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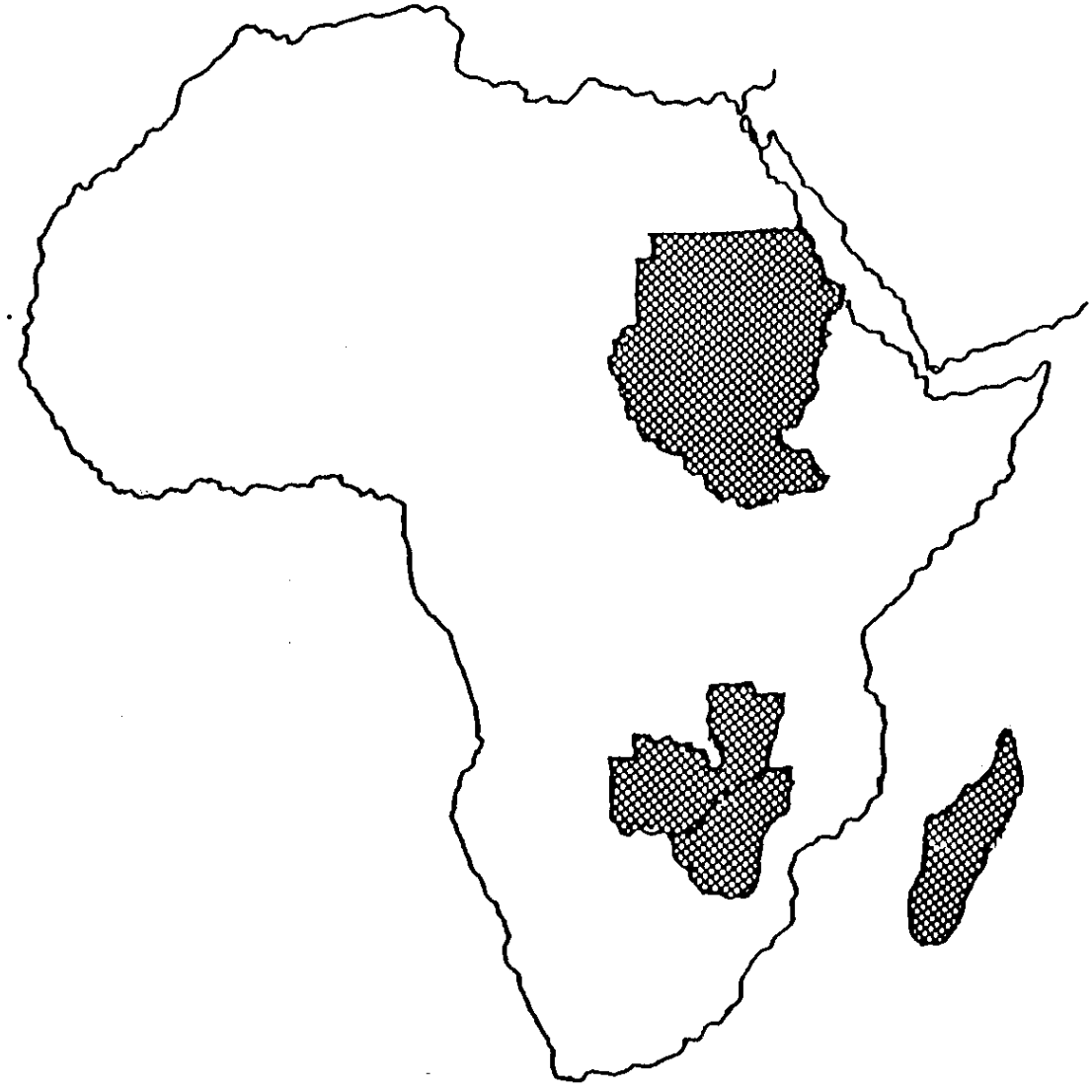
SECOND EXPLORATORY MISSION TO AFRICA

Final Report



INTERNATIONAL IRRIGATION MANAGEMENT INSTITUTE

INTERNATIONAL

IRRIGATION MANAGEMENT

INSTITUTE

SECOND EXPLORATORY MISSION TO AFRICA

(MADAGASCAR, ZAMBIA, ZIMBABWE, SUDAN)

9 NOVEMBER - 4 DECEMBER 1985

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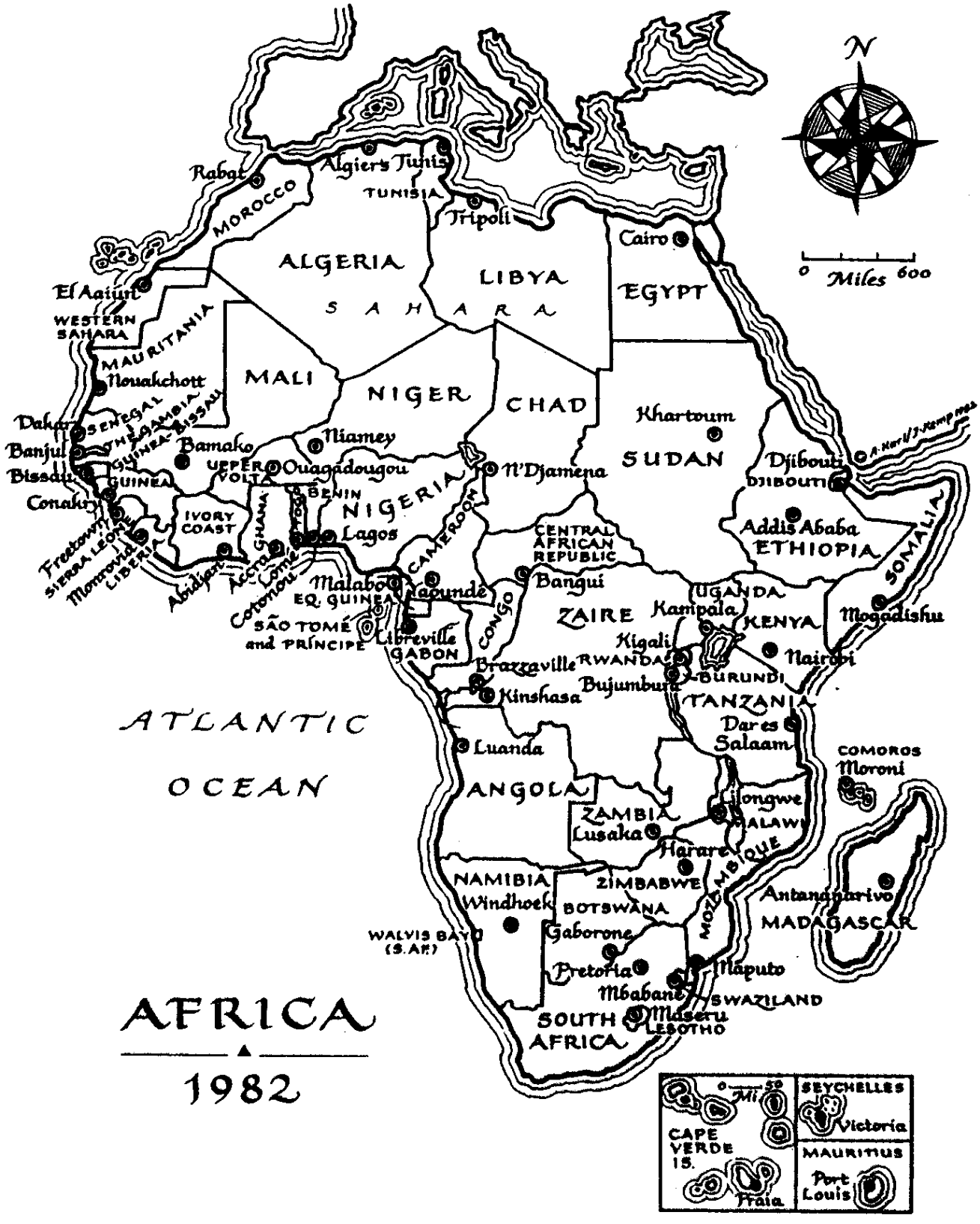
FINAL REPORT

January 1986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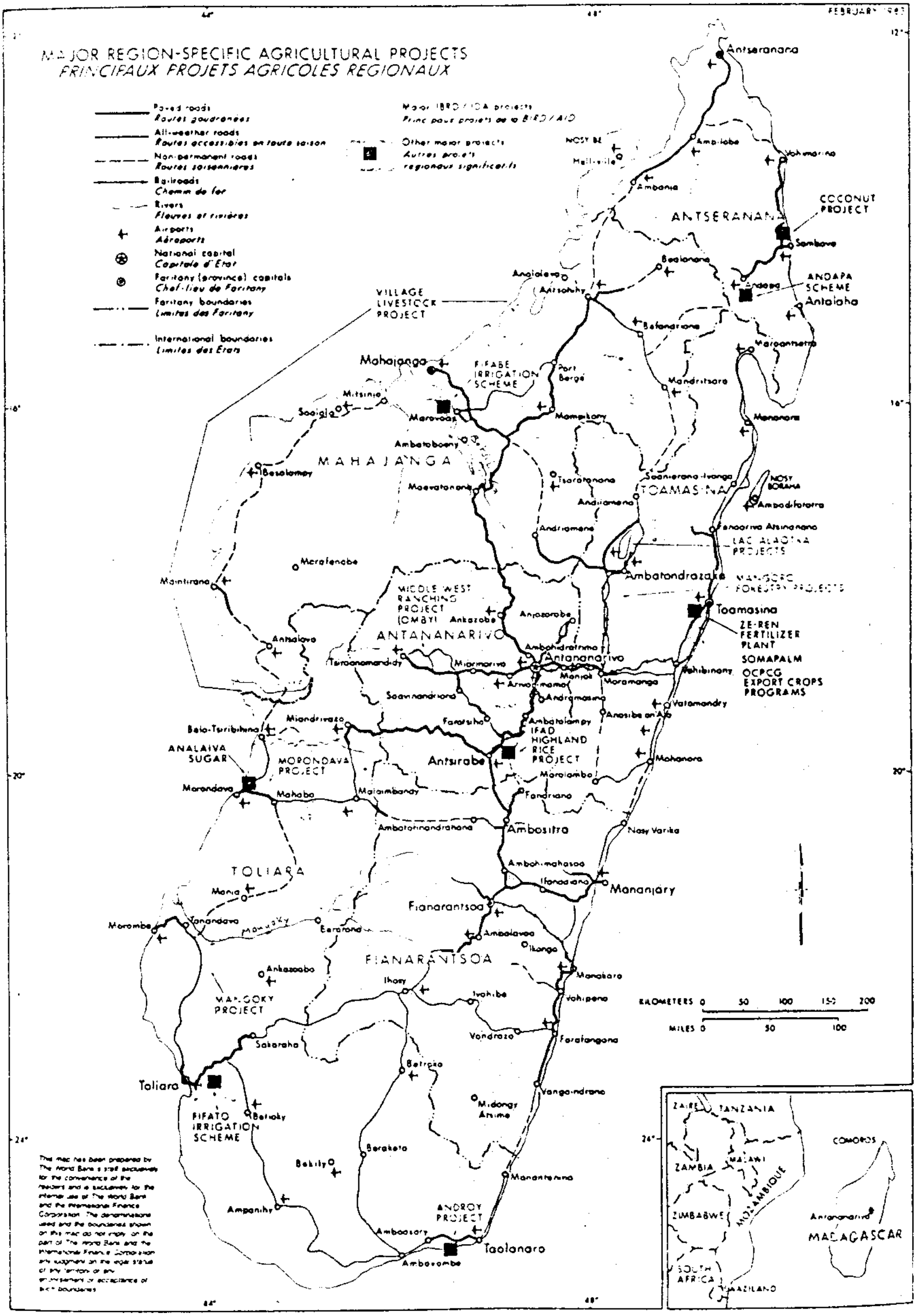

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APPENDICES

1 INTRODUCTION

1.1 This report gives the observations, conclusions and recommendations of IIMI's second exploratory mission to Africa. This mission visited Madagascar (9 - 17 November 1985), Zambia (18 - 21 November), Zimbabwe (21 - 27 November) and Sudan (27 November - 4 December).

1.2 The members of the mission were Charles L Abernethy, mission leader (consultant; United Kingdom); Daniel Berthery (IIMI staff); Dr David Groenfeldt (IIMI staff); and Dr Alfred S Waldstein (consultant; United States). Mr Abernethy and Mr Berthery are engineers; Dr Groenfeldt and Dr Waldstein anthropologists.

1.3 The terms of reference of the mission are given at appendix A, and its itinerary at appendix B.

1.4 This mission was conceived as an integral part of the process by which IIMI is formulating its policy for assistance in the solution of Africa's irrigation management problems. This process will, it is hoped, culminate in the production and approval of an Africa policy document by IIMI during the early part of 1986; which is an essential preliminary step after which IIMI can begin to make effective proposals for positive, problem-oriented actions and collaborations in chosen African locations.

1.5 The mission was, therefore, not aiming to proffer immediate help to any African country; but rather to seek information, to learn what are the opinions of those now involved in irrigation, and most of all to identify which are the major current problems of irrigation people (farmers, engineers, officials, academic researchers, foreign donors) about what is needed in order to enhance the performance of African irrigation.

1.6 We therefore wish to thank all those who gave valuable time to respond to the many questions the mission had to ask. These people are recorded at Appendix C. Our hope is that, as a result of all these conversations and field visits, IIMI will shortly be able to launch a programme in Africa that will be thought helpful by those whose help we have had.

1.7 IIMI's concern is irrigation management. Without going deeply into the exact definition of "management", we should here remark that this means some emphasis upon people (irrigation users) and their institutions, their relations with irrigation bureaucracies, their

motivations and their economic lives; and these factors will tend to take precedence over (but not to exclude) the physical questions of water-control devices, tillage and cultivation techniques, and so on.

1.8 Some readers may enquire why, among the 40 - odd African nations practicing some irrigation, we chose these four. IIMI's first exploratory mission, in June 1985, had already visited four west African nations (Senegal, Mali, Burkina Faso and Niger); other contacts had been made with Morocco and Sudan. For this mission, aimed geographically at eastern and central Africa, we tried to visit a representative set of countries, including two (Sudan and Madagascar) with much existing irrigation, through of very different types: these two account between them for about 30% of all Africa's irrigated land. We chose Zimbabwe because of its curious situation as one of the most successful irrigators of high value export crops, and possessor of an indigenous capacity to manufacture irrigation equipment, even though its total irrigated area is not vast.

1.9 Zambia is different: its irrigated area is small, but it is nevertheless typical of a class, being one of 19 African states whose present irrigated area is between 10,000 and 50,000 ha. Many of these states, are in Zambia's situation: their population is rising rapidly, their food-production capacity will prove to be finite, but on the whole they still have scope to choose between policies to enhance rainfed production, or policies to introduce irrigation. Most such countries encounter a planning difficulty, which may be summarized as, how does a country get started in irrigation? At first they lack professional manpower and farmer know how: how and at what step should these barriers be surmounted. It is these difficulties that keep many African states at the threshold of irrigation (a condition long since passed in most of South Asia); but, since it is clear that pressures of population are ultimately going to force several such countries to attempt the leap into large scale irrigated agriculture, Zambia was chosen by this mission as an example.

1.10 Each country section of this report, and the main report itself, ends with two sections: in the penultimate one we try to isolate a number of irrigation management issues, some which have been pointed out to the mission by its hosts, some which we imagine we have discerned ourselves. In the final section, we try to select from these some kind of agenda for IIMI. Naturally, the extent to which IIMI later implements this agenda will depend upon resources made available to it.

2 MADAGASCAR

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2.1 INTRODUCTION

Compared to the African world nearby, Madagascar appears original in respect to its socio-economical features. Most of the Malagasy traditions and particularly those related to rice production, the major staple crop, show closer relationships with Asia than with Africa. (Agricultural practices observed in Madagascar are somewhat similar to those used for paddy cultivation in south-east Asia). The Asian origin (Indonesia) of some of its population groups might be a tentative explanation. In fact the natural, climatical, hydrographical and topographical conditions played an essential role in the distribution of rice irrigation, while origin and behavior of the population and its density in the various regions have determined the introduction and the development of rice cultivation.
(F. le Bourdiec - 1974).

2.2 THE AGRICULTURAL SECTOR.

The total surface area of Madagascar is about 592,000 km2, of which 60% are natural pastures, 35% is non cultivated area (forests, lakes, mountains) and 5% only cultivated land. Agriculture dominates the economy and contributes about 40% of total GDP, accounts for more than 80% of export earnings, and supports directly over 80% of the population. Rice occupies a preeminent position in the agricultural sector; it is grown on almost one half of all cultivated land and is the staple food of most of the population. Cattle also play a vital role; long the traditional symbol of Madagascar, cattle are reared throughout the country. After rice, cassava (manioc) is the most important food crop, mainly consumed on the farm.

The growth of Madagascar's agricultural production over the past 15 years has been disappointing, with average rate of increase somewhat less than the population growth rate of 3% a year. From 1970-75, the annual rate of increase was about 2%. This performance largely reflected the low rate of growth of the two main agricultural productions: rice and cattle.

Madagascar is no longer exporting rice, but has imported more and more in recent years: 175,000 tons in 1980, up to 350,000 tons in 1982. Among the reasons for the slow growth are marketing problems for many crops, agricultural pricing policies, poor roads, and ineffective development institutions. Since 1982 new government policies including price increases for several commodities, seem to have reversed this trend.

Potential for agricultural development in Madagascar is very substantial, both for rainfed and irrigated agriculture. The scope for increased output through intensification of production exists in almost all parts of the country, subject to rehabilitating the existing infrastructure, roads and irrigation systems in particular. Expansion of the cultivated area is also possible on the West coast where there are large areas of undeveloped yet fertile land which can be brought into production.

2.3 MAIN FEATURES OF THE NATIONAL WATER SYSTEM

2.3.1. Madagascar is located between 12 and 25 degrees latitude south. Its climate is influenced by the air circulation prevalent in the South-West of the Indian Ocean, modified by the continental aspects of the "Big Island", resulting in four main rainfall zones:

- The whole eastern sector, exposed to the trade winds, receives more than 2,000 mm/year, and up to 3,250 mm/year.
- Further to the West, a zone including the Highlands and the North-East is subject to the summer monsoon but relatively protected against the winds, it receives an average of 1,400 to 2,000 mm/year.
- The lee-side of the island extending to the North, has a typical monsoon climate with a dry winter and a rainy summer. Average rainfall ranges from 800 to 1,400 mm/year.
- The South is dry. Rainfall is irregular and can be as low as 400 mm/year.

However mean annual rainfall does not account for the high variability in the weather which results from the movement over the island of tropical depressions which very much affect the cultivation. Total rainfall can be twice as much as the average, higher air-humidity content and lower temperature can suddenly affect the crops and major damages due to cyclones are rather frequent.

2.3.2 Besides rainfall, temperatures and sunlight are factors to be considered in assessing potential area for paddy cultivation in Madagascar. The highlands get more sunshine but have lower winter temperatures due to the elevation. This is an additional parameter to be considered for management of rice cultivation; two irrigation seasons are possible but not double cropping on the same plot. However, despite the mountainous conditions which might have made the Highlands less suitable for irrigation, it seems that traditional practices and farmer's skill overcame these difficulties.

2.3.3 The topography of Madagascar which extends from North to South has developed a divergent and dense hydrological network composed of some major streams and many smaller rivers. All major water courses are characterised by the irregularity of their profile and extreme variation in their hydrological regime. Rivers are generally embedded in deep valleys at their upper reaches and develop large deltas when reaching the sea. Data are available since ORSTOM set up some hydrological stations which were operated from 1951 up to 1973 when it left the country. Major river basins are the following:

- In the North, Mahavavy North river is born in the Tsaranana Massif at 2,200 m elevation and drops down to 200 m within a distance of 60 km. It has a delta 25 km long at the sea.

- On the Western side which covers 365,000 km2, the Highlands around Antananarivo generate: (i) the Betsiboka/Ikopa river system which is the most important in the country and which has been well developed for hydropower, and (ii) Tsiribihina river. Mangoky river system ranks second in importance; it is generated from the highlands in Fianarantsoa area. The topographical conditions of these major streams make irrigation development difficult except in their lower courses which however are subject to flooding. Smaller rivers and tributaries seem to offer more appropriate conditions. Rivers in the Highlands also get good water supply conditions (average module 15 to 50 l/s/km2) and with low flows which range from 1 to 15 l/s/km2 in October and November, thus they offer good prospect for irrigation by diversion even in the dry months.

- Rivers on the Eastern side, which is only 100 km wide, have got different conditions, profiles are irregular in their upper course and these impetuous torrents running down the eastern escarpment get lost in the swampy lagoon systems along the coast. Flows are important throughout the year (average module 20 to 100 l/s/km2). Maningory is the outlet of Lake Alaotra, itself draining a 12,645 km2 catchment area. Namorona, Faraony, Mananjary, Onive are among the principal rivers of the eastern side. Drainage and flood protection are the main difficulties in developing these areas which nevertheless offer double cropping possibilities.

- In the South, Mandrare and Menarandra rivers have a very irregular hydrological regime of "Oued" type with sudden flood and extremely low flow.

2.3.4 Most important lakes in the country are:

(i)	Lake Alaotra: 220 km2,	(ii)	Lake Kinkony: 85 km2,
(iii)	Lake Itasy: 42 km2,	(iv)	Lake Antsohary: 39 km2,
(v)	Lake Bemamba: 38 km2,	(vi)	Lake Ihotry: 34 km2,
(vii)	Lake Tsazompanitry: 32 km2,	(viii)	Lake Mantasoa: 20 km2.

Total lake surface areas including the lagoon system interconnected by the Pandalames canal along the Eastern coast cover about 770 km2.

2.3.5 Most of the soils (67.5%) of the country, including the central Highlands are of ferrallitic or ferruginous type as a result of the pedogenesis which affected crystalline rocks of the basement. These are rather poor soils with low fertility. As far as rice cultivation is concerned, appropriate soils originated from alluvium or peat have a limited extent in the country (2%). They can be met mainly along the Western coast mainly (alluvial soils or "baiboho") and in poorly drained basins in the hills (hydromorphic soils). Such are the plains of Antananarivo, Ankaizina, Didy and the surroundings of Lake Alaotra. Halomorphic soils are also rather frequent in most of the Western and North-West coastal plains and at the downstream end of the deltas. Reclamation of delta salty soils which cover more than 200.000 ha has been tried, but economical feasibility is still questionable.

2.

2.3.6 The mission did not come across information regarding groundwater development in Madagascar. Considering the nature of the geological substratum (igneous), one cannot expect much groundwater resource. However, in the highlands, springs which often occur, play an important role in the development of irrigation along the "tanety" (steepy valley bottom) and for the supply of the paddy nurseries located upstream the terrasses.

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2.3.7 Population in Madagascar totals about 10 million inhabitants. Distribution is uneven, and 3/4 of them live in 1/10th of the country in areas located either in the central section along the eastern coast where the average population density is 74 persons/km2, or in the central highlands in the Antananarivo (200 persons/km2) and Fianarantsoa areas.

2.

In the Highlands, these heavily populated areas overlap respectively with the Merina and Betsileo ethnic group regions. The Merina is the more important group and the Betsileo rank third in the 20 ethnic groups existing in the country. Both claimed to be the original and exclusively rice cultivating societies in Madagascar. Traditions are still strong in many respects: agricultural practices which have reached a high technical level in controlling a difficult environment for rice irrigation, spirit of family, and devotion to the dead ancestors.

In the eastern coast, the population includes the Betsimisaraka, second ethnic group and the Tanala. Both are mainly rice cultivators in association with other cash crops (vanilla, clove, coffee...) which tends to become more attractive than paddy for which the region is not self-sufficient. The Tanala who live in the forested escarpment originally grew rainfed rice in association with maize direct seeding after deforestation and burning (shifting cultivation), but irrigated rice cropping is now progressing in valley-bottoms.

In the rest of the country except the far South, several other ethnic groups (Sakalava in the S.W coast, Tsimihety in the N., Bara in the central S.) are also rice cultivators either dry or irrigated. However it seems that has resulted from food habit changes, population migration and government incentives. Irrigation is practiced with little water control and extensively in terms of labor devoted to the crop (50 to 90 working day/ha instead of 200 to 220 days for the Betsileo): rapid puddling with all animals available, broadcasting, no weeding would give hardly 1 ton per ha. yield. In fact, paddy is grown for subsistence only; the primary economic activity is cattle husbandry with which agriculture is competing and for which the western part of the country offers good pasture.

2.4 PRESENT ROLE OF IRRIGATION.

2.4.1 About 1/3 of the cultivated land (1,000,000 ha) is equipped with a system for controlling water to irrigate rice most generally, or cotton and sugar cane in some places. Government considers that irrigation is of the utmost importance for the country's agriculture and solutions to improve management and maintenance of irrigated systems are sought.

2.4.2 Irrigation systems in Madagascar can be organized in 3 major groups:

- The farmers' community irrigation systems,"la petite hydraulique villageoise", covers up to 700,000 ha. They include family systems gathering farmers on 10 to 200 ha, each having 1 to 5 ha, and traditional systems of 50 to 500 ha. Main structures of the latter, in general river intakes, may have been upgraded with government support when requested by the local communities (Opération Microhydraulique). All are managed and maintained by the farmers.

- The small irrigation schemes, "les petits périmètres irrigués (PPI). Many of these were developed with government support after world war II. There are about 120 of these systems which range from 500 to 3,000 ha each. They cover about 200,000 ha (under command) but

100,000 ha are actually irrigated. In the recent past, government MPARA has been responsible for their operation and maintenance but they have severely deteriorated. It is one of the present priorities for government to have them restored and an important rehabilitation project financed by government and a consortium of donors is going on.

- The large public schemes, "Les grands périmètres". There are six large schemes managed by parastatal companies. Altogether they represent an irrigated area of 80,000 ha and cater for rice needs of the urban areas. The most important are: (i) SOMALAC - Lac Alaotra basin, in the central highlands, 150 km N.E. of Antananarivo). (ii) FIFABE - Betsiboka valley in the Marovoay/Mahajanga region, N.W. of the island. (iii) SAMANGOKY -Mangoky delta in the S.W. of the country. (iv) SODEMO - Morondava scheme in the S.W. of Madagascar, (v) the Andapa Bassin Administration (N.E.) and (vi) the sugar cane scheme in Nosy-Be area.

2.4.3 Lake Alaotra Basin.

The total irrigated area in the basin covers some 68,000 ha. 35,000 ha so called "modern schemes" were built after World War II and with foreign aid, and 33,000 ha are traditional systems currently subject to improvement programs "microhydraulique". So far, the region is the main rice producing area in the country as it produces about 125,000 to 150,000 tons of rice per year and 1/3 of total marketed production (300,000 tons).

SOMALAC was created in 1961 in order to implement the agrarian reform and to develop irrigation systems existing during the colonial period in the Lake Alaotra basin. Initially, the land was redistributed to farmers in 4 ha plots each, and farmers were encouraged to acquire land ownership; however, rapid progress of the irrigation has now resulted in land concentration among a few of them (Source: WB evaluation report - 1983). Under present conditions, water is not a major constraint but problems lie with inadequate distribution which discourages transplanting. Water is either diverted from rivers through intake weirs (Sahamilany for the PC 23), larger diversion structures (Anony scheme), or storage dams (Samaloto scheme). Drainage water goes to the lake. Farmers do only single cropping of rice and cattle are brought to the fields after harvesting. Although mechanized ploughing is progressing, cattle are largely used for land preparation. Broadcasting is the common practice and so far only random transplanting has been accepted by farmers. Agricultural input consumption is limited and average yields are 2.1 tons/ha in modern systems, 3 tons in the best managed scheme.

SOMALAC is responsible for operation and maintenance of some of the

"modern systems" in the Lake Alaotra basin. Such are PC 15, PC 23, PC North and also the adjacent traditional systems. SOMALAC's responsibilities have grown gradually throughout the years and it is now concerned with: irrigation system development, land settlement, extension services for all modern systems, marketing, etc. Since 1970, SOMALAC has experienced severe financial difficulties and degradation of irrigation systems resulting from lack of maintenance. Production which used to be 104,000 tons in 1967, 140,000 tons in 1970, is now 65,000 tons/year. A rehabilitation project and restructuring of SOMALAC are presently going on with the World Bank support.

2.4.4 Mangoky valley development.

The Mangoky long term master plan has estimated the surface area which can be irrigated from the Mangoky river to be more than 100,000 ha. The development area lies under arid and semi-arid conditions in a remote and sparsely populated area. Alluvial soils in the delta are of various types and research has shown excellent potential for cotton production.

Present farming systems in the region consist of two types:
(i) cultivation of cotton (80%) and rice (20%) with irrigation in the SAMANGOKY development area (about 7,000 ha actually irrigated so far) by "associated farmers" under the supervision and with technical and financial assistance of SAMANGOKY; and (ii) cultivation of other crops by traditional farmers under rainfed conditions and on "baibohos" (the Mangoky flood plain). Since the irrigation system was launched in the early 1960's, it has faced a number of unexpected difficulties, technical, salinity, flood damages, sociological and managerial issues which have delayed implementation but have more or less been resolved with time. The irrigation is operated by gravity from a river intake, canals are lined and regulated by float operated inlet gates. It used to be considered the most sophisticated and efficient system in Madagascar. Both yields for cotton and rice have been satisfactory according to the World Bank appraisal report, 1979. However, the situation of the system is now critical. Poor maintenance in the recent past has led to a very serious degradation of all parts of it: flood protection banks have breached, sedimentation basin has become silted and ineffective, leaking canal....

Rehabilitation of the Mangoky scheme is part of the priority project currently financed by a consortium of donors which concerns rehabilitation of the irrigation in the country.

2.4.5 The Morondava irrigation scheme.

The Morondava scheme lies 150 km north of the Mangoky river. SODEMO was established by the Government to implement the IDA financed

project in 1970. SODEMO was supposed to organize and to manage tobacco and cotton state farms. In 1976, due to many difficulties, the target of the project was cut down from 9,300 to 3,800 ha, namely 2,500 ha for irrigated rice cultivation, and 1,300 ha for rainfed cotton.

2.5 EXISTING IRRIGATION MANAGEMENT.

2.5.1 The Ministry of Agricultural Production and Agrarian Reform (MPARA) is the main institution concerned with irrigation. MPARA was reorganized in 1982 and presently includes:

The Cabinet Minister with 4 inspectors and 4 advisors.

The Permanent Secretary and five Directorates:

a. Finance & Personnel,
b. Programming, (D.P.)
c. Rural Infrastructure (D.I.R.), previously "Génie Rural".
d. Agricultural Extension, (D.V.A.)
e. Input supply,

The "Opération Microhydraulique" which used to report directly to the Office of the President, is now attached, since 1984, to the D.I.R.

Each of the three directorates (a),(b),(c) have got 6 Provincial divisions and 17 "Circonscriptions" (local sub-division).

2.5.2 D.I.R. employ 1,400 persons and comprises three Services at headquarters:

a1. Irrigation Service,
For all government managed schemes, the Service is responsible for planning, design and construction supervision; feasibility studies, tendering and contracting with consultants or contractors in parastatal managed schemes.

a2. Irrigation Management Service,
This service is in charge of operation, maintenance and development of the small scale irrigation schemes (P.P.I.). It also manages the outposted staff in the various systems and is supposed to coordinate activities with other agricultural departments. Recurrent budget for 1983 of the Service was US$ 1.1 million, mainly spent for salaries. In the 1970's, the MPARA's "Brigades du Génie Rural" in charge of maintenance of the systems were abolished and their equipment plant for construction and land preparation transferred to parastatal companies. Since then, government practically ceased to maintain the P.P.I. and their

degradation further worsened.

a3. "Amenagement Rural" Service.
It is concerned with the Toamasina paddy storing facilities and some oil-mills.

2.5.3 D.V.A. employ about 4,000 persons and HQ is split in three Services:

d1. Service for extension support & liaison with Research.
d2. Encadrement Service.
d3. Plant protection Service.

Activities of D.V.A. Services on the field are very much hampered by lack of funds. Their activities are neither evaluated nor followed up. Applied research has been very limited in the past ten years. (Source: WB appraisal report - 1985).

2.5.4 Directorate of Input Supply includes also three Services for:

e1. Marketing (input supply),
e2. Production of seeds and plant materials,
e3. Agricultural mechanization.

2.5.5 FOFIFA - The National Center for Applied Agricultural Research on Rural Development. FOFIFA is a public institution under the supervision of MPARA and governed by a management committee. It was established in 1974 to centralize agricultural research activities previously conducted by a number of research institutes.

2.5.6 Other parastatals. The Government uses many publicly-owned and mixed capital companies to further its goals in the agricultural sector. For: Agricultural research (FOFIFA), management of large irrigation schemes (SOMALAC, FIFABE, SAMANGOKY etc.), consultant for irrigation design (MAMOKATRA,..), implementation of development programs (various "OPERATIONS"), construction of irrigated systems (A.A.A.), marketing of agricultural commodities (COROI, for fertilizers and other agricultural inputs), and agricultural credit (BTM, the Rural Development Bank of Madagascar).

2.5.7 The "Opération Microhydraulique", (village irrigation development). In addition to the parastatals proper, semi-autonomous agricultural institutions ("Opération") have been created to implement programs on behalf of the government. These organizations are under the administrative authority of MPARA and are staffed by MPARA personnel, but they have more flexibility than regular ministry services, because they are endowed with their own funds which can be spent on the instructions of the "Opération" director.

Since 1966 the "microhydraulique" which used to be included initially in an integrated package financed by EDF or FAC and which comprised: extension services, inputs supply, marketing and research, ("Groupement Opération Productivity Rizicole"), has for long been attractive among villagers and relatively successful. Its main objective was to increase the rice production within the traditional village irrigation systems located in the central Highlands, by better water control allowing better yields and eventual extensions of the irrigated land.

From 1976 up to now, the "Opération Microhydraulique" substituted for the old programs and focused on civil engineering works, (intake structure upgrading mainly). The pre-conditions allowing such an intervention are still: (i) an initial request from the farmers concerned, (ii) the agreement of the local government, (iii) the technical feasibility and the cost involved for the construction which has to be checked by the O.M.H., (iv) a strong motivation and participation of the farmers who had to provide part of the building materials and the labor force under the supervision of hired skilled laborers.

After more than 20 years of continuous support, EEC is presently undertaking a comprehensive evaluation about the performance and benefits achieved through the "Operation Microhydraulique". Since 1967, about 86,000 ha commanded and 48,000 ha irrigated involving more than 1,200 projects have been affected, with an investment cost in the range of US$ 150 to 300 per ha under command. ($270-540 per ha actually irrigated).

