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Improvement of Rainfed Rice Growing Areas in the western part of The Gambia

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- Final Report -

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Mees van Krimpen

Deutsche Gesellschaft fuer Technische Zusammenarbeit (GTZ), GmbH

Eschborn, Federal Republic of Germany

ABBREVIATIONS

DOA	Department of Agriculture
DWHH	Deutsche Welt Hunger Hilfe (German Agro Action)
DWR	Department of Water Resources
EAU	Extension Aids Unit
FAO	Food and Agriculture Organisation
FFHC	Freedom from Hunger Campaign
FRG	Federal Republic of Germany
FYP	Five Year Plan
GARD	Gambia Agriculture and Diversification Project
GDP	Gross Domestic Product
GTZ	Deutsche Gesellschaft fuer Technische Zusammenarbeit
ISRD	Irrigation and Swamp Rehabilitation Division
MOA	Ministry of Agriculture
NGO	Non Governmental Organisation
OMVG	Organisation de la Mise en Valeur du Fleuve Gambie
PPMU	Project Planning and Monitoring Unit
RWS	Rural Water Supply
SWMU	Soil and Water Management Unit
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Program
UNSO	United Nations Sahalian Office
USAID	United States Agency for International Development
VEW	Village Extension Worker

Per 01.10.88

1 DM = Dalasis 3.90

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ACKNOWLEDGEMENTS

Many individuals I have met during my five and a half year assignement have, directly or indirectly been involved in executing the project. Their status ranged between decission making politicians at ministerial level and hard working rice farmers in the field. Each and everyone has contributed, in one way or the other to the implementation of the project described in this paper. It would be an impossible task in this context to list all but I hope they will accept my sincere thanks.

However, for certain groups and individuals I want to make an exception. First of all I wish to thank my project staff; Famara Badjie, Kebba Khan and Saikou Njie for their confidence, commitment and enthusiasm showed, often under difficult circumstances and off working hours. In addition I would like to thank the directorate of the Department of Water Resources headed by Mr.M.M.Sahor for the freedom and flexibility given, inevitable needed when implementing a pilot project; Fatou Kujateh (ne Jasseh) for her support and advice; Fabala Camara for the successfull supervision of the construction works in Brefet; Stanley Adams for drawing uncountable plot boundaries and fieldpoints when preparing the maps; Jerre Trawally and Alkali Badjie for their assistance at various levels; all division heads of the Department of Water Resources for their support and provision of data; Sompo Ceesay as my contact person at the Department of Agriculture and Baboucar Sompo Ceesay as my contact person at the Ministry of Economic Planning.

Special thanks goes to "Pa" Sanyally Bojang, former chief but above all a farmer at Kaimbujae for his advice and unrestricted support to the project.

Last but not least, my sincere gratitude goes to all people of the 16 project villages for showing confidence in the project's concept and their participation, albeit at different levels in implementing it with the aim to improve their rice production and, eventually their well being.

Mees van Krimpen

Leusden, The Netherlands

PREFACE

This report is not 'final' in the true sense of the word. It merely describes the project "Improvement of Rainfed Rice growing areas in the western part of The Gambia' from the 1st of January 1985 up to the 30st of September 1988. From the 1st of October 1988 the project continued, for a second phase but under a different heading and with another local counterpart organisation.

After a brief description of the project's history and its rationale the report proceeds with a project description. An outline of the objectives and target group, Gambian and German contributions in terms of personnel, transport and equipment is followed by a description of the project area, its natural resources and the involvement of other, similar projects. The execution of the project is seperately described with respect to the technical aspects, village participation, incentive system, agricultural follow-up and maintenance. The experience gained is followed by the results and a brief economic analysis. The report ends with the conclusions and recommendations.

Specific aspects are covered in six Annexes including a summary of the infrastructure constructed and a brief outline of all the 16 schemes developed during this project period.

References made in the text are numbered and marked between brackets ('[ ]') and presented in a seperate section.

1. EXECUTIVE SUMMARY

The Government of The Gambia gives high priority to the goal of increasing food production. It should be noted, in this context that 75 percent of the population is rural and that the agricultural sector contributes to about 30 percent of GDP and up to 90 percent of the export earnings.

Specific agricultural objectives as listed in the 1980-1985 (but todate still valid) Five Year Plan are:

- to increase food crop production and productivity in order to raise the nutritional status and better meet the food requirements of the population,

- to encourage efficient use of the land and water resources in order to reduce soil degradation and enhance land productivity.

Considerable resources have been invested in developing the nation's rice growing potential, a task which is complicated by the diversity of the rice growing ecologies in The Gambia.

The bulk of rice development resources have sofar been devoted to exploiting the potential for pump-irrigation e.g. the development of small scale irrigated perimeters on the floodplains of the River Gambia Since the inflow of fresh water in the River Gambia during the dry season is negligible, the potential for expanding pump-irrigation, on a short and even medium term basis are clearly limited. An additional extraction of fresh water would push the salt interface further upstream contaminating productive rice land and endangering already existing schemes in their year round supply of fresh water. For most of the Gambian farmers, rainfed and/or (frehwater) tidal land are therefore the only choises available for cultivating rice.

In the light of these facts, it is necessary to examine the potential for developing and improving rainfed rice cultivation. The only possibility to increase rice production in the western part is to increase the productivity (yield per hectare) by improving the growing conditions in already existing, traditional rice growing areas. These traditional, rainfed areas still form the vast majority of The Gambia's rice land and are the areas which show the highest potential for a productive exploitation in the short term.

