their household	☐	35
Hired workers	☐	36
Other (specify)	☐	37

4. What proportion of the paddy given to the farmer as his share, if any, is used for barter?

PERCENT ☐☐ 38-39

5. Does irrigating the land cause a salt (alkaline) problem on the land in your section?

No 0
Yes 1
D.K. 2

☐ 40

6. On average how has the yield per acre of the paddy crop in your section/unit changed since 1963?

Increased 0
Remained the same. 1
Decreased 2

☐ 41

(i) If increased, Why?

D.K.	☐	42
Better seed	☐	43
Improved farm practices	☐	44
Use of manure	☐	45
Use of chemical fertiliser	☐	46
Use of insecticides	☐	47
Other (specify)	☐	48
....	☐	49

(ii) If there has been a decrease in paddy yields, how can you account for it?

Poor weather conditions	☐	50
Lack of labour	☐	51
Declining soil quality	☐	52
Alkalinity	☐	53
Other (specify)	☐	54
....	☐	55

CARD 2 — 2 — 56

III. CURRENT FARMING PRACTICES

1. What main storage facilities do your farmers have?

Bin 1
Granary 2
House 3
Enclosure 4
Other (specify)
.... 5

☐ 1

2. Do any of your farmers store any crops other than paddy in their house?

No 0
Yes 1

☐ 2

If yes, What crops?

Maize	☐	3
Cotton	☐	4
Beans	☐	5
Peas	☐	6
Sweet potatoes	☐	7
Sorghum and millet	☐	8
Other (specify)	☐	9
....	☐	10

3. On average, last season how much house storage of grain does a farmer in your section and unit have?

BAGS ☐☐ 11-12

4. Do your farmers grow any non-irrigated crops?

No 0
Yes 1

☐ 13

If Yes, what are your main non-irrigated crops?

Maize	☐	14
Cotton	☐	15
Beans	☐	16
Peas	☐	17
Sweet Potatoes	☐	18
Sorghum and millet	☐	19
Onions	☐	20
Other (specify)		
....	☐	21
....	☐	22

IV. LABOUR

1. Last season on average how many days did your farmers work on their land in:

	DAYS	
(i) maintenance of irrigation facilities	☐☐	23-24
(ii) preparation of paddy fields	☐☐	25-26
(iii) planting and care of seedling beds	☐☐	27-28
(iv) transplanting seedlings	☐☐	29-30
(v) weeding and insect control	☐☐	31-32
(vi) harvesting paddy	☐☐	33-34
(vii) non-farm jobs	☐☐☐	35-37

2. On average last season how many days of agricultural work did your farmers spend on other land of theirs within the scheme?

DAYS ☐☐ 38-39

3. On average how many days did your farmers work on other land (outside the scheme) they own?

DAYS ☐☐ 40-41

4. On average last season, how many hired labourers did your farmer use in farming?

NUMBER ☐☐ 42-43

5. What percent of wives, children and other adults in the household help farmers on the holding?

	PERCENT	
(i) Their wives	☐☐	44-45
(ii) Children of working age	☐☐	46-47
(iii) Other adult members of household	☐☐	48-49

V. FINANCE

1. Apart from crops, what other sources of income do your farmers have?

From other work they do	☐	50
From investments	☐	51
Other (specify)		
....	☐	52

2. What off-scheme opportunities are available to your farmers?

Work in village	☐	53
Work in rice mill	☐	54
Work for Mwea Credit Co-operative Society	☐	55
Work for others	☐	56
Other (specify)		
....	☐	57

3. As far as you know, do any of your farmers succeed in saving money?

No 0
Yes ...... 1 ☐ 58

4. What banking or postal savings facilities are available to your farmers?

Post Office	☐	59
Kenya Commercial Bank	☐	60
Mwea Credit Co-operative Society	☐	61
Barclays Bank	☐	62
Other (specify)	☐	63

5. As far as you know, do any of your farmers use the banking or postal savings facilities available to them?

No 0
Yes 1

[ ] 64

6. Do your farmers invest in farms outside the Mwea scheme?

No 0
Yes 1

[ ] 65

7. Do any of your farmers invest in the Mwea Rice Mills Ltd?

No 0
Yes 1

[ ] 66

8. Do any of your farmers invest in any trucking companies in the area?

No 0
Yes 1
D.K. 2

[ ] 67

9. To what extent do they use them?

Some 1
Average 2
Much 3

[ ] 68

CARD 3 [3] 69

VI. EDUCATION

1. What standard did you reach at school?

[| |] 1-3

2. Where did you get your primary schooling?

Public school 1
Missionary school 2
Agricultural school .. 3
Trade school 4
Other (specify) 5

.... [ ] 4

(i) Standard completed?