2.5.8 "Fokonolona institutions" (Local governments). The "Fokonolona" originates from time immemorial in Madagascar, and is characterised by a particular type of village community based on group cohesion and effective collaboration principles. Since 1972, the Malagasy Government has undertaken a major reorganization of local administration and government. Representative institutions have been established at four territorial levels. The objective of the reorganization was to create a decentralized system of <u>local government which incorporate traditional institutions and practices</u>. The four territorial levels are: (i) the six Faritany (province), (ii) the Fivondronana (s/prefecture) about 115, (iii) the Firaisana (canton) about 1,250, (iv) the Fokontany (village) about 11,400 units in all. Each level has got a legislative and an executive body ("Conseil populaire" and "Conseil executif") respectively. Until recently, the fokonolona institutions were given important responsibilities. All microhydraulique projects concern irrigation systems which are managed by the Fokontany without any government participation.

2.5.9 A full range of management arrangements exist depending of the size of the systems. Community managed systems are many in the country, and except upgrading of main structures, government did not intervene in their management. P.P.I. are so far fully managed by government, but plans are currently implemented for phasing out government responsibilities in management and handing over to farmer organization. Large schemes are controlled by parastatals.

2.5.10 The cropping pattern and systems in Madagascar are extremely diversified (cf: Hommes et paysages du riz à Madagascar, by F. le Bourdiec - 1974), and almost every type of crops is grown in one area or another. However double cropping was not a common practice, and much efforts have been devoted to promote it. In the highlands the cold winter which occurs from June to August with temperatures close to 0 C. at night does not make double rice cropping possible on the same plot. Current practices are to cultivate two rice crops, the main one ("vary hosy") planted in the lower paddy fields which have been equipped for irrigation, will be harvested in December/January, and a secondary one ("vatomandry") whose vegetative cycle coincides with the rains, located in the upper paddy fields and being harvested in May/June. Counter-season crops, like vegetable, tomatoes, or onions are also grown with some success if market is available. Promotion of wheat and soybean cultivation is also important in order to diversify the highlands'economic base and to stimulate agro-industrial activities. Programs financed by CCCE and INI (Spain) are currently going on.

2.5.11 Most systems get water through diversion from perennial rivers. Flow regulation with storage dams do not appears common, at least in the highlands, and this might still be an area for potential improvement of water management in some parts of the country. On the other hand, government (Génie Rural) has been doing a lot during the last ten years for improving intake structures of community managed systems (Microhydraulique). Distribution of water in scheme visited in Antsirabe area (Ambohibary PPI) is done by means of ordinary type of gate operated by government staff.

2.5.12 The official marketing system handles about 10% of annual production. While there is a lack of reliable information on the operations of the parallel market, it handles at least as much as the official circuits, and probably more (Source: IFAD Staff Appraisal Report, 1983). Most of the paddy produced, except in the surplus areas like Lake Alaotra, is consumed by the producer or used for seeds. Responsibility for official marketing lies chiefly with parastatals. SINPA (Société d'Intérêt National des Produits Agricoles), SOMALAC and FIFABE being the principal.

SINPA was created in 1975 to control prices, purchasing, milling and selling of paddy. Consumer price of rice was subsidized and kept

much below production costs and costs of imported rice (FMG 55/kg from 1976 to 1980). This resulted in a degradation of the situation: financial difficulties for SINPA, disincentive to producers, huge imports. The market were freed (except for the surplus areas: SOMALAC and FIFABE, where it remains controlled) in May 1983, under pressure from the Bank. This political decision has proved to have a major impact for the benefit of the economy. Price ceiling (FMG 300/kg) has been enforced up to 1985 but has recently been entirely freed (FMG 560/kg of rice today in Antananarivo.), except a minimum price for buying of FMG 80/kg. (FMG 600 = US$ 1)

2.5.12 Tradition in Madagascar is closely related to the values attached to the ancestral lands. Land is important socially as well as economically, as it represents one's ability to provide the ritual services for one's ancestors and parents as well as to support future generations. For this reason, farmers would never sell or even rent out their ancestral lands; thus, the land market is very narrow and land fragmentation by inheritance results in very small holdings (0.6 ha average per family in the highlands), long distances to access plots and that hampers efficient labor work. In the highlands, this is a major constraint for rehabilitation and for development as land consolidation seems just unthinkable. Land rights are ruled by tradition and effective use, even if not materialized by titles. In the Ambohibary P.P.I. for instance, farmers got land when they squatted on this large colonial farm (initially mechanized). The creation of the "Petits périmètres irrigués" (P.P.I.) by "Génie Rural" was the first attempt to provide a water distribution system within the more or less anarchically settled area, but without affecting the land distribution pattern.

2.6 FUTURE IRRIGATION PLANS.

2.6.1 Besides the current programs for continuing development of the large schemes (cf above), government priority emphasizes now rehabilitation of existing systems and particularly the small scale irrigation systems (P.P.I.) which are many, scattered in the country. Considering the present transportation difficulties in the country, this target is viewed as the appropriate means to increase food self-sufficiency within the rural areas and to reduce food imports by 50%, as well as to contribute to satisfy local demand for income increase.

The World Bank together with EEC, CCCE and the Magalasy Government are cofinancing the first phase (US$ 29 million) of a long term program called: "PROJET DE REHABILITATION DE L'IRRIGATION". The project is an attempt to develop a methodology for a systematic rehabilitation of 116 P.P.I. (142,000 ha). A key objective of the project is to set up locally viable self-managed structures and to help farmers to finance maintenance of the rehabilitated systems

themselves. The project also includes as a matter of urgency, the rehabilitation of the Samangoky scheme and the strengthening of the MPARA capacities to implement the project successfully over the years.

2.6.2 So far, the management and maintenance of the P.P.I. has been under responsibility of MPARA/DIR through its outposted staff but DIR has not had the resources to do it. Since 1982, new laws concerning management, maintenance and taxation of the users of irrigated systems have been adopted and tentatively applied. This reform has introduced the concept of a larger participation of the farmers in the management of irrigation systems through WATER MANAGEMENT COMMITTEES (WMC). The texts provide for the establishment of WMC for each irrigation scheme, composed of elected representatives of farmers, and designated members of local communities and MPARA and to be chaired by a representative of the users. The WMC which could be in the form either of Cooperatives or User associations will have the followings responsibilities:

a. to manage water-distribution from the scheme's main water intake down to the individual plots;

b. to provide for the operation and maintenance of the irrigation system and the observance of the agriculture calendar (periods for planting and transplanting, date for end of ploughing, watering, and closing down canals); contracting for major maintenance works;

c. to establish annually the list of users with their taxable cropping areas as well as to record the participation of farmers in kind or in labor on the system; and

d. to prepare the budget for the operation and maintenance of the scheme and to control the accounting of the association.

User obligations are to be stipulated in an "arrêté de classement" (implementation regulations) and in a "dinan'asa" (traditional collective contract among villagers) adopted by the WMC.

The texts define two types of water charges: One is to repay, at least in part (about 30%) infrastructure improvements according to conditions stipulated in the contract for rehabilitation of the civil works. The other is to cover scheme management and maintenance costs. The charge for reimbursing the costs of irrigation improvements is to be borne solely by those users who will have benefitted from agricultural civil works. The "contractual" payments are to be in cash per crop cycle. But it is also stated that the charge to be levied for these costs is to be equivalent to 50 kg of paddy per hectare and per crop cycle. All proceeds from the improvement tax are to be deposited in the National Treasury and reserved for a rice development fund. The law foresees sanctions,

including seizure of crop, against users who fail to meet payments.

The current P.P.I. project is following these principles. Only three pilot schemes out of five included in the first phase financed so far have been studied: SOAVINA, ABELAMUTS and BEHARA, none of them has been implemented yet. In Antsirabe area, the mission visited Ambohibary irrigation system (within SOAVINA); the management of the system already exercises the new principles that government intends to promote for the rehabilitation of the P.P.I. and it might serve as a reference.

2.7 EXISTING RESEARCH CAPACITIES.

2.7.1 FOFIFA. The mission did not succeed in contacting this institution, but it seems that it has at present limited capacity to carry out research programs and is badly lacking senior researchers. Research carried out in Madagascar used to be important in the past, with the French assistance in particular (up to 300 IRAT researchers at that time). Programs more or less broke down when they left. FOFIFA has a technical staff of about 1,000, it experienced six successive reorganizations during the last years. Up to 1984, FOFIFA had no research budget. According to Mr Jim Hoopper from IRRI, presently assigned to the center, research on farming systems would start from now (Mrs RABELOLALA); the mission was also told that a research fellow is presently being trained in France on water management and he might be posted to FOFIFA where a Section on water management within the department of technology is anticipated. Revitalization of FOFIFA, and strengthening the links with MPARA's extension activities is one of the present priorities expressed by Government and this issue is addressed within the current IFAD financed Highland Rice Project. Communication with other research networks is limited, except with IRRI and ISNAR.

2.7.2 University of Antananarivo. The mission did not have the opportunity to contact the University. However, the literature communicated to the mission indicates that some research capacity does exist at the University in the field of geography and social sciences in particular (Mrs Janine RAMAMONJISOA Directeur de l'U.E.R. de Géographie). However, it does not seems to have relationships with MPARA.

2.7.3 Ministry of scientific research, technology and development.

2.7.4 Etablissement d'enseignement supérieur des sciences agronomiques.

2.8 REGIONAL ORGANIZATIONS CONCERNED WITH IRRIGATION.

2.8.1 The mission did not come across any regional organization. Madagascar, appears to be for sociological, historical and geographical reasons, very isolated. Irrigation in the country cannot be compared to any other African countries nearby and it seems that it has very limited relation and information exchange with the African world. Although it might have more similarity with Asian countries, it is even more separated by distance and language. However the current problems faced by the Malagasy government in trying to get farmer participation for better management of irrigated systems and improved performances for instance, are not unique to Madagascar. Therefore the country would benefit from an association with any regional or international network able to provide more opportunities to break off the isolation of the Big Island.

2.9 IRRIGATION MANPOWER AND TRAINING NEEDS.

The organizational changes planned in the management of the small scale irrigation systems (cf above) will result in some reduction of the outposted government staff. However, its role will become essential for the success of the rehabilitation program undertaken. Therefore the Malagasy authorities are particularly concerned with the training needs of this category of personnel working closely with the producers on the field. On the other hand the mission also noticed the youth of many of MPARA's executives and the general scarcity of graduate officers with high levels of education.

The recent National Workshop about Agricultural Training held in June 1985 in Antananarivo, with the support of F.A.O., ended with recommendations out of which those related to irrigation follow. Particular attention was been drawn to: (i) Training of personnel at the medium level, (ii) Need for continuing education and further training for executives, both in the government institutions and the parastatals. (iii) Strengthening the links and increasing the transfers between the agricultural research and the extension services. (iv) Rebuilding government capacity to produce training materials. Project proposals included:

- elaboration of a program for PhD thesis at the EESSA. (US$ 35,000). (Etablissement d'enseignement supérieur des sciences agronomiques)
- setting up at the EESSA of a structure to support further training for government executives. (US$ 35,000)
- support and further training for FOFIFA executives. (US$ 15,000)

- support and further training for staff of the Directorate of Extension services and support for audio-visual equipment (US$ 200,000).

A target of 100 technicians, and 100 engineers trained per year has been mentioned to illustrate the importance of the needs. Needs for specialists (hydrologist,..) and graduate researchers is also important.

2.10 MANAGEMENT ISSUES AND RESEARCH NEEDS.

Because of the importance of irrigation in Madagascar, and the varied conditions (sociological, climatological, physical, etc.) which presided over its development, management issues are several. Some are specific to the country, others are more general issues and might be relevant to a network research project.

2.10.1 Specific issues.

a. Hydrological data for management.

Most of the irrigation in the country and especially those in the Highlands rely on more or less perennial water in the rivers, for which hydrological data are essential for management. However the national hydrological network run by ORSTOM was disorganized when it left the country in 1973. Since then, the Ministry of Transport and Meteorology has been responsible for it, but did not maintain it; stations are no longer visited and new gauging would be needed due to siltation. Reorganization is currently planned and the Ministry of Scientific Research and Technology and MPARA might be responsible for the operation of the primary and secondary networks respectively. ORSTOM is presently working on the synthesis of data collected from 1979 up to 1982.

Rebuilding the national hydrological network and capacity to make use of it seems a prior condition to further manage water resources and irrigation. Research could focused on the better use of hydrological data for irrigation management.

b. Irrigation performance assessment and monitoring.

There is a large variety and number of irrigated systems in the small scale range in Madagascar. Actual performances achieved by irrigation in that sector are not well known, neither is the impact of government intervention (microhydraulique, P.P.I. before and after rehabilitation, etc.). Comparative studies on irrigation performance of the

small scale systems in various types of situation and management would be possible and a statistical approach might be fruitful in order to contribute to the monitoring and evaluation of MPARA's policy.

2.10.2 Network issues.

a. Phasing out government in managing small irrigation schemes.

The organizational change in management currently planned by government along with rehabilitation of the P.P.I. might be the more important issue to follow up as it also meets the wishes of many other countries in Africa and elsewhere. Implementing agencies are still defining on the job the appropriate approach for doing it. It seems that it might help to have some research contribution in this process. This should be brought in to help understand difficulties as they arise and to contribute in their solutions. Lack of research capacity in the country, and lack of acquaintance of the implementing institutions with that matter did not make it possible so far.

Research should be primarily focused on the difficulties arising in setting up of farmer organizations, transferring system management responsibilities, getting commitment to maintain it, but research should also concern the institutional aspects faced by MPARA for coordinating its various departments at the local level in an effective way.

b. Role of State intervention in community managed irrigation systems.

Government has got a considerable amount of experience in dealing with community managed irrigation systems since the G.O.P.R. program started in 1966 taken over, up to now, by the "Operation Microhydraulique". However, it appears that government (and donors) could no longer afford to run such a program which used to be relatively successful and is still very popular. This experience could provide valuable material for research focused at the role of government intervention in that irrigation sector. What are the techno- hydraulical needs for improving performance? What are the economics involved, and how can physical improvements be integrated into the existing management institutions to minimize costs and preserve or enhance farmers'capacity to manage their own systems? This issue appears well in line with the comprehensive evaluation going on that E.E.C. felt necessary to undertake after its long range support to "Microhydraulique" in the country.

2.11 POSSIBLE AVENUES FOR IIMI ACTIVITY.

Madagascar offers a special interest for IIMI activity, for various reasons.

First, this country possesses after Egypt and Sudan the largest irrigated area in Africa, distributed amongst a considerable number of systems under various conditions.

Second, the potential for improved performance of existing irrigation through management innovation is huge and could have a tremendous impact on the national economy. In addition, the prospects for new development are important.

Third, the government policy has changed and now encourages, as far as management of P.P.I. is concerned at least, the shift from State to farmer Organization responsibilities. This issue which is presently addressed as a priority by the Malagasy government with the support of the donor community, could have a broad applicability in Africa and in many developing countries. It is important therefore, to monitor progress in this attempt and to identify difficulties faced which might require research contributions.

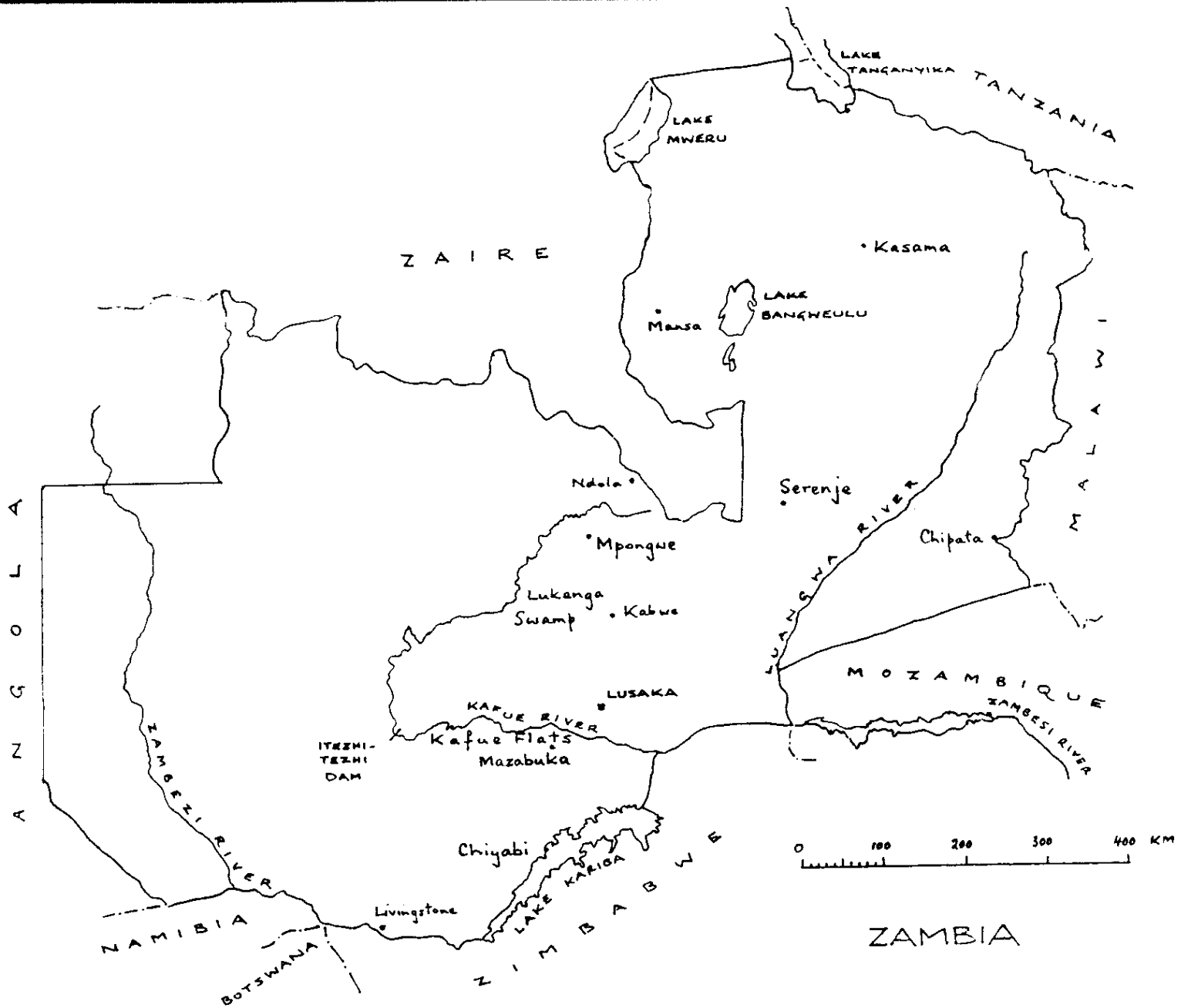
2.11.1 Exchange of information to break off Madagascar isolation. Developing awareness in the Malagasy government, about the various aspects of irrigation management and the role that research can play, should be the initial step. Invitation of key people of the MPARA to the next IIMI Workshop on Small-scale Irrigation System in Katmandu, or any other related issues in Sri Lanka would be advisable. The World Bank Resident Representative suggested that IIMI invite Mr José ANDRIANOELISON, Minister of MPARA. The Permanent Secretary would welcome an invitation for the Director of Rural Infrastructure (DIR/MPARA). This appears rather important in respect of the very technical and engineering oriented nature of MPARA irrigation activities.

2.11.2 Professional development for MPARA executives and FOFIFA researchers is a priority that has been pointed out strongly by Government and which cannot be ignored in any attempt to promote research in irrigation management for improved performance. This can be done through (i) Training session, EDI or other session conducted in French preferably; Mr Jean RAKOTONIRAINY, Head of irrigation management service/MPARA is one of the candidates to be recommended as well as Mr Harisson E. RANDRIARIMANANA, Head of the Antananarivo provincial service/MPARA, (ii) Support to the research capability of FOFIFA in the field of hydrological and sociological aspects of management in particular.

2.11.3 Research on the constraints faced in the current P.P.I. rehabili-

tation process which includes transfer of management responsibilities from government to farmers'associations. To be undertaken in collaboration with FOFIFA and MPARA from an IIMI research unit to be set up in the country and which would primarily focus on irrigation in the Highlands.

3 ZAMBIA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Ndola
Serenje
Mpongwe
Chipata
LUANGWA RIVER
MALAWI
Lukanga Swamp
Kabwe
LUSAKA
MOZAMBIQUE
ZAMBESI RIVER
KAFUE RIVER
Kafue Flats
Mazabuka
ITEZHI-TEZHI DAM
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ZAMBIA

3 ZAMBIA

3.1 MAIN FEATURES OF THE NATIONAL WATER SYSTEM.

3.1.1 In comparison with most other African countries, Zambia has a very favorable balance between land, water and people. It is rather sparsely populated; it has several large perennial rivers and many small ones; its rainfall, though not abundant, is sufficient for one crop season in much of the country; its altitude means that temperatures, and therefore evapotranspiration, are not excessive.

3.1.2 The country lies between 8 and 18 degrees south latitude. It occupies part of the extensive central African plateau which runs from Namibia to Uganda and western Kenya, and which divides the Atlantic - flowing rivers of the Congo basin from the Indian Ocean rivers of the Zambezi and smaller basins.

3.1.3 The great majority of Zambia is between 900-1500 m.altitude (3000-5000 ft.). The Luangwa and lower Zambezi valleys are incised deeper than this down to as low as 300 m (1000 ft), and there is a small area of high mountains on the Malawi border.

3.1.4 Figure 1 shows the principal rivers, and main places mentioned in this section.

3.1.5 The area of the country is 74.3 M ha (74300 Km^2;287000 sq miles), and its population in 1982 was 6.163 M; so the density of population in 8.3 persons/Km^2 (21.5 persons /sq.mile). Population is estimated to be growing at 3.5% /year, and to reach about 23.8 M (32.0 persons/Km^2)in 2025.

3.1.6 According to the methods of the FAO studies of population-supporting capacities, Zambia's soil/climate system is capable of producing enough food, under rainfed systems, and with traditional (relatively low) levels of agricultural inputs, to support a population of 48.8 M. With medium inputs it is estimated capable of supporting 215.8 M.

3.1.7 These figures imply that Zambia has no absolute need for irrigation in order to feed its own foreseeable population. However the foregoing figures assume many things, such as effective marketing, transportation and price systems; they also are based on an "average" year, so they assume the existence of ample storage facilities for surpluses. The reality, at present, is that Zambia was obliged to

import significant amounts of food in the recent years of below - average rain.

3.1.8 Mean annual rainfall does not show very wide variations across the country. It is about 700 mm (28 inches) in the south, along the Zimbabwe Border, and increases fairly steadily in the northern and eastern direction, to maxima of about 1500 mm (60 inches). The main rainfall months, throughout the country, are November to March. May to September are virtually dry everywhere.

3.1.9 However, although the variations of rainfall are not great, there are nevertheless big differences in agricultural potential. In the north and north-east, rainfall usually exceeds potential evapotranspiration throughout the November-March wet season. In the south, the variability of rainfall is greater, and its average excess over evapotranspiration is very much less, so the drought risk is rather high. Figure 2 illustrates rainfall and evapotranspiration curves from three fairly typical locations.

3.1.10 Zambia has four main river basins. The Zambezi, which originates in Angola, traverses the west of Zambia, and then forms much of its southern boundary. The Kafue and Luangwa likewise traverse Zambia from north to south, draining the center and east of the country before entering the Zambezi. The fourth river, the Luapula, originates within Zambia at Lake Bangweulu, and forms the border with Zaire, before flowing into Lake Mweru in the north.

3.1.11 All of these systems have abundant tributaries. The total run-off is estimated at an annual average of 90,000 Mm^3/y, some of which is shared with neighbor countries.

3.1.12 Lakes cover about 1.5 M ha of the country :2% of the total. Only one large lake, Bangweulu, is wholly within Zambia, but the country shares Lakes Kariba, Mweru and Tanganyika with various neighbors. The major development structures so far built on these rivers are the Kariba Dam on the Zambezi (for power generation, shared with Zimbabwe) and, on the Kafue, the Itzhitezhi Dam (5.7 Km^3) and Kafue Gorge Dam (0.8 Km^3), both of which are also single-purpose power dams.

3.1.13 Soil resources are not especially good, being in general leached of nutrients and often rather shallow. Alkalinity and sodicity problems do not appear to be widespread, and the soils generally do not appear to deteriorate under cultivation.

3.1.14 As in many other parts of Africa, the shortness of the growing season is a significant constraint in Zambia. In the south and east of the country natural growing-season length is usually restricted to 120-130 days or less; in both north-east and north-west it is much more satisfactory, generally in the range 150-190 days, allowing a wider crop choice and fewer peak-season labor constraints. Water availability is the main restrictor of the growing season, so irrigation clearly offers one way of reducing this difficulty.

3.1.15 The amount of land estimated (by FAO) as usable for rainfed agriculture is 51.1 M ha, or 69% of the total. The amount actually in use in 1982 was 5.1 M ha (6.9%). These figures show how much unutilized capacity remains. The figures reflect the low population density, for even on the 1982 figures the area cultivated amounts to 0.83 ha/person. This area in present use per person is one of the highest in Africa (where the average for the whole continent is 0.33 Ha/person), and indicates that labor availability is probably a significant constraint on agricultural development.

3.2 PRESENT ROLE OF IRRIGATION.

3.2.1 Zambia has not, up to the present time, developed much irrigation. During our visit the team was frequently told that the country now wished to expand its irrigation activities, especially because the impact of the recent drought years has caused concern about the country's food - production capacity. However, the present reality is that Zambia has one of the smallest proportions of irrigated farming in Africa.

3.2.2 The area at present under irrigation is said to be about 17000 ha(42000 acres), which is about 0.3 % of all cultivated land. However, there seems to be some doubt about the accuracy of this figure, which may not account for all irrigation on private commercial farms.

3.2.3 By far the largest existing system is the Nakambala sugar estate of the Zambia Sugar Company, near Mazabuka in the Southern Province. This has about 9000 ha, mainly under furrow irrigation but with some sprinklers. They have in addition 400 ha under outgrowers, and a new smallholder outgrower project (Kaleya) will add a further 1900 ha to this in 4 ha plots. Water is drawn from the Kafue river for this project. Yields are good (117 t/ha cane; 12% sugar) and the company is able to export some sugar.

3.2.4 Other significant irrigated estates include about 400 ha of coffee north of Kasama (Northern Province) and 300 ha of tea in Luapula Province. The Mpongwe wheat project near Ndola (Copperbelt Province) is a relatively new commercial venture, by which farmers grow irrigated, wheat in the dry season, on 50 ha plots; the present total is 450 ha.

3.2.5 Small-holder irrigation is as yet very little. The main area is the Gwembe valley, where a certain amount of small-holder irrigation is being established with pumped water in plots of 0.25 ha on the shore of Lake Kariba but has met many practical difficulties, especially due to recession of the lake and consequent drying-out of the pump sites. These schemes (Sitwiinda, Buleya Malima, Chiyabi) were intended to alleviate some of the special difficulties of the Tonga people, displaced from access to flood-recession agriculture in the Zambezi valley by the filling of Lake Kariba 20 years ago. The German Gossner Mission has been much involved in them.

3.2.6 There is also an unquantified amount of commercial irrigation in the periphery of Lusaka and Kabwe, supplying vegetables and other crops to the city market.

3.3 EXISTING IRRIGATION MANAGEMENT.

3.3.1 Because the irrigation sector is so small in Zambia, there is no formal system of managing or supervising it within government. The Ministry of Agriculture and Water Development is the responsible ministry, but has no irrigation unit and very little professional irrigation expertise. A proposal for the establishment of an irrigation unit has recently been made, but it is not yet certain that it will be implemented.

3.3.2 Nakambala and the smaller commodity estates have their own management systems. The commercial sector appears to be reasonably prosperous and is being stimulated by personal loan programmes assisted by the British government and shortly by the European Community, with particular emphasis on wheat for which there is at present a substantial shortfall met by importation. For the Mpongwe project a Mpongwe Development Corporation has been established recently.

3.3.3 The main management problem appears to be in the small-holder sector. Small-holder schemes launched so far do not seem to have met with much success, and the government is therefore still in search of suitable models of organization that will really work well and motivate farmers. It is probably significant that some reports from Gwembe say that farmers have been unwilling to give the necessary

attention to their plots: This seems to confirm the point (para 3.1.15) that usable land for rainfed farming is plentiful in Zambia, and that the time may not yet be ripe for intensive development of small-holder irrigation.

3.3.4 Another type of management problem is the question of water allocation, which at present affects principally the Kafue river. Here a special difficulty was posed by the varying gradient of the river. The best site for power generation was at Kafue Gorge, where a locally very steep reach of the river provides excellent head; but upstream of this the river gradient is very flat, and so the building of a major dam at the Gorge would have caused extensive flooding. The main storage is therefore upstream of the flats, at Itzhitezhi; but power is generated at Kafue Gorge, 250 km (155 miles) downstream.

3.3.5 Between these facilities the river traverses the Kafue Flats, which are widely regarded as well suited to rice irrigation. However, the electricity generating authority considers that the available water is committed for power generation. Zambia's power needs, including the requirements of the Copperbelt mines, are substantial, so this conflict has inhibited agricultural development on the Kafue.

3.3.6 A factor which may be relevant to irrigation development is the change in price policies in recent years. Prices of principal crops, including maize, have been freed from government control, and this has the effect of stimulating agricultural rewards. However, given the large excess of unutilized land in the country, it does not seem certain that this will yet stimulate much demand for irrigation.

3.3.7 One of the perplexing features of the Zambian scene is the fact that state-sponsored small-holder irrigation has not as yet got an impressive record, whereas private commercial farmers and companies who practice irrigation seem to be doing reasonably well, even if, as yet, on a rather small total area. This experience is repeated, on a rather larger scale, in Zimbabwe, and is discussed in the following chapter. It poses a number of policy questions, such as:

- ought government therefore to invest in success, by such devices as loan systems for commercial farmers, rather than put money unproductively into the small holder sector? or would this create unacceptable social inequities?

- is there no way by which the expertise of the commercial sector can be used to the benefit of the infant small-holder sector? or is the gulf of knowledge and financial resources so great that the practices of the former cannot be used by the latter?

3.4 FUTURE IRRIGATION PLANS.

3.4.1 Zambia has at present few firm plans for development in the irrigation sector. Such plans as it does have are contingent upon the attitude of aid donors and lenders. As with many other African states, Zambia's scope for independent decisions on capital investment has become rather small because of her heavy use of external funds.

3.4.2 Three relevant planning processes are under way at present. The Fourth National Development Plan, which will probably run from 1987-1991, is being drafted. There is also a Task Force preparing an Investment Plan for the Ministry of Agriculture and Water Development, and as part of this an Irrigation and Water Resources Plan has been drafted (but not yet approved) by Dr K Osafo, who is on special assignment from FAO to MAWD. Thirdly, it is intended that a Water Resources Master Plan will be compiled: terms of reference for this work have been prepared, and it is envisaged that it will be done during 1986-87.

3.4.3 In all plans there tends to be some gap between hopes and achievements. The Third National Development Plan (1979-83) envisaged a four-fold approach to irrigation:

a) small-scale schemes with small capital investment and simple methods.

b) medium-scale scheme in each district.

c) large-scale schemes for wheat, rice, sugar etc. for import substitution or export.

d) small irrigation dams and weirs.

3.4.4 The irrigation plans then envisaged under c included:

Mpongwe wheat(22,000 ha)
Munkumpu(20,000 ha)
Chambeshi river(75,000 ha)
Shesheke(20,000 ha)
Kafue Flats(20,000 ha)
Lake Bangweulu rice

However, the resources allocated were only some K 30 M (US $ 5 M), and of these projects it has so far been possible only to make a start at Mpongwe (450 ha)and, very recently, to begin at Kafue Flats.

3.4.5 This performance suggests that in any new plans modest targets should be set, and a clear choice is probably needed between the large, medium and small scales, unless very greatly enhanced resources are anticipated.

3.4.6 Present plans include:

a) Kaleya outgrowers scheme (Southern Province; Sugar; 1200 ha in 4 - ha plots, see para 3.2.3.

b) Extension of Mpongwe wheat (Copperbelt Province): commercial farmers, see para 3.2.4.

c) Lukulu North (Northern Province): this is under construction. It will be mainly rainfed, but there is to be about 400 ha of gravity irrigation from the Lukulu River, a tributary of the Luangwa.

d) Three pilot small-holder projects with FAO/UNDP assistance: these are at Chiyabi, Gwembe Valley (Southern Province); Serenje (Northern Province); and Mansa (Luapula Province), and will initially be rather small (order of 100 ha).

e) Chanyanya, on the Kafue Flats: a rice scheme with North Korean assistance. Initially there is to be a 50-ha research area, and the aim is to establish 1000 ha in the next 5 years.

f) Lukanga (Central Province): 150,000 ha under sprinklers for maize, wheat, beet and tobacco. At appraisal stage.

g) Mazabuka-Monze (Southern Province): 200,000 ha under pumped irrigation from Kafue River for maize, sugar and beef. At appraisal stage. The pumping head of 235m. will require highly efficient production to justify the operating costs.

h) Mkushi (Central Province): 176,000 ha under pumped irrigation from the Lunsemfwa and other rivers (tributaries of the Luangwa) for maize and wheat.

3.4.7 Here it should perhaps be noted that in modern times (the last 30 years) few African states have developed new formal irrigation schemes at rates faster than 2000 ha/y. Sudan, the most successful in this respect, has laid out about 30 000 ha/y on average; but Sudan has three times as large a population as Zambia; it has great irrigation experience, and a full Ministry of Irrigation (Even so, its rapid rate of new development has caused strains, notably the

inability to attend at the same time to maintenance of existing systems). Altogether, it is very hard to imagine that a country with Zambia's resources of professional and technical manpower should aim to equip any more than 3000 ha/y of new irrigation.

3.4.8 Apart from plans for irrigation systems, there are also ideas under consideration to help the commercial irrigation sector by an Irrigation Development Fund, and an Irrigation Equipment Manufacturing Project.

3.4.9 On the organizational side, the idea of a formal irrigation section within the Ministry of Agriculture and Water Development is being considered.

3.5 EXISTING RESEARCH CAPACITIES.

3.5.1 The main organization interested in irrigation research is the National Irrigation Research Station (NIRS) at Mazabuka in the Southern Province. This was set up in 1965 and has been assisted by UNDP/FAO and by the West German Government. It lies about 105 km (65 miles) south of Lusaka, in the dry zone of the country with mean annual rainfall about 850 mm and potential evapotranspiration similar in the November-March wet season. The research station has 100 ha of irrigable land. Its objectives can be summarized as agronomic research in irrigated crops. It has a staff of 180, but of these only 12 are professionals and only 2 have formal irrigation training.