Project objectives have been formulated in a project framework of 1984, which also contains the project goal, expected results and envisaged activities. Basically the project has been designed as a pilot project developing and testing various techniques and approaches for the improvement of rainfed rice production. Although stricktly speaking formulated as an activity which, together with other activities should lead to goal and objective, the project has basically embarked on:

-"developing and testing a package of technical as well as agricultural measures to improve the growing conditions and thus production in traditional rainfed rice growing areas in the western part of The Gambia"

The target group consists of small scale farmers and/or groups of farmers engaged with rainfed rice cultivation. Rice cultivation in The Gambia, especially at subsistence level is the responsibility of the women. Hence, the improvement of the conditions in traditional rainfed rice growing areas will directly benefit the women.

The 'Irrigation and Swamp Rehabilitation Division'(ISRD), one of the six Divisions comprising the Department of Water Resources (DWR) was appointed as the local counterpart organisation.

In terms of personnel and according the project agreement the Government of the Federal Republic of Germany has made available for the period January 1985 up to December 1987:

- one expert in land and water use engineering for 36 manmonths,

- short term experts in various fields for 6 manmonths.

A project extension from January 1988 up to September 1988 provided:

- one expert in land and water use engineering for 9 manmonths,

- short term expert(s) for 1.5 manmonths.

The Gambian contribution, in terms of personnel would consist of one trained extension- agronomist and three additional technicians.

To be able to cover an as large as possible variety of rice growing areas but keeping in mind the limited number of staff, budget and time span it was decided to select the pilot schemes and concentrate the activities in the Western Division.

The technical measures developed, tested and meant to improve the growing conditions entail three type of structures:

- dikes, to prevent tidal flooding and further salt intrusion in the lower reaches of the area, simultaneously retaining surface run-off (also called 'anti salt dikes')
- contourbunds, to retain surface run-off in the upper reaches
- sluice gates and spillways (or combinations of these two), to regulate waterlevels upstreams of these structures and to drain excess water out of the entire area

The agronomy section has concentrated its activities on:

- variety selection and promotion
- seed distribution and multiplication
- agricultural practices
- trials and demonstrations
- yield surveys
- maintenance issues

The project embarked on a high level of village participation especially during the construction. Consequently the designs had to be simple enough to be built by unskilled labor. Village participation was considered crucial in project implementation. Basically the idea was:

- to involve the villagers in the planning process right from the beginning rather than imposing certain ideas and interventions
- to raise awarness and responsibilities among the villagers during project executiun as to secure a long term engagement and involvement especially with regards to maintenance issues
- to involve the villagers during construction in planning the follow up with emphasis on agriculture related issues like adapted varieties, water management etc.
- to economize construction cost

Despite numerous arguments against it the GTZ project decided to introduce a cash incentive system. The main argument to do so was to compensate not only for the labour invested by each individual participant (opportunity cost) but also to compensate for some sort of uncertainty; inevitable due to the nature of a pilot project.

Experience has shown that a number of factors have, individual or in combination with each other contributed to the success or failure of project interventions. During project implementation four categories have been identified:

- environmental factors
- design factors
- village participation
- scheme operation

Experience gained during project execution has led to the following conclusions:

- the project has developed appropriate and low cost measures to improve the growing conditions for rice in traditional rainfed areas

- designs of the structures are sufficiently appropriate to allow an entirely manual construction

- the construction methods used entail regular maintenance

- designs are sufficiently adjusted to allow a minimum of interventions (operation) with regards to water management

- the success or failure of project interventions mainly depends on the rate of village participation which is strongly influenced by the incentive system offered

2 INTRODUCTION

2.1 History of the Project

In 1979, the Ministry of Agriculture and Natural Resources requested the Government of the Federal Republic of Germany to support a program to reclaim and rehabilitate salt affected tidal swamps for, mainly, rice production. In response the "Deutsche Gesellschaft fuer Technische Zusammenarbeit" (German Agency for Technical Cooperation), GTZ was commissioned to appraise a project within the framework of the bilateral technical cooperation between the governments of The Gambia and the Federal Republic of Germany. On the basis of an appraisal study [12] a project agreement was signed in   and GTZ, as the appointed executing agency provided an agronomist and a land and water use engineer who took up their duties in August 1982 and January 1983 respectively.

Since all swamp development work had become the mandate of the Irrigation and Swamp Rehabilitation Division (ISRD) of the Department of Water Resources (DWR) within the newly created Ministry of Water Resources (1981), both GTZ experts were attached to that Division.

The DWR had already undertaken a program of swamp reclamation in 4 swamps (Sifoe, Pirang, Jibanack-Bajagarr and Burock) all situated in Western Division. However, before initiating any new schemes it was decided to conduct a comprehensive investigation on the soil/water relations in the aforementioned existing schemes. This study, implemented during the 1983/84 cropping season, sought to clarify:

- the extent to which actual and/or potential acid sulphate soils were present in the schemes being studied
- the impact of swamp reclamation structures i.e. dikes, bunds and sluice gates on processes in the soil such as acidification, salinisation, leaching etc.
- the impact of direct precipitation and water retention behind the structures on those processes in the soils.

The conclusions of that study [10] were as follows:

1. the reclamation schemes near the villages Pirang, Jibanack and Burock all comprise actual as well as potential acid sulphate soils
2. the reclamation of tidal, formerly mangrove covered swamps as practiced near the villages Jabanack and Burock has turned the near neutral but potentially acid sulphate soils severely acid. Therefore, together with associated toxicities the reclamation was, in fact prohibiting rice cultivation
3. in the swamps protected from salt water flooding by dikes, direct precipitation alone was not providing sufficient leaching of excess salts from the top soil
4. most of the reclaimed land was therefore not used by the farmers and the reclamation of saline tidal influences swamps as practiced by the DWR had not lead to any improvement.

Consequently, the study recommended that the DWR abandon its program of saline tidal influenced swamp reclamation and shift the emphasis to improving the growing conditions in the adjacent rainfed rice growing areas (locally known as 'Bantafaros'). This recommendation was fully endorsed by the DWR and in October 1984 the Government of the Federal Republic of Germany, during the bilateral negociations agreed to support a pilot project of 3 years to develop and test strategies for improving conditions in rainfed rice growing areas, effective as from the 1st of January 1985 (see Annex 1.)