.... [| |] 5-7

3. Where did you get your secondary education?

Public school 1
Missionary school 2
Agricultural school ... 3
Trade school 4
Other (specify) 5

.... [ ] 8

(i) Standard completed?

.... [| |] 9-11

4. Did you get any certificates or other qualifications from school?

No 0
Yes 1

[ ] 12

5. Have you been on any training course since leaving school such as:

Agricultural 1
Trade school 2
Missionary school 3
University training .. 4
Other (specify) 5

.... [ ] 13

6. Are you at present enrolled in any training or school programme?

No 0
Yes 1

[ ] 14

If Yes, Can you tell me which one you are enrolled in?

[ ] 15

7. Why did you enrol in that particular programme?

Suggested by authority [ ] 16

Following example or suggestion by friend [ ] 17

For advancement [ ] 18

For status [ ] 19

Other (specify)

.... [ ] 20

.... [ ] 21

VII. GENERAL INFORMATION

1. Age of field assistant? [|] 22-23

2. How long have you been at Mwea?

MONTHS [ ] [ ] [ ] 24-26

3. What was your principal job before coming to Mwea?

Farmer 1
In school 2
Unemployed 3
Worker on plantation ... 4
Worker for government .. 5
Other (specify) 6
.... [ ] 27

4. What was your principal occupation before you were a field assistant?

Farmer at Mwea 1
In school 2
Plantation worker 3
Water guard 4
Farmer 5
Hired labourer 6
Other (specify) 7
.... [ ] 28

5. Which district did you live in before coming to Mwea?

.... [ ] [ ] 29-30

6. How long have you been a field assistant at Mwea?

MONTHS [ ] [ ] [ ] 31-33

7. How long have you been employed by the National Irrigation Board?

MONTHS [ ] [ ] [ ] 34-36

8. Are there any major personal problems connected with your work at Mwea?

No irritations	[ ]	37
Too much responsibility	[ ]	38
Lack of co-operation	[ ]	39
Lack of supervision	[ ]	40
Other (specify)		
....	[ ]	41

9. Do your farmers show any signs of resisting your authority over them?

No 0
Yes 1
[ ] 42

If yes, On average how many occasions have you had trouble?

	NUMBER	
Daily	[ ] [ ]	43-44
Weekly	[ ] [ ]	45-46
Monthly	[ ] [ ]	47-48

(i) What is your major problem?

Insubordination 1
Lack of co-operation . 2
Lack of responsibility 3
Other (specify) 4
.... [ ] 49

(ii) How serious are these problems?

Very serious 1
Moderately serious .. 2
Minor .... 3 [ ] 50

10. How effective do you consider the personal incentives of the Mwea scheme to your farmers?

Very effective 1
Moderately effective ... 2
Relatively ineffective . 3 [ ] 51

11. Do you have hopes of being a manager at Mwea or a similar irrigation scheme?

No 0
Yes 1
D.K. 2
[ ] 52

12. If you were in power to do so, would you make any changes in the rules of the Mwea scheme?

No 0
Yes 1
D.K. 2
[ ] 53

If Yes, what changes?

....

....

13. Do you think the farmers should have a bigger say in the running of the Mwea scheme?

    No 0
    Yes ...... 1 ☐ 54

    If Yes, How?

    ....

    ....

14. How effective is the Tenant Liaison Council and the Tenant Advisory Council in assisting the farmers with their problems?

    Effective 0
    Moderately effective. 1
    Not effective .... 2 ☐ 55

15. Are there any channels for farmers' ideas to be considered and possibly implemented on the scheme?

    No 0
    Yes ...... 1 ☐ 56

16. Why does paddy crack while in the field?

    ....

    ....

    .... ☐ 57

17. Are there any changes you would like to see in the scheme?

    No ,..... 0
    Yes ...... 1 ☐ 58

    If Yes, What?

    ....

    ....

    ....

18. What sources of information do you give your farmers to improve their work?

    Meetings........... 0
    Newspapers 1
    Journals 2
    Radio (Voice of Kenya) 3
    Information from others 4
    Vocational schools. 5 ☐ 59

19. If you owned a farm outside of the Mwea scheme, would you leave Mwea?

    No 0
    Yes ...... 1 ☐ 60

    If Yes, Why?

    ....

    ....

20. In your opinion how do you visualise the Mwea scheme in the future?

    ....

    ....

    .... ☐ 61

21. In your opinion what major problems do you see for Mwea in the future?

    ....

    ....

    .... ☐ 62

22. Are you satisfied with the salary you are receiving?

    No 0
    Yes ...... 1 ☐ 63

23. How have things changed since you have been on the Mwea scheme?

    ....

    ....

    ....

    .... ☐ 64

24. Are there any general comments or questions that you think we should have asked but did not ask?

    ....

    ....

    .... ☐ 65

Thank you for your time and co-operation for this enquiry.

Time interview ended ______________________