3.5.2 It has clearly suffered from lack of funding in recent years (its gross budget this year is K.57000;US $ 9,500), and has not at present many results to show. Its principal practical involvement has been in the Gwembe small-holder project, which as noted earlier has encountered serious practical difficulties because of its dependence on pumping from a reservoir with widely-varying water levels. No published research reports were available at NIRS.

3.5.3 The University of Zambia has had at times staff members interested in irrigation, but there has been no continuity in irrigation research there, and the Ministry of Agriculture and Water Development does not appear to have sponsored such research. The Kafue Basin Research Committee, based at the University, has been active in promoting seminars and publications on that river.

3.5.4 The Rural Development Studies Bureau of the University is a multi-disciplinary organization with a socio-economic emphasis. It has

however a quite small staff (7 academic staff, plus 4 on study leave) and has not hitherto taken up any studies concerning irrigation.

3.5.5 The main Agricultural Research Station of the Ministry of Agriculture and Water Development is at Mount Makulu, on the outskirts of Lusaka. It does not do irrigation research.

3.6 REGIONAL ORGANIZATIONS CONCERNED WITH IRRIGATION.

3.6.1 The only significant regional body is SADCC (Southern African Development Coordination Conference) whose functions in relation to food security, agricultural research and water conservation are mentioned in chapter 4.

3.7 IRRIGATION MANPOWER AND TRAINING NEEDS.

3.7.1 At present Zambia's irrigation is small, and its trained manpower is correspondingly small. There are six people in the Ministry of Agriculture and Water Development who have had formal training in irrigation, but (even if we include the Zambia Sugar Company's area) there are only about 17000 ha of irrigation; so this means one professional per 2800 ha, which is not a bad staff ratio, by the standards of other countries. Excluding the sugar estate, it is about 1 per 1000 ha.

3.7.2 However, there can be no doubt that, if Zambia were to plan for rapid expansion of irrigation, manpower would soon appear as a major constraint. The country would not be able to train its own requirements, because of the restricted possibilities of gaining experience locally.

3.7.3 Training of Irrigation staff is therefore a potential rather than an immediate need: it depends upon the government's decision (and its donors' decisions) about whether, and how rapidly, to pursue the kind of projects mentioned in section 3.4.

3.7.4 If, say, the target were to implement about 3000 ha/y of new irrigation, and if the aim were to have operation and maintenance staff at a level of about 1 per 1000 ha, and if we assume that, initially at least, designs would mainly be done by foreign consultants, then it seems that Zambia may have a need for training about 4 professional irrigation staff per year, allowing for some

losses to the private sector and elsewhere.

3.7.5 There would also be a variety of other training needs, at Farmer, technician and administrator level; but it does not seem fruitful to speculate about the scale of these until decisions about the type and scale of development have been made.

3.8 MANAGEMENT ISSUES AND RESEARCH NEEDS.

3.8.1 It is not easy, at this stage of development, to identify clear areas of irrigation management where research, training or general problem-solving capacities are needed. Zambia has, as we have noted, very little irrigation, and what it does have is for the most part profitably managed either by the Zambia Sugar Company or by commercial farmers.

3.8.2 There is no existing government structure for promoting or supervising irrigation, and no formal government policy in these directions. There is, on the other hand, a government-financed National Irrigation Research Station; but inevitably such an organization finds it hard to formulate fruitful research programmes, and also hard to secure even minimal funding for field activities, in the absence of national policies and objectives.

3.8.3 The recent years of low rainfall and consequent shortage of certain major food crops may have changed attitudes in some important ways, but that has yet to be translated into policy, plans and organizational structures.

3.8.4 At present, certain planning operations are under way: the Fourth National Development Plan and the Agricultural Investment Plan while the Water Master Plan is shortly to be prepared. As a result of these, the future pattern of irrigation development should gradually become clearer over the next 6-12 months. It is obvious, from the statistics of population, land and rainfall, that one option available to government is to do nothing at all to promote state - sponsored irrigation, and leave further development entirely to commercial processes. It is also obvious, from comparison of many other African countries, that that course is not likely to be thought wholly satisfactory on political and social grounds, and that the current planning processes are rather likely to produce proposals aimed in some way or other at promoting small-holder irrigation with (initially at least) a degree of state capital and supervision.

3.8.5 There seem to be special problems that confront a country like Zambia, seeking ways of beginning this class of irrigation. Professional manpower is one obvious problem: while the numbers are low, irrigation planning will be difficult and unsatisfactory schemes may be produced through inexperience: but until a significant extent of irrigation exists or is firmly decided on, government can hardly be expected to rectify this shortage. That means an initial reliance on expatriates; but this has produced well-known problems of continuity, which can be especially acute in irrigation because it has quite long time scales of planning and implementation, even without the financing delays that a government in Zambia's situation usually encounters.

3.8.6 All of these factors point in the same direction. They mean that Zambia must not spread out and diffuse such personal and financial resources as it has. If state-sponsored irrigation development is to proceed and succeed, there must be certain clear and realistic political choices and decisions. It is not practical to seek (at any early date) development of irrigation at all scales, small, medium and large: even nations with much more need for irrigation, and experience of it, often find problems in developing at all these scales.

3.8.7 The large-scale irrigation development calls for its own institutions, and a rather tight, disciplined management structure. Its capital investment levels per hectare are usually high, so the need to produce substantial marketable surpluses is evident; hence, if government is promoting this level of activity, it needs strong management and adequate professional staff, to safeguard the returns on its investment. In Zambia's present manpower situation, it appears that such an enterprise will have to be entrusted to, or at least shared with, an expatriate organization, for which the Zambia Sugar Company is an apparently successful model.

3.8.8 The small scale presents a different set of problems. Here we deal with farmers who lack (probably) any experience of irrigation practices; who may resent its added disciplines; who quite possibly have rainfed alternative land; who must, nevertheless, be stimulated to produce a significant surplus, over their family subsistence needs, if the state's investment is to make any economic sense.

3.8.9 Sometimes (as at Gwembe, where people displaced by the flooding of Kariba Dam have a special, localized land shortage and an obvious reason to expect the state to do something for them) the economic rules can be set aside and irrigation installed for social, not economic objectives; but such cases are rare, and do not give us good models for subsequent development. In general, states must seek a good marketable surplus production from irrigation; otherwise they

are rather unfairly subsidizing the "beneficiaries" at the expense of the rest of the community.

3.8.10 In Zambia, there is not yet (so we understand) an example of a small-holder system of irrigation producing such a marketable surplus. This would be the first policy objective, if the government should, as a result of the current planning process, decide to invest in small-holder systems: how should these be organized, so as to ensure that the investment produces its intended returns?

3.8.11 Questions that will present themselves include:

a) How should the farmers be organized, in regard to joint activities such as water control, canal maintenance, purchase of inputs, sharing of machinery or equipment, payment of any necessary staff like pump attendants, marketing, crop storage etc.?

b) How should the farmers organizations be related to the state?

c) How much land should be irrigated from a given water source?

d) What should be the size of individual land-holding to ensure good land husbandry, adequate instruction and incentive to work?

e) Should the farmers have rainfed land in addition? Should this be formally organized as part of the project, with some degree of sharing of facilities and duties as under a above?

f) Should they have security of tenure, freedom to buy and sell the irrigated land, etc? or should plot sizes be rigid, in which case, should there be a system for evicting the unsuccessful?

g) How should government recover part (or all) of its investment? What charging systems can be envisaged?

3.8.12 All of these matters need to be evaluated, against three basic criteria of management:

will the scheme be productive?
will it be equitable among its users?
and will its operating cost be reasonably low?

3.8.13 We doubt that the National Irrigation Research Station, as at present staffed, has the classes of professional people to deal with all these issues. Agricultural economists and sociologists would evidently be necessary, but not, perhaps, for ever; so it would seem logical for the complementary disciplines of NIRS and the Rural Development Studies Bureau to be associated in any such research programmes.

3.9 POSSIBLE AVENUES FOR IIMI ACTIVITIES.

3.9.1 In this section we consider whether there is any role that IIMI might play in relation to the development of irrigation management in Zambia. As an international body, IIMI is clearly not in the position of a donor interested only in improving some particular situation within Zambia, but is also concerned with the wider questions of developing good irrigation management methodologies for countries with similar development problems.

3.9.2 The question of what IIMI might do must await the clarification of the Zambian government's own policy aims in regard to irrigation. If the government should decide in favor of large-scale development on a commercial estate basis, there will probably be little that IIMI could propose to do. But on the other hand, if the government should decide to sponsor small-holder irrigation on any substantial scale, all of the questions set out in para 3,8,7 will become very relevant, and IIMI would be well suited to offer some kind of collaboration in research to solve these questions.

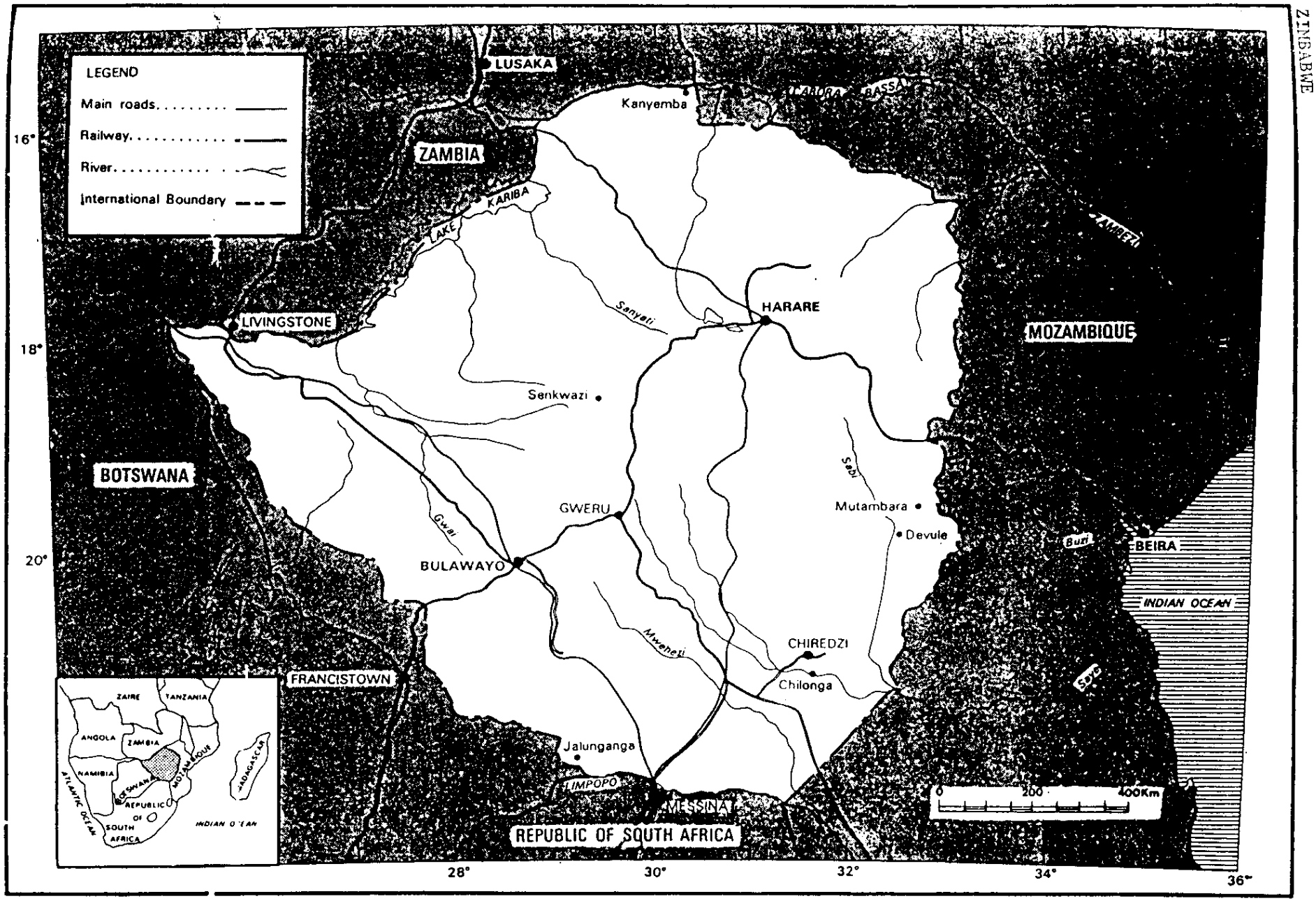
3.9.3 In the meantime, there may be two areas in which IIMI can offer earlier assistance. First, in the formation of the Water Master Plan. Our understanding is that the Ministry of Agriculture and Water Development has drawn up terms of reference, so that external consultants can be sought to perform this exercise during 1986-7. It seems possible that IIMI might offer some input to this process. Such work should be of direct interest to IIMI's more general objectives. There are several other countries in Africa which are in Zambia's situation, contemplating some significant involvement in irrigation but inexperienced in it, and uncertain how to plan for it or to incorporate into their wider planning strategies. The development of methods for dealing with this phase would therefore be useful elsewhere. Planning is an essential component of management.

3.9.4 Secondly, IIMI could contribute to the development of Zambian professional resources by a certain amount of training. Initially, Zambian staff could be invited to attend to IIMI's short courses, workshops or seminars as appropriate. This would have particular

benefit in exposing them to new ideas and other systems of irrigation. An obvious early candidate for any such invitations would be Mr J B Siakantu, officer in charge at the National Irrigation Research Station.

3.9.5 It seems unlikely, in view of the small extent of irrigation in Zambia, that IIMI can in the foreseeable future justify locating a resident staff member there. However, if there is a resident IIMI scientist located somewhere in the East/Central Africa plateau countries (Botswana to Kenya) that person can be asked to maintain liaison with the Zambian authorities, and look for occasions for proposing collaboration as the Zambian irrigation plans nature.

4 ZIMBABWE


LEGEND
Main roads
Railway
River
International Boundary
LUSAKA
ZAMBIA
Kanyemba
CABORA BASSA
KARIBA
LAKE
ZAMBEZI
LIVINGSTONE
Sanyati
HARARE
MOZAMBIQUE
Senkwazi
BOTSWANA
Sabi
GWERU
Mutambara
Devule
Gwai
BULAWAYO
Buzi
BEIRA
INDIAN OCEAN
Mweheti
CHIREDZI
Chilonga
Save
FRANCISTOWN
Jalunganga
LIMPOPO
MESSINA
REPUBLIC OF SOUTH AFRICA
0
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16°
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34°
36°
ZAIRE
TANZANIA
ANGOLA
ZAMBIA
NAMIBIA
BOTSWANA
MOZAMBIQUE
MADAGASCAR
REPUBLIC OF SOUTH AFRICA
ATLANTIC OCEAN
INDIAN OCEAN

4 ZIMBABWE

4.1 MAIN FEATURES OF THE NATIONAL WATER SYSTEM

4.1.1 Rainfall is sparse in most of the country, and concentrated during the summer rainy season which lasts from November to March. Only in the Eastern escarpment is rainfall fairly abundant (1000 to 2000 mm). As a rule, rainfall decreases as one moves from North and East (700 to 1000 mm) to the West and Southwest (350 to 700 mm).

4.1.2 The two major river systems of Zimbabwe, the Zambezi to the Northwest and the Sabi-Limpopo to the Southeast divide the country into two hydrological units separated by a ridge running through the center of the Zimbabwe plateau. Those rivers flowing north join the Zambezi; rivers flowing south join the Sabi and/or Limpopo rivers. The two exceptions are the Nata river in the west, which flows into the sands of Botswana, and some of the rivers of the eastern highlands which flow eastwards through Mozambique into the Indian Ocean.

4.1.3 Preliminary estimates of groundwater potential are in the order of 1,000 million cubic meters (cited in the IBRD Agricultural Sector Survey of 1983:78. Approximately 60% of the country, including most of the communal area is covered by granite and metamorphic rocks where groundwater potential is low. The softer sedimentary formations such as those found in the Sabi and Limpopo valleys are more promising, but have not yet been sufficiently investigated. In general, boreholes are becoming increasingly important water sources either by themselves, or to supplement surface water. Groundwater supplies can be enhanced through small dams and/or by improved grazing practices.

4.1.4 The landform of Zimbabwe consists of an elevated (between 1000 and 1500 meters) plateau broken by granitic intrusions in the form of domes or boulders. The natural vegetation is various types of savannah woodland, i.e. fairly short, well-spaced trees with a good cover of tall grass beneath.

4.1.5 The population of 8 million (1983) is growing at a rate of 3.2% overall, and in some of the communal land areas at a rate of 4%. While land pressure would not appear to be acute on the basis of national level statistics (20 persons/km2), much of the land is locked up in large commercial holdings, while much of the communal sector is of poor quality and experiencing continual degradation. Add to this one of the world's highest population growth rates, and the value of irrigated agriculture becomes highly significant.

4.2 ROLE OF IRRIGATION

4.2.1 The irrigated land area of roughly 155,000 ha is notable in several respects. First of all, it has been developed very recently; in 1960 the total area stood at only 20,000 ha. A second feature is that the vast majority (ca. 85%) of the irrigated area is in large-scale "commercial" farms and estates, i.e., land that was settled in the early part of this century by white colonial farmers and entrepreneurs for commercial agriculture on a generally large-scale. This land today is privately owned and stands in marked contrast to "communal" lands which remained in the hands of native tribal groups during the colonial era partly because it did not have sufficient agricultural potential to attract commercial investment. Land tenure on communal lands today is held by groups (usually tribes) and not, legally speaking, by individuals. For reasons of both land quality, land tenure, and communal poverty, irrigation in the Communal Areas is negligible, comprising only 1.3% of the cropped area. A third feature is the large share of marketed crops, and in particular export crops, which are grown under (mostly commercial) irrigation: 100% of wheat and sugarcane, 70% of coffee, 55% of tea, 45% of cotton, and 8% of maize.

4.2.2 Irrigation schemes in Zimbabwe can be divided into five major categories: (1) company estates and settlers, (2) commercial farms, (3) government estates and settlers, (4) small-scale communal schemes, and (5) unofficial communal schemes.

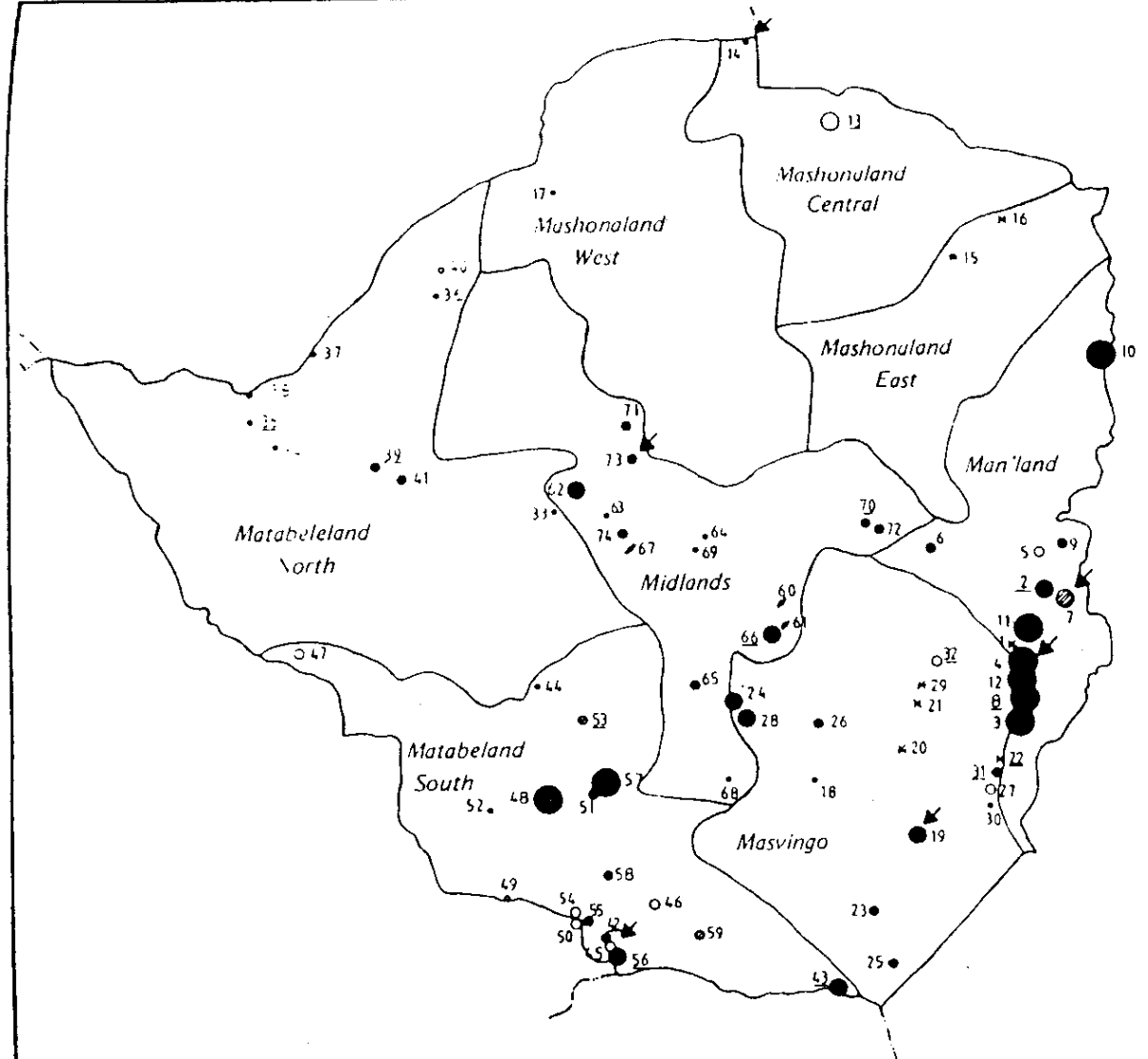
1. Company Estates and Settlers. Large-scale commercial estates owned and managed by private companies are concentrated in the south-eastern Lowveld but can also be found in other parts of the country. Examples are the sugar estates of Triangle (12,000 ha), Hippo (12,000 ha) and Mkwasine (6,400 ha) and the citrus estates at Mazoe. Large-scale commercial settler farms for cotton and wheat were developed in the Lowveld during the late 1960s by the company estates and government agencies.

2. Commercial Farms. Much of the best agricultural land was settled by white farmers during the colonial era; about 1400 farmers have remained after Independence and comprise the backbone of the national economy. With holdings ranging from 10 ha to more than 1,000 ha, these farmers have increasingly turned to sprinkler irrigation as a supplement to rainfed agriculture to grow tobacco, maize, wheat, barley, cotton, and oilseeds.

3. Government Estates and Settlers. The Agricultural Rural Development Authority (ARDA) manages nine medium size irrigation schemes located in the Communal Areas. The two largest are Chisumbanje and Middle Sabi in the southeast which are both more than 2,400 ha. These estates are run as commercial enterprises with a component of small-scale settler farms up to 4 ha in size. Other more modest irrigated settlement schemes are planned for erstwhile commercial farm land which the government has purchased since Independence. The decline in irrigated area within the commercial sector since 1980 (155,000 ha to 144,000 ha in 1984) represents this transfer of ownership from commercial farmers to the state, and then back to private small-scale farmers under the settlement policy.

4. Small-Scale Communal Schemes. There are 67 small-scale irrigation schemes in the Communal Areas with a total irrigated command area of 4,700 ha of which only 2,800 ha is currently being utilized (perhaps because of damage and neglect during the recent war). The Department of Rural Development (DRD) within the Ministry of Lands, Resettlement and Rural Development used to be responsible for the management of these schemes; recently (October 1985) this function has been turned over to AGRITEX in the Ministry of Agriculture. The number of farmers on communal schemes is over 7,000, in spite of the small land area. Most of the communal schemes were constructed for famine relief and assume that the farmers have access to communal rainfed plots elsewhere. The early schemes (e.g., Nyanyadzi and others in Manicaland established after 1935) were laid out on 1 acre (0.4 ha) plots. More recent schemes, particularly those in the central and western regions where pastoralism is a significant part of the rural economy, allotted smaller holdings of .25 acres (0.1 ha), so-called "comma-one" schemes. (See map, "Location of Communal Schemes".)

LOCATION OF COMMUNAL SCHEMES



Manicaland
1 Bondi
2 Chakowa
3 Chibuwe
4 Devure
5 Maranke
6 Murambinda
7 Mutambara
8 Mutema
9 Nyachowa
10 Nyamaropa
11 Nyanyadzi
12 Tawona

Mashonaland Central
13 Gutsa
14 Kanyemba

Mashonaland East
15 Nyagande
16 Nyakasoro

Mashonaland West
17 Gache-Gache

Masvingo
18 Banga
19 Chilonga
20 Dabwa
21 Fuve
22 Gudo's Pool
23 Malikango
24 Makonese
25 Manjinji
26 Mapanzure
27 Muteyo
28 Muszuugwa
29 Roswa
30 Rupangwana
31 St Joseph
32 Tambara

Matabeleland North
33 Fairsoni
34 Lambo
35 Lokosi
36 Nabusenga
37 Sinamatelele
38 Tsheziya
39 Tshongokwe
40 Tshoba Vlei
41 Zinapi

Matabeleland South
42 Bili
43 Chikwarakwara
44 Duncal
45 Jalunganga
46 Kwalu
47 Maitengwe
48 Makwe
49 Mambali
50 Mankonkoni
51 Masholomoshe
52 Mbembeswana
53 Mzinyatini
54 Rustler's Gorge
55 Sabasa
56 Shashi
57 Silalabuhwa
58 Sukwe
59 Tongwe

Midlands
60 Bangure
61 Charandura
62 Exchange
63 Hozori
64 Mabodza
65 Mabwe Matema
66 Mhende
67 Mkoba
68 Mondi Matanga
69 Mtorahuku
70 Mwerahari/Sachipiri
71 Ngondoma
72 Nyahoni
73 Senkwazi
74 Shagari

SCHEME TYPE
- DERUDE operational
- Community operated
- Non-operational / abandoned
- DERUDE planned

SCHEME SIZE
- < 15 HA
- 15-50 HA
- 50-150 HA
- > 150 HA

SCHEMES VISITED
- Selected for feasibility study
- Schemes visited
- Remaining Schemes

Note : Map also includes 7 community - operated schemes.

5. Un-official Small-Scale Communal Schemes. The use of surface water for irrigation is illegal unless permission is taken from the government authorities. Data on stream-bank cultivation, small dams systems, and dambo cultivation are therefore highly problematic. The World Bank estimate of 400 ha under un-official irrigation is almost certainly an underestimate. Another type of un-official scheme is former AGRITEX-managed systems whose farmers have not paid their water fees (see below) and who operate the system without government assistance. There are seven schemes of this type.

Summary of Irrigated Area by Category

1.	Company Estates and Settler Farms	40,900 ha
2.	Commercial Farms	80,000 ha
3.	Government Farms	5,900 ha
4.	Small-Scale Communal Schemes	2,800 ha
5.	Un-official Small-Scale Communal Schemes	(not known)
	TOTAL	>129,600 ha

(Source: IBRD 1983; GKW 1985; Blackie et al 1984)

4.3 EXISTING IRRIGATION MANAGEMENT

4.3.1 AGRITEX has replaced the DRD in managing communal irrigation systems and constructing and maintaining water distribution networks within the command area for schemes under 500 ha, although DRD will (we understand) continue to design these. Larger schemes run as government estates come under the jurisdiction of ARDA. (see Table 1 for a list of ARDA schemes). Construction of the headworks for all schemes, and conveyance of water down to the field edge is the responsibility of the Ministry of Energy and Water Resources (MEWRD). Site identification can come from the initiative of either AGRITEX or MEWRD, but usually the former. MEWRD does not charge communal farmers for its services (they pay an annual fee to AGRITEX); however commercial farmers are charged on the basis of recovering MEWRD's operating and maintenance costs. AGRITEX provides a free irrigation design and extension service to all farmers, both commercial and communal.

4.3.2 Farmers on communal systems are charged a maintenance fee of Z$145 per hectare per year which represents ca. 1/3 of the government's actual costs. MEWRD does not charge any farmers directly; its budget comes from central government funds. AGRITEX provides extension

TABLE 1

Current ARDA Irrigation Schemes

Estate	Total Area	Operations	Crop Grown
Antelope Estate, Matabeleland (CA)	585	Irrigation	Cotton, Wheat
Balu, Bulawayo State Farm	360	Dairying	Pastures
Chisumbanje, Manicaland	3,000	Irrigation 2,000 ha core estate, 1,000 ha outgrowers	Cotton, Wheat
Nyamazura, Manicaland	80	Supplementary irrigation	Virginia Tobacco
Middle Sabi, Manicaland	3,160	Irrigation 2,700 ha core, 460 outgrowers	Cotton Wheat
Nandi, Chiredzi	150	Irrigation	Cotton Wheat
Ngwezi, Matabeleland	460	Irrigation	Cotton Wheat
Nijo, Harare	80	Irrigation	Horti-culture Vegs. to supply Harare
Pungwe Valley, Manicaland	672	Irrigation	Tea and Coffee
Nkwazi, Chipinge	23	Irrigation	Coffee
Sanyati, Mashonaland	970	Irrigation	Cotton, Wheat
Sunnyside, Chipinge	34	Irrigation	Coffee
Jotsholo Matebeleland	530	Irrigation	Cotton Wheat
Rusitu, Manicaland	439	Irrigation	Coffee
Mzarabani, Mashonaland Central	550	Irrigation	Cotton, Green Mealies

Source: Blackie et al (1984:59)

services to all farmers; to communal farmers, its role is much more management intensive. Farmer committees have been set up, at least nominally, on communal schemes to deal with water allocation and farmer compliance with established procedure. AGRITEX officers (who until October 1985 were DRD officers) oversee the committees through project-level staff.

4.3.3 In the commercial sector, the main annual crops grown under irrigation are (in order of areal extent) wheat, cotton, maize, and soybeans. The perennials are sugarcane, citrus, other fruits, coffee and tea. Some tobacco is also irrigated. On a regional basis, sugar cane is the main commercial crop of the southern lowveld; citrus is produced in the Mazoe Valley. On the highveld, wheat, cotton, maize and tobacco are the major crops, with coffee in some areas of Mashonaland North. Irrigated tea and coffee are also grown in the Eastern Districts. In the small-scale communal schemes, the predominant cropping patterns are maize or maize and cotton in the summer, followed by a combination of wheat, beans and vegetables in the winter. Maize is the most important crop on all schemes; beans are more important than wheat (in terms of area) as a winter crop, and vegetables are also highly favored for yielding high returns, but are subject to marketing constraints.

4.3.4 Cropping intensities vary considerably within the communal sector, ranging from 170% on the Manicaland schemes to 90% in some other areas. In the commercial sector intensity for irrigated annual crops range from 140% in the highveld to 160% in the lowveld. Agricultural productivity is high throughout the country, but an interesting finding by a recent DRD consultancy team is that yields in the communal sector are sometimes higher than in commercial farms. Cotton yields, for example, are significantly higher in communal schemes and the cotton is of a higher grade (Potten, personal communication).

4.3.5 The predominant form of irrigation in the commercial sector is by sprinkler; water abstraction is effected through dams and/or boreholes, and pumped to conveyance canals or pipes. In the communal sector there are only two schemes where sprinkler irrigation is employed; the reasons for this low rate of sprinkler adoption are a topic worthy of research (see section 4.8). About half the small-scale communal schemes are gravity fed only; the other half depend partly or solely on pumps. The typical case is to convey water by pump or gravity into a night storage tank designed to hold a 12 hour supply, and then release the water to the fields by open channels. Both border strip and furrow irrigation are used.

4.3.6 Low interest (9.9% instead of the normal 13.9% interest) credit for irrigation infrastructure is available through the Agricultural Finance Corporation (AFC) which has launched a special irrigation

fund aimed at increasing wheat production. The fund was previously in effect for several years in the 1970s and proved very successful; this year it is being reinstated with a proviso that Z$6m of the 16 million be earmarked for communal farmers, who are absolved from having to grow wheat. However, since the loans are given for sprinkler irrigation systems only, it is highly unlikely that there will be much demand from communal farmers for irrigation loans. Credit for agricultural inputs is also available through the AFC, but at the commercial rate of interest.

4.3.7 Marketing irrigated crops does not appear to be a constraint in the commercial sector where there is an excellent road system. Some of the communal schemes are comparatively isolated which severely limits marketing opportunities for perishable vegetables. Maize, wheat, cotton, and groundnuts are sold to the Grain Marketing Board.

4.3.8 Land tenure is often cited as a major constraint in developing the irrigation potential of the communal sector where private ownership is not legally possible. In practice, there is a degree of tenurial security through social custom and institutional obligations so that a communal farmer is unlikely to be removed from his land by the tribal authorities. The tenurial status of irrigated farmers is more precarious, however, since agencies of the central government are involved (DRD, AGRITEX, MWEP) and farmers can be evicted from their irrigated communal plots for non-payment of taxes or other violations. In the commercial sector land title is given to individuals; water, however, is everywhere the property of the government.

4.4 FUTURE IRRIGATION PLANS

4.4.1 One of the most consistent messages the team encountered was that the government has no coherent irrigation strategy; the future is unknown. The current rate of irrigation development was difficult to assess; while officials spoke with enthusiasm of future irrigation development it was not clear what new projects, if any, are actually in the construction phase. There are plans to double the size of Chisumbanje (from 2,700 ha to 5,300 ha), but the World Bank and the Commonwealth Development Corporation (CDC) have yet to come to an agreement with ARDA over the scheme's management. An exhaustive study of small-scale communal systems funded by Kreditanstalt fur Wiederaufbau (KFW) for the DRD is aimed at identifying suitable schemes for rehabilitation, but thus far no concrete proposals have ensued.

4.4.2 While specific courses of action have not been set out, two general policies appear to guide the thinking of government officials and are also reflected in a 1983 DRD policy paper (cf. Blackie et al 1984:55): (1) A policy which favors the establishment of new irrigation schemes in communal lands for reasons of rural employment, social welfare, and food security, and (2) A policy to hand over eventually the running of small holder schemes to irrigation management committees elected by the irrigators.

4.4.3 The recent consolidation of irrigation responsibility to AGRITEX from DRD reflects a concern with streamlining the administrative apparatus. There is now an "Irrigation Liaison Committee" comprising representatives of MEWRD, ARDA, AGRITEX, and the regional water authorities, which may be a step in the direction of integrated planning.

4.5 EXISTING RESEARCH CAPACITIES

4.5.1 There is very little irrigation research ongoing, and what there is spread among several agencies. There is no equivalent of the National Irrigation Research Station found in Zambia, for example.