A project evaluation, carried out in February 1987 [7], as well as others [2, 6, 17, 20] recommended, due to the apparent incapability (financial as well as manpower wise) of the DWR, to shift the project to the Ministry of Agriculture (MOA) as to establish a closer link with agricultural services e.g. extension, research etc. and to assure its longterm sustainability.

The Gambian Government endorsed this recommendation, as part of a comprehensive re-organisation of the MOA. Anticipating a transfer of the project to the MOA this Ministry requested, in October 1987 a project continuation within the Soil and Water Management Unit (SWMU) of the Department of Agriculture (DOA) as the likely to be appointed new counterpart organisation.
During the bilateral negociations of February 1988 the Government of the Federal Republic of Germany agreed, under certain conditions to support a project extension. Furthermore, to assure a smooth tranfer of the project from the DWR to the DOA, which needed cabinet approval and became only effective from the 1st of July 1988 and to give GTZ sufficient time to submit a new project proposal the existing project agreement was extended for nine months up to the 30st of September 1988.

The physical handing over of the project to the Department of Agriculture took place on the 5th of October 1988.

2 Rationale for the Project

The Government of The Gambia gives high priority to the goal of increasing food production. To mention a few objectives, quoted from the 1980/81 - 1985/86 Five Year Plan (FYP) but to date still valid:

- dependency on external supplies of goods and services 'particulary food', will be reduced...,
- to expand employment and productivity in agriculture in the rural areas,
- to better utilize natural (agricultural) resources through productivity oriented investments in rural development.

It should be noted, in this context that 75 percent of the population is rural and that the agricultural sector contributes to about 30 percent of GDP and up to 90 percent of the export earnings.

Specific agricultural objectives as listed in the FYP are:

- to increase food crop production and productivity in order to raise the nutritional status and better meet the food requirements of the population,

- to encourage efficient use of the land and water resources in order to reduce soil degradation and enhance land productivity.

Considerable resources have been invested in developing the nation's rice growing potential, a task which is complicated by the diversity of the rice growing ecologies in The Gambia (definitions of the different rice growing ecologies, as found in The Gambia are given in Annex 2.)

The bulk of rice development resources have sofar been devoted to exploiting the potential for pump-irrigation. Examples are the development of small scale irrigated perimeters on the floodplains of the River Gambia and the Jahally-Pacharr pump-irrigation scheme. The latter designed as a pilot project for an estimated 10.000 to 15.000 ha of double cropped irrigated rice after the completion of the proposed bridge barrage at Balingho [15]. Since the inflow of fresh water in the River Gambia during the dry season is negligible, the potential for expanding pump-irrigation, on a short and even medium term are clearly limited. An additional extraction of fresh water would push the salt interface further upstream contaminating productive rice land and endangering already existing schemes in their year round supply of fresh water. Furthermore, up to approximately km 100 upstream the river is perennial saline and pump-irrigation using river water is therefore impossible. For most of the Gambian farmers, rainfed and/or tidal land are the only choises available for cultivating rice.

In the light of these facts, it is necessary to examine the potential for developing and improving rainfed rice cultivation, especially in the western part of The Gambia where no other alternatives to grow rice are available. In fact, the only possibility to increase rice production in the western part, and especially in Western Division is to increase the productivity (yield per hectare) by improving the growing conditions in already existing, traditional rice growing areas. In this most densly populated part of the country a considerable land pressure exists (90 persons per sq.Km arable land) and possibilities in expanding the cultivatable area, especially those suitable for rice, are very limited. These traditional, rainfed areas still form the vast majority of The Gambia's rice land and are the areas which show the highest potential for a productive exploitation in the short term (see also [5,16,17]).

3 PROJECT DESCRIPTION

3.1 Objectives and Target Group

Project objectives have been formulated in a project framework of 1984, which also contains the project goal, expected results and envisaged activities. Basically the project has been designed as a pilot project developing and testing various techniques and approaches for the improvement of rainfed rice production in the western part of The Gambia. In more specific terms the project goal has been described as:

-"Self sufficiency in rice supply to rural households throughout the year is achieved"

and the project objective as follows

-"Increase of rainfed rice production of small farms in the Western Division of The Gambia".