4.5.2 The Agricultural Research Center (ARC) within the MLARD has three divisions: Crops, Livestock, and Research and Specialist Services. A part of the latter is the Soils Research Institute which has undertaken some irrigation research dealing with water-related properties of soils. Main field stations are located at Chiredzi, Chisumbanje and Middle Sabi in the southeast or lowveld. Located within the ARC is a Farming Systems Research Unit funded by IRDC. This unit is working mostly in the North on social, economic, and agronomic field studies not directly related to irrigation, but which could conceivably incorporate an irrigation component.

4.5.3 AGRITEX has a Monitoring and Evaluation Unit which the team was not able to meet, but the Deputy Secretary, MLARD, suggested it might be a suitable body for IIMI to liaise with. Since AGRITEX has only recently assumed responsibility for the operations of small-holder systems, this M&E unit may also have been recently formed.

4.5.4 The University of Zimbabwe has interests in irrigation research, mainly through the Faculty of Agriculture (Dean M. J. Blackie). Dr. M. Rukuni and Dr. A. P. Hungwe have conducted research into socio-economic aspects of small-holder systems. The Center for Applied Social Sciences (Prof. M. Murphree, Director) is studying community property resources though not specifically irrigation, in the communal areas.

4.5.5 The Agricultural Research Trust is sponsored by the Commercial Farmers' Union. Research on agronomic inputs including irrigation is conducted on its 260 ha farm near Harare.

4.5.6 There are some active field research projects under bilateral (mainly British) assistance. At Nyanyadzi a 400 ha small holder system in Manicaland, the water distribution is being measured in a cooperative study with AGRITEX and Hydraulics Research (Wallingford, England). At Mushandike near Masvingo a 500 ha former commercial farm being prepared for small-holder resettlement, a research project on schistosomiasis is ongoing with the same agencies, plus Blair Research Laboratory. Near Marondera a study of dambo agriculture is being carried out by the University of Zimbabwe Civil Engineering Department (Dr. Windram) with ODA assistance. KFW has sponsored an overview of communal schemes (KFW 1985) oriented towards eventual rehabilitation of one or more of them. Phase II of this project is now underway and involves detailed analysis of several schemes.

4.6 REGIONAL ORGANIZATIONS

4.6.1 The only regional organization concerned with irrigation issues is the Southern African Development Coordination Conference (SADCC) with headquarters in Gaborone (Botswana). Member nations include Tanzania, Mozambique, Malawi, Zambia, Angola, Zimbabwe, Botswana, Lesotho, and Swaziland. Of the various countries assigned lead roles for particular programs, Zimbabwe has responsibility for food security issues, which includes (as one of 12 subtopics) irrigation management. Donor support is being sought for each of the subtopics, but as yet no funds or collaboration have been arranged for irrigation studies. Dr. Sam Muchena (Deputy Secretary, MLARD) is the key liaison person between SADCC and the Zimbabwean agricultural agencies.

4.7 IRRIGATION MANPOWER AND TRAINING NEEDS

4.7.1 Several officials commented on the need for more and better trained irrigation specialists. Since 1980, many of the experienced AGRITEX officers left the agency for positions in the private sector, and the gap they left has yet to be filled. There is a real need for both more training and more staff, particularly with the added responsibility now given to AGRITEX for communal irrigation schemes (replacing DRD in this, though presumably the DRD staff will be retained in AGRITEX). Training needs are outlined in some detail in Blackie, Hungwe and Rukuni (1984). For short-term solutions they

suggest (pp.67-68) sending staff abroad for short courses as well as encouraging foreign experts to run short training courses in Zimbabwe. In addition, improved training materials for field level staff, and training courses for communal irrigation committees are recommended. Long-term solutions entail building up the undergraduate and graduate curriculum in irrigation design and/or management at the University of Zimbabwe, and improving the irrigation courses offered at Chibero and Gwebi agricultural colleges. Some of the current irrigation officers in AGRITEX, DRD, and ARDA who have substantial practical experience would benefit from postgraduate courses or degrees from foreign institutions. An alternative to the suggestions made by Blackie et al that might be effective in the medium-term would be to place a foreign expert in a research and training position within an irrigation agency (e.g., AGRITEX's monitoring and evaluation unit) to train staff on the job through collaborative work.

4.8 MANAGEMENT ISSUES AND RESEARCH NEEDS

4.8.1 Zimbabwe's irrigation scene is dominated by a very striking paradox. Side by side, there exist highly successful, diverse, profitable and modern commercial irrigation, and a small struggling small-holder system which is quite reasonably productive, but in many cases (most notably many of the pump schemes) not economic. In addition, there are various intermediate models, ARDA state farms in particular.

4.8.2 It seems strange to the outsider that Zimbabwe's small holder systems contain so little evidence of influences from the commercial sector. Indeed, such influences as are visible (use of pumping rather than gravity, present lining of field channels) add to operating costs, but without raising output to the levels where cash surpluses may justify the high costs. It is not at all clear that transfer of technology between the two sectors can be stimulated, but it does seem worth trying, at least to identify the conditions under which particular technologies, and most particularly sprinkler irrigation, are appropriate.

4.8.3 Even within the existing small-holder sector there seem to be wide divergences in the levels of success and motivation, and these do not seem to have been well explained. What is the management capacity of communal farmers? Why are some irrigation committees successful and others not? The current plans to turn over greater management responsibility to communal farmers appears to be based on an untested belief that both farmers and the government will benefit from the arrangement. There is a need to better understand the factors underlying present management successes and failures in the communal sector before new policies are implemented.

4.8.4 There is a further economic issue to be considered in the communal sector. Some of the pump schemes are woefully uneconomic and are being continued at great social cost. What alternatives exist to lower costs through modifications in irrigation technology, to raise returns through new crops and marketing strategies, or to develop local rainfed agriculture through improved practices and discontinue exorbitantly expensive irrigation?

4.8.5 The informal sector of irrigated agriculture has no natural constituency in government, since it is technically illegal, yet there may be tremendous potential for agricultural production through irrigated farming techniques which are currently frowned upon. The use of dambo lands for agriculture is one technique that is being experimented with. If the water resources of dambos can be tapped without harm to downstream supplies, the irrigation potential of Zimbabwe could be much greater than the current figure of 600,000 ha.

Another issue that touches on Zimbabwe's irrigation future is the problem of new settlements. Most new irrigation schemes, even small-scale schemes, are constructed where population density is low and farmers must be brought in and induced to settle permanently. The selection of settlers, the tenure rights they are given, the size of their allotments, and the provision of basic services become factors which affect the productivity of irrigation water.

4.9 POSSIBLE AVENUES FOR IIMI ACTIVITY

4.9.1 Zimbabwe is clearly a country of potential interest to IIMI. The country has a spectrum of irrigation types, the government is interested in expanding the irrigation sector, and there is research potential in the university. Zimbabwe boasts some of the most prosperous irrigators in all Africa. It has a manufacturing capacity to produce irrigation equipment probably superior to any other Africa state. It is in the geographical center of SADCC, with better communications than any where else in the other nations of that group.

4.9.2 On the other hand, Zimbabwe accounts for only 1.7% of all irrigated land in Africa, (and even all SADCC only 5.4%) so it is not immediately likely that IIMI could readily justify placing a resident scientist for this country alone within the context of the plausible scale of staff resources that may initially be available to IIMI's Africa programme.

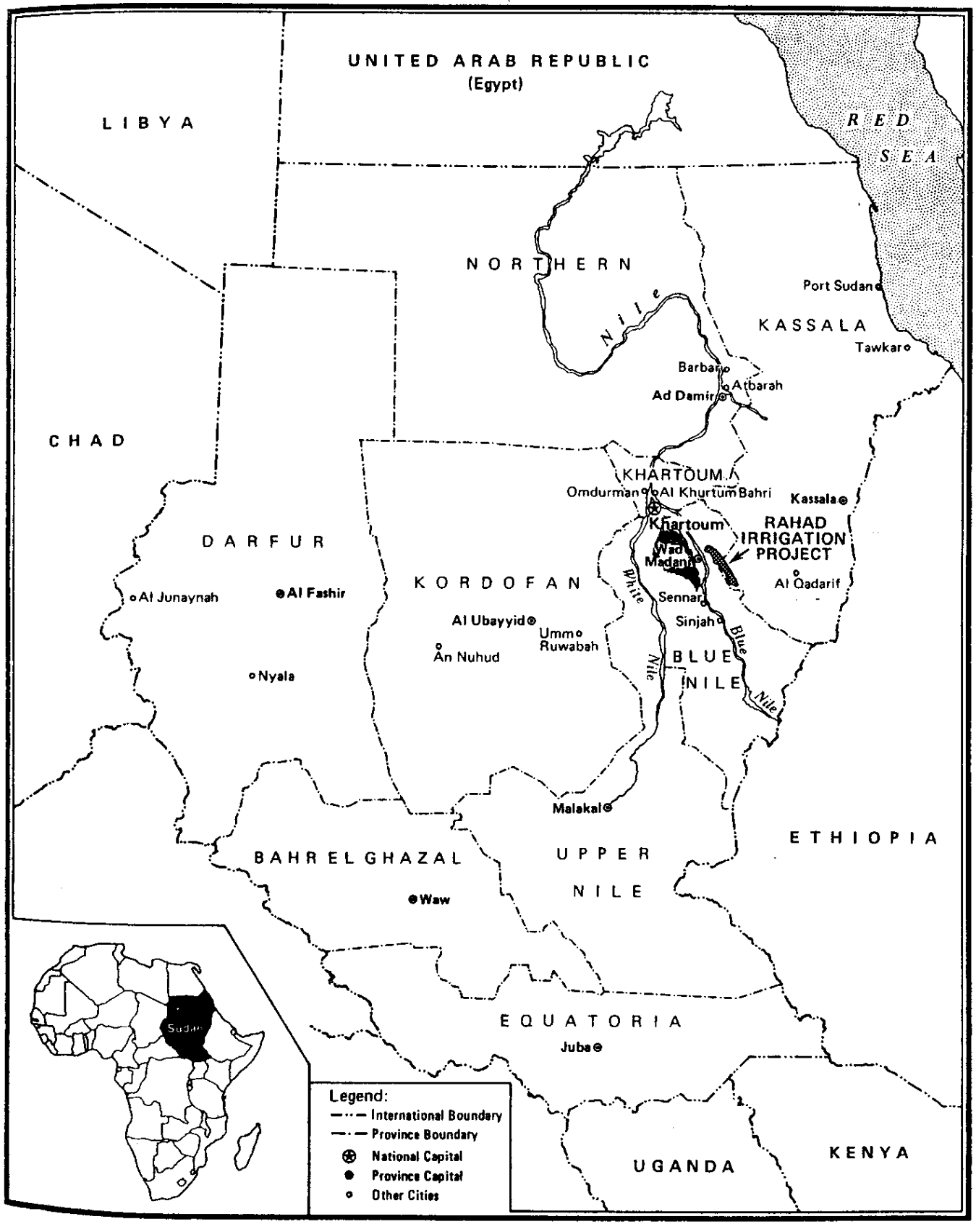
4.9.3 In the first place, therefore, it seems that IIMI may find the most effective use of its own resources will be within the irrigation management sections of SADCC's food security programme. We are not sure how much effort is to be devoted to this item, but we suggest that IIMI make an early offer of participation. This would presumably involve the stationing of an IIMI scientist at Harare for some time, with a regional assignment.

4.9.4 Alternatively, or subsequently, IIMI could initiate a proposal to the Zimbabwe government for collaboration in studies of some of the issues raised in section 4.8. Early candidates for this should be the questions of social and institutional factors affecting small-holder irrigation performance and transfer of technology from the commercial to the small-holder sector.

4.9.5 If arrangements are first made for an IIMI scientist to participate in the SADCC studies as just proposed, he will of course be well placed to refine the objectives of such further collaborative proposals, beyond that the team could expect to achieve in its brief visit.

5 SUDAN

SUDAN


UNITED ARAB REPUBLIC
(Egypt)
LIBYA
RED SEA
NORTHERN
Nile
Port Sudan
KASSALA
Tawkar
Barbar
Atbarah
Ad Damir
CHAD
KHARTOUM
Omdurman
Al Khurtum Bahri
Kassala
Khartoum
RAHAD IRRIGATION PROJECT
Wad Madani
DARFUR
KORDOFAN
White Nile
Al Qadarif
Al Junaynah
Al Fashir
Sennar
Sinjah
Al Ubayyid
Umm Ruwabah
An Nuhud
BLUE NILE
Blue Nile
Nyala
Malakal
ETHIOPIA
BAHR EL GHAZAL
UPPER NILE
Waw
EQUATORIA
Juba
UGANDA
KENYA
Sudan
Legend:
International Boundary
Province Boundary
National Capital
Province Capital
Other Cities

5 SUDAN

5.1 MAIN FEATURES OF THE NATIONAL WATER SYSTEM

5.1.1 Sudan covers 2,505,813 square kilometers. It is the largest country in Africa.

5.1.2 The northern third of the country usually receives only a few sprinkles a year. The western two-thirds of this zone is the Nubian desert, mostly sandy and gravelly plains unpopulated except for oases in the northwest. The eastern third of the zone, between the Nile and the Red Sea, is hilly and receives enough rainfall to support transhumant pastoralism. The only sedentary rural population in the zone is along the narrow ribbon of alluvial soils on either side of the Nile.

5.1.3 The central third of the country receives from 100 to 800 millimeters of rain per year spread from early July through September. The northern part of this zone supports mainly transhumant pastoralists with some spotty cultivation during particularly rainy years. The 30 year average 400 millimeter isohyet runs more or less on a parallel through Wad Medani. South of here rainfed cultivation is possible on a fairly regular basis.

5.1.4 The southern third of the country receives from 800 to 1200 millimeters of rain per year. The rainy season lasts from 6 to 9 months.

5.1.5 Nelson (1982:77) points out that, "All perennial streams and many of the intermittent ones - the wadis - in Sudan are part of the Nile system. In addition to the wadis that flow to the Nile or its tributaries in the rainy season (or stay empty in the dry season) there are others that drain into swamps that have no outlet or disappear into the sands of an inland basin. A very few .... originating in western Darfur flow westward toward the Lake Chad drainage system."

5.1.6 Nile River water is, therefore, practically the only water available in Sudan for irrigation purposes. As D'Silva (1985:13) points out, "The allocation of the Nile waters between Egypt and Sudan is based upon the 1959 Nile Waters Agreement, which allocated the estimated 74 billion cubic meters of the water between Egypt (which receives 53.5 billion cubic meters of water) and Sudan (which receives 20.5 billion

cubic meters). Under present methods of water allocation and estimation of water requirements, Sudan could have used nearly all of its share of the Nile waters by 1984." The only way for Sudan to increase the areas it irrigates from Nile waters is now to use those waters more efficiently. The Nile River travels the entire length of Sudan from Uganda in the south to Egypt in the north. The Bahr al Jabal and its tributaries coming from the south and the west form the White Nile at Lake No. They have a gentle grade and a steady flow. The Blue Nile and the other tributaries joining the Nile from the east (the Sobat and the Atbara are the two most important ones) flow much more rapidly with seasonal peaks, Consequently, during the rainy season the Blue Nile contributes about two-thirds of the flow of the main Nile north of Khartoum. During the dry season, November through March, the Blue Nile drops its contribution to about one-fifth of the main Nile flow.

5.1.7 Groundwater resources are not well known nationally. Lack of knowledge of the groundwater resource makes tubewells a risky undertaking and is one factor limiting the expansion of this technology. The government has a pilot tubewell scheme in the west, Sag el Na'am. It is proving more expensive to run than anticipated. There are a number of private tubewell schemes scattered around the country. A second major problem confronting expansion of this sector is that all fossil fuel must be imported at the present time at great expense and then transported great distances to a tubewell site. The development of groundwater irrigation will, therefore, remain unattractive on any large scale for the foreseeable future.

5.1.8 Sudan has four main types of soils. First are the sandy soils of the north and west central areas. The second are the clay soils of the central zones. The third are the lateritic soils of the south and ironstone plateau in the southwest. The final group are the alluvial soils of the lower reaches of the White and Blue Niles and the main Nile to the Egyptian frontier, and the deltas of the Gash and Baraka rivers. Agriculturally the most important are the clays and the alluvial soils in the central part of the country.

5.1.9 An official estimate in 1981 put the population of Sudan at about 19 million people. Annual growth has been estimated at between 2.8 and 3.2%. Refugee inflows from bordering countries and inflows of labor from West Africa make it difficult to have confidence in population estimates or projections. Population density overall is in the order of 7 to 8 people per square kilometer. The population density on arable land, however, is about 62 people per square kilometer.

5.1.10 In a 1955/56 survey, 39% of the Sudanese population claimed Arab ethnic identity. Arabs are the overwhelming majority in Khartoum, Northern and Blue Nile provinces. They are also the majority in

Kordofan and Darfur but by a smaller share. In 1955/56 they made up 55% of the population in the northern provinces overall. At that time 10% of the northern population came from West Africa, 60% of them from Nigeria. Arabic was the mother tongue for 51% of the national population. The tendency toward Arabization of non-Arab Muslims means that today the share of Arabic native speakers in the national population is considerably higher than thirty years ago.

5.1.11 Over half the national population is Muslim. The Nubians are the largest Muslim group after the Arabs. They live along the Nile north of Khartoum. The northern provinces shelter 90% of the Muslims in the country. They are 75% of the population there. Between 4 and 10% of the national population is Christian.

5.1.12 The second most widely spoken mother tongue in Sudan is Dinka, spoken by 11% of the population. The Dinka and related Nilotic peoples make up three-fifths of the population of the southern region. The Dinka, themselves, make up two-thirds of that number.

5.2 PRESENT ROLE OF IRRIGATION

5.2.1 According to various figures between 7.2 and 12.4 million hectares have been under cultivation annually in the Sudan in recent years. As the following table shows, a little over 1.8 million hectares, between 15% and 25% of the total, is under irrigation. According to FAO estimates Sudanese irrigation is about 19% of total African irrigation. Government schemes represent 93% of the total irrigated area. The Nile is the source of water for 93% of the schemes. The Blue Nile alone supplies two-thirds of the total.

5.2.2 The table presents existing Sudanese irrigation schemes by type and location. It adapts Table 1, Annex 3 of the World Bank's 1979 Sudan Agricultural Sector Survey by using the table "Irrigated Areas of the Sudan" from Fadl and Bailey (1985).

5.2.3 The table has probably seriously underestimated the surfaces commanded by private pumping and private tubewell schemes. First of all they have been the most rapidly expanding classes of irrigation in recent years. Secondly, they expand in a spontaneous way without any central planning and consequent tracking. However, despite their rapid growth these two classes of irrigation still will account for less than 10% of Sudanese land under irrigated cultivation.

5.2.4 About one-third of irrigated land in Sudan relies on pumping. Most of the remaining two-thirds irrigate by gravity. The Gezira Scheme alone with its Managil Extension covers close to half the national irrigated area. The Rahad Scheme is classified with the gravity schemes although it is, in fact, a hybrid. During flood season it is fed by gravity from the Rahad River while during the dry season it relies on pumping from the Blue Nile.

5.2.5 Apart from the Gash and Tokar all of the gravity schemes rely on storage of river floods behind a dam for their irrigation water. The Gash and Tokar schemes, however, are entirely dependent on the flooding the deltas of the Gash and Baraka Rivers respectively to determine the extent of irrigated cultivation possible in a given year.

Table 1

Existing Irrigation Systems in Sudan

Scheme	Irrigation Method	Net Commanded Area (hect.)	% of total	Source of Water
Gezira Main	gravity	476,868	26.17	Blue Nile
Managil Exten.	gravity	397,446	21.81	Blue Nile
Rahad (stage 1)	gravity & pumping	126,000	6.91	Blue Nile
New Halfa	gravity	138,600	7.61	Atbara
New Halfa Sugar	gravity	8,232	0.45	Atbara
Gash Delta	gravity	33,600	1.84	Gash River
Tokar Delta	gravity	12,600	0.69	Baraka River
		1,193,346	65.48	
Kenana (sugar)	pumping	34,020	1.87	White Nile
Hagar Asalaya	pumping	12,180	0.67	White Nile
Abu Na'ama	pumping	12,600	0.69	Blue Nile
Es Suki	pumping	36,498	2.00	Blue Nile
Sennar Sugar	pumping	13,650	0.75	Blue Nile
Hurga-Nurel Din	pumping	9,240	0.51	Blue Nile
Guneid Sugar	pumping	16,254	0.89	Blue Nile
Guneid Exten.	pumping	19,068	1.05	Blue Nile
White Nile Agri. Production Corp.	pumping	151,032	8.29	White Nile
Northern Agri. Production Corp.	pumping	43,260	2.37	Main Nile
Blue Nile Agri. Production. Corp.	pumping	122,640	6.73	Blue Nile
Private Schemes*				
	pumping	35,070	1.92	Blue Nile
	pumping	87,360	4.79	Main Nile
	pumping	11,780	0.65	White Nile
		604,652	33.18	
Northern Province Schemes	basin	16,800	0.92	Main Nile
Sag el Na'am	tubewell	1,260	0.07	groundwater
Private Schemes*	tubewell	6,300	0.35	groundwater
		7,560	0.42	
GRAND TOTAL		1,822,358	100.00	

* surfaces commanded in the private schemes are possibly seriously underestimated.

5.3 EXISTING IRRIGATION MANAGEMENT

5.3.1 As pointed out in paragraph 5.2.1 93% of the land under irrigation in the Sudan is in government schemes. Responsibility for government irrigation schemes in the Sudan is split between the Ministry of Agriculture and the Ministry of Irrigation. The Ministry of Irrigation is responsible for supplying irrigation water up to the field outlet pipe (FOP), the outlet from a minor canal into the lateral (Abu XX) that supplies the field ditches (Abu VI) for the farmer.

5.3.2 The Ministry of Agriculture takes over at the FOP. It is represented in the fields by a corporation responsible for each particular scheme. Thus the Sudan Gezira Board is responsible for the largest scheme. The Rahad Corporation and the New Halfa Agricultural Production Corporation manage two other large schemes. In 1967 the government nationalized a number of private pumping schemes along the White Nile and put them under the management of the White Nile Agricultural Corporation. Similar developments led to the creation of the Northern Agricultural Production Corporation and the Blue Nile Agricultural Production Corporation. These three corporations now manage over 400 individual schemes. Finally the government sugar estates are run by their own corporations such as the Sennar Sugar Company, the Guneid Sugar Company, the Kenana Sugar Company and the Halfa Sugar Company.

5.3.3 The management arrangements and pattern of production relations developed at Gezira have served as a model for the other government schemes. In general the canal layout for the gravity and pump schemes consists of a main canal, branches, major canals, minor canals, laterals (Abu XX) and field ditches (Abu VI).

5.3.4 The Ministry of Irrigation has divided the Gezira scheme into six subdivisions. An assistant division engineer (ADE) is responsible for each sub- division. For its part the Sudan Gezira Board has divided the scheme into 14 groups, 6 in Gezira and 8 in the Managil extension. Each group is divided into blocks. A block covers about 2500 hectares. There are, therefore, about 350 blocks in the scheme. Each group is directed by a group inspector. Each block is directed by a block inspector.

5.3.5 Irrigation sub-division boundaries contain whole blocks only. The relationship between the ADE and the block inspector is critical to delivery of the correct amount of water to the field. The block inspector has a number of minor canals in his jurisdiction. He knows, on each minor, the exact area cultivated in each crop. He is, therefore, able to calculate the exact water needs of his block for a

given period. In principle each week the block inspector submits the exact water demand along each minor canal in the block for the coming week. The ADEs simply add up the demands for the blocks and signal the dam at Sennar how much water to release every day.

5.3.6 At each intermediate regulator an Ministry of Irrigation employee adjusts the opening according to directions he receives from Sennar. At one time there was a telephone network linking the control points. The reestablishment of an effective internal communication system is one of the components of the I.B.R.D. Gezira Rehabilitation Project. The internal regulators are, in fact, only infrequently adjusted these days. Moreover, water control in the majors and the minors is poor. Consequently there is inequitable distribution of flows both in space and time throughout the scheme and the rational farmer is inclined to use water according to when he can get it rather than according to the objective water requirements of his crops.

5.3.7 The FOP is the outlet from a minor canal to a lateral (Abu XX). A water bailiff, an employee of the Sudan Gezira Board, is responsible for controlling the flow of water through the FOP. Laterals (Abu XX) normally supply water to an area of 90 feddans (37.8 hect.). In a Gezira plot of 90 feddans (37.8 hect.), known as a number, there are nine field ditches (Abu VI) supplying water to farmer fields of 10 feddans (4.2 hect.) each. In Managil and most of the pump schemes the laterals (Abu XX) supply 18 field ditches (Abu VI) each supplying water to 5 feddan (2.1 hect.) farmer fields.

5.3.8 The tenants of the farmer fields along groups of three neighboring laterals (Abu XX) generally join together under the leadership of a "samad". The Sudan Gezira Board appoints him from among the tenants to act as an agricultural leader. He exercises some management responsibilities at the lateral (Abu XX) level.

5.3.9 The general rule is that those who hold the rights to the farms, the tenants, do not, themselves, carry out all, if any, of the work in the fields. They generally hire itinerant agricultural labor for that purpose. During peak labor periods such as cotton harvesting thousands of itinerant laborers work in the Gezira alone. These laborers tend to come from western Sudan but large numbers come from as far away as Nigeria.

5.3.10 The farmer is a tenant on his plot in the government schemes. He does not have ownership rights.

5.3.11 The government determines what will be grown and where it will be grown. It determines the prices and marketing arrangements for

cotton and sugarcane. It provides such inputs as are available but for use only on the crops it indicates. It is responsible for the maintenance of the canals, gates, spillways, etc.

5.3.12 D'Silva (1985:35) maintains, "The only major decisions that tenants control are timing of weeding and harvesting and allocation of labor between hired and family for the various operations." In some schemes he is also given a limited choice on what crop to grow, if any, at certain points in the rotation.

5.3.13 Table 2 is also taken from the table "Irrigated Areas of the Sudan" in Fadl and Bailey (1985). It shows the cropping rotations at the main government schemes in Sudan.

5.3.14 The crop rotation in the private schemes is harder to generalize because it depends on the owner's evaluation of his needs, the production potential of his plot and the market. There is, however, a general interest in the private schemes in subsistence crops in the wet season and fruit and vegetables for the urban markets during the dry season.

5.3.15 The rotations at Gezira Main and at the Managil Extension grew out of a program of agricultural intensification and diversification that began in the 1960s but crystallized with the 1975/76 cultivation season. The objective was to increase cropping intensity and maximize land use within the schemes by introducing cash crops like vegetables and strategic food crops like groundnuts and wheat into the rotations.

5.3.16 This program created a serious management challenge. How could it be implemented without expansion of water storage and conveyance capacity or bringing new land under irrigation? The only way was to calculate precise crop water requirements to determine adequate water to irrigate crops and use these calculations to program water applications. Under these conditions strict adherence to planting dates and irrigation timings became essential. The completion of the Roseires Dam in 1964 was a factor which accelerated intensification because of the availability of more water.

5.3.17 The crisis in the intensified system comes between October 15 and November 15. The water requirement for cotton peaks during that period. Wheat is sown then. Groundnuts are still in the ground. If the Blue Nile is low at this time the Sudan Gezira Board has to determine what it will sacrifice. In October, 1984, for example, it decided it had to safeguard the cotton crop by asking tenants not to plant wheat.

Table 2

Rotation and Crops Grown in the Main Schemes

Scheme	Crops and Rotation	Intensity
Gezira	cotton-wheat-sorghum & groundnuts-fallow	75%
Managil	cotton-wheat-sorghum & groundnuts	100%
Rahad	cotton-sorghum & groundnuts-fodder (smaller vegetables/fruit & dairy tenancies)	100%
New Halfa	cotton-wheat & sorghum-groundnuts	100%
New Halfa Sugar	sugar	100%
Gash Delta	cotton-castor and/or sorghum	NA
Tokar Delta	sorghum	NA
Kenana	sugar	100%
Hagar Asalaya	sugar	100%
Abu Na'ama	Kenaf	100%
Es Suki	cotton-sorghum & groundnuts-fallow	67%
Sennar	sugar	100%
Guneid	sugar & groundnuts	67%
Guneid Exten.	cotton-wheat-sorghum & groundnuts	83%
White Nile Agricultural Production Corp.	cotton-wheat-sorghum & groundnuts-fallow	75%
Northern Agricultural Production Corp.	maize, sorghum & okra-wheat & winter legumes or citrus, dates & lucerne	100%
Blue Nile Agricultural Production Corp.	cotton-sorghum & groundnuts-fallow	67%

5.3.18 Almost all canals are unlined thanks to the low permeability of the clay soils that predominate in most schemes.

5.3.19 Main canals are divided into reaches controlled by cross regulators. These are of the vertical lift type, such as rack and worm, or roller sluice gates. In the Gezira scheme the reaches are from 6 to 22 km. long. The cross regulators maintain upstream pools at more or less constant levels so that branches and major canals can draw off the water they need.

5.3.20 Major canals are similarly divided into reaches of about 3 km. each by cross regulators. In the Gezira, Managil and Rahad schemes movable weirs are regulators on the major canals.

5.3.21 Minor canals in the Gezira Scheme have intermediate regulators as well. These are night storage weirs. Their purpose is to store night flows until the day when they are distributed to the fields. The night storage system has broken down with the agricultural intensification of the last decade.

5.3.22 The standard irrigation cycle is 14 days. Each lateral receives water for during 7 days in the cycle. The cycle is not really adequate during months of peak evapotranspiration. Cane has responded particularly poorly.

5.3.23 There are two methods of distributing water over the field, the furrow system and the basin system (angaya system). The basin system applies to the Gezira scheme, the Managil Extension and the New Halfa Scheme. In this system the standard farmer field is divided into smaller plots (angayas) by small channels and checks about 17.5 meters apart. Each angaya is divided into small basins. Irrigation water is channeled to the farmer field through a field ditch (Abu VI) coming from a lateral (Abu XX). The water goes through the small channels to flood the basins until there is free standing water throughout the field.

5.3.24 The basin system has several problems. The network of basins and cross-bunds prevents removal of drainage water. The problem is all the more serious during the rainy season. It may lead to waterlogging. The other problem with the basin system is that the division of the field into small plots, criss-crossed by small channels and checks hinders the use of agricultural machinery for field operations.

5.3.25 The Rahad Scheme has tried to adopt the furrow system. It is moving back to the basin system, however. The furrow system uses siphons for offtake. The raw material for the siphons has to be imported. Tenants have to be trained in their use. Also the furrow system requires intensive supervision because of the tendancy for the siphons to get clogged. Otherwise, as Ibrahim (1985) points out "The introduction of furrows on the existing schemes would require raising of water levels throughout the canal system because of the higher commands required in the watercourses. Moreover, excessive earthmoving will result from the land levelling which is a prerequisite for the proper flow of water through the furrows. .... It remains to be seen whether the introduction of the long furrow system will prove a successful substitute for the angaya system."

5.3.26 Production credit for the tenants comes from the corporation responsible for the scheme.

5.3.27 The Sudanese government determines the market price for cotton and holds a monopoly for cotton marketing. It determines the price for wheat but wheat can be bought and sold on the open market. Groundnut marketing was denationalized in 1979 and it is bought and sold on the open market as well. Its price is determined by market forces. Sorghum and vegetables follow that pattern.

5.3.28 Table 3 list the charges per hectare for cultivating various crops in the Gezira Scheme.

Table 3

Charges Per Hectare for Cultivation by Crop

Crop	cotton	groundnuts	wheat	sorghum	vegetables
Charge	LS 119	LS 59.5	LS 98.8	LS 59.5	LS 104.8

5.3.29 The charges are deducted from the tenant's cotton revenues. Cotton is the only crop he must sell through the corporation outside the sugar schemes.

5.3.30 Production inputs are available only through the various schemes. They are available only for cotton, wheat and sugar, the crops in which the government is most interested.

5.3.31 Before 1980 the schemes posted their tenants' charges in joint accounts. A tenant had a responsibility to a group to pay his share of the group's debt. This caused a lot of social tension because more responsible tenants did not want to have to cover the debts of less responsible tenants to stay in the scheme's good graces. Since 1980 charges have been posted on individual accounts. The thinking behind this is that personal responsibility will increase tenant performance. In fact cotton yields have, in recent years, recovered from 475 kg./hect. to about 1430 kg./hect. Many people maintain that this is due, at least in part, to the change in the accounting system.

5.3.32 There are three classes of holding agricultural land in Sudan.

5.3.33 As is common throughout rural Africa, the right to cultivate unused land in a rural community is vested in the individual who clears it. He can pass his rights to his heirs but ordinarily he cannot sell it or transfer it to some-one with no kinship ties to the community. Ownership is in the community, not the individual. The bulk of land used for pasture and subsistence cultivation follows this pattern.

5.3.34 A system of land registration has long existed through which title to a piece of land can be established. Such registration has been extensive along the Blue Nile, the White Nile and the main Nile. Private pumping schemes along those rivers owe their tenure to titling.

5.3.35 The government owns most of the land in the irrigation schemes. It leases the land to tenants. These tenants retain cultivation rights at the sufferance of the corporation. From recruiting and settling tenants to their possible eviction due to failure to meet contract conditions, the corporation maintains strict authority. The tenancy is a non-mortgageable, non-transferable farming unit which varies in size from scheme to scheme. It is 40 feddans (16.8 hect.) in Gezira and 22 feddans (9.24 hect.) in Rahad. In practice it is not uncommon for one individual to have multiple tenancies.

5.4 FUTURE IRRIGATION PLANS

5.4.1 Table 4 is taken from D'Silva (1985:8). It outlines present plans and ongoing activities in the irrigation sector financed through public sector investment.

Table 4

Ongoing & Planned Public Sector Investment in Irrigation

Project	Hectares	Million US$	Purpose and Duration
Gezira	870,114	282	Rehabilitate and modernize existing project (1983/84-1989/90)
White Nile pump schemes	151,032	55	Rehabilitate and strengthen infrastructure (1982/83-1986/87)
Blue Nile pump schemes	122,640	67	Rehabilitate and build infrastructure (1982/83-1986/87)
New Halfa	138,600	128	Rehabilitate (1981/82-1985/86)
Northern Regional agricultural schemes	43,260	50	Rehabilitate (1983/84-1988/89)
Gash Delta	33,600	11	Rehabilitate
Rahad	126,000	20	Complete Phase I of development (1982/83-1984/85)

5.4.2 Since the completion of the Managil Extension all of the new irrigation schemes in Sudan have been pumping schemes with the possible exception of the Rahad scheme which is a hybrid. Pumping is costly, whether power comes from electricity or petroleum-based fuels. This raises a number of cost/benefit questions. Moreover, the pumping schemes have generally been modelled on the structures and practices of the Gezira scheme which is gravity fed throughout. To what degree is this appropriate?

5.4.3 Sudan's share of Nile waters is virtually all obligated. Sudan would have the water resources to operate new irrigation schemes if it determined and instituted more efficient water use techniques in existing ones. Otherwise the only source of water for new schemes would be development of expensive water resources such as tubewells or the Jonglei Canal which will save on Nile waters that evaporate while crossing the swamps of the southern region. The problems with tubewells were cisted in paragraph 5.1.7. Work on the Jonglei canal has been at a stand-still since 1984 due to civil disturbances in the

area. On completion, 3 to 4 years after the resumption of work, Sudan's share of Nile waters will increase by about 2 billion cubic meters per year.

5.4.4 The largest current commitment to investment in the irrigation sector is for the rehabilitation and modernization of the Gezira Scheme. The effort is funded by the World Bank, the Sudanese government and several bilateral donors, the Federal Republic of Germany, the United Kingdom, Netherlands and Kuwait among others. Funds have not yet been released. The rehabilitation project includes $1.6 million earmarked for research. The themes for this research have been only partly defined. One theme, for example, will be to set up a management information system to strengthen the ability of the Sudan Gezira Board to track performance in the scheme. A contract for this may soon be let to a Sudanese consulting firm working in collaboration with Louis Berger International. A second theme that has been proposed is a study of the feasibility for the introduction of livestock into the Gezira rotation. The Sudan Gezira Board has been talking with an Irish NGO about carrying out this study.

5.4.5 Of equal interest, the Gezira rehabilitation project has $2.0 million earmarked for pilot farms and pilot schemes. The pilot farms will be on 300 hectare tracts. The pilot schemes will take over the entire production on a minor canal, about 6,300 hectares. The purpose of these pilots is to ascertain the impact of revised systems of management (e.g. abolition of night storage, new methods of flow control and indenting). They will have to be conducted within the framework of a working system with tenants who still have to ensure their own livelihood so the scope for radical innovation may prove to be limited.

5.5 EXISTING RESEARCH CAPACITIES

5.5.1 University of Gezira, Wad Medani - The Faculty of Agricultural Sciences has created the Water Management Programme at the undergraduate and graduate levels. The program is multi-disciplinary. Courses are given by engineers from the MOAI, and by research scientists and faculty in the Faculty of Agricultural Sciences and the Faculty of Economics and Rural Development. Professor Osman A. Fadl, Dean of the Faculty of Agricultural Sciences, heads the program. He has been researching irrigation issues in Sudan for some years. Much of it has recently been under Ford Foundation grants. In addition, Abdullahi Osman el-Tom, an anthropologist in the Faculty of Economics and Rural Development, has been studying landless labor in the Gezira. He is now researching broader human aspects of irrigation. He is trying to get British Council, Overseas Development Institute and Ford Foundation

assistance in fielding an advanced graduate student to assist him. In the meantime Mirghani Abdel Aal Hammour, Dean of the Faculty of Economics and Rural Development is asking the Ford Foundation to fund a study evaluating the comparative impact of the joint accounting system and the individual accounting system on tenant performance in Gezira.

5.5.2 University of Khartoum - There are a few faculty members who would be interested in research in irrigation issues but there is no program in the University of Gezira sense.

5.5.3 Sudan Gezira Board - It has a socio-economic unit which collects data related to costs of production of different crops by different tenants in different villages and analyzes them to get a profile of the tenants that are making a profit. The unit has also studied the seasonal labor sector and village composition. It is now doing research on the intensity of vegetable cultivation in the Gezira with an eye to making recommendations to encourage its extension. It publishes periodic reports mainly in Arabic. In the past the unit has hosted advanced graduate students doing field research and it would do it again under the right conditions. In principle it is interested in intensive applied research of the type IIMI would be carrying out.

5.5.4 Rahad Corporation - It, likewise, has a socio-economic unit. Ford Foundation had a three year Rahad Socio- Economic Research Project which ended in 1983. The objective was to build up the capacity of the socio- economic unit to carry out research. The results were disappointing.

5.5.5 Agricultural Research Corporation - It is in charge of a network of research stations spread around the country. The Gezira Research Station is in Wad Medani. The ARC program is heavily weighted to agricultural science and engineering. It has no socio-managerial research programs.

5.5.6 Hydraulic Research Station - It is jointly funded by the Sudanese government and the UNDP. Its research agenda concentrates on engineering questions. While HRS does not generally carry out socio-managerial research, it collaborates closely with the Water Management Programme at the University of Gezira. Several engineers at the HRS lecture at the university. In addition, HRS has a joint research program with Hydraulics Research, Ltd., Wallingford, U.K. The University of Gezira has a $100,000 grant from the Ford Foundation to supplement the Wallingford study with a sociological study of farmers' reaction to more controlled or ordered irrigation systems. At present HRS is conducting research on evaluating night

storage versus continuous flow and on measuring discharge at FOPs to be able to improve the efficiency of water distribution within the Gezira Scheme and on water storage and sedimentation problems at the Roseires dam.

5.5.7 National Council of Agricultural Research - This is a clearinghouse for agricultural research in Sudan.

5.5.8 Overseas Institutions - Sudan sends an unusually high proportion of its professional staff overseas for post-graduate training. Often these people undertake at foreign universities (especially in Great Britain and America, but also in Germany, the Netherlands, Ireland and other European countries) masters and doctoral theses on Sudanese problems. The sum total of these efforts is substantial but the results not readily accessible to potential beneficiaries.

5.6 REGIONAL ORGANIZATIONS CONCERNED WITH IRRIGATION

5.6.1 The Arab Authority for Agricultural Investment and Development is one regional organization concerned with irrigation active in the Sudan. It does not carry out research as such but it does fund promising proposals of other organizations.

5.6.2 The Joint Nile Waters Authority groups the five countries that share the Nile Basin, Egypt, Sudan. Uganda, Kenya and Ethiopia. It is a weak organization and does not fund any research. It is, however, the repository of Nile River hydrological data.

5.7 IRRIGATION MANPOWER AND TRAINING NEEDS

5.7.1 The irrigation schemes in Sudan are now placing a premium on increasing precision in water application in terms of timing and amounts. To do this requires an ability to measure and to track water in the canal network. The H.R.S. is doing research in water measurement techniques. An important aspect of implementing any policy for using water more economically will be to train agents of each scheme effected in how to measure the water and control its flow.

5.7.2 Another aspect will be to program extension workers in working through the implications of the new water applications policy for the farmer and what the farmer's adaptation to it will be. The new

policy will have an impact on the farmer's use of labor, on the crops he may grow, on the way he deploys his time, on his outlays for tools and inputs, etc.

5.7.3 Sudan has put a lot of effort into providing post-graduate training both at home and overseas to its irrigation staff. It now has a group of well-trained professional staff at post all over the country. In order to assure the continued maintenance of quality and growth in numbers of this staff it needs some fellowship assistance.

5.8 MANAGEMENT ISSUES AND RESEARCH NEEDS

5.8.1 There are two broad areas of management issues and research needs in Sudanese irrigation. The general opinion was that these are the priority areas of concern.

5.8.1.1 The first area is more economic use of water. This issue links improvements in the performance of the Gezira Scheme to expansion of irrigation elsewhere in the country. Gezira is so huge that the only practical way to free up the quantity of water needed for the expansion of irrigation is, first and foremost, to institute more economic water use practices schemewide. Important research questions in this area are:

a. Equity of distribution of water - At present nobody is able to track the quantity of water distributed per farm. There is evidence, however, based on cotton yield data, that water distribution is inequitable over space and time. The reasons behind this need to be investigated.

b. Water regulation along a minor - Fluctuations in the water levels in the minors has an impact on farmers' water use behavior and, by extension, on crop yields. Two issues must, therefore, be addressed. What is the most cost-beneficial strategy for operating a minor? It may be necessary to develop a model simulating water flows in the minor to answer the question. The second issue is, through applied research, to experiment technologies at the offtake of the minor for regulating the water distribution despite the variations of water level in the secondary canals.

c. Incentives for more economic farmer use of water - Farmers now treat water as a free good. The corporation charges them a fixed fee to cultivate irrespective of the water they use. Given this fact coupled with the irregularities of water flow they,

therefore, have every incentive to water as much as they can whenever they can. The problem here is to identify a package of demonstration plots, cost-effective methods of measuring flows, water charges and information to show farmers the advantages of more careful water application.

5.8.1.2 The second area is looking at the same management issue but from the farm perspective as opposed to the scheme perspective. It is the farm management issue. The following are important research questions in this area:

a. The labor constraint - The labor constraint is an important factor in Sudanese irrigation. The effectiveness of a farmer's utilization of water is, in large part, a function of the labor at his disposal. Hired labor makes up the bulk of the on farm labor force. What are the numbers of this force? How is it recruited? What are its tasks and compensation? How does work in the scheme fit into the overall resources at its disposal? How does that effect the day to day work strategy of the labor force? An understanding of the behavior and motivation of the hired labor will shed light on the use and productivity of water.

b. Tenant management strategies - How do tenants manage their farms? How do they define the resources at their disposal? What is their free decision range? What are their constraints? How do they invest their revenues both in upgrading their farms and off the farm? What is the overall estate of the tenants? How do they divide their estates among their successors to maximize the welfare of each? How have the tenants responded to intensification and diversification in terms of the way they invest their time and their capital resources? How have they responded to the change from joint accounting to individual accounting? What is the strategy tenants use to assure adequate water for their crops? To what degree is mechanization a possible release of the labor constraint? If water were available on a more dependable basis in time and space, how would tenant farm management strategies change? These are all important questions illuminating how a tenant deploys his tenancy rights as one of the resources he can use to maximize his welfare.

c. Tenant inter-relations and performance - Another set of issues in the same area has to do with the impact of tenant relations on the performance of the system. What determines how water is distributed among the 9 tenancies normally found in a number? Fakki, el Bedawi

and Bailey (1986) demonstrate that returns at the tail of the lateral (Abu XX) are inferior to those at the head. Why? What is the social relationship of tenants within a number? To what degree to they cooperate and/or socialize? To what degree does their hired labor cooperate? How do the tenants and the laborers work out conflict at that level?

5.8.2 In addition to these two priority management research themes, more economic water application and the on-farm perspective, other topics were highlighted at various meetings.

5.8.2.1 The Gash project has a history going back to the 1920s when it was a commercial estate. Flush irrigation, the method used in the Gash, is a distinctive technology which is fairly widespread in countries when waters descend the mountains in seasonal torrents only to disappear in broad flat plains. The cultivable area in the system can change dramatically from year to year depending on the volume and routing of the river flow. Tenant plot size and location can, likewise, change dramatically from year to year. Flush irrigation, therefore, presents a peculiar management problem which has application to a number of systems in the Middle East.

5.8.2.2 There are a group of problems associated with the pump schemes. There is no manual of operations for the pumping stations. The organization of the pumping schemes is closely based on that of the Gezira. How appropriate is this? What is the most cost-effective way of organizing and operating these schemes? What is the most effective way of dealing with the land tenure problem in those schemes which were nationalized under the land reform of the 1960s and 1970s? What is the actual cost of operating the schemes and how does that compare with alternative investment possibilities?

5.8.2.3 Rahad is a complicated scheme with a lot of social heterogeneity. A number of its tenants have spilled over from the seasonal labor supply at Gezira. The bulk of the tenants come from pastoral backgrounds and are juggling a commitment to irrigation with a continuing interest in maintaining their herds. What is the formula for maximizing irrigated production under these conditions?

5.8.2.4 The number of village or even household level schemes outside of the Nile Valley is expanding rapidly. This is especially true in the oases and wadis of western Sudan where the droughts of the early 1970's and mid 1980's have pushed essentially pastoral peoples to take up cultivation. These irrigation systems are very small in scale. They play an important role in local food security. The problem is to develop inexpensive small scale irrigation technologies using local resources to their maximum that need produce food only on the local self-sufficiency scale.

5.9 POSSIBLE AVENUES FOR IIMI ACTIVITY

5.9.1 The Sudanese professionals contacted by the team clearly expressed the opinion on several occasions that IIMI should concentrate its efforts during a first phase in Sudan on the Gezira scheme.

5.9.1.1 First of all the most promising local institutions in the country for irrigation research are located in the Wad Medani area.

5.9.1.2 Secondly, the impact of research on the Gezira will be felt at the national level. Improvements in the operations at Gezira will have repercussions nationally because Gezira has been a laboratory for most of the other irrigation projects and because water economies, for example, only at Gezira will be of such a magnitude to permit extension of the national irrigation system.

5.9.1.3 Thirdly, from a practical logistics point of view, it will be easier to get research activities under way quickly and maintain them in Wad Medani than at any other site in the country.

5.9.2 A major objective of the third year of IIMI's involvement in Sudan will be to define a research program outside of the Gezira area.

5.9.3 Several institutions will have to be involved to carry out multi-disciplinary research effectively in the Gezira. These institutions are the Hydraulic Research Station, the Ministry of Irrigation, the Sudan Gezira Board and the Water Management Programme of the University of Gezira. The specific research program and the administrative and logistical arrangements for carrying it out will have to be negotiated in a series of roundtable discussions with representatives of these institutions.

5.9.4 Since the scale of the undertaking will be large IIMI should post a research liaison scientist full time to Wad Medani. Depending on his/her background he/she would be attached to the University of Gezira, the Hydraulic Research Station, the Sudan Gezira Board or the Gezira Research Station of the Agricultural Research Corporation. This research scientist will negotiate arrangements for establishing a collaborative program between IIMI and the Sudanese institutions directed at issues identified in section 5.8 above. The exact scope and scale of this program will depend on the financial resources that IIMI can make available when its Africa program is defined. There seems no doubt in principle that numerous fruitful research

opportunities in IIMI's lines of interest are available and that relevant Sudanese entities will welcome such collaboration.

5.9.5 IIMI should launch negotiations with the I.B.R.D. and the Sudanese government to take over one of the pilot farms or pilot schemes under the Gezira Rehabilitation Project (see section 5.4 above). There IIMI would develop a long term applied research program. It would carry out research on any number of water management and on-farm management issues, experiment with alternative arrangements and follow the outcomes.

6 SUMMARY OF FINDINGS

6.1 The mission's findings, in regard to management problems, research opportunities, etc., in each of the four countries visited, have been set out in each of the country chapters, especially in sections 2.6, 3.8, 4.8 and 5.8. In this chapter we try to provide a summary of these points, and also to identify some common themes that exist among the various countries. The selection of a set of proposed actions for IIMI is then dealt with separately, in Chapter 7.

6.2 The question of devolving some aspects of irrigation management, from the state to some type of farmer organization, is an active one, especially in Madagascar, but also in Sudan and Zimbabwe. The objectives, or anticipated benefits, of this process are not always obvious : at minimum, it seems to be intended to reduce the State's burden in operating schemes whose economics are unsatisfactory; but people also claim that it will improve farmers' motivation through a sense of greater involvement and control, or that it will improve the performance of junior field staff through making them answerable to the local farmers' committee instead of the remoter officials.

6.3 None of these results seems inherently certain to come about. There is great difficulty (for example, in Madagascar) in devising the constitution or articles of these associations in such ways as will ensure favorable results. In Zimbabwe it seems that there has been wide divergence among the results achieved in these "self - managed" systems, and the process of transfer to farmer control is far from complete. In general, there are grounds for fearing that equity may be less satisfactory under farmers' control: in water-deficient systems, a neutral "umpire" in the form of the government official may be necessary.

6.4 The mission thought that there were particularly favorable circumstances for studying these issues in Madagascar, where a substantial number of medium-scale schemes (or PPI) are to undergo transition to farmer management in the early future. Any such research should seek to establish what are the consequences (in terms of output,equity, and operating costs) of the transfer to farmers' control, and to try to identify what are the characteristics of a successful farmers' organization.

6.5 One of the principal factors distinguishing African agriculture and irrigation from South Asia is the very different population density : typical figures in Africa being 10% or so of typical South Asian levels. This means that labor, rather than land or water, is often

the scarcest resource, and so the farmer is adapting his behavior to maximize his returns on labor input. This fact can introduce management problems which surprise outsiders more familiar with South Asian systems where production per hectare can usually be regarded as the dominant criterion. A significant case occurred in Sudan in the 1970's, where, following an increase of crop intensity which was dictated by government without offering corresponding rewards or incentive to the farmers, yields suffered and water-control disciplines broke down as farmers attempted to reallocate their limited available labor.

6.6 The issues of how the farmer reacts to the water delivery system; how his family and his hired laborers allocate their time, how he adjusts his technology (furrows, basins, border strips), how he copes with erratic flows, whether he should have access to night flows, and many other similar points, constitute a large area of potentially valuable investigation, in which present knowledge is still rather vague and controversial.

6.7 The mission thought that this topic could well be pursued in Sudan, where the imminent rehabilitation of the Gezira system is bringing such questions to the forefront. Such research would not be easy, but the Gezira system offers the unusual advantage that it is physically homogeneous (as to soil, water, crops, land holdings) over a great area, so that it is possible, by introducing different systems of water control or allocation in different areas, to know that any observed differences of farmer behavior would probably not be due to other extraneous differences.

6.8 The aim of any such research would be to determine what system of water control, or pattern of water delivery, best suits the farmer's needs and enables him to be most productive. There is much talk nowadays of "irrigation on demand:" this is rarely a practicable objective in developing - country systems, due to inbuilt rigidities, but it is desirable to investigate how far we can go in the general direction of flexible deliveries and accommodating the different needs of farmers with different domestic or labor constraints.

6.9 The question of training and professional development was raised in all countries visited, although perhaps less in Sudan. In Madagascar, Zambia and Zimbabwe this was seen as a high priority. Formally - trained professional staff are considered to be in short supply; but also the trained staff complain of difficulties in keeping up to date and learning of relevant developments.

6.10 Clearly there are things here which IIMI is well suited to do. The existing trained staff are usually rather valuable in their existing

posts, and to take them away for extended training may be more disruptive than beneficial; so there is an obvious role for short courses, workshops and seminars with an African orientation. It will also be useful to make arrangements for African irrigation staff to see south Asian irrigation and learn its different organization and methods.

6.11 There seems to be a need to quantify the training issue : to consider what are the necessary staff/land ratios at the various technical levels. Certainly, in some countries (Madagascar is one) there have been stages where the irrigation bureaucracy has become too big and expensive. It may be a function that IIMI could undertake, to ascertain what are the ratios of trained staff both in established, and fast-growing, irrigation economies, so that advice on training needs, and the size of any future training ventures, can be in numerical terms.

6.12 The mission's itinerary covered two countries (Sudan and Madagascar) where irrigation is a well-established way of life for a large section of the population, and two (Zimbabwe and Zambia) where it is still the rather specialized activity of relatively few people. The latter two are more representative of conditions in Africa generally. In Zimbabwe and Zambia, the mission felt that there is a potential role for IIMI in the planning process. These countries are undecided as yet about the correct, or most satisfactory, models to adopt for small holder irrigation : how big should projects be, how big and how rigid should land holdings be, how deeply must the State involve itself, how will costs be defrayed, which farmer organizations will be appropriate?

6.13 In addition expansion of irrigation has to weighed (for many decades to come) against the alternative policy choice of expanding rainfed agriculture, for which suitable land and soils do still exist, and whose technologies can be further upgraded. There are also possibilities of conjunctive use of irrigated and rainfed farming (as in north central Sri Lanka): in Zimbabwe this has taken the form of irrigated micro-plots of 0.1 ha where the farmer's labor is of the order of 1 day/week outside of the harvest and land preparation seasons. (Such systems offer further interesting opportunities for studying farmer choices between these available options for allocation of labor.)

6.14 All these choices are influenced, in the policy perspective, by the knowledge that population growth rates remain high and that production growth rates of the order of 5% per year must therefore be sought, if people are to see any rise in living standards. The past three years of region drought, or rather rainfall deficit, in most of southern Africa, have introduced high awareness of a physical,

hydrological factor : the relatively large statistical variability of rainfall in those areas where the annual average is moderate. This has raised the priority of irrigation, as a measure for giving food security in systems that may remain predominantly rainfed.

6.15 The mission felt that IIMI may contribute to the planning processes, and the resolution of issues like these, summarized in the question of when and how a country that has as yet relatively little irrigation should embark on this technology. A useful starting-point for such activity seems to be the irrigation management sub-programme within the food security programme of SADCC, which will be led by the Zimbabwe Ministry of Agriculture and Water Development.

6.16 Zimbabwe also contains a special phenomenon, the highly profitable commercial sector run mainly by individual farmers of European origin. Although recent history naturally makes this seem like an isolated and unintegrated peculiarity, the mission felt that success should not be ignored, and that the possibility of transfers of technology from this sector to the small-holder sector ought to be explored.

6.17 Throughout its travels the mission was aware of the need for better storage and availability of information about irrigation management. This is at a level quite distinct from the training needs already mentioned. Reports, whether of studies, project appraisals, or research, are hard to obtain; such documents are precious and scarce; information more than about three years old is quite unusual; inter-country information transfers are few. Here again, there is a void that IIMI can, if it has the resources, help to fill.

6.18 Certain deficiencies of practical engineering information exist, without which no management system, however well devised, is likely to succeed. In Madagascar, where there is heavy reliance on run-of-river irrigation systems, hydrological date collection has apparently been virtually absent for some 10-15 years past. It is, quite simply, not possible to design such systems well without this basic information; and schemes designed to be too large, or too small, for the available water supply will tend to present a continual succession of management difficulties.

6.19 In Sudan, Zimbabwe and Zambia the existing irrigation is devoted largely to cash crops: cotton, groundnut, sugar, tobacco. The signs, at least in Zimbabwe and Zambia, are that governments will increase their attention to staple food crops, without the export objectives of the major cash crops. This seems to be leading towards a wish for systems at a different economic level, where the scheme costs are lower and the need to ensure substantial marketable surplus is therefore not so pressing. Existing models in these countries have,

because of their origins, quite high costs, both in capital and operation, and the search for new models of management (para 6. 12-13) has to take this aspect into account.

6.20 In general, the search continues for methods by which governments can stimulate, at acceptable cost per hectare, the performance of the very small scale irrigation sector. This problem does not seem to have been solved on a durable basis anywhere. The mission noted that in Madagascar where this sector (micro-hydraulic) is very significant and accounts for 700,000 ha, the previous sponsoring organization (GOPR) had to be wound up, fundamentally because its involvement was too deep and its unit costs excessive; and the continuance of its successor (OMH) now seems vulnerable, depending on the current evaluation by its major donor, the EEC. This seems to be a matter for regret. Certainly it is of national importance to find a viable way of channelling help to these systems, but their small size, scattered distribution and high variability, no doubt make it difficult to find systems of organization of technical input on the government side.

7 FUTURE AGENDA FOR IIMI

7.1 IIMI's Africa programme does not yet exist, so this final section is to be read as a short list of suggestions as to what IIMI could do in these four countries, if such a programme is established.

7.2 Sudan and Madagascar have large irrigated areas that take them into the scale of medium to large systems by world standards. They both present research opportunities of high interest, whose results would have relevance well beyond the national boundaries. The mission felt that IIMI should aim to be represented at an early date by a resident scientist in each of these two countries. The scale and diversity of their irrigation systems is such that any such person should be very fully occupied. The mission therefore does not think that these scientists should be asked to take up regional responsibility for liaison with adjacent countries.

7.3 We note that the Ford Foundation has for some years had a representative at Khartoum with rather similar objectives, and (although we are quite certain that there is abundant work for both) we think therefore that, if there is any need to choose priorities as between Sudan and Madagascar, Madagascar should be the first place for an IIMI appointment.

7.4 In both countries we understood that there would be a general welcome for such an initiative from IIMI. In Madagascar, the awareness of what an organization like IIMI might contribute seemed rather less widespread, so IIMI should anticipate a somewhat longer preparatory phase there.

7.5 The relevant organizations to which an IIMI resident staff member would mainly relate seem to be, in Madagascar, MPARA (Ministry of Agricultural Production and Agrarian Reform) and FOFIFA (National Center for Applied Agricultural Research in Rural Development), both of which are based at Antananarivo. In Sudan they are the Ministry of Irrigation (especially its Hydraulics Research Station) and University of Gezira, while the Sudan Gezira Board (although not having responsibility throughout the national irrigation system), would obviously be of high relevance. As these organizations are all headquartered at Wad Medani, we suggest that is the site for any IIMI resident.

7.6 Initial research topics have been in sections 6.2 to 6.9. The mission is confident that ideas for collaborative research in several other fields will grow out of the process of familiarization between

IIMI and the national bodies and does not feel it appropriate to make recommendations beyond the first steps, at this point. However a number of ideas about potential future areas of interest appear in chapters 2 and 5.

7.7 In Zimbabwe and Zambia the mission feels that the scale of existing irrigation, the lower strength of existing irrigation authorities, and the anticipated pace of imminent new irrigation development, do not at this moment combine to justify a resident IIMI presence committed wholly to either country. However the mission considers that it would be appropriate to locate a resident IIMI scientist for general liaison with the SADCC regional group (Swaziland, Lesotho, Botswana, Mozambique, Zimbabwe, Angola, Zambia, Malawi, Tanzania) which together has over 5% of Africa's irrigated area.

7.8 We propose that IIMI offer, initially, that such a person make a contribution to the SADCC irrigation management programme, for which Zimbabwe has been allocated the lead role. Such a person should therefore to be based at Harare.

7.9 The mission has noted needs for professional development and information exchange. The ways of solving these depend on the overall structure of IIMI's African programme, and this mission can only note that they exist, and are very relevant to IIMI's objectives and capabilities. Initially, IIMI should begin making selective invitations to local irrigation people to suitable seminars etc. in Sri Lanka and elsewhere.

7.10 Finally, the mission wishes to record its thanks to all national staff who assisted it towards these conclusions, and to express its hope that these efforts will lead on to renewed association in joint programmes.

APPENDIX A

TERMS OF REFERENCE OF THE MISSION.

APPENDIX A

1. To address how IIMI may make its irrigation management programme relevant to parts of Africa, a Second Exploratory Mission will visit four countries in east and southern Africa, Zambia, Zimbabwe, Madagascar and the Sudan.

2. The overall purpose of the Mission is to explore prospects for IIMI's activities in the selcted countries, and to prepare a larger survey of management opportunities to improve irrigation performance in Africa which can be incorporated into IIMI's programme.

3. In each country, the Mission will attempt to identify Government agencies and Institutions whose participation is important to implement programs in irrigation management. Particular attention will be given to institutions working at the regional level. The objectives and limitations of these institutions will be investigated as well as their constraints in developing collaboration among countries.

4. The Mission is expected to visit irrigation schemes in each country and to report briefly on the current status of training, research, or action-research in irrigation management by development agencies or national and regional Institutions. As a guideline for the review, the following fields may be considered:

   - Irrigation management and planning (field, watercourse and system levels:
   - Institutional and social aspects of irrigation;
   - Small-scale (village) irrigation systems;
   - Economic research in irrigation;
   - Policy-oriented research;
   - Training in irrigation management; and
   - Participation in irrigation management information networks;

5. The Mission should identify areas of special interest and need in irrigation management in the countries visited. Special attention should be given to illustrate by examples the nature of problems faced, the kinds of questions to be answered, and the type of research and training to be performed.

6. The Mission should assess the willingness and ability of agencies and institutions to collaborate with some of IIMI's programs.

7. The Mission should also suggest a tentative agenda for further steps to be taken, including additional missions in Africa, to get the proposals worked out in depth with the associated parties, and to make the survey more complete.

8. Based on the findings of the present and prior IIMI missions in Africa, the Mission may recommend an appropriate procedure for the Institute to prepare at a later date an IIMI-Africa strategy paper.

APPENDIX B

MISSION ITINERARY

APPENDIX B

Sunday 10 November		Mission members assembled at Antananarivo Accommodation : Hotel de France
Monday 11 November	1200 (CLA/DB)	Antananarivo to Antsirabe by air
	1300 (DG/ASW)	Antananarivo to Antisrabe by rail
	pm (CLA/DB)	Session of CEFIGRE irrigation seminar (Mr J P Millo, organiser).
Tuesday 12 November	a.m.	Discussion with Mr Randrianarisonana, Co-ordinator, PPI rehabilitation + Mr Rakotonirainy + Mr Raharison, Mamokatra
	pu	Field visit cancelled
	evg.	World Bank team (Mr H Boumendil, Mr V Nguyen) and other donor representatives (Mr Gleizes, Mr Martin Caisse Centrale; Mr Carreau,EDF).
Wednesday 13 November	a.m.	Closing session of CEFIGRE seminar
	1300	Returned Antsirabe to Antananarivo by rail. Accommodation : Hotel de France
Thursday 14 November	0830	Mr Paul Blay, Resident Representative,World Bank + Ms Tina Kimes
	1030	Mr S D Ramarakoto, Secretary,General, MPARA
	1400(DG/ASW)	Mr S Rea, USAID
	1500	Mr B Ravalomanga,Director of Rural Infrastructure. + Mr J Rakotonirainy + Mr Jean Pierre
	1730	Mr R Gambini, EDF
	1900	Mr G Gleizes, Caisse Centrale
Friday 15 November	0830	World Bank Office, for making appointments
	1030(DG/ASW)	Professor Ravelojoana,University of Antananarivo.
	(CLA/DB)	Mr Jean Marie Ralaizanadraoto, Deputy Director, Micro-hydraulic.
	Lunch	Mr Asmond,World Bank Project leader, PPI rehabilitation
	1500	Mr.Galland, Engineer, technical assistance MPARA.
	1600(CLA/ASW)	Mr P Rakotondrabe, Deputy Director, Agricultural Extension.

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Saturday 16 November	0700	Antananarivo to Ambohibary PPI, accompanied by Mr.H.Randriarimanana, chief of rural infrastructure, Antananarivo Province.
	1400	Micro-hydraulic project Betafo
	1900	Return to Antananarivo.
Sunday 17 November	0900	Mr J Hooper, IRRI
	p.m.	Antananarivo to Nairobi by air . Accommodation: Intercontinental Hotel
Monday 18 November	0800	Nairobi to Lusaka by air
	1200	Mrs Roma, World Bank mission
	1400	Mr W J Veldkamp, soil scientist, Mount Makulu.
	1700	Mr.J Olivares, World Bank, + Mr R Wiersinga, Euroconsult Accommodation : Intercontinental Hotel
Tuesday 19 November	0800	Lusaka to Mazabuka by road
	1000	Mr J B Siakantu,officer in charge, National Irrigation Research Station.
	1400	Mr.D.Tate, managing director,Zambia Sugar Co.
	1500	Mr F Mbewe,acting permanent secretary, Ministry of Agriculture.
	evg.	Mr.Olivares + Mr Wiersinga
Wednesday 20 November	0900	Prof.A Chilivumbo, acting director, Rural Development Studies Bureau.
	1000	Dr K Osafo, Irrigation Economist, MAWD
	1400(DG/ASW)	Dr G Howard, Dept.of Biology,Univ.of Zambia.
	1400(CLA/DB)	Mr Erhard Loher,European Committe.
	1500(CLA/DB)	Mr Mutelo,Director of Agriculture(Cancelled)
	1530(DG/ASW)	Prof. J A Williams, Dept.of Geography, University of Zambia.
	1600(Cla/DB)	Mr U G Mbanefo, Resident Representative,World Bank
Thursday 21 November	0900(CLA/ASW)	Mr J Mutelo, Director of Agriculture
	1000(CLA/ASW)	Mr G Williamson, Wheat Officer, Dept. of Agriculture.
	p.m.	Lusaka to Harare by air. Accommodation : Holiday Inn.

Friday 22 November	0930	Mr M A Burney Resident Representative, World Bank
	1430	Mr P T Z Mpofu, Acting Director, Dept. of Natural Resources.
Saturday 23 November	a.m.	Visit to dambo research project near Marondera, accompanied by Mr.A Windram, Dept,of Civil Engineering, Univ. of Zimbabwe + Mr R Lambert, Wedc U.K. + Ms P Hotchkiss, Wedc U.K.
	2000	Prof M J Blackie, Dean of Agriculture, Univ. of Zimbabwe.
Sunday 24 November	0800	Harare to Masvingo by road Met Mr.A Draper, + Mr H Goldsmith, Hydraulics Research, Wallingford,U.K. Visit to Makonese small-holder irrigation
	1800	Returned to Harare
Monday 25 November	0930(DG/ASW)	Prof.Murphree, Centre for Applied Social Studies, Univ. of Zimbabwe
	1100	Mr T Davidson,Commonwealth Development Corporation.
	1430	Mr J Makadho, Chief Irrigation Officer, Agritex.
	1600(CLA/DG)	Mr A Munzara, Deputy General Manager, Agricultural Finance Corporation. + Mr J Culver, As. Gen. Manager + Mr Hove
	1600(DB/ASW)	Mr L Mhlanga, General Manager, ARDA
Tuesday 26 November	0900	Mr A S Mpala,Deputy Secretary, Ministry of Energy and Water Development
	1000	Mr R Fenner,Assistant Director, Agricultural Research Centre.
	1100(DG/ASW)	Mr Mushale,Agricultural Development Officer,USAID
	1130	Mr D Potten, Hunting Technical Services Ltd.
	1400	Mr A Pilditch, Irrigation Specialist Commercial Farmers Union. Visit to Agricultural Research Trust. Visit to farm of Mr.P
	evg	Mr & Mrs A Windram

Wednesday 27 November	0900(ASW)	Dr Mandivamba Rukuni, University of Zimbabwe
	0900(CLA/DB)	Dr S Muchena,Deputy Secretary,Ministry of Lands,Agriculture and Rural Development. Harare to Nairobi by air. Nairobi to Khartoum by air Accommodation: Meridien Hotel
Thursday 28 November	0900	Dr C Bailey, former Resident Representative,Ford Foundation (departing for Dhaka) Ms M Robertson, new Resident Representative, Ford Foundation. Dr B Wallach, Program Officer.
	1100	Khartoum to Wad Medani by road
	1400	Professor Osman, Univ. of Gezira.
	1500	Mr B E F El Monshid, Hydraulics Research Station, Ministry of Irrigation. + Dr Ahmed Salih + Mr Omer Accommodation : Gezira Club
Friday 29 November	0900	Field visit to Gezira Irrigation Scheme, Hamza Minor; accompanied by Mr.Omar,Hydraulics Research Station.
Saturday 30 November	0930	Mr B E F El Monshid
	1200	Mr Abdullah El Zubeir, General Manager, Sudan Gezira Board + Mr Izz El Din,director of agriculture.
	1300	Dr T Wickham,Director,-General-IIMI,arrived + Dr B Wallach,Ford Foundation
Sunday 1 December	0900	Field visit in Gezira
	1100	Discussion at HRS with Mr Monshid, Prof. Osman,Prof El Tom, Mr.Disougi, Mr. Omer,Dr.Ahmed Salih, Dr Abd El Salam, Mr Ahmed Abd El Wahab.
	1400	Lunch at Yugoslavia Hotel, arranged by HRS
	evg.	Reception at Sudan Gezira Board, Barakat

APPENDIX B

Monday 2 December	0800		Field visit to Rahad.
	1400		Lunch at Yugoslavia Hotel arranged by University of Gezira.
	1530		Dr Wickham + Dr Wallach + Dr Groenfeldt returuned to Khartoum
	1800		Discussion with Dr Ahmed Salih
Tuesday 3 December	0800	(CLA/DB/ASW)	Field visit to Sennar Dam and Es Suki irrigation project accompanied by Mr Omer
Wednesday 4 December	0900	(CLA/DB/ASW)	Mr Said M Farah, Gezira Research Station
	1100	"	Depart to Khartoum
	1400	"	Dr Wallach
	2300	"	Depart for London by air.