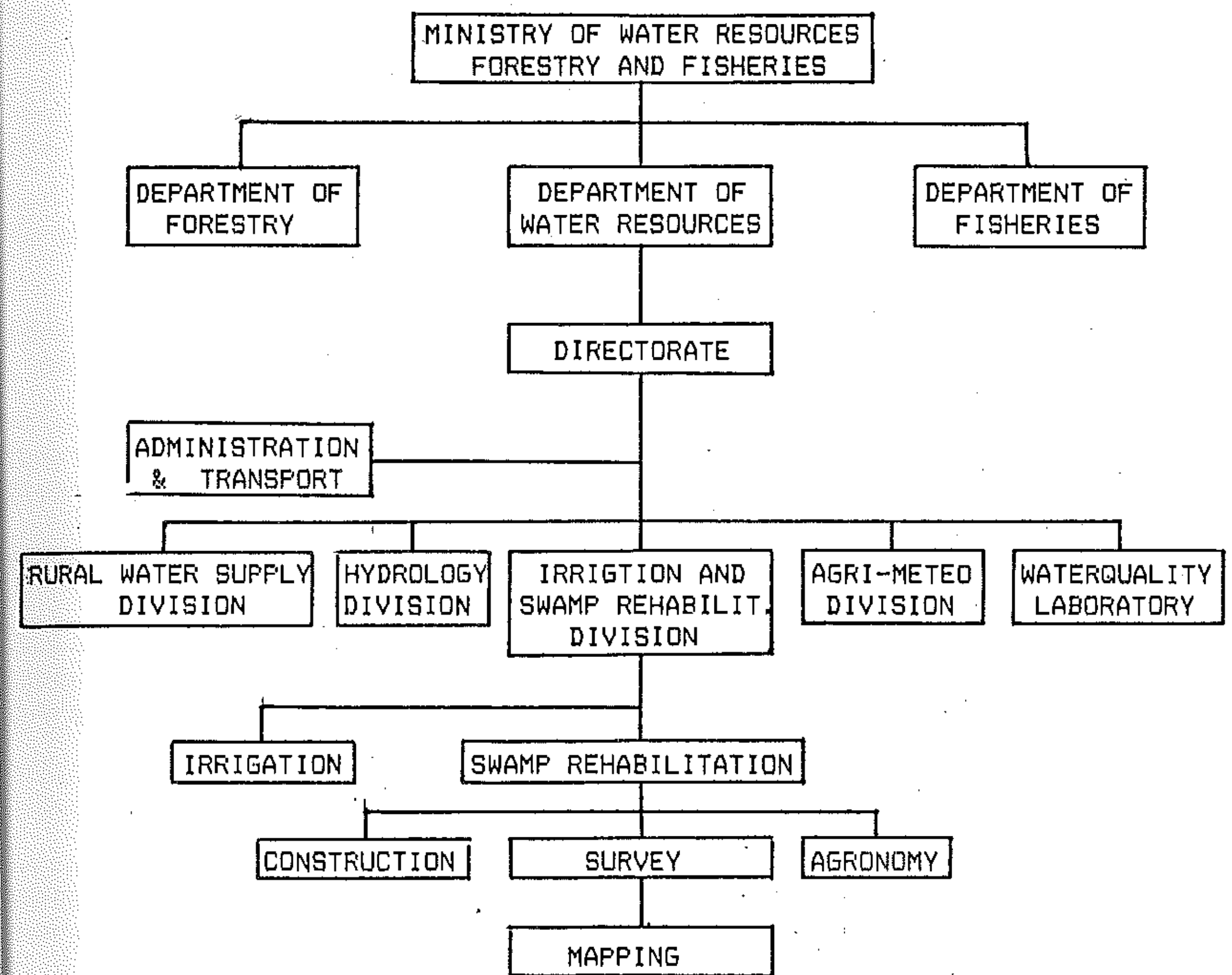
As a pilot project it was, by its nature, not expected to be consistant and rigid with the aim and targets originally formulated. It should rather be flexible to respond to findings and experiences during implementation. The freedom to adjust the goal, objectives and the envisaged activities was never taken which led to the conclusion of the 1987 evaluation mission that the above mentioned goal and objective were too ambitious and unrealistic for a pilot programme.

Although originally formulated as an activity which, together with other activities should lead to the above mentioned goal and objective the project has basically embarked on:

-"developing and testing a package of technical as well as agricultural measures to improve the growing conditions and thus production in traditional rainfed rice growing areas in the western part of The Gambia"

This 're-formulated' project objective should be kept in mind when reading the following paragraphs and chapters of this report.

The target group consists of small scale farmers and/or groups of farmers engaged with rainfed rice cultivation. Since the project, during implementation anticipates commitment and participation from the whole farming community at village level it expects both men and women to contribute to project activities. Rice cultivation in The Gambia, especially at subsistence level is the responsibility of the women, see [3] and [4]. Hence, the improvement of the conditions in traditional rainfed rice growing areas will directly benefit the women.


MINISTRY OF WATER RESOURCES FORESTRY AND FISHERIES
DEPARTMENT OF FORESTRY
DEPARTMENT OF WATER RESOURCES
DEPARTMENT OF FISHERIES
DIRECTORATE
ADMINISTRATION & TRANSPORT
RURAL WATER SUPPLY DIVISION
HYDROLOGY DIVISION
IRRIGTION AND SWAMP REHABILIT. DIVISION
AGRI-METEO DIVISION
WATERQUALITY LABORATORY
IRRIGATION
SWAMP REHABILITATION
CONSTRUCTION
SURVEY
AGRONOMY
MAPPING

3.2 Counterpart Organisation

The 'Irrigation and Swamp Rehabilitation Division'(ISRD), one of the six Divisions comprising the Department of Water Resources (DWR) was appointed as the local counterpart organisation. The position of the ISRD within the Department is shown in the organigram, together with the link to the Ministry of Water Resources, Forestry and Fisheries (formerly named as "Ministry of Water Resources and the Environment").

The Department of Water Resources (formerly the Department of Hydro-Meteorlogical Services, "HydroMet") has a variety of responsibilities. It is basically a supporting Department by offering a wide range of services such as collecting climatic-, hydrological-, hydrogeological-, water quality data, weather forecast etc. which is reflected in its sub-division as shown in the organigram. Only the Rural Water Supply (RWS) division, sponsored by a variety of donors and the ISRD are in fact the only sections with a construction component and physically implementing structures.

Before the GTZ project started the ISRD was involved in swamp reclamation projects in the western part of The Gambia and the lining of irrigation canals of small perimeters in the eastern part of the country, the latter sponsored by the UNDP. Simultaniously with the start of the GTZ project the ISRD received a considerable consignement of earth moving equipment financed by the UNCDF (UNCDF-GAM/81/C02) donated to assist the Division in swamp reclamation work. This approach (large scale, mechanised) was contrary to the approach envisaged by the technical assistance of GTZ (small scale, labour intensive, participation of target group) and caused a considerable confusion at donors level. After a review by UNDP it was decided to combine the UNCDF involvement with a project proposal of UNSO to assist the Division in constructing small dams in tributaries of the River Gambia east of Basse with supplementary irrigation facilities downstreams of those dams. This project started, with 2 technical advisers from an Italian consulting firm by the end of 1986.