APPENDIX C

PEOPLE AND ORGANISATIONS MET.

MADAGASCAR.

THE WORLD BANK - Immeuble Macoma, Tsaralalana B.P. 4140, Antananarivo.
Paul BLAY, Resident representative, & Mrs Tina KIMES, Assistant.
Vantuu NGUYEN, E.& S. Africa Depart. Washington. D.C.
Henri BOUMENDIL, Consultant in Irrigation for the Bank and for EEC, Marseille, France.

MINISTERE DE LA PRODUCTION AGRICOLE ET DE LA REFORME AGRAIRE - (MPARA).
Samimiadana Daniel RAMAROKOTO, Secrétaire Général, BP301 Antana.

Direction de l'Infrastructure rurale - B.P.1061 Nanisana, Antananarivo.
Benjamin RAVALOMANGA, Directeur.
Jean PIERRE, Chef du service de l'Irrigation.
Jean RAKOTONIRAINY, Chef du service de la Gestion des réseaux.
Harisson E. RANDRIARIMANANA, Chef de service Provincial de l'I.R. d'Antananarivo - B.P. 242 Nanisana, Antananarivo. 101

Direction de la Microhydraulique - B.P. 685 Nanisana, Antananarivo.
Jean Marie RALAIZANADRAOTO, Directeur Adjoint de l'O.M.H.L. (Opération Microhydraulique)

Direction de la Vulgarisation
Pascal RAKOTONDAVE, Chef du Service d'encadrement agricole.

Direction de la Programmation
Rakotobe RANDRIANARIJAONA, Coordinateur du Projet de Réhabilitation des Petits Périmètres Irrigués (P.P.I.).
Dr. ASMOND - Assistant technique , Chef de Mission WB, Ope.P.P.I.
BOUCHET, Assistant Technique, Expert en animation Rurale (P.P.I.).
GALLAND - Technical assistant (France).

Direction des Approvisionnements -
RATSIMANADISA, Directeur (met at Antsirabe Cefigre session).

Direction Financiére et du Personnel -
Olivier RAVELOARISON, Directeur (met at Antsirabe session).

FOFIFA - National Center for Applied Research on Rural Development
Jim HOOPER, Researcher from IRRI assigned to FOFIFA.

AGRO - Etablissement d'Enseignement Supérieur des Sciences Agronomiques. Campus Universitaire, B.P. 175, Antananarivo.
Prof. Gilbert RAVELOJOANA, Président.

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MAMOKATRA Entreprise de développement rural (Public consultant firm).
Pierre F. RAHARISON, Directeur, B.P. 961 Antananarivo.

ANTOK'ASA ENY AMBANIVOHITRA (A.A.A.) - Entreprise de travaux public et d'équipement rural. BP 7148, Antananarivo.
Rambeloarison RABETRENA, Directeur Général.

CCCE - Caisse Centrale de Coopération Economique, BP 557 - Antananarivo.
Gérard GLEIZES, Directeur Adjoint.
Marc Antoine MARTIN, Ingénieur du GREF, Chargé de Mission. Représentant la CCCE, Paris.

USAID - Sam REA, Resident representative.

EEC - Mr CARREAU, Délégué. Immeuble Ny Havana, BP 746, Antananarivo.
Ricardo GAMBINI, Conseiller pour les projets agricoles

Organisation & Environnement, (Consultant appointed by the EEC to evaluate the Operation Micro-hydraulique).
Cuirec DELANOE, Economist, Chef de mission.

CEFIGRE - (training session on Irrigation planning, design and management organised in Antsirabe).
Jean Louis MILLO, Head of the Irrigation department &
Mrs Caroline VIGIER.

The mision visited following irrigated systems in ANTSIRABE area, in the company of Mr Harisson E. RANDRIARIMANANA, Chief of Provincial Service - Antananarivo (DIR):

AMBOHIBARY Small irrigated system (P.P.I.)
BETAFO irrigation systems (Opération Micro-hydraulique)

The mission also tried, but without success, to meet the following persons:
Mr RAMANJASOA, MPARA Cabinet advisor.
Dr Charles RAZAFINDSAKOTO, Director General FOFIFA.
Dr Clet Pascal RAVAHITRAVIVO, Director scientifique FOFIFA, Rice co-ordinator.
Mme Robertine RAHARINOSI, Directeur de la programmation, Ministére de la recherche,
Germain RAKOUTOUNIRAINY,
Mrs Janine RAMAMONJISOA, Directeur de l'U.E.R. de Géographie, Université de Antananarivo.
Jean Aimé RAKOTOARISOA, Muséum, Antananarivo.

ZAMBIA.

THE WORLD BANK - Lusaka.
Uche G. MBANEFO, Resident Representative
Mrs ROMA, Assistant.
World Bank Mission - Options and Strategies for Investment, Phase II.
José OLIVARES, Washington.
Ruud Th. WIERSINGA, Team Leader Euroconsult, The Netherlands.

MINISTRY OF AGRICULTURE AND WATER DEVELOPMENT (M.A.W.D.).
F. MBEWE, Acting Permanent Secretary, Director Planning Division.
Mr MUTELO, Assistant Director of Agriculture.
C.R.W KAYOMBO, Director of water affairs. (not met)
Dr Kwaku OSAFO, Irrigation Economist.

UNIVERSITY OF ZAMBIA.

Rural Development Studies Bureau - Great East Road, Munali.
J. T. MILIMO, Director. (not met)
Prof. CHILIVUMBO, Acting Director.

Department of biology.
Dr G.W. HOWARD.

Department of geography.
Prof. G.J. WILLIAMS.

NATIONAL IRRIGATION RESEARCH STATION - MAZABUKA.
Dr M.A. QASEM, FAO Senior Technical Adviser (not met).
Josy Bubala SIAKANTU, Officer in charge, Team leader Irrigation Research.

MOUNT MAKULU RESEARCH STATION.
KALIMA, (not met)
W.J. VELDKAMP, Soil specialist from the Dutch technical assistance.

THE ZAMBIA SUGAR COMPANY LTD. - P.O. box 30489, Lusaka.
David A. TATE, Managing Director.

E.E.C. Erhard LOHER, Agricultural Advisor.

ZIMBABWE.

THE WORLD BANK - Cabs Center, PO Box 2960, Harare.
Mahmud A. BURNEY, Resident Representative.

MINISTRY OF LANDS, AGRICULTURE AND RURAL DEVELOPMENT.

Head Office, Robert Fletcher building, P/Bag 7701 causeway, Harare.
Robbie MUPAWOSE, Permanent Secretary (contacted but not met).
Dr S. MUCHENA, Deputy Secretary, Coordinator for SADCC programs in Zimbabwe.
Frank H. DRANE, Technical Adviser - SADCC Food Security technical and administrative unit.

Agricultural Technical & Extension Services (AGRITEX), Box 81117.
J. MAKADHO, Chief Irrigation Officer,

Agricultural Research Center, 5th Ext, Box 8108 Causeway, Harare.
Bob FENNER, Assistant Director.
Dr AVILA, Team leader, Farmer System Research Unit (not met).

MINISTRY OF ENERGY, WATER RESOURCES AND DEVELOPMENT.
Head Office - Compensation house, P/bag 7712, Causeway, Harare.
Eng. A.S. MPALA, Deputy Secretary.

AGRICULTURAL RURAL DEVELOPMENT AUTHORITY (ARDA) - PO Box 8439, Harare.
Dr Liberty M'HLANGE, General Manager.

COMMONWEALTH DEVELOPMENT COORPORATION (CDC), Harare.
T. DAVIDSON,

AGRICULTURAL FINANCE CORPORATION (AFC), Kurima House, PO Box 369, Harare.
A.M. MUNZARA, Deputy General Manager (Finance & Administration)
Mess HOVE and CULVER.

UNIVERSITY OF ZIMBABWE - Mount Pleasant, Box MP.167, Harare.
Faculty of Agriculture.
Prof. Malcom P. BLACKIE, Dean faculty of agriculture.

Center for Applied Social Sciences.
Prof. MURPHREE, Director.
Dr Mandivamba RUKUNI, Agricultural Economist.

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Department of Civil Engineering,
Allan WINDRAM, lecturer.

Department of Land Management,
Prof. Karl EICHER, US researcher of Michigan Univers. (not met).

COMMERCIAL FARMERS UNION - Agric. house, Moffat Street, Box 1241/TA.
J.R. RUTHERFORD, Vice President (contacted but not met).
Allan PILDITCH, production and extension executive, Zimbabwe Cereals Producers association.

HUNTING TECHNICAL SERVICES LTD (Consultant), Elstree way, Borehamwood, Hert, WD6 15B (UK).
D. POTTEN, Economist.

USAID - Agricultural Development Office, Harare.
Mr MUSHAORI,

USAID - Southern Africa Regional Program, P.O. Box 3340, Harare.
Dale B. PFEIFFER, resident representative.

The mission had also field visits, in company of the following persons:

MAKONESY irrigation scheme, at MASVINGO.
Andrew DRAPER, Engineer from Hydraulic Research, UK.
Hugh GOLDSMITH, Engineer from Hydraulic Research, UK.

CHIZENGENI, visit of a "Dambo" in company of MR A. WINDRAM and
Pat HOTCHKISS, MSc, Water and waste engineering for developing countries, (WEDC) England.
Robert A. LAMBERT, MSc, WEDC, England.

Commercial farms in company of Mr Allan PILDITCH:
Agricultural Research Trust.
Peter's farm, about 50 km from Harare.

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SUDAN.

THE FORD FOUNDATION - P.O.Box 1794, Middle Road, New Extension, Khartoum.
Dr Charles BAILEY & Mrs Margaret ROBERTSON, Resident Representatives.
Dr Bret WALLACH, Program Officer.

MINISTRY OF IRRIGATION - Wad Medani.

Hydraulic Research Station, PO Box 318, Wad Medani.
Badawi El Fadli El MONSHID, Director General.
Ahmed Abd ELWAHAB, Deputy Director.
Dr Abd Alla Abd ELSALAM,
Dr Adam Ahmed SALIH, Senior Researcher.
Engineer Omer ELAWAD,

Irrigation Services,
Eng. Kamal ABDU, Director General (met by the previous mission).
Eng. Ahmed DESOUGI, Director for Gezira Scheme Irrigation.

SUDAN GEZIRA BOARD - Barakat. TLX GEZBO 50001
Abdalla El ZUBEIR, Director General, President of the Board.
Dr Nasr el DIN, Director of Agriculture.

AGRICULTURAL RESEARCH COORPORATION (A.R.C.). - PO Box 126, Wad Medani.
Dr Hassan KHALIFA, Director General (met by previous mission).
Dr Mohamed FATIH, Deputy Director General (met by lst mission).
Prof OSMAN, Senior Agronomist (met by the previous mission).

Agronomy and Crop Physiology Section.
Dr Saeed M. FARAH, Professor, Gezira Research Station.

UNIVERSITY OF GEZIRA - PO Box 20, Wad Medani, D.R. of the Sudan.

Faculty of Agriculture Sciences.
Prof. A.A. Osman FADL, Dean of agriculture, (soil physics).

Faculty of Economics & Rural Development, PO Box 20, Wad Medani.
Prof. Mirghani Abdel Aal HAMMOUR, Dean.
Dr Abdullahi Osman El TOM, anthropologist,
Salah MAGID, socio economist, on Rahad Agricultural Project.
The previous mission met other members of the Water Management Group:
Prof. Adam S. HUSSEIN, (agroclimatology).
Dr Ali ADEEB, (agricultural engineering).
Dr Mohamed Ahmed Abdel GADIR, (management science).
Dr Abdel Bagi SUBAEI, (agricultural economist).

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UNIVERSITY OF KHARTOUM -
Department of geography.
Prof. M.O. SAMMANI,

THE ARAB ORGANISATION FOR AGRICULTURAL DEVELOPMENT - PO Box 474, Khartoum.
Dr Hassan Fahmi JUMAH, Director General. (met by IIMI DG)
Dr Mohamed Osman SALIH, General Manager, and
Dr Abdel Aziz KHALAFALLA, Head, Agricultural Production Division.
(both met by the previous mission)

The present mission had the opportunity to make following field visits:

RAHAD Irrigation Project and meeting the Manager/irrig. and Ahmed Abdelkasim Mohammed, Director of the Agricultural Coorporation.
GEZIRA Irrigation Scheme, SENNAR Dam and meeting the Resident Engineer.
KASSAB NORTH Pumping Scheme and meeting the Agricultural Coorporation.
ES SUKI Pumping Scheme and meeting the Agricultural Manager.

In addition, the previous mission also met in June 1985 at Khartoum:
Eng. Saghayoun El Zein Saghayroun, Chairman, Public Corporation for engineering and earth moving. (former Minister of Irrigation).
Abdel Galil Abdel JABBAR, Director Rehabilitation Project Management Unit.

APPENDIX D

Summary of discussions and field visits in Madagascar.

APPENDIX D

MADAGASCAR - IIMI Mission - November 1985
Discussion with : Mr. RANDRIANARIJAONA, Co-ordinator of the Project of rehabilitation of small irrigation schemes (P.P.I.) Planning Direction of MPARA (DINIKA).
Participants : C. Abernethy, A. Waldstein, D. Groenfeldt, D. Berthery.
Comments by : D. Berthery.
Date : 11/11/1985

In the past, Mr Randrianarijaona was Director of "Génie Rural". He is presently in charge of co-ordination for the implementation of a project which is a priority for the national policy : Phasing out government responsibility for managing and maintaining small irrigation systems, the so called " Petits Périmètres Irrigués ", and handing it over to newly set up organizations of users (Associations syndicales). Government aims at providing advice with minimal staffing and extension services.

1. Types and scales of irrigations systems. Irrigation systems in Madagascar can be sorted out in 3 majors groups:
- "la petite hydraulique villageoise", 700,000 ha overall which includes systems of 10 to 200 ha each where the government doesn't intervene; and systems of 50 to 500 ha where government has to upgraded structures, mostly river intakes at the request of local communities ("Opération Microhydraulique").
- "les petits périmètres irrigués (P.P.I.), about 200,000 ha overall under command but 100,000 ha actually irrigated with systems of 500 to 3,000 ha each. Many of these originated from the development that occurred after World War II. There schemes were placed totally under government control during the recent past and they have severely deteriorated through lack of maintenance.
- "Les grands périmètres". Six projects covering an irrigated area of 70,000 to 80,000 ha. Among which the most important are Lake Alaotra (35,000 ha), Majunga (20,000 ha), Bamanbulle (10,000 ha) and the sugar cane scheme around Nosy Be.

2. Government organizational set up. The MPARA is concerned with agricultural production; animal production falls under a different ministry. MPARA includes: (i) The Minister Cabinet with 4 inspectors and 4 councilors. (ii) The Permanent Secretary and its 5 Directorates: Planning, Financing & Personal, Rural Infrastructure (previously "Génie Rural"), Agricultural Supplies, Extension Services.
The Microhydraulique Operation used to report directly to the Presidency. Since 1984, it is attached to the Directorate of Infrastructure.

APPENDIX D

MADAGASCAR - IIMI Mission - November 1985
Discussion with : Mr. Marc Antoine MARTIN, IGREF Chargé de Mission, CAISSE CENTRALE DE COOPERATION ECONOMIQUE, Paris. (Lecture given during the CEFIGRE training session in Antsirabe).
Participants : C. Abernethy, A. Waldstein, D. Groenfeldt, D. Berthery.
Comments by : D. Berthery
Date : 11/11/1985

THE C.C.C.E. POINT OF VIEW ABOUT CURRENT P.P.I. REHABILITATION.

A. The context of the project:

- Food self-sufficiency is a priority in the Highlands as it is the most populated area in Madagascar. At present, rice imports are 200,000 tons per year, while population growing rate is 3% .
- The potential is important; the State intervened on some 140 P.P.I. (170,000 ha) family managed system excluded.
- But infrastructure has largely deteriorated as the State has not been able to manage them.
- The logic of heavy investments applies for rehabilitation of the larger schemes which is not applicable for P.P.I.

Since the vocation of large schemes is cash crops for export or supply for the urban centers they require important financial resources; the Small Schemes could meet the demand of the local rural population.

B. The main objectives of the project.

Objectives are to respond to local demand, and finally to increase farmers income. They should in particular:

- Stop the deterioration of infrastructure.
- Improve the water distribution.
- Secure the perenniality of the systems through more user responsibility.
- Cut down rice imports by half with rehabilitation of 100 schemes; the rest is being covered by the large schemes.

C. Definition of the project.

MPARA has tried to develop a methodology to reach the project objectives. A pragmatic approach is followed. It consists of experiments in 5 different locations with a view to find out appropriate solutions in various cases. No generalization is expected yet. The basic concepts considered in selecting and designing projects for rehabilitation are:

- The best cost/benefit ratio should be considered for selecting projects.

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- Water availability is a necessary condition but not sufficient.
- New management structures have to be set up through a step by step process, including legal aspects.
- Provision for phasing the implementation of the rehabilitation program should be made at the design stage; and it is not intended to make major changes in the design concept of the project.
- Effort for master planning for development at the sub-region level should be improved. (concept of cluster of rehabilitated systems).
- Utilization of existing organizational structures should be preferred and creation of new ones avoided.
- Scheme management basis: self-government, corporate legal status and financial autonomy.

In terms of financial resources, 43% is allocated to physical works, and 57% to organization, training, extension and supplies.

D. Economical analysis.

Despite several difficulties assessing the appropriate data which are necessary for carrying out a proper cost/benefit study, the analysis was performed by comparing three possible levels of rehabilitation:

1. Minimal target level: First season irrigation with unchanged farming practices.
2. Rehabilitation of the basic infrastructure, including some improvement of the irrigation system, regulators, etc.
   Target: Securing irrigation possibilities for first and second crop areas but without changing the farming practices (no yield increase).
3. Physical rehabilitation and improved farming practices, (fertilizers, varieties, etc.).
   Target: increased yield from 1.6 to 2.8, 3, or even 4 tons/ha.

The analysis has shown that only levels 2 and 3 would be viable with an internal rate of return closed to 12% However, if such a study might better formulate constraints/objectives and compare solutions. The keys was on sustainability of the schemes and on the ability to collect user fees for maintenance.

<u>Compared to the previous situation, dominated by close State supervision, decentralization has been the answer. It aims at contracting responsibilities with the users against a commitment to maintain.</u>

Therefore, CCCE imposes its following end of project conditions ("conditions suspensives"): (i) Before the end of the rehabilitation work, the official management structure either user association, syndicate, cooperative, management committee should be set up and its legal status in force. (ii) Government will support initial capital cost, while all recurrent cost should be met by the farmers. Furthermore, the payment of water-charges should be requested in advance, but this question!... is still under discussion.

APPENDIX D

MADAGASCAR - IIMI Mission - November 1985
Discussion with : Mr. Harisson E. RANDRIAMANANA, Head, Provincial Service, DIR/MPARA, BP 242, Nanisana - Antananarivo.
Participants : C. Abernethy, A. Waldstein, D. Groenfeldt, D. Berthery.
Comments by : D. Berthery
Date : 16/11/1985

1. Field visit to AMBOHIBARY irrigation system (P.P.I.) in Antsirabe area.

The system visited is part of the SOAVINA P.P.I. which is one of the five pilot rehabilitation projects presently going on, as a first phase of the World Bank/CCCE/EEC financed program. AMBOHIBARY represents as far as the management of the scheme is concerned, a tentative model of organization that MPARA is trying to promote.

However, the scheme is not representative of the situation prevailing in other P.P.I. in the country which appear generally much more run down and generally do not have existing farmer-organization contributing to maintenance the way they do in the present system.

The scheme is 3,000 ha. Rehabilitation will include, rebuilding the dam intake, canal enlargement, straightening and digging river bed to improve flow conditions and to prevent flooding of irrigated land.

The present management set up comprises: 1 Chief of the system and 7 laborers. They were 12 when they were supposed to do all maintenance work with some equipment before MPARA got reorganized. The present "Chef de périmètre" is known as one of the best project managers of DIR/MPARA, having both skill and authority over farmers. Each year, when canal have to be cleared before the release of water can start, the Chief call on the representatives of farmers in the area concerned and asks for a given number of " Heads" at a certain time and for a particular section. He and his men record the farmers that show up, allocate the work to be done by them and supervise the execution. Those who do not come are penalized. They have either to hire somebody else to do the job (one man/day labor is FMG 350) or to pay FMG 400 per missing day; if not, they will not obtain the approval required for selling their paddy production to the collecting organization.

The selling price on site is presently FMG 100/kg on average. A minimum buying price of FMG 80/kg is fixed by the government; there is now no ceiling, and the on site selling prices sometimes rises to FMG 200/kg. Average yields are now around 2.7 tons/ha instead of 2.0 tons/ha when "Génie Rural"(G.R.) was fully in charge of maintenance. But in the past 3.0 tons/ha yield used to be recorded. Hopes are to recover the yield level reached in the old times with the rehabilitation project and agricultural inputs.

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Comments:

a. In this scheme, the institutional change in management took place smoothly because the farmer organization actually took over from "génie rural" in maintaining the canals when it was reorganized. In most of the P.P.I., the change has actually resulted in a decline; "Génie Rural" did not have the means to do much, but after its phasing out, nothing at all is done. The project will formalize the existing farmer-organization by appropriate laws and new regulations in accordance with the principle which prevails for the creation of the decentralized local governments. The objective is to have only the "Chef de périmètre" paid by government. Other staff, casual laborers as well as material or hiring of equipment, should be supported by farmer contributions and water charges.

b. It has to be noted, that the rehabilitation project does not affect land tenure at all. For traditional reasons, the land market is very limited and land sales might be less than 10% of the total surface area. Therefore the price of the land is high (FMG 100,000/ha), but land would have to be registered first and title to be issued before any selling and this would add some FMG 50,000/ha to the cost. During the colonial period, the Ambohibary scheme was a single farm of 2,000 ha operated with mechanization and local laborers. After Independence, farmers settled freely on it in a disorganized way which led to very irregular plots. Since then, population migration to the scheme expanded it to 3,000 ha. The creation of the P.P.I. scheme by "Génie Rural" was the first attempt to organize water distribution with canals in that chaotic settlement. The present Rehabilitation aims now to rationalize the system. Its design is going to be double checked to accommodate the existing land situation.

2. Field visit to BETAFO traditional irrigation system (microhydraulique).

The G.R. through the "opération microhydraulique" intervened in 1978 to upgrade an existing intake structure initially built by farmers. It also came back in 1984 to reline the dam. For a long time, the intake has supplied an old system which irrigates some 50 ha of land. Intervention of the G.R. originated from the request of the local community (Fokonolona). Then, the following took place: (i) a survey and technical investigations where made by the G.R. and a project outline was drafted covering the total area that can be supplied from the dam. (ii) the outline was submitted for agreement to the local government and people were told to provide manpower and materials for the construction (sand, gravel...). (iii) execution plans for improvement of the main canal and rebuilding of the dam were finalized. (iv) G.R. provided the cement (from EEC fund), supervised the construction and left. However, G.R. did not intervene on the management of the scheme which remains within the competence of the local community. Only some recommendations were made respecting the operation of the new dam; they did not appear to be followed at the time of the visit.

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MADAGASCAR - IIMI Mission - November 1985
Discussion with : Mr. Jean Marie RALAIZANADRAOTO, Deputy Director O.M.H.L. (Opé. Microhydraulique) BP 685, Nanisana - Antananarivo.
Participants : C. Abernethy, A. Waldstein, D. Groenfeldt, D. Berthery.
Comments by : D. Berthery
Date : 14/11/1985

The department so called "Opération Microhydraulique" comprises 184 persons, including 112 technical officers. Mr J.M. Ralaizanadraoto, has been assigned to his position since 1981. The department is under the technical supervision of the MPARA's Directorate of Infrastructure. The Operation took over in 1978 from G.O.P.R. (Groupement Opération Rizicole) which was abandoned because of the difficulties to manage it.

Intervention of O.M.H.L. It intervenes and takes up work at the request of farmers communities. Size of irrigation systems concerned is between 20 ha to 500 ha maximum. Work done is mainly upgrading of existing structures, dam intake; financing is provided by foreign aids (EDF), government and farmers.

Intervention mode implies following phases: (i) Preliminary field investigation, (ii) Active participation of farmers, (iii) Irrigable land survey, (iv) Planning & Programming, (v) Design, (vi) Election of a local representative of the farmers to be Chairman of the dam, (vii) Contracting with the Chairman. The contract specifies the conditions by which the farmers will provide manpower (skill laborers from the village are hired), material (20% should be on site before construction starts) (viii) Construction supervision, (ix) Advises for operation of the dam.

Report of activities. O.M.H.L.'s activities are restricted to the two Provinces of Antananarivo and Fianarantsoa; each divided in five sections for the Operation. This because OMHL techniques are limited to water diversion from rivers essentially without drainage.

From 1978 up to 1985, FMG 5.0 millions (US$) have been spent on infrastructure works including also culvert, track, store... These concerned 62,000 ha under command with 48,000 ha actually irrigated over 1,210 projects. Average cost of projects has been estimated about FMG/ha 150,000 all included; but E.E.C. limits its disbursements from the EDF grant to FMG/ha 45,000 only.

Current problems. EEC is presently supporting a comprehensive evaluation of the Operation. Since it starts, an average yield increase from 2.0 to 2.5 tons/ha has been observed overall. However, deficiencies have been pointed out in three mains areas:

a. Lack of training of the users about rational use of water,
b. Maintenance problems,
c. Technical deficiencies in the design.

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So far, the O.M.H.L.'s staff is trained by either internal memo, on the job, by technical assistants, or by the annual seminaire of the regional Directorate. F.A.O. has organized in 1985 a training session and some pilot project site near Antananarivo. To be noted, the design manual[1] produced for training purposes with the technical assistance of R.F.A. and financed under EDF Grant Vth. However, time constraint and lack of D.I.R.'s resource does not allow sufficient technical studies. For instance, dam embankment protection are design from guesstimate because of the lack of hydrological data. Similarly, project and irrigable areas, estimated from 1/100,000 map are therefore very inaccurate.

Another debated question relates to water-charge in the Microhydraulique projects to meet the maintenance cost. An attempt to mobilize resource by collecting farmers contribution has been done in ARIVOUNIMAN section.

Perspectives. Despite the large number of projects implemented, demand from the farmers communities is still important (more than 200 pending requests in Antsirabe area) and depends chiefly from the motivation of the local leaders. Present criteria for project selection are:

a. Age of the demand,
b. Results from the preliminary investigation.
c. Average cost which should not overpass the limits fixed by EEC,
d. Geographical areas not yet covered or where demands have not been well satisfied.

For instance, the TSIVORY area has been dropped and replaced by MORAMANGE on the EEC program as it was to much expensive. However, OMHL still continue to intervene in that area.

Extension areas have been identified and six zones already studied: the North-West of Antananarivo area, Ichtouche, Betuk.... But difficulties are expected with the farmer organizations in these new zones which are not as active as they are in Antsirabe area for taking up maintenance collectively.

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1. Memento Microhydraulique, AGRAR- UND HYDROTECHNIK GMBH, Janvier 1985.

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MADAGASCAR - IIMI Mission - November 1985
Discussion with : Mr.Samimiadana Daniel RAMAROKOTO, Secrétaire Général du MPARA, BP 301 - Antananarivo.
Participants : C. Abernethy, A. Waldstein, D. Groenfeldt, D. Berthery.
Comments by : D. Berthery
Date : 14/11/1985

Presentation of IIMI and introduction of the purpose of the mission had to be made prior to the discussion to prevent any confusion with consultant visits. However, the mission had to explain what kind of contribution IIMI as an International Institution might offer in term of collaborative research, professional development, and information exchanges.

Government priorities mentioned by the Permanent Secretary:

1. Management of the P.P.I.
2. Setting up the local Management Committees.
3. Professional development and training of project managers, system users and farmers.

A central problem:

"How to make people understand that they have to maintain."
P.S. suggest that IIMI could help by looking at the conditions and means necessary to do that training.

Institutions and persons suggested for contact by the IIMI mission:

a. Operation Microhydraulique Directorate (attention is drawn upon its participation to village organizations)
b. Director of Rural Infrastructure and its section Heads.
c. FOFIFA. Director General, Mr Charles RAZAFINDSAKOTO.
& Ministry of Research, Mme Robertine RAHARINOSI, Director programming. and Mr Germain RAKOUTOUNIRAINY.

Suggested follow up:

- Further discussion with the Director of DIR and if possible, IIMI could invite him to some relevant seminaire or workshop.

- Correspondences exchange between IIMI and MPARA.

Comment: Permanent Secretary said that english language and not only french should be considered in matters related to Information exchange and Professional development in Madagascar.

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MADAGASCAR - IIMI Mission - November 1985
Discussion with : Mr. Benjamin RAVALOMANGA, Directeur de l'Infrastructure. BP 1061, Nanisana, Antananarivo.
Participants : C. Abernethy, A. Waldstein, D. Groenfeldt, D. Berthery.
Comments by : D. Berthery
Date : 14/11/1985

The discussion followed an interview with the Permanent Secretary by the mission on the same day. The Director emphasize on the priority attached by government to the rehabilitation of P.P.I. and the transfer of management responsibilities from state to users which should result. This will be materialized by handing over a guidebook (in preparation) to the newly established "Management Committees".

The three main divisions of the Directorate (DIR) are:

a. "Aménagement Rural" division, (dealing with equipment annexed to the irrigation scheme: store, water supply...)
b. Irrigation division, (responsible for design of new projects)
c. Irrigation management division (see below).

The Microhydraulique is now included to DIR but it seems that OMHL is still having a relative independence.

DIR is dealing with irrigation schemes whose size is between 300 to 2,000 ha; local communities are managing systems smaller than 300 ha. For the relevant division, irrigation management is restricted essentially to the operation of gates, repair of breached canal, maintenance of dams.

The Division comprises staff at various geographical level:

a. At headquarters:
   1 engineer "Génie Rural",
   1 deputy engineer,
   5 assistant technical officers.
b. At the Provincial level (SPIR):
   1 engineer "Equipement Rural",
   1 deputy engineer,
   1 technical officer (general certif. level).
c. At the G.R.C.O. level (previously s/prefecture):
   1 technical officer & 2 technicians,
d. At the scheme level (location):
   1 technical officer,

The P.P.I. Rehabilitation project will strengthen the capacity of both the Divisions of Irrigation & Irrigation management by one technical assistant expatriated each.

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Current plan:

Besides on going Rehabilitation Project of selected P.P.I. MPARA in planning the setting up of a steering committee between the three technical Directorates: Infrastructure, Extension services and Supply of inputs, to coordinate their action in dealing with the P.P.I. A pilot system have been chosen for this experiment to begin in 1986: ANKILIZANO (500 ha) near MAHABO in the Western area. Other systems to be involved are: Katsaoka and Ambararatabe in the Antananarivo province, Iazafo and Alakamsy in the Fianaransoa province, Lanana, Tsiannaloka and Ampara where regional offices of the three directorates are closed together.

The joined action will include some repairs of systems by DIR, supply of inputs, extension... Water charges will not be levied at the initial phase but same objectives are pursued:

(i) Increased production in the long run as a result of the better environment provided to producers.

(ii) Reduction of the State financial contribution to the operation and maintenance.

Research issues suggested and training needs:

a. Accounting management training (cf. Somalac)
b. Training of the users, on both technical and financial aspects.
c. Training of local government staff in charge of systems.
d. Training technical staff about the use of hydrological data.
e. Training water technical staff to other disciplines.

f. Research on the appropriate formula for concerted action between the different MPARA'Directorates.

Relevant Institutions mentioned:

a. "Service de la réforme agraire et de la Coopérativisation" (This office is directly attached to the Permanent Secretary.)

b. FOFIFA.

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MADAGASCAR - IIMI Mission - November 1985
Discussion with : Mr. Jean RAKOTONIRAINY, Chef du Service de Gestion des réseaux hydro-agricoles. DIR/MPARA, BP 1061, Nanisana, Antananarivo.
Participants : C. Abernethy, A. Waldstein, D. Groenfeldt, D. Berthery.
Comments by : D. Berthery
Date : 11/11/1985

The rehabilitation process engaged at SOAVINA P.P.I.

SOANIVA irrigation scheme is 1,200 ha and has 900 farmers in the Antsirabe area. The farmer organization has been created with a president, secretary, treasurer... It includes 25 farmers representatives of the hydraulic sectors. Altogether they are 30. The legal status of the farmer organization ("Association d'usagers") is well in line with the decentralized community system which prevail in Madagascar. Standardized agreement between Government and Farmer organization have been adjusted to the local conditions, that defines the farmers' obligations.

An agreement between the organization and the individuals farmers has still to be studied by the O.D.R. ("Organisation Rizicole des Hauts Plateaux) the IFAD financed project in the region.

The physical rehabilitation works are on the verge to start. The training of the responsible personnel is going on.

Plans are made to record the contribution of individual farmers to collective activities, participation in labor to maintenance, production, yield, etc. A standard format in use at the SOMALAC irrigation scheme might be adapted.

Advantages expected from the project:

(i) For the Government, to reduce the State contribution which amount in 1985 at FMG 5,000/ha/year (795 millions for the p.p.i. and 1,084 millions for the large schemes). (ii) For the farmers, first to get the system rehabilitated, second to allow food self-sufficiency for the family by mastering the system of production of the farm and third to get an outcome to finance social charges and funeral expenditures.

Suggested agro-economical research issues - CROP DIVERSIFICATION.

In the Highlands, there is a current problem rooted with the farmer behavior: How to introduce winter counter season crop? (potato after soil wiping up, then bean and wheat for instance) or How to introduce fodder crop which is short between August and December? (cf the FIFAMANOR Norwegian project).

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MADAGASCAR - IIMI Mission - November 1985
Discussion with : Professeur Gilbert RAVELOJOANA, Président de l'ETABLISSEMENT D'ENSEIGNEMENT SUPERIEUR DES SCIENCES AGRONOMIQUES.
Participants : A. Waldstein, D. Groenfeldt,
Comments by : A. Waldstein
Date : 16/11/1985

Prof. Ravelojoana is an agronomist/rice entomologist. His institution, Agro, is in the University Campus. It has 5 departments, agro-industry, agricultural economics, "eaux et forêt", "aménagement du territoire", agriculture, and livestock. The institution is 22 years old.

The institution insists that teachers carry out research and maintain high professional standing. The institution has no research budget of its own, however, and most of the teachers do research under other institutional arrangements. His laboratory, for example, is in FOFIFA. A lot of the people in Agro work for FOFIFA.

In order to get a research program going first talk with "Ministère de la Recherche Scientifique, de la technologie et du Développement". FOFIFA is under this ministry. The ministry will assign research responsibility to one of its institutions as appropriate.

Agro has no tenured faculty in irrigation. It relies on adjunct faculty from FOFIFA or MPARA to teach irrigation courses.

Agro has had experience putting on training seminars. It put on a part of the seminaire sur la Formation Agricole at the Hilton in July, 1985 for the "Ministère de la Production Animale et des Eaux et Forêts". (We got an FAO report on this activity; FAO Financed it) very interested in Fellowship Aid to students for irrigation research.

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MADAGASCAR - IIMI Mission - November 1985
Discussion with : Mr Pascal RAKOTONDAVE, Chef de service d'encadrement agricole, DIRECTION DE LA VULGARISATION, MPARA.
Participants : A. Waldstein, D. Groenfeldt, C. Abernethy
Comments by : A. Waldstein
Date : 16/11/1985

These are three services in this directorate. In addition to "Encadrement Agricole" there is "Protection des Végétaux" and "Liaison avee la Recherche".

This service is responsible for collecting field data to evaluate the rehabilitation potential for PPIs. They also do extension work in PPIs. They do technical extension, management of the systems and supply inputs.

There are several levels of extension workers. Overall, of all types there are 1000. They tend to be older and not very mobile, energetic or up to date.

In Antananarivo province, one vulgarisateur oversees 186 Lect. He makes his visits once every two weeks.

Part of the problem with the extension service is they have not recruited any new people since 1980. In fact MPARA has had to let 3000 people go in the last five years.

IBRD has financed an evaluation of the extension program and the extension service. By June, 1986 MPARA will have a plan to revitalize the service. They will have to develop a wholly new extension training program to adapt to the new realities of the rehabilitated PPIs.

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MADAGASCAR - IIMI Mission - November 1985
Discussion with : Mr Sam REA, U.S.A.I.D., Representative, Antananarivo
Participants : A. Waldstein, D. Groenfeldt,
Comments by : A. Waldstein
Date : 15/11/1985

AID has US$ 5 million for the first phase of the Agricultural Rehabilitation and Support Project. The first phase will include US$ 5 million for technical assistance and training and US$ 4.5 million to import needed equipment, supplies, goods, commodities, etc.

One objective of the technical assistance under the first phase is to plan out later phases. A team of AID people will be coming from Nairobi in December to work on this.

AID wants to bring in IARCs to study development questions, build up the data base and analyze the data.

IRRI is already working with FOFIFA on research on rice and rice farming systems. Jim Hoopper is the IRRI person.

FOFIFA is under the "Ministère de la Recherche Scientifique, de la technologie et du Développment". Mme Robertine RAHARINOSY (247-69) is responsible for research programs in FOFIFA. She works with all the donors to develop research programs.

APPENDIX E

Summary of discussions and field visits in Zambia.

APPENDIX E

ZAMBIA - IIMI mission - November 1985
Discussion with : Mr. J V VELDKAMP, Soil Scientist
MOUNT MAKULU AGRICULTURAL RESEARCH STATION.
Participants : C L Abernethy, D Berthery, D Groenfeldt, A S Waldstein
Comments by : C L Abernethy
Date of meeting : 18 November 1985

Mr Veldkamp who is from the Netherlands, gave the team a general overview of soils in Zambia, and handed over the paper "Agro-climatic zones in Zambia" of which he is joint author.

He described the major zones and their irrigation interest from the soil and climate viewpoint.

In the NE soils are rather poor, and acid; rainfall relatively good.

In the north generally there is little irrigation in the high -rainfall zone, except at Mpongwe, where wheat irrigation is supported by EDF and other donors. Soils are permeable. Break-even wheat yield is around 4.5 t/ha.

Irrigation potential is best in the centre and east of the country. In the west soils are again sandy.

The major existing irrigation is the Nakambala sugar estate in the south.

There is little African tradition of irrigation in the country, although the Lozi people in the west (along the Zambesi) practised some flood irrigation methods.

Commercial irrigation is spreading, including some US private investment in centre-pivot systems near Chirundu; but it is not yet much in extent.

The main focus of interest, for substantial irrigation potential, has for some years been the Kafue Flats west of Lusaka, an extensive area of vertisols. A North Korean- aided project just starting aims to irrigate rice on 1000 ha.

There are the beginnings of competition for available water, e.g. between power and irrigation in the Kafue, between commercial and peasant farmers in other places.

Dambos are widespread in most parts of the country, but are often acid.

Groundwater mapping is in progress, under the National Council for Scientific Research.

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ZAMBIA - IIMI mission - November 1985
Discussion with : Mr. José OLIVARES, World Bank and
Mr. R WIERSINGA, Euroconsult.
Participants : C L Abernethy, D Berthery, D Groenfeldt, A S Waldstein
Comments by : C L Abernethy
Date of meeting : 18 November 1985

Mr Olivares and Mr Wiersinga outlined the project for which they were visiting Lusaka. This is a project to assess (in several countries) national options in the development of irrigation, using rapid appraisal techniques, based on existing information only.

The aim is to rank options and priorities within the country.

The project arose from recommendations in the first Brandt report.

In the first phase of the project, rapid appraisals have been done in Mali, Senegal,Peru, Morocco, and Thailand, and reports on these have already been prepared.

In this second phase,now beginning , and funded by the Netherlands Government,Zambia, Zimbabwe, Botswana, Kenya, and Orissa(India) will be the subjects. Their present visit is introductory: a small team from Euroconsult will follow to implement the work.

They expressed themselves satisfied with the rapid appraisal methodology, except in a country such as Thailand where irrigation types and scales were too diverse and data dubious.

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ZAMBIA - IIMI mission - November 1985
Discussion with : Mr S B SIAKANTU, Officer in Charge
NATIONAL IRRIGATION RESEARCH STATION, P/B 53, MAZABUKA.
Participants : C L Abernethy, D Berthery, D Groenfeldt, A S Waldstein
Comments by : C L Abernethy
Date of meeting : 19 November 1985

Mr Siakantu handed over a paper on the history of the NIRS, and gave a short account of it. It was founded in 1955 as a pilot for polder development on the Kafue Flats; initially it was private, and it was transferred to government later. In 1972 the government sought UNDP assistance, and a German team was there in support from 1972-78.

It became the NIRS in 1978. At that stage the main problem was lack of professional training .

In 1980 an FAD mission visited, and since then FAO has assisted NIRS in establishing three pilot projects for small-scale settler irrigation. These are on the Lake Kariba shore at Chiyabi (Gwembe Valley), on a dambo near Serenje (Central Province) and on a river diversion near Mansa (Luapula Province).

He spoke of the potential significance of dambo (ill-drained valley bottom) land. There is estimated to be 1.3 M ha. FAO is sponsoring a workshop on their development, in December. Dambos are "sour" (acid : pH down to 4.4) in the north-east, "sweet" (pH neutral) in the south.

NIRS has had funding problems, not only due to internal shortages, but also intermittent inputs of external aid. At present it has 2 Zambian engineers, 2 FAO people (one soil scientist, one civil engineer), and a Japanese volunteer.

It does water research on irrigation methods, optimum water applications, land reclamation, the hydraulic regimes of soils.Water is pumped from the Kafue. It has 100 ha available for research, of which 40 ha now in use. Facilities include sprinklers, basin and border strip layouts. It also does agronomic adaptation work, agro-technical trials, and socio-economic and market investigations.

Total staff number 180, of whom 12 are professionals. This year the capital budget is K 21000 (K6 = US $1); the recurrent budget K 15,000, and staff budget K21,000 (presumably for staff additional to the 180).

Mr Siakantu explained the Chiyabi (Gwembe Valley) project in some detail . It is a 10 ha pilot area on the Kariba lakeshore, using basin irrigation with pumped water from the lake. Rice is the wet season crop, vegetables/maize/beans in the dry season. There are 30 farmers, having 0.3 ha each, and organised in groups of 5 for various shared activities.

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All form a marketing co-operative, and there is a steering committee of bureaucrats, politicians and the district governor. The Italian Government is giving financial assistance.

There has been a question of how much assistance to give to farmers. They receive some help in year 1, but in the second season must meet all their costs. Credit is obtainable through the co-operative union.

New settlers have existing rainfed land, in order 0.25 - 10 ha. Other similar lakeshore projects exist, areas up to 120 ha. Some are run by the Gossner Mission (German). The major practical problem has been recession of Lake Kariba, by over 2 km., which made pumping costs very heavy.

At the Mansa pilot project in Luapula Province (20 ha), there is an Italian agronomist and a Netherlands volunteer. They will probably also relate to the Serenje pilot scheme.

NIRS is involved in rice variety trials for the North Korean project in the Kafue Flats, where 50 ha is now laid out as a pilot for a 1000 ha state farm.

Mr Siakantu specified particular research needs at NIRS as:

hydrological data.
crop/water relations.

Speaking of the overall irrigation scene in Zambia, he said 17000 ha are irrigated, of which 16000 ha is commercial farming, mainly at Nakambala Sugar Estate. 2000 ha in Mazabuka District is commercially irrigated, including centre-pivots.

The main potential area is Kafue Flats, where there is 132,000 ha irrigable land. But there is competion over water rights there, between ZESCO the electricity parastatal, Lusaka water-supply, and those who want to irrigate.

APPENDIX E

ZAMBIA - IIMI mission - November 1985
Discussion with : Mr. TATE, Managing Director, ZAMBIA SUGAR COMPANY.
Participants : C L Abernethy, D Berthery, D Groenfeldt, A S Waldstein
Comments by : C L Abernethy
Date of meeting : 19 November 1985

Mr Tate explained the operations of the Zambia Sugar Co, It is the only producer of sugar in Zambia and is a subsidiary of Tate and Lyle of the United Kingdom. They have 9000 ha at Nakambala, near Mazabuka, plus 2 commercial outgrowers with 400 ha. The forthcoming Kaleya extension, based on involving small-holder out-growers, will add 1900 ha, which will be under supervisory management by the Commonwealth Development Corporation Outgrower plots in Kaleya will be 4 ha each.

The water system involves direct pumping from the Kafue River to a contour canal, thence further lifts by smaller pump stations to night-storage dams. Maximum lift is about 135 m (450 ft.) Drainage returns to the Kafue.

Nakambala uses furrow irrigation mainly, and some sprinklers. Its yields average 117 t/ha of cane, at 12% sugar content. It is commercially successful, and is exporting sugar.

Beans, soya and winter wheat are also grown on the estate.

Mr. Tate thought that factors constraining the general development of irrigation in Zambia included the sparseness of the population (leading to weak markets), the problem of power resources for pumping (plentiful resources, but not necessarily where required in rural places), and price control for some important crops (although policy on the latter has been moving in the direction of greater incentives and reduced state intervention). He also mentioned the problems of water-related diseases, especially Schistosomiasis and malaria, in the more rainy parts (Northern and Luapula Provinces).

APPENDIX E

ZAMBIA - IIMI mission - November 1985
Discussion with : Mr. F MBEWE, Acting Permanent Secretary,
MINISTRY OF AGRICULTURE AND WATER DEVELOPMENT.
Participants : C L Abernethy, D Berthery, D Groenfeldt, A S Waldstein
Comments by : C L Abernethy
Date of meeting : 19 November 1985

Mr Mbewe outlined the general policy background to irrigation development. He emphasised that the significance of irrigation development and the interest in it had been enhanced by the experience of three years of below-average rainfall.

On the other hand he also make it clear that policy as yet was in a formative stage and that no definite decisions had been taken. An inventory of resources was a necessary preliminary step. He recommended the mission to see the draft irrigation plan being prepared by Dr.Osafo (interview ZAM 7).

He said that the Fourth National Plan, which was in preparation now and should run for 5 years from about 1987, may contain some irrigation projects, but that was not yet certain.

APPENDIX E

ZAMBIA - IIMI mission - November 1985
Discussion with : Professor A Chilivumbo, Acting Director, Rural Development Studies Bureau, UNIVERSITY OF ZAMBIA.

Participants : C L Abernethy, D Berthery, D Groenfeldt, A S Waldstein
Comments by : C L Abernethy
Date of meeting : 20 November 1985

Professor Chilivumbo described the institute's interests. It shares premises with the older Institute of African Studies (formerly Rhodes-Livingstone Institute) which made notable early studies of anthropological questions. The Rural Development Studies Bureau has certain common interests with then, but concentrates upon social research in agricultural development.

It has about eight academic staff. It conducts research studies for client departments in government. The Ministry of Agriculture and Water Development is naturally the main source of funds for the Bureau's commissioned research.

The Bureau has not hitherto conducted any research on irrigated agriculture, but would feel interested to do so if someone requested it and supported the work financially.

Professor Chilivumbo gave the mission various papers and the Bureau's annual report , from which it is apparent that the Bureau's range of activity in remarkably wide for such a small staff team.

APPENDIX E

ZAMBIA - IIMI mission - November 1985
Discussion with : Dr K OSAFO, Irrigation Economist,
MINISTRY OF AGRICULTURE AND WATER DEVELOPMENT.
Participants : C L Abernethy, D Berthery, D Groenfeldt, A S Waldstein
Comments by : C L Abernethy
Date of meeting : 20 November 1985

Dr Osafo is from Ghana, and is attached to the Ministry under United Nations sponsorship. He has prepared on Irrigation Development Plan for the country. This is now going through internal discussion but (at the suggestion of the acting Permanent Secretary) the mission was provided with a copy so that we could form an idea of the possible lines of development.

Dr Osafo said that Zambia had potential (suitable soils and water) for 2 M ha of irrigation, but so far the amount was very small, only 16-18,000 ha, of which Nakambala sugar and Mpongwe wheat were the most significant economically. Mpongwe was so far 400 ha but could rise to 5000 ha; for the present it would be limited by power availability for pumping.

Donors are urging irrigation development, because there is now some pressure upon food resources. The government is interested but policy has not yet crystallised. The Planning Division (of MAWD) has been looking at the need for a resource inventory, and preparing terms of reference for the drafting (presumably by foreign consultants) of a national water master-plan. The need for this stems especially from the power/irrigation/water-supply conflicts over use of Kafue water.

There is a dearth of professional staff. A programme of trainning is envisaged at the National Resource College.

Because of the professional manpower problem small-scale irrigation is favoured. But the Gwembe Valley experiences, where irrigation costs have been up to K 60,000 /ha (US $ 10,000), seem to show that it will be expensive. Gwembe has also suffered from the lake recession problem, meaning high fuel cost and difficulties of pump maintenance.

Apart from the small-scale projects like Gwembe, Dr Osafo drew the mission's attention to two areas of major potential, on each of which Energo-proyekt of Yugoslavia has made some pre-feasibility study. These are Lukanga Swamp near Kabwe, which could be drained to augument the Kafue River flow and also to irrigate 150,000 ha nearby; and the Mazabuka-Monze area south of the Kafue, where 200,000 ha was irrigable, though pumping heads up to 950 m were involved.

There is also a plan to accelerate the development of commercial-sector irrigation by a fund that would subsidise loans to commercial farmers for introducing or expanding irrigation.

...

There is a proposal, not yet adopted, to introduce an Irrigation Unit, perhaps in the Department of Water Afrairs. At present irrigated agriculture is the responsibility of the Land Use Branch of the Dept. of Agriculture.

As to other constraints upon the acceleration of irrigation development, Dr Osafo thought it was primarily a question of awaiting a firm political decision in this direction. Water rights were not a significant difficulty, except on the Kafue, and the easing of price controls was stimulating the commercial sector. But state-sponsored irrigation would be slow unless there was a formal administrative set-up devoted to irrigation, and some means of increasing the supply of technical manpower.

He mentioned how the National Irrigation Research Station had suffered from frequent changes of expatriate staff.

As to a possible field of activity for IIMI, Dr Osafo thought it could be helpful in funding research, and in training. He also thought it could make some contribution in the master-plan preparation.

APPENDIX E

ZAMBIA - IIMI mission - November 1985
Discussion with : Mr. Erhard LOHER, EUROPEAN ECONOMIC COMMUNITY.
Participants : C L Abernethy, D Berthery, D Groenfeldt, A S Waldstein
Comments by : C L Abernethy
Date of meeting : 20 November 1985

Mr Loher explained the extent to which the EDF was interested in aiding irrigation in Zambia. They were impressed by the very different levels of success being achieved in the commercial and the state sectors. State irrigation on the patterns used in Gwembe seemed very expensive for comparatively little result, whereas commercial farming in the Lusaka-Kabwe-Ndola belt was already making a good contribution to the economy and could be stimulated to increase this, especially in wheat which Zambia continues to import.

The EC was therefore expecting to finance a scheme for loans to farmers, aiming especially at wheat growers in the north and Copper belt. The primary macro-economic purpose in this is import substitution, since Zambia's greatest economic difficulty is its high importation levels.

Earlier, the EC interested itself is irrigated rice production in the north but withdrew because of the poor economics of the scheme. These were attributable mainly to the low population density and consequent weakness of markets.

APPENDIX E

ZAMBIA - IIMI mission - November 1985
Discussion with : Dr. G HOWARD, Dept. of Biology, UNIVERSITY OF ZAMBIA.
Participants : C L Abernethy, D Berthery, D Groenfeldt, A S Waldstein
Comments by : C L Abernethy
Date of meeting : 20 November 1985

Dr Howard handed over various reports of the Kafue Basin Research Committee in which he is a participant. He discussed the conflict, mentioned also by several others, over apportionment of Kafue waters, saying that in a dry year existing commitments add up to 114% of river flow.

He is currently doing on early environmental-impact study for a proposed dam on the Zambesi below Kariba. The study is more ecological than agricultural, but he is aware of existing water users who may be disrupted.

He recommended the mission meet Dr Moses Banda, a socio-economist with his group, currently studying rural development on the lower Zambesi(However, this was not possible as Dr Banda was suffering from malaria).

APPENDIX E

ZAMBIA - IIMI mission - November 1985
Discussion with : Mr. J MUTELO, Director of Agriculture,
MINISTRY OF AGRICULTURE AND WATER DEVELOPMENT.
Participants : C L Abernethy, D Berthery, D Groenfeldt, A S Waldstein
Comments by : C L Abernethy
Date of meeting : 21 November 1985

Mr Mutelo felt that, so far, the approach to irrigation development had not been systematic or coherent. No one institution addresses irrigation questions. To put the several institutions that deal with irrigation under one umbrella is one of his objectives.

Until recently irrigation was thought of as a side-line. Now the government sees its importance as a way of mitigating the unreliability of rainfall.

Present policy is to encourage small-scale irrigation with minimum use of imported equipment and other supplies.

The manpower problem presents other difficulties. There is a pattern of labour shortages often coinciding with points of high irrigation potential. Resettlement is therefore an important theme of irrigation planning. The government has been designing its settlement policy on the following considerations:

a. people do not ordinarily live close to the rivers;

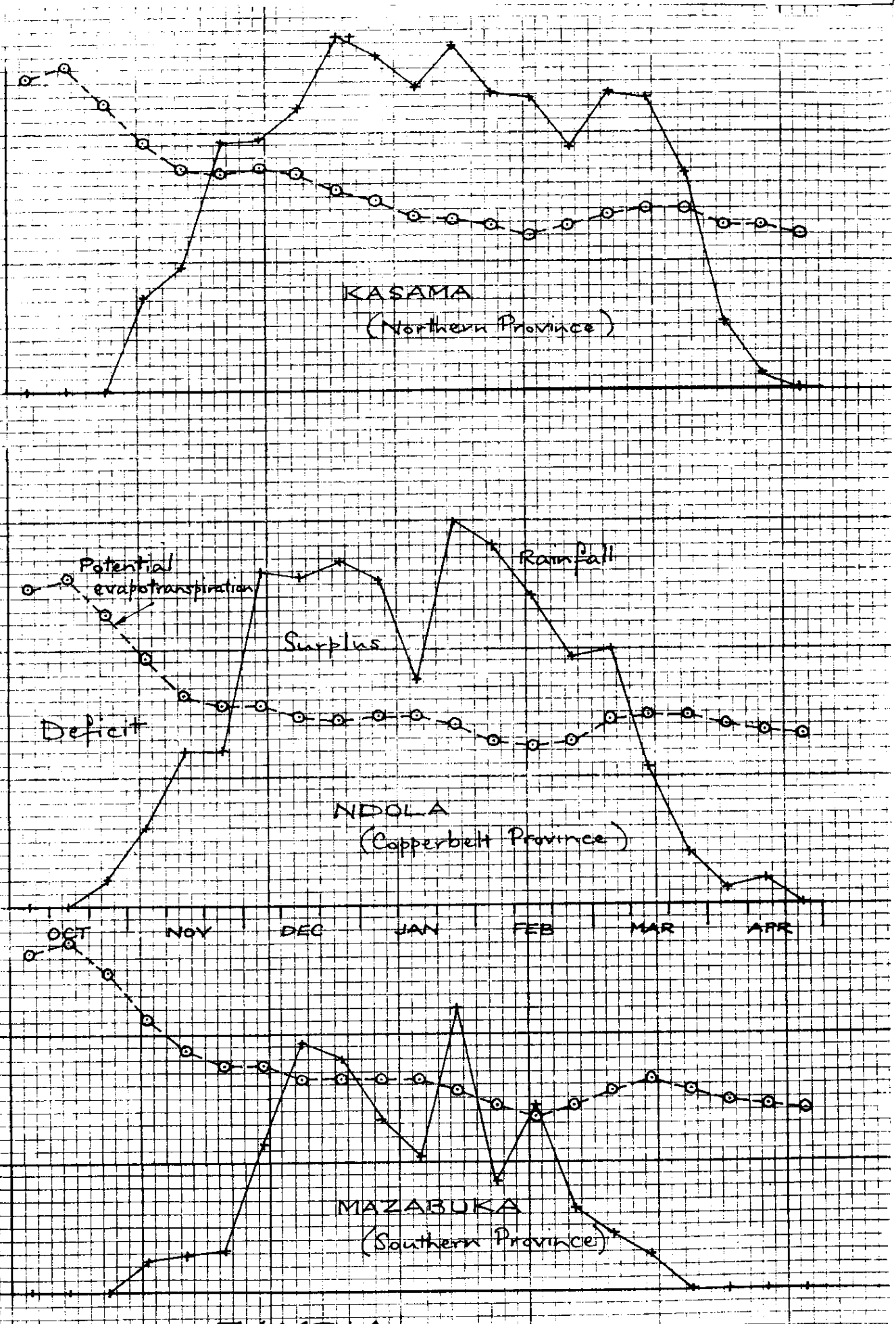
b. people do not have familiarity with irrigation and its techniques, so a strong training element is important, at farmer level;

c. there must be a water-sharing policy effective at farmer level, but a traditional basis for this is (generally) absent;

d there will be a need to alter attitudes to water: to make water a marketable product, to make irrigation a permanent, year-round occupation, to place irrigation on par with dry land cultivation, to institutionalise its uses.

Mr Mutelo (and later Mr George Williamson in his department) described the programme by which the United Kingdom government has assisted commercial irrigation, particularly wheat and sugar. This is essentially a foreign-exchange facility. Farmers withover 20 ha under wheat get access to sterling pounds with which they can import irrigation equipment, spares and other inputs.

Mr Mutelo also said that commercial farmers were indirectly assisted by free access to the extension service and some design help.



ZAMBIA:
RAINFALL AND EVAPOTRANSPIRATION IN THE

APPENDIX F

Summary of discussions and field visits in Zimbabwe

APPENDIX F

ZIMBABWE - IIMI Mission - November 1985
Discussion with : Mr. Mahmud A. BURNEY, WORLD BANK Res. Representative, Harare.
Participants : C. Abernethy, D. Berthery, A. Waldstein, D. Groenfeldt
Comments by : D. Groenfeldt
Date : 22/11/1985

In the past 7 weeks, 11 missions and 43 people have visited the World Bank office, which indicates the intensity of donor activity in this country. Mr Burney gave an overview of the government agencies involved with irrigation development and discussed the Bank's interest in project authorities to oversee new projects such as the expansion of Chisumbanje. The Bank's focus is on the communal sector not for political reasons but because the majority of the rural population lives on communal lands which are of poor quality.

The Bank's lending program in the agricultural sector include (1) a line of credit to the Agricultural Finance Corporation, (2) direct loans to MLRAD and (3) Afforestation projects in communal areas. With 60% of the population living on communal lands and a 4% population increase in these areas, something must be done.

APPENDIX F

ZIMBABWE - IIMI Mission - November 1985
Discussion with : Mr. T.P.Z MPOFU, Acting Director,
Mr. J.B. MAGUIRE, Asst. Director,
Mr. Sam KAVALO, Chief Inspector, Lands Department of Natural Resources,
MINISTRY OF NATIONAL RESOURCES AND TOURISM
Participants : A. Waldstein, D. Groenfeldt
Comments by : D. Groenfeldt
Date : 22/11/1985

There is a real need for hydrological studies that look at environmental effects on water resources. District administrations have a role in managing land and water resources through the District Development Fund (DDF) which provides funds for constructing small dams, though not necessarily for irrigation purposes. The only irrigation project that the DNR is involved in currently is a proposal for eight pilot projects (one in each province) to replace irrigated agriculture along stream banks (where it is not allowed according to the conservation laws) with communal gardens >30m away from the stream bank.

APPENDIX F

ZIMBABWE - IIMI Mission - November 1985
Field Trip to : A flei near MARONDERA (East of Harare).
Discussion with : Dr. Alan WINDRAM, Associate Professor, UNIVERSITY OF ZIMBABWE, and Patricia HOTCHKISS and Robert LAMBERT, LOUGHBOGOUGH UNIVERSITY (England).
Participants : A. Abernethy, D. Berthery, A. Waldstein, D. Groenfeldt
Comments by : D. Groenfeldt
Date : 23/11/1985

Dr. Windram is the driving force behind the "Dambo Project" which is a study of the agricultural potential of a flei (=Dambo) near Marondera. Ms. Hotchkiss and Mr. Lambert are researchers on the project. Dr. Windram told us that there are probably several million hectares of flei land in Zimbabwe, of which perhaps 30-40,000 ha are being used (illegally and hence not recorded) for agriculture. The Dambo Project is trying to demonstrate that certain types of agricultural activity can be carried out on fleis without threatening their soils or causing erosion. The dambo being studied is a small drainage which forms a small intermittant stream feeding into a larger stream. The two arms of this "Y" are each dambos. The projects has built weirs across both arms to measure the water flow as part of a water balance study. The soils of the dambo are peat-like and hold water; some dambos are noticeably marshy, but this particular dambo was not. The water table, however, was just a few feet below the surface. Several holes had been dug (by farmers) to extract water by bucket. The major form of "irrigation" was through subsurface water; maize and several types of vegetables were growing well simply by tapping into the groundwater. Mr. Lambert demonstrated a "rope and washer" hand pump he had designed to lift water from a shallow (ca. 1 m) hole to the surface. With a 2" pipe he was able to generate ca. 1 lt/sec.

APPENDIX F

ZIMBABWE - IIMI Mission - November 1985
Discussion with : Prof. Malcolm BLACKIE, Dean, College of Agriculture, UNIVERSITY OF ZIMBABWE.
Participants : C. Abernethy, D. Berthery, A. Waldstein, D. Groenfeldt
Comments by : D. Groenfeldt
Date : 23/11/1985

Prof. Blackie gave the group an overview of some of the individuals and institutions that have an interest in irrigated agriculture. CIMMYT recently established a maize station at the University. The major agricultural research body in the government is the Department of Research and Special Services in the Ministry of Agriculture. Unfortunately most of the key scientists in this organization were visiting Botswana and the group was unable to meet them. ARDA runs several estates, some of them focussing on wheat. The farmers provide labor for weeding and harvesting; all other inputs are done for them. Some of these schemes were never designed to make a profit, but merely to keep the population in the countryside.

Agricultural research is done by both the Ministry of Agriculture, which runs the research stations, and by the university, which concentrates on on-farm trials. In addition to research, training is extremely important. Ex-patriot scientists working with government agencies sometimes serve as PhD supervisors for other officials working on the degrees. It is better to keep the students in Zimbabwe during their training, even if they must leave for 4-7 months at a stretch, so that when their training is finished they can continue working on the same projects.

APPENDIX F

ZIMBABWE - IIMI Mission - November 1985
Field Trip to : MAKONESI small-holder irrigation scheme, near Masvingo.
Discussion with : Hugh GOLDSMITH and Andrew DRAPER,
HYDRAULIC RESEARCH UNIT Wallingford Associates.
Participants : C. Abernethy, D. Berthery, A. Waldstein, D. Groenfeldt
Comments by : D. Groenfeldt
Date : 24/11/1985

Built in 1972, the Makonesi scheme was designed to supplement rainfed agriculture in this communal area. It is an example of a "Comma One" scheme with each farmer receiving an initial plot of 0.1 ha, which was in some cases supplemented with additional plots after his productivity was demonstrated. The average irrigated holdings are about 0.2 ha today. The scheme involved some resettlement, but over very short distances; apparently rainfed farming is still the major source of income for the farmers, though we were not able to determine this in our short visit. Several villages are represented among the 354 farmers who cultivate the 60 ha of command area. The scheme consists of a dam and reservoir, with three electric pumps (operated by an employee of MEWRD) lifting water into a canal network that carries it ca. 1 km to a night storage reservoir, and then into the canals that serve the fields. All canals are concrete lined. There are 12-15 secondary canals which receive water on a rotating basis; at any given time (except at night when the water goes into night storage) about 8 plots are receiving water. There is also no irrigation on weekends, since the MEWRD pump operator keeps to a normal working week. As a result the canal system dries out every week, an unintended mechanism of pest control. In addition to the pump operator, there are two full-time officials from DRD (now shifted to AGRITEX) on site, an irrigation supervisor and an extension agent. Since we visited on a Sunday, we were not able to meet them.

The management of the scheme is handled by a committee of ten farmers headed by a secretary, whom we met. The committee oversees the opening of the metal shutters which control water in the channels. Farmers can appeal to the committee for more water or for an extra turn; the standard issue is once per week. Extra water is given only in extenuating circumstances. Farmers can be evicted for non-compliance with the committee's rules; there have been a few cases of eviction. Since there are about 400 farmers on a waiting list for inclusion in the scheme, enforcement among the current irrigated farmers becomes easier.

Water is conveyed from the channels to the fields by blocking a short stretch of the channel using a small iron weir to create an adequate head, and then using siphons to draw the water over the concrete channel to the fields. Nearly all fields were planted in very healthy looking maize; a few plots had tomatoes and groundnuts planted as well. Cropping intensity is close to 300%.

APPENDIX F

ZIMBABWE - IIMI Mission - November 1985
Discussion with : Mr. T. DAVIDSON, COMMONWEALTH DEVELOPMENT CORPORATION
Participants : C. Abernethy, D. Berthery, A. Waldstein, D. Groenfeldt
Comments by : D. Groenfeldt
Date : 23/11/1985

The CDC is not involved in any irrigation projects at the moment, though they may become involved in Chisumbanje. The CDC gives no outright grants but provides loans particularly for agriculture, and generally for export crops. Recently there has been a growing interest in food crops, if the commodity markets are open enough to provide farmer incentives. The Harare office opened in 1982. The only agricultural project in Zimbabwe is an integrated dairy development scheme. CDC Involvement in Chisumbanje depends partly on finding a suitable arrangement with ARDA for a semi-autonomous management authority which would handle the money which CDC and the World Bank would lend it. A major problem in Zimbabwe's irrigation development is the muddle of different agencies all having some irrigation responsibilities; IIMI could have a beneficial impact towards a coordinated planning effort. At the scheme level, problems of settlement and land title would be important to study.

Other irrigation work which the CDC is involved in regionally include: (1) Swaziland - A sugar estate and factory with small farmer outgrowers who also cultivate some food crops; (2) Zambia - Nakanballa sugar estate which includes a small holder scheme, Kaleha, on 3,000 ha; (3) Malawi - several sugar estates. There is an interest in small holder agriculture, both irrigated and rainfed, as a means of stimulating agriculture and avoiding the need for settlement schemes. Future plans in Zimbabwe include irrigated cotton along the middle Sabi River valley, on 5-10 ha plots.

APPENDIX F

ZIMBABWE - IIMI Mission - November 1985
Discussion with : Mr. Joe MAKADHO, Chief Irrigation Officer, AGRITEX
Participants : C. Abernethy, D. Berthery, A. Waldstein, D. Groenfeldt
Comments by : D. Groenfeldt
Date : 25/11/1985

There is a lack of direction in irrigation planning and no clear-cut policy, Mr. Makadho said. Many of the management problems at the scheme level stem from this lack of policy direction further up. Irrigation in the communal areas is viewed by the farmers as a supplement to their dry land agriculture. When the rains are good, they show little interest in careful management of their irrigation water.

The Ministry of Water Resources is responsible for bringing water from the source (e.g., a dam) to the field edge at which point AGRITEX takes over the management responsibility. Until the previous month (October 1985), the Ministry of Rural Development played the major role in operations and AGRITEX handled design and construction. Though AGRITEX and MRD have now been merged for irrigation functions, Water Resources is still a separate entity. A major problem is the shortage of manpower, both for extension and for designing schemes. Although there are private consultants in Harare, they work in the commercial farm sector. The differences between a large farm managed by one person and the complicated situation of government agencies managing a multitude of farmers creates qualitatively different situations. Furthermore, when donors give funds for a scheme they prefer to use their own consultants or other foreign experts.

Some schemes are non-viable in a financial sense but they provide food for the people in isolated areas. The Government wants to rehabilitate some of these schemes but donors won't release funds for projects that have a negative return. The main reason that some schemes (e.g,, Makonesi) are more successful than others is a strong irrigation committee and the cooperative action of the people. Other research areas where IIMI could contribute, according to Mr. Makadho: (1) optimum plot size and land tenure arrangement - Do farmers need title to their land before they will invest in improvements? The current guideline is that a farm family should have enough land to produce 18 bags of maize; apparently this is where the concept pf 0.1 ha plots comes from. (2) involvement of farmers -- at what point and in what way should this happen (planning, design, etc.).