It soon became obvious that the Division was not in the position, financial as well as manpower wise to support all these projects efficiently. Moreover, a much needed agricultural follow up in all aforementioned projects was not sufficiently secured since the DWR had no agricultural supporting services of its own and, as experience has shown, difficult access to those services rendered by the Department of Agriculture. Mainly because of this lack of a firmly established link with supporting agricultural services, of paramount interest in swamp reclamation, irrigation and other agricultural related projects several independant consultants, including an evaluation of the GTZ project in 1987 recommended the government to transfer the ISRD to the Ministry of Agriculture. As mentioned in section 2.1 these recommendations were accepted by the Gambian government and the transfer became effective on the 1st of July 1988 as part of a comprehensive re-organisation of the Ministry of Agriculture [20].

Name & position		1985 JFMAMJJASOND	1986 JFMAMJJASOND	1987 JFMAMJJASOND	1988 JFMAMJJAS	Total MM
Principal Irrigation Engineer/ Head ISRD	Planning ac.agreem.	============	============	============	=========	45
Mrs.Fatou Jasseh	Planning	============	============	============	=========	45
	Actual	_ _ _	_ _ _	****** _ _	*******	8
Agronomist	Planning ac.agreem.	============	============	============	=========	45
Famara Badjie	Planning	============	============	============	=========	45
	Actual	___________	____________	____________	_________	43
Construct. Supervisor	Planning ac.agreem.	============	============	============	=========	45
Kebba Khan	Planning	============	============	============	=========	45
	Actual	____________	____________	____________	_______	43
Works-Overseer	Planning ac.agreem.	============	============	============	=========	45
Alkali Badjie	Planning	============	============	============	=========	45
	Actual	________	____________	____________	_________	39
Works-Overseer	Planning ac.agreem.					
Ibrahima Ceesay	Planning					
	Actual			__________	________	18
Surveyor	Planning ac.agreem.	============	============	============	=========	45
Saikou Njie	Planning	============	============	============	=========	45
	Actual	____________	____________	____________	_________	45
Total Man-months brought forward	Planning ac.agreem.	60	60	60	45	225
	Actual	43	51	62	40	196

see continuation

Table 2.: Planned and Actual Involvement CP Personnel

Name & position		1985 JFMAMJJASOND	1986 JFMAMJJASOND	1987 JFMAMJJASOND	1988 JFMAMJJAS	Total MM
Staffman	Planning ac.agreem.	============	============	============	=========	45
Fabala Camara	Planning	============	============	============	=========	45
	Actual	____________	____________	____________	_________	45
Staffman	Planning ac.agreem.	============	============	============	=========	45
Jerre Trawally	Planning	============	============	============	=========	45
	Actual	____________	____________	____________	_________	45
Draftsman	Planning ac.agreem.					
Stanley Adams	Planning	= = =	= = = =	= = = =	= = = =	15
	Actual	_ _ _	_ _ _ _	_ _ _ _	_ _ _ _	15
Tractor Driver	Planning ac.agreem.					
Demba Sowe	Planning	============	============	============	=========	45
	Actual	____________	____________	____________	_________	45
Driver	Planning ac.agreem.					
	Planning		========	============	=========	27
	Actual		________	____________	_________	27
Total man-months brought forward	Planning ac.agreem.	60	60	60	45	225
	Actual	43	51	62	40	196
Total man-months project period	Planning ac.agreem.	84	84	84	63	315
	Actual	83	97	114	79	373

Counterpart seconded to UNCDF/UNSO Project

Continuation Table 2.: Planned and Actual Involvement of CP Personnel

DETAILS OF ESTABLISHMENT

Sub-Head	Numbers 1987/88	Numbers 1988/89	Detail	Grade	actual number posted
06			(3) IRRIGATION		
			Salaries (010)		
(28)		1	Principal Agricultural Officer (Irrigation)	16	1
(29)		1	Senior Agricultural Officer (Irrigation)	15	—
(30)		1	Agricultural Officer (Irrigation)	14	—
(31)		1	Agricultural Superintendent (Surveys)	10/12	—
(32)		2	Agricultural Assistants (Surveys)	8	1
(33)		3	Draughtsmen	6/7	2
(34)		1	Senior Works Supervisor	10	—
(35)		2	Works Supervisors	8	1
(36)		2	Assistant Works Supervisors	6	1
(37)		4	Irrigation Assistants	6	3
(38)		1	Field Worker	5,6/7	—
(39)		4	Field Workers	4	2
(40)		1	Driver/Plant Operator	5/6	—
(41)		1	Mechanic	4,5/6	—

Table 1.: Gambian personnel according estimates and actual situation

3.3 Personnel

3.3.1 Gambian Contribution

The number of civil servants previously attached to the ISRD but transfered to the DOA effective from 1st July 1988 according the 'Estimates' [21] including the number of posts actually assigned is summarized in Table 1.. It is obvious that the Division has grossly been (and still is) understaffed. This situation even detoriated more after a retrenchment exercise of governement as part of the Economic Recovery Programme (ERP) initiated in 1986 and the resignation of one of the Irrigation Engineers and a secondment of another Irrigation Engineer both in 1987.

The Principal Irrigation Engineer (PIE), the official appointed counterpart of the technical adviser is, as head of the Division mainly concerned with administrative matters, preperation of reports, budgeting and budget control. Besides, from February 1987 onwards the PIE became the local engineer of an UNSO/UNCDF sponsored irrigation project (see 3.1) in the eastern part of the country near Basse, implying a permanent posting in Basse up to July 1987 and from January 1988 up to July 1988. This explains the only part time involvement of the PIE in the day to day management of the GTZ project and reflected as such in the barchart of Table 2.