APPENDIX F

ZIMBABWE - IIMI Mission - November 1985
Discussion with : Mr Arthur MUNZARA, Deputy Director Manager,
Mr John CULVER, Assistant General Manager,
AGRICULTURAL FINANCE CORPORATION.
Participants : C. Abernethy, D. Groenfeldt
Comments by : D. Groenfeldt
Date : 25/11/1985

The Agricultural Finance Corporation has been giving irrigation loans to commercial farmers for a number of years. The National Irrigation Fund was set up originally for the commercial sector, to stimulate wheat production, giving cheaper rates (9.9% vs. 13.9%) if a farmer commits himself to a certain area of wheat. This year, Z$ 6 million of a total Z$ 16 million irrigation loans have been earmarked for the communal sector. The loans would go to individuals who want to purchase irrigation infrastructure. In practice, this means sprinkler systems. There has never been an irrigation loan for anything but sprinklers, and there has not yet been a single irrigation loan to the communal sector.

APPENDIX F

ZIMBABWE - IIMI Mission - November 1985
Discussion with : Mr MPALA, Deputy Director, Operations,
MINISTRY OF WATER RESOURCES AND ENERGY.
Participants : C. Abernthy, D. Berthery, A. Waldstein, D. Groenfeldt
Comments by : D. Groenfeldt
Date : 26/11/1985

The general course of action in developing an irrigation resource in communal areas is: (1) Agriculture identifies the area that requires irrigation, (2) Water Resources constructs the dam and canal (and pump if necessary), and (3) Agritex does the tertiary infrastructure and operates the scheme. The initial impetus for construction can also come from Water Resources if it has a site it feels would be good for developing. The construction can either be done in house, or with contractors. Maintenance responsibilities are limited to the dam, canals, and pumps. They install a water baliff to manage this. The Ministry gets its funds from the government, not from farmers; there are no loan schemes for financing the construction of communal irrigation (this is a gift from the Government), but for the commercial sector, the farmers do pay capital costs.

There is an "Irrigation Liason Committee" comprising representatives of all the concerned ministries and departments, which must approve construction requests. Only a few communal schemes have come on-line recently. Any projects above 500 ha go to ARDA instead of Agritex, but the headworks and main delivery systems are constructed by the Ministry is either case. Members of the committee include MWR, ARDA, Agritex, and the regional water authorities. There is a national master plan currently being drawn up for site selection.

APPENDIX F

ZIMBABWE - IIMI Mission - November 1985
Discussion with : Mr FENNER, Director of Crops Research Division, AGRICULTURAL RESEARCH CENTRE
Participants : C. Abernethy, D. Berthery, A. Walstein, D. Groenfeldt
Comments by : D. Groenfeldt
Date : 26/11/1875

The irrigation research here is limited to plant, soil, and water relationships. There are 3 divisions within the Research Centre: (1) Livestock, (2) Crops, and (3) Research Services, which includes plant protection, soil chemistry, and advisory functions. There is a research station (Churesi) in Region V (South) in the dry zone where rainfed agriculture is very precarious (av. rainfall = 600mm). The rain comes during October to February/March in heavy bursts, and is highly variable (st. dev = 40%). There is another station in Chisumbanje and there used to be one in the Sabi Valley, closed since the war.

The low level of irrigation research is due partly to the flight of middle level management people from Agritex (under its former name) to private firms and the university. There used to be irrigation specialists in every province; these people laid out the irrigation schemes which exist today. Liason with both Government (Agritex) and the university, is done on an informal basis.

Farming Systems Research Unit: The team leader is Dr Avilla, a socio-economist. This unit is funded by IDRC, and is located within the Agricultural Research Centre. We did not get a chance to meet Avilla; presumably this project is related to the farming systems work that Professor Blackie is doing. The unit is semi-autonomous, reporting directly to the director. They have not yet done any work in irrigated areas.

APPENDIX F

ZIMBABWE - IIMI Mission - November 1985
Discussion with : Mr David POTTEN, HUNTING TECHNICAL SERVICES
Participants : C. Abernethy, D. Groenfeldt
Comments by : D. Groenfeldt
Date : 26/11/1985

Mr Potten has been working on a sector overview of communal irrigation, as a consultant for KFW. Potten has spent 5 months since October 1984 on Phase I which consisted of a sector overview and a feasability study of six representative schemes. Now he is finishing Phase II, a rapid appraisal (which will be written up as such for the journal, Agricultural Administration) of 12 schemes with feasability studies of some of them. Conclusions from Phase I: Agricultural productivity is very good on most of these schemes. Many of the farmers are 2nd and 3rd generation irrigators. They realize Z$ 2,000 to 4,000/ha/yr gross returns. The major constraint to higher production is water, due to limited catchments or because of poor design and leaky conveyance systems. On about 1/3 of the schemes the extraction costs are "horrendously expensive", exceeding crop values. These tend to be schemes that were built for political and/or welfare reasons in the first place; some were compensation to displaced residents of land that was given to commercial farms prior to Independence. The yields for cotton are significantly higher in the communal schemes than in commercial farms, and the cotton is of a higher grade. Maize yields are highly variable. Another surprise from the research is that the modal size in "comma-1" schemes is closer to 0.4 ha; the 0.1 ha was merely an initial allotment until the farmers proved their productive capacity and were given more plots. The concept of the 0.1 ha farmer is a myth, though it is still an influential planning concept.

The communal irrigation project began with KFW's interest in rehabilitation work, by which they suggested a feasability study of potential sites. The Ministry of Rural Development wanted a sector review of all communal schemes (74 schemes totalling only 3,000 ha), so the team did both tasks. The Ministry has been very pleased with the results, while KFW has been less pleased with the 6 feasibility studies, since only two sites were found with good potential. For Phase II, the team has selected 12 more promising sites, and will do a detailed study of two of these. KFW will probably rehabilitate 3 or 4 eventually. Foreign consultants will continue to be needed, says Potten, because the local irrigation consultants are unfamiliar with small-holder irrigation, and they are in any case already overloaded with work in the commercial sector.

...

Of the 74 communal schemes, 7 of them have been completely cut-off from Agritex for various reasons, e.g., not paying their irrigation fees. This happened pre-1980; today they receive extension services but no irrigation assistance. An interesting avenue of research could be to compare these schemes with Agritex schemes.

Policy recommendations from the study: (1) Continue all existing schemes but try to reduce costs wherever possible, (2) Devolve management responsibility to farmer committees after doing any necessary rehabilitation work, (3) The government's role should be limited to extension and upper-level management (Agritex) and providing the water supply (Water Resources). If farmers replaced the Agritex officials at the field level, they could apply the current charge of Z$ 145/ha from salaries to water charges and in-field maintenance.

APPENDIX F

ZIMBABWE - IIMI Mission - November 1985
Discussion with : Mr PILDITCH, A retired Government person, at one time acting chief of irrigation
Participants : C. Abernethy, D. Berthery, A. Walstein, D. Groenfeldt
Comments by : D. Groenfeldt
Date : 26/11/1985

Mr Pilditch took us out to visit the Agricultural Research Trust (ART) farm just outside Harare. This is a private research station set up by the commercial farmers, but with very close government links, and a stated interest in helping all sectors of the farming community. They have a center pivot that has been operating for 3 seasons. Domestically produced, it seems to be working well now. Their main irrigation technique is sprinkler, as is true on most commercial farms. They have several bore holes on the farm. The water table is ca. 150', but the stability of that level is not known. Irrigated farming is quite recent in Zimbabwe, mostly since the 1960s and much basic research (e.g. hydrology) remains to be done.

The team visited a 1500 acre farm where the owner has constructed a dam and an elaborate canal sprinkler system irrigating about 400 acres. His total labor force is ca. 100 permanent and another 50-100 casual worker which is roughly 1 person (or family) for 10 acres. The main crops are wheat (irrigated) and tobacco (both irrigated and not). A neighboring farm has no irrigation, which is unusual now. Top quality unirrigated land sells for ca. Z$ 300/acre. Water rights are on a first come, first served basis. Each farmer is required by law to let all but his pre-established water right flow downstream to his neighbors who have prior rights; if they cannot get as much water as they are entitled to, the upstream farmer may be obligated to let more water pass by. This limits the amount of new dams that can be constructed downstream or upstream, since any new dams will be last in line during dry years. The technology this farmer uses is an electric pump sitting on a floating platform in his reservoir, pumping water up to his fields where there is a division box sending water down 3 different channels, and from there into a sprinkler system. Another electric pump sends water by pipe to another part of his farm.

APPENDIX F

ZIMBABWE - IIMI Mission - November 1985
Discussion with : Dr. Sam MUCHENA, Deputy Secretary, MLARD
Participants : C. Abernethy, D. Berthery
Comments by : C. Abernethy
Date : 27/11/1985

Dr. Muchena is the official mainly concerned with relations with SADCC in regard to agriculture. The various countries in SADCC have been assigned lead roles in particular programs. Zimbabwe has been assigned Food Security; Botswana is the home base of SACAR; Lesotho is doing soil and water conservation. The SADCC secretariat is in Gabarones; participating countries are Tanzania, Mozambique, Malawi, Zambia, Angola, Zimbabwe, Botswana, Lesotho, and Swaziland.

Withing the Food Security program, there will be 12 projects:

1) Information exchange (seminars, workshops)
2) Early warning system for crop, storage, and transport info.
3) General information systems
4) Regional inventory of agro-climatic potential
5) Grain reserve
6) Food aid
7) Post-harvest losses
8) Food processing technology
9) Marketing infrastructure
10) Manpower recruitment and retention
11) Seed supply
12) Irrigation management

Donors are being sought to support work in each of these program areas; so far none has been found for #12, Irrigation Management.

There is heightened interest in irrigation mangement issues because of the recent drought and problems of food supply. Dr. Muchena discussed the development of the land formaerly scheduled as African purchase areas, which were a sort of half-way stage between the commercial farming of the former European lands and the communal lands (in which individual ownership is not allowed). He said performance in those areas had been disappointing, and attributed this to the fact that the new owners with sufficient resources to buy the land probably had urban interests and did not necessarily regard themselves as professional commercial farmers.

There is a need for agronomic research to better orient crop patterns and timing to fit market demand. He suggested that the monitoring and evaluation unit of Agritex might be the appropriate body with whom IIMI could collaborate in irrigation research.

APPENDIX G

Summary of discussions and field visits in Sudan.

APPENDIX G

SUDAN - IIMI Mission - November 1985
Discussion with : Mr Omer M. A. ELAWAD, Research Engineer,
HYDRAULIC RESEARCH STATION, Wad Medani
Participants : C. Abernethy, A. Waldstein, D. Groenfeldt, D. Berthery.
Comments by : A. Waldstein
Date : 29 November 1985

The team spent the entire day with Omer M. A. Elawad, research engineer in irrigation and water management, Hydraulic Research Station, Wad Medani. He escorted the team into the Gezira Scheme to present and explain the physical arrangements for water control.

The water for the Gezira Scheme is stored behind the Sennar Dam on the Blue Nile. It is brought by twin main canals as far as kilometer 57 where the main canal branches. One branch serves the main Gezira Scheme. It continues to kilometer 204. The other serves the Managil Extension.

Each of these branches of the main canal supplies a number of major canals. There are 72 majors in the system. The major canals supply minors. There are 880 minors in the system. The minors supply the Abu Ishreen or Abu XX. Each of these is about 1.5 kilometers long and handles about 120 liters per second flow. These feed water into farmers' fields by field ditches (Abu Sitta or Abu VI).

An Abu Sitta or Abu VI supplies a 90 feddan area called a number. The entire number is planted in one crop. The crop rotation is cotton to wheat to groundnuts, sorghum and garden vegetables to fallow. The number is divided into nine 10 feddan plots each assigned to an individual tenant. Each of these plots measures about 300 meters by 150 meters. A 10 feddan plot covers 42,000 square meters.

APPENDIX G

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The Sudan Gezira Board has organized the Gezira Scheme into 14 groups. Gezira Main has 6 groups and the Managil Extension has 8. Each group is divided into blocks. A block covers 6,000 feddans. The group is headed by a group inspector; the block is headed by a block inspector.

The Ministry of Irrigation has divided the Gezira Scheme into 6 sub-divisions. Each sub-division is headed by an assistant division engineer (ADE). Subdivision boundaries contain only whole blocks. The block inspector and the ADE have to work well together to assure delivery of proper amounts of water to the field.

The responsibility of the Ministry of Irrigation is to get water from the Sennar Dam to the head of the minor canal including setting the gate at the off-take of the minor. The Sudan Gezira Board is responsible from that point on.

A block inspector has a number of minors in his block. He knows, for each minor, the exact area cultivated in each crop. He adds up the needs of each minor to get how much water he will need in the major canal in his block. At 13:00 every Monday he relays to the ADE how much water he will need in his major for the coming week. The ADE adds up how much water he will need for the majors in his sub-division and then the Ministry of Irrigation adds up how much water each sub-division will require and, factoring in seepage and evapotranspiration, calculates how much water must be released from the Sennar Dam on a day by day basis.

Within each minor there are a number of night storage weirs. At one point irrigation took place only in day light hours. In the last decade, with deterioration of the communication system and disrepair of other infrastructure as well as with the agricultural intensification program, the weirs have fallen into disuse.

Farmers along three neighboring Abu XX are grouped together under the leadership of a samad. He plays an important role as an intermediary between the field level and the Sudan Gezira Board. He chosen by the Sudan Gezira Board on the advice of the farmers. He is often the pilot farmer for new technology and techniques. He helps adjudicate disputes.

The farmers also have a powerful tenants' union.

Omer Elawad, himself, is managing a research project which tracks flows in minor canals. The team visited several of the measuring devices used in the study.

APPENDIX G

SUDAN - IIMI Mission - November 1985
Discussion with : Mr Mirghani Abdel Aal HAMMOUR, Dean, Faculty of Economics and Rural Development, UNIVERSITY OF GEZIRA, Wad Medani
Participants : A. Waldstein, D. Groenfeldt,
Comments by : A. Waldstein
Date : 30 November 1985

The Faculty is very interested in irrigation research. Professor El Tom especially has been doing research and trying to get money to get students involved. The Faculty is now putting together a proposal for the Ford Foundation to research how productivity in the Gezira has been effected by the change from joint accounting to individual accounting. Many people believe the incentives are higher under individual accounting but no-one has yet done an objective study on the problem.

APPENDIX G

SUDAN - IIMI Mission - November 1985
Discussion with : Mr Badawi el Fadli El MONCHID, Director,
Ahmed Abd El WAHAB, Deputy Director,
Adam Ahmed SALIH, Senior Researcher,
Omer ELAWAD, Research Engineer,
Abdalla ABDELSALAM, Research Engineer,
HYDRAULIC RESEARCH STATION (England)
Participants : C. Abernethy, A. Waldstein, D. Groenfeldt, D. Berthery.
Comments by : A. Waldstein
Date : 30 November 1985

The University of Gezira has a $100,000 grant from the Ford Foundation to supplement studies the Hydraulic Research Station is doing with Hydraulics Research, Ltd., Wallingford. One of the lecturers at the university is in the U.K. right now discussing the results.

Since the Managil Extension was built all the new irrigation schemes in Sudan rely on pumping. Since the early 1970s, in particular, there has been a great expansion of pumping schemes. The presnet electric bill for pumping is in the order of L S 6,000,000 to L S 7,000,000. There is a question, are the pumps worth the expense? Is it worthwhile to leave a pump idle for the Gezira scheme in the pump schemes? Is it effective to base irrigation practices in the pump schemes on those in the Gezira scheme which is a gravity scheme?

Practically all of Sudan's share of Nile waters is committed to existing projects. The only way to expand irrigation in Sudan now is to develop more expensive water resources.

Agrarian reform projects present a distinctive set of complicated problems. The government has nationalized a number of private pumping schemes that had been profitable during the 1960s. It tried to rationalize their use by reforming the distribution of land, for one thing. This has lead to a number of social problems. The Blue Nile and White Nile pumping schemes are now under rehabilitation.

The problem of better use of Nile waters is critical to maximizing the country's agricultural production. This is especially true given the string of drought years recently. Specifically, better water management in the Gezira will free up lots of water for irrigation uses elsewhere.

Three important research areas toward that end are farmers' attitudes, water measurement methodologies and on-farm management to increase water use efficiencies.

Rahad should be a priority. But Gezira is the backbone of the economy and a school for national irrigation. Improvements in performance there will be reflected throughout the irrigation sector later. On-farm management is the question of the day.

APPENDIX G

SUDAN - IIMI Mission - November 1985
Discussion with : Mr Abdalla el ZUBEIR, Managing Director,
Nasr el DIN, Director of Agriculture, SUDAN GEZIRA BOARD, Barakat
Participants : C. Abernethy, A. Waldstein, D. Groenfeldt, D. Berthery. B. Wallach, T. Wickham
Comments by : A. Waldstein
Date : 30 November 1985

The Sudan Gezira Board (SGB) used to have a social research section belonging to the social services department. The department has recently been dissolved. The social research section is now under the socio-economic unit. The unit is involved in collection of data relating to costs of production of different crops by different tenants in different villages. It analyzes the data to determine under what conditions and in which villages tenants are profiting from the scheme. The social research section in other social problems such as the seasonal labor sector and village social and economic composition. It has also been doing research on the commons system. More recently the administration has asked the section to do research on the intensity of vegetable cultivation in the Gezira and to recommend measures to encourage further expansion. The socio-economic unit has about 5 M.A. level staff with technicians and data collectors. The staff divides into teams to administer questionnaires in the field. They do this annually for certain crops in selected villages.

A major problem confronted by the SGB is to be able to make the best use of water to be able to irrigate the maximum amount of land. One of the questions on which this result depends is whether to continue the angaya system of watering or to go to a long furrow system. Rahad, for example, started out with the long furrow system but is now moving back to the angaya system. The problem with the long furrow system starts with the siphons that farmers use to draw water out of the furrow. The farmers need training to use the pipes. The pipes are expensive because they have to be made from imported materials. The angaya system operates without any special tools. Farmers do not have the skills to use the siphons properly. In addition, the long furrow system requires more supervision because the pipes get clogged with mud.

The main canal for the Gezira scheme is 204 kilometers long. There are 14,000 kilometers of canals in the scheme overall. The daily flow through the system is 31 million cubic meters of water. On any given day half the area of the scheme, or 1 million feddans, is irrigated. The water application is, therefore, 31 cubic meters of water per feddan per day.

...

The scheme is divided into 14 groups each with its group manager. Each group is divided into blocks.

A major problem in indenting is the complete collapse of the internal communication system.

The Board of Directors of the SGB is responsible for making policy. It meets every two months. El Zubeir is Managing Director and Chairman of the Board of Directors of the SGB. He is assisted by a deputy director and four directors of administrations. The four administrations are: (i) the administration of agriculture, (ii) the administration of finance, (iii) the administration of engineering and (iv) the administration of administrative affairs. Each administration is divided into departments. There are 28 departments total.

The SGB employs 2,500 professional staff, 15,000 support staff and 12,500 laborers. All of these are permanent staff. In addition tenants employ up to half a million casual laborers at peak season.

The SGB levies the following charges per hectare: cotton L S 50, groundnuts L S 25, wheat L S 31, sorghum L S 25 and vegetables L S 44. The charges are all deducted from the cotton the tenant delivers.

The scheme was nationalized in 1950. It was then that the SGB replaced the Sudan Gezira Syndicate.

There are two rotations in the Gezira Scheme. In the Gezira Main, the older system, there is a four course rotation to suit the tired soils. This rotation includes one year of fallow. In the Managil Extension, the newer system, there is a three course rotation. The rotation goes from cotton to wheat to sorghum and/or groundnuts without the succession of the fallow year at this point as in the Gezira Main system.

Areas along the minor canals are divided into field numbers, 90 feddan units devoted to one crop. Each of these units is divided into 9 tenancies. Each tenancy is 10 feddans. The same 9 tenants in one number are grouped together in other numbers for the other crops in the rotation. Each number has a field outlet pipe (FOP) to take water from a minor channel into an Abu XX. A water supervisor controls the FOP.

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The World Bank in conjunction with several bilateral donors is a bout to launch a Gezira Rehabilitation Project. The project will last 5 years at a cost of $282 million. The foreign component will be $190 million. Within the project there is some money for studies. The SGB will be contracting for development of a management informations system from a Sudanese contractor who will be working with Louis Berger. The SGB will also be setting up some pilot farms for research organizations under this project. There are five local organizations that must be involved for successful research projects: the SGB, the Tenant's Board, the Hydraulic Research Station, the University of Gezira and the Ministry of Irrigation.

The system was collapsing in the late 1970s. There was a crash program from 1981 to 1983 which successfully brought the system back to life. Among other things the SGB initiated a new relationship with tenants. It moved from joint accounting to individual accounting in 1980.

APPENDIX G

SUDAN - IIMI Mission - November 1985
Discussion with : Professor Abdullahi Osman ET-TOM, Department of Anthropology, Faculty of Economics and Rural Development, UNIVERSITY OF GEZIRA, Wad Medani
Participants : A. Waldstein, D. Groenfeldt,
Comments by : A. Waldstein
Date : 1 December 1985

El-Tom is studying landless labor in the Gezira at present. In general he has been researching human aspects of irrigation. How do people deal with the water supervisor, with crop/water requirements, etc.? He has been trying to get a student he could post in a Gezira village to carry out his research. The student would be registered at a university in the U.K. but would work under El-Tom. The student has been chosen. He has a 1983 M.A. with work on refugees. There is now a problem getting him a scholarship through the British Council because he is not affiliated with any Sudanese government institution. The proposed project is a collaboration between the British Council, ODI and the Ford Foundation. Ford, however, will not fund the field research until the British Council has agreed to the fellowship. Other questions that interest el-Tom are areas where tenants invest their profits, how people conceive of the crop water requirements, who handles water in the field, the tenant or the sharecropper and how are regulations regarding the use of water implemented and how does the community feel about that.

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There is irrigation in Northern Province, along the Atbara, in the White Nile and Blue Nile pump schemes and in the flood irrigation in Gash and Tokar in addition to Gezira and Managil. All the schemes have problems. But the type of assistance offered is best focused on Gezira rather than remote areas where logistics and supplies are tough and create more problems than the research itself.

Government policy has been to develop irrigation to help solve the problem of settling pastoralists and facilitate giving them infrastrucutral support such as roads, schools and health care. Until recently that meant developing new irrigation schemes. Now policy is to improve the performance of old schemes.

b. Water more than land is the constraint on production so any saving in water would be very helpful.However, there is very little room for saving water in the Gezira. Overall efficiency is very high in the Gezira compared with any other similar project. But with high efficiency there is inequitable distribution with respect to space and time. There are complainta about this from block inspectors and from farmers. Yet there are no figures on the degree of inequity. It is important now to define to what degree this inequity is serious. Why is there this unsatisfactory performance? Is it due to improper operation of the regulators, to siltation, to unauthorized opeing of the regulators by the farmers or the water supervisors? We do not know the impact of each of these factors on performance. Moreover, this is an important field of research in Sudan in general.

It is certainly true that it is easier to work in Gezira than elsewhere in Sudan. A lot of expenses can be avoided. In addition, irrigation elsewhere is just a small model of the Gezira Scheme. However, soils and climates have to be taken into account for each specific site. Therefore, recommendations based on Gezira can not be applied indiscriminantly everywhere.

c. Considering the area of Gezira and the amount of water consumed, Gezira is very important. But IIMI must not exclude other newer schemes from consideration. They have their own problems often because they were modeled, rightly or wrongly, on the Gezira. Pump schemes, in particular have thir own set of problems which Gezira never had to deal with. One question there is to analyze the cost of pumping to compare with the costs at Gezira. A second question would be to look into the operations of the pumping stations. There is no manual of operations comparable to that of the Gezira for the pumping stations.

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d. Gezira is the backbone of the national economy and could profit from further research. But other schemes draw from the Nile. Isn't the Gezira experience relevant to the other schemes.

Meanwhile the traditional sector needs help. This is an important point. People in isolated rural areas use boreholes and wadis to irrigate. This is an important source of dependable food for them. This has been demonstrated during the recent drought years. Research could help them. While IIMI can concentrate on the Gezira it should not ignore the traditional agricultural sector.

e. There is agreement that IIMI should concentrate on Gezira and Managil. They use gravity mainly but there are also small areas where there is pumping. After 1966 they have been facing a water shortage problem. The reason is that water control in the majors and the minors is poor. Pegging water distribution to crop water requirements is based on defective research. The method of indenting is not correct. It is a mistake to assume there is a standard flow through the FOPs. In fact the flow depends on the level of the minor. The control of the minors is inadequate. The night storage system is not being followed. There are so many crops now. Each one has its own sowing date. If farmers do not adhere to the planting scheduel there will be overlapping of crops in the fields and there will, therefore, be too much demand for water and water shortages during that period. In drought periods, as well, if needs are not well forecast there will be water shortages.

f. There is agreement with most of the things that have been said. If IIMI opts for studying large scale irrigation schemes there is a field of study in water supplies. Are there any means of improving the present situation? Can water be saved? There is a lot of room for improvements in the productivity of water used per unit land: (1) partly in better technology, seeds and management standards, (2)in adequacy and reliability of water availability in the field, (3) in production of data at both ends of the system, (4) in synthesizing insights from a number of specializations. All of this is if IIMI wants to look at large scale systems.

But IIMI should be looking at national needs. Where does the country want work to be done? Part of the answer is in the rainfed areas or areas using wadis. In the past these areas were net food exporters. In the past few years they have become net food importers. IIMI can not pass these areas by.

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In addition, flood irrigation in Gash and Tokar is an area of particular national interest due to the poverty, disease, refugees and ecological fragility which characterize the zones.

g. Gash is fantastic for research. There are no canals there. It is flood irrigation. Lots of social problems. It would be ideal to do something there. But within the resources that IIMI can offer it would be preferable to find a site with no difficulties in infrastructure, inputs, logistics and conditions for researchers to live. In these terms Gezira is preferable.

h. Total agreement but it is still possible to design a program using the people already assigned there to carry out the research. It is necessary to deal with these areas. Even simple collection of data as opposed to full-fledged research would be a contribution. With the cooperation of the people already there a lot of work can be done without transferring IIMI from Sri Lanka to the Gash.

i. Engineers need agriculturalists to tell them what is needed. Agriculturalists need to set out the best manner to deliver water. What does the farmer need? Farms are not standard units. In the 60 years of the Gezira Scheme great divergences and discrepancies have developed among farmers. Studies need to go from the farmer up. We need to optimize farmer performance.

The Fakki/Bailey research is impressive. The disparity in yields along an Abu XX is impressive. There are clearly stresses at the Abu XX level. How do the 9 farmers along an Abu XX adjust the water distribution among themselves? What are the reasons for the disparity? How do we go about keeping it to a minimum?

Farbrother shows that there are great variations over time in water supplies coming out of FOPs. There are no regular flows in the system. Everything is oscilating. How much do the flows vary through the season? Is adequate water received over time at the field level? Averages are not good enough to answer this question. Do individual plants receive timely applications? Are yields depressed because of unequal delivery of water? There are also lots of questions regarding the macro-system but they will probably be dealt with through consultancies within the rehabilitation project. The best area for IIMI is farmer behavior in response to water.

APPENDIX G

SUDAN - IIMI Mission - November 1985
Discussion with : Mr Ahmed Abdelkasim MOHAMMED,
RAHAD AGRICULTURAL CORPORATION, El Fau
Participants : C. Abernethy, A. Waldstein, D. Groenfeldt, D. Berthery.
B. Wallach, T. Wickham
Comments by : A. Waldstein
Date : 2 December 1985

The team spent the day on a field trip to the Rahad Scheme.

Rahad is different from Gezira in several ways: (1) it is a hybrid scheme in which water is fed into the scheme by gravity from the Rahad River during the flood season but is pumped from the Blue Nile during the dry season; (2) it has a drainage system; (3) the cropping rotation is different; (4) it has laterals from the minor before the Abu XX; (5) the farms are 22 feddans; (6) water distribution was planned on the long furrow system; (7) livestock are welcome.

The main canal for Rahad is 101 km long and feed 7 majors. At present phase 1 of the scheme, 300,000 feddans, is complete.

There are about 15,000 tenants in the Rahad Scheme. They have come mainly from the settlement of pastoralists who had been herding in the area. There are also some tenants who have come from western Sudan by way of a stint as laborers in the Gezira Scheme. The tenants have settled in 49 villages. The total population of these villages is 80,000 to 90,000 not counting the seasonal laborers.

An agricultural officer is assigned to each village. He is, therefore, in charge of working with 200 to 250 tenants.

The standard tenancy is a two course rotation alternating between 11 feddans of cotton and 8 hectares of sorghum and/or groundnuts with 3 hectares of fodder. There is 20,000 feddans of 5 feddan fruit and vegetable tenancies and a number of 12 feddan livestock tenancies. Cotton production last year was 7 kintar per feddan of medium staple cotton. In Gezira it was 6+ kintar per feddan.

APPENDIX G

SUDAN - IIMI Mission - November 1985
Discussion with : Professor M. O. SAMMANI, Department of Geography, UNIVERSITY OF KHARTOUM
Participants : D. Groenfeldt,
Comments by : David Groenfeldt
Date : 3 December 1985

The Rahar Socio-Economic Research Project is a creation of the Ford Foundation (1980) now being funded by the I.D.R.C. under a three year, $100,000 grant. Ford, itself, has contributed about $250,000. The object of the effort is: (1) to fund M.A. level students to do thesis research on Rahad; (2) to fund university faculty research on Rahad; and (3) to create a capacity within the Rahad Corporation to monito, evaluate, and generally carry out research on the socio-economic aspects of the scheme. So far 23 M.A. students, most of them in U.K. universities, have been or are being trained under the project. Only one of them is doing research on irrigation, however. No progress at all has been made on the third objective. The only Rahad staff with a socio-economic orientation are the agricultural economic unit, the head of which we met at El Fau yesterday, the agricultural extension unit and the social sciences unit. All of these staff members were already at post at the initiation of the Ford Foundation project. They do little research beyond compiling crop production figures and other statistics. Rahad, therefore, has not generated a great deal of research within its staff. The socio-economic unit has, so far, failed to get off the ground. Sammani, however, feels that Rahad is worth studying and work be interested in working with IIMI in this area.

There is also not much interest at the University of Khartoum in irrigation studies. However, the Ford Foundation project has created a group of university people who might want to get involved in some aspect of IIMI's work in the medium term. Ted Scudder originally planned to develop a socio-economic unit within the Agricultural Research Corporation based, perhaps, at Wad Medani. Professor Abdullah encouraged the idea. The Agricultural Research Corporation did not receive the idea very favorably. Scudder, Sammani and the Ford Foundation then went in search of an irrigation scheme within whose Corporation structure they could work. They got a good reception at the Rahad Corporation.The initial enthousiasm did not last and they have made little progress in promoting in-house research.

Sammani feels that there is still some potential for working with the Rahad Corporation but IIMI will have to provide support in the form of a full-time staff member perhaps seconded from some other agency. There is no career incentive for Rahad Corporation staff to work full-time on research. Sammani encourages IIMI to look at small-scale project in the north and the west of the country. There are villages in those areas that hvae developed their own small-scale irrigation schemes. The big need is for knowledge about the best techniques to use for small scale development, including tubewells, small reservoirs, water harvesting, conjunctive use of groundwater.

APPENDIX G

SUDAN - IIMI Mission - November/December, 1985
Discussion with : Omer ELAWAD, Research Engineer, H. R. S. Wad Medani, Saliq ZUBEIR, Resident Engineer, Sennar Dam Saif Hammad ABDALLAH, Engineer, Sennar Dam Representatives of BLUE NILE AGRICULTURAL CORPORATION AND OF KASSAB TENANTS UNION, AGRICULTURAL MANAGER OF THE ES SUKI CORPORATION AND SOME TENANTS ON THE SCHEME.
Participants : C. Abernethy, A. Waldstein, D. Berthery.
Comments by : A. Waldstein
Date : 3 December 1985

a. The Kessab Pump Scheme was created in 1952 by a private entrepreneur. It has since been nationalized. It is composed of three projects. Kessab North is the largest. It has about 1000 holdings with about 15,000 feddans total. Kessab Middle has 100 holdings and Kessab South has 160 holdings. The scheme has a three course rotation. Each holding has 5 feddans of cotton, 5 feddans of sorghum and 5 feddans fallow.

Recently they have been having pumping problems and some of the area has not been irrigated. An irrigation technician from the Blue Nile Agricultural Corporation is responsible for the distribution of the water. A mechanic in Sennar is responsible for the operating condition of the pumping station. Sixteen people working in three shifts are employed at the pumping station.

The three projects have one combined tenants union of 1700 members.

The Blue Nile Agricultural Corporation supplies seeds and fertilizer, plows the fields, and makes credit available. It buys the cotton and deducts these expenses from the tenant's income.

The main problem the tenants have is that when the water behind the Sennar Dam is low they can not irrigate their fields properly. This is particularly a problem in the rainy season when they have to plant but can not supply supplemental irrigation. In cases of water shortage a council of representatives from the entire scheme meets to determine how to distribute the water.

The tenants would like to see a change in the nature of their relationship with the Blue Nile Agricultural Corporation. They complain that they are accountable to the Corporation but the Corporation is not accountable to them. They claim that they owe their debt to the Corporation whether or not the Corporation has been able to fulfill its part of the bargain, to keep them supplied with adequate quantities of water. Cotton yields are 4+ kantar per feddan in this scheme

b. The Es Souki Agricultural Production Scheme is run by the Es Souki Corporation. This project is not related to the Blue Nile Agricultural Corporation schemes.

Es Souki was begun in 1971. It now covers 33,000 hectares. The scheme is cultivated in a two course rotation. Each tenant has 5 feddans under cotton and 5 feddans under sorghum and/or groundnuts. There is no fallow.

There are now about 7,000 tenants on the scheme. They have been mainly people resettled from eastern and western Sudan. The pastoralists who lived in the area before the creation of the scheme have not become tenants in any significant numbers. This may be because the scheme does not permit fodder cultivation or livestock association.

This was the first scheme to use electric pumps.

Water shortage is a major problem. Livestock are not permitted on the scheme because there is not enough irrigation water to grow fodder. The October peak demand period is always a problem.

The highest cotton yields were in 1977/78 and 1978/79. Since then the yields have dropped due to unwise replacements of equipment. Cotton yields at present are 5 kantars per feddan.

The scheme has an active tenants' union. Every 100 tenants elect a representative to the union.

APPENDIX H

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