The additional technical personnel (four in number) attached to the project on a permanent basis was according the project agreement, with some more additional supporting staff attached later as mentioned in Table 2. Nevertheless, the number of personnel was regarded as the absolute minimum required for an accountable project execution. Absenteeism, due to leave or sickness, was immediately reflected in the execution of the project and often causing delays.

As stipulated in the project agreement, a qualified rice extension agronomist, on the pay-roll of the Department of Agriculture was seconded to the project, on a permanent basis from the 1st of March 1985 onwards.

From all the attached personnel only the rice extension agronomist had been trained to an appropriate level i.e. short term courses in Liberia and Taiwan and a Diploma Course General Agriculture in Ibadan, Nigeria. The draftsman followed a 1 year course in cartography at the ITC, Enschede, Holland with a fellowship from the dutch government.

The construction supervisor and the surveyor, both secondary school leavers with limited experience when joining the ISRD were trained 'on the job' during project implementation. Due to their commitment they were soon able to perform their duties independant and were bearing resposibilities far beyond their grade and actual position within the ISRD.

Position & name		1985 JFMAMJJASOND	1986 JFMAMJJASOND	1987 JFMAMJJASOND	1988 JFMAMJJAS	Total MM
Project-leader	Planning ac.agreem.	============	============	============	=========	45
Mees van Krimpen	Planning	============	============	============	=========	45
	Actual	____________	____________	____________	_________	45
Short Term Expert H.Holler + M.Zoebisch	Planning ac.agreem.	==	==	==		6
	Planning			==		2
Evaluation	Actual			__		2
Short Term Expert G.Groetecke	Planning ac.agreem.				==	1.5
	Planning				__	1.5
Project proposal	Actual				__	1.5
Total Man-months	Planning ac.agreem.	14	14	14	10.5	52.5
	Actual	12	12	14	10.5	48.5

Table 3.: Planned and Actual Involvement of GTZ Personnel

3.3.2 German Contribution

In terms of personnel and according the project agreement (see Annex 1.) the Government of the Federal Republic of Germany has made available for the period January 1985 up to December 1987:

- one expert in land and water use engineering for 36 manmonths,

- short term experts in various fields for 6 manmonths.

During this period only 2 manmonths short-term expertise were used (Project Evaluation of February 1987).

The agreed project extension from January 1988 up to October 1988 provided:

- one expert in land and water use engineering for 9 manmonths,

- short term expert(s) for 1.5 manmonths.

The planned and actual involvement of the technical adviser and short term experts are reflected in Table 3.

3.4 Transport and Equipment

The project catered for two vehicles (VW Transporter Vans) to cover the transport needs. The type of vehicle appeared to be handy and sufficiently sturdy to reach even the remotest villages (during the dry season).

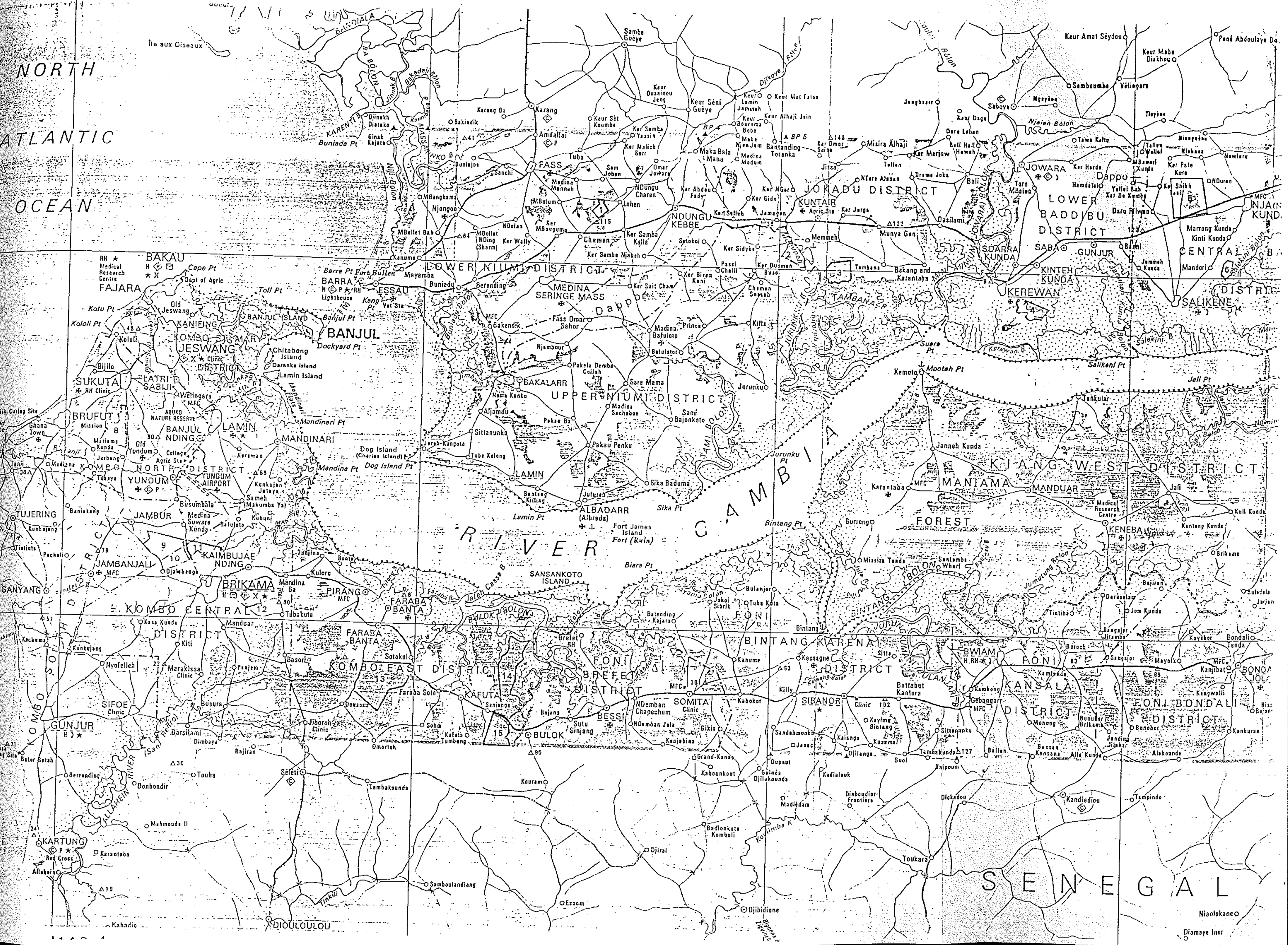
To cover a temporary shortage in transport needs the project could borrow one additional vehicle from the Department (but covering the running cost). Unfortunately this vehicle had to be returned after the creation of a 'pool' of vehicles administered by the Department of Public Works.

To ease the movement of extension personnel, especially during the cropping season one motorcycle and two bicycles were purchased.

All purchasing- and running cost were paid from project funds.

To provide the various sections with tools and additional equipment the project imported soil survey- and testing equipment, soil laboratory equipment, topographical survey equipment, drawing materials and equipment, water quality testing equipment and a variety of office equipment. For the vehicles and part of the office equipment spare parts were imported.

Construction material and equipment was, for the greater part purchased locally.



NORTH
ATLANTIC
OCEAN
BAKAU
FAJARA
BANJUL
BARRA
ESSAU
LOWER NIUMI DISTRICT
UPPER NIUMI DISTRICT
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LOWER BADDIBU DISTRICT
CENTRAL BADDIBU DISTRICT
KUNTAIR
NDUNGU KEBBE
FASS
JOWARA
KEREWAN
SABA
GUNJUR
KINTEH KUNDA
SUARRA KUNDA
SALIKENE
MEDINA SERINGE MASS
BAKALARR
ALBADARR (Albreda)
Fort James Island
RIVER GAMBIA
KIANG WEST DISTRICT
MANIAMA
MANDUAR
FOREST
KENEBA
KANIFING
JESWANG
SUKUTA
BRUFUT
LAMIN
MANDINARI
YUNDUM
KOMBO NORTH DISTRICT
TUJERING
JAMBUR
JAMBANJALI
KAIMBUJAE NDING
BRIKAMA
PIRANG
FARABA BANTA
SANYANG
KOMBO CENTRAL DISTRICT
KOMBO EAST DISTRICT
KOMBO SOUTH DISTRICT
SIFOE
GUNJUR
KARTUNG
KAFUTA
BULOK
FONI BREFET DISTRICT
FONI BINTANG KARENAI DISTRICT
SOMITA
SIBANOR
BWIAM
FONI KANSALA DISTRICT
FONI BONDALI DISTRICT
SENEGAL
DIOULOULOU

3.5 Project Area

The project was supposed to develop and test techniques and approaches for the improvement of traditional rainfed rice growing areas in the western part of The Gambia where no alternatives (e.g. irrigation) in increasing rice production exist (see 3.1). Moreover, being a pilot programme it was necessary to select project sites with varying soil, agro-hydrological, agricultural and topographical characteristics apart from lesser emphasised but nonetheless important issues like land tenure systems, socio-economic relations, (sexual)-division of labour etc.

To be able to cover an as large as possible variety of rice growing areas but keeping in mind the limited number of staff, budget and time span it was decided to select the pilot schemes and concentrate the activities in the Western Division (see Map 1.) only. To include the western part of the North Bank Division would mean arduous and often unreliable ferry crossings and was therefore pure for logistic reasons rejected.

3.5.1 Natural Resources

<u>Climate</u>

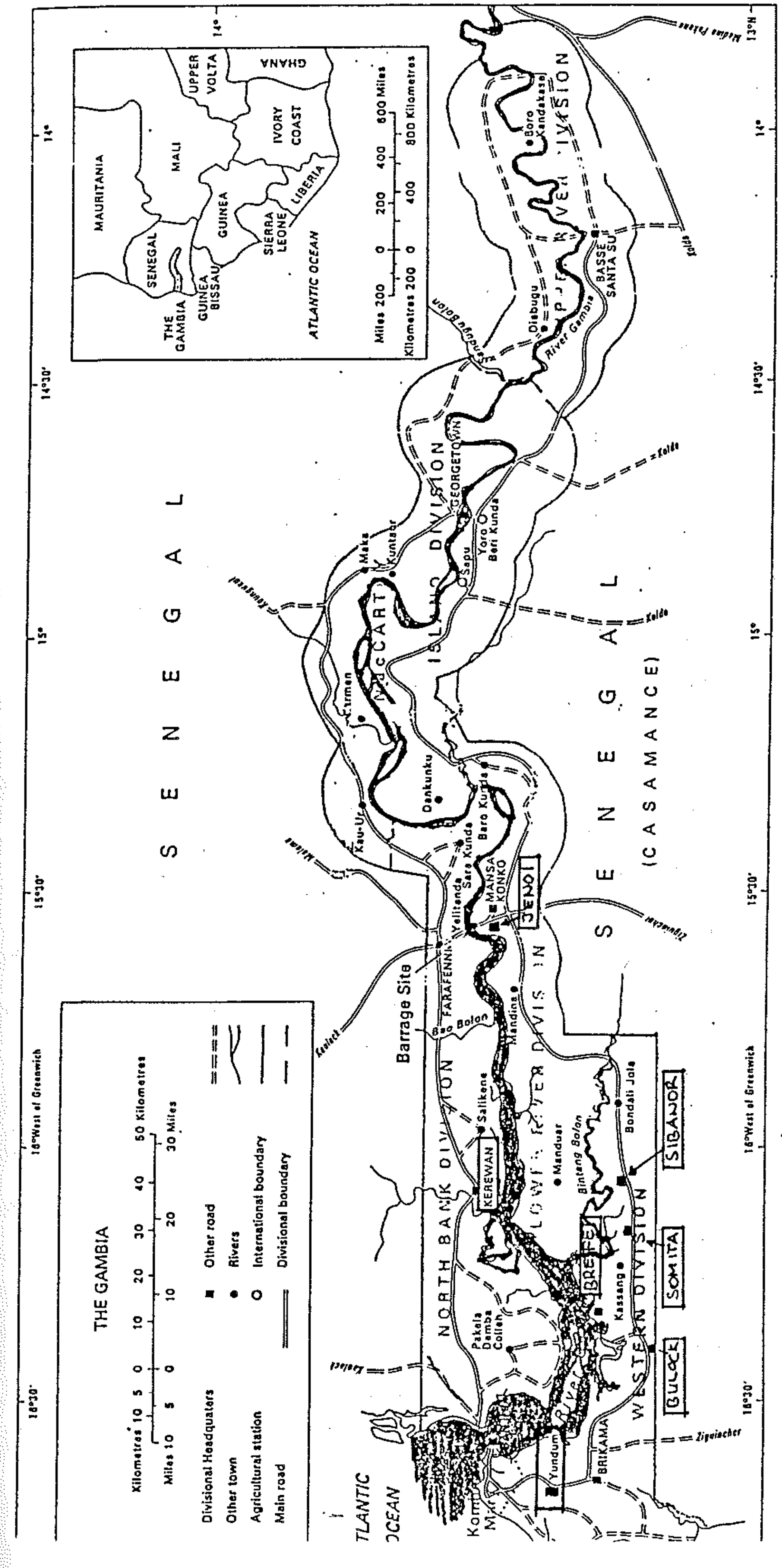
The dominant aspect of the climate of The Gambia is the juxtaposition of a five months period with rainfall (June - October) with seven months dry season. A comprehensive analyses of the climate in the Gambia is given in [8]. Only rainfall, air temperature and evaporation are briefly described below.

The annual rainfall totals from 1980 up to 1988 for five stations in and around the project area (see Map 2.) plus the country average for each yea are presented in Table 4.

STATION	1980	1981	1982	1983	1984	1985	1986	1987	1988
YUNDUM	635	682	848	<u>424</u>	642	962	762	800	1229
KEREWAN	701	684	732	454	612	638	600	956	1337
SOMITA	733	854	766	732	889	-	-	-	-
JENOI	616	829	583	489	706	630	877	849	916
SIBANOR	-	-	-	-	-	-	-	925	<u>1709</u>
COUNTRY AVERAGE	682	712	719	<u>486</u>	639	760	807	895	<u>1021</u>

Country average over 8 stations
Station Sibanor established in 1987

Table 4.: Yearly Rainfall Totals in mm



MAP 2

RAINFALL STATIONS

Monthly totals of up to 5 stations from 1985 up to 1988 are presented in Table 5.

YEAR	STATION	MAY	JUN	JUL	AUG	SEP	OCT	TOTAL
1985	YUNDUM	TR	19.3	379.9	325.3	197.0	33.7	955.2
	KEREWAN	TR	27.5	182.9	260.9	158.9	8.1	638.3
	JENOI	0	53.1	198.0	133.5	184.1	60.8	629.5
1986	YUNDUM	0	34.3	48.0	395.9	217.8	65.7	761.7
	KEREWAN	0	33.3	116.8	201.2	189.4	58.8	599.5
	JENOI	TR	21.2	130.3	395.5	260.7	68.9	876.6
1987	YUNDUM	TR	43.8	134.8	292.4	231.0	98.4	800.4
	KEREWAN	TR	105.4	204.6	391.9	214.3	39.1	955.6
	JENOI	TR	110.7	152.1	305.3	206.9	73.9	848.9
	SIBANOR	0	97.2	261.8	402.6	125.6	38.2	925.4
	BULOCK	TR	107.0	235.0	299.7	178.4	90.1	910.2
1988	YUNDUM	0.9	21.6	382.5	547.3	214.9	61.6	1228.8
	KEREWAN	27.6	76.3	266.6	680.5	220.7	65.3	1337.0
	JENOI	8.6	35.7	257.5	364.9	204.2	44.7	915.6
	SIBANOR	2.1	68.7	353.2	713.3	534.0	37.3	1708.6
	BULOCK	10.0	27.5	209.5	477.8			
	BREFET	-	-	245.3	545.9			

Station Brefet recorde from 1st July 1988

Table 5.: Monthly Rainfall Totals in mm

On many occaisions, particularly at the beginning and end of the season, the rain falls in very intense short storms each only a few kilometers in diameter. Thus sites only a few kilometrs apart may record different rainfall over a short period. Measurements of rainfall at a particular location is therefore of limited value for the estimation of rainfall elsewhere and agricultural experiments depending on rainfall should be gauged individually. The project sites Bulock, Ndemban and Brefet (see Map 2.) were each provided with a raingauge and recorded daily, unfortunately only with reliable data over the years 1987 and 1988 but nevertheless included in Table 5.

As can be seen from Table 4., during the project period and after the driest year ever recorded in The Gambia (1983) annual totals have drastically increased.

Rainfall distribution (in time) used to be unimodal with the peak in August but their is a slight tendency towards a bimodal distribution with a short dry period during the last two weeks of July. Distribution in time is very uneven and during project execution dry spells of about 7 days occured frequently and dry spells of 15 days have been recorded. On the other hand, in the village Brefet only 3 individual days without rain during the month of August 1988 were recorded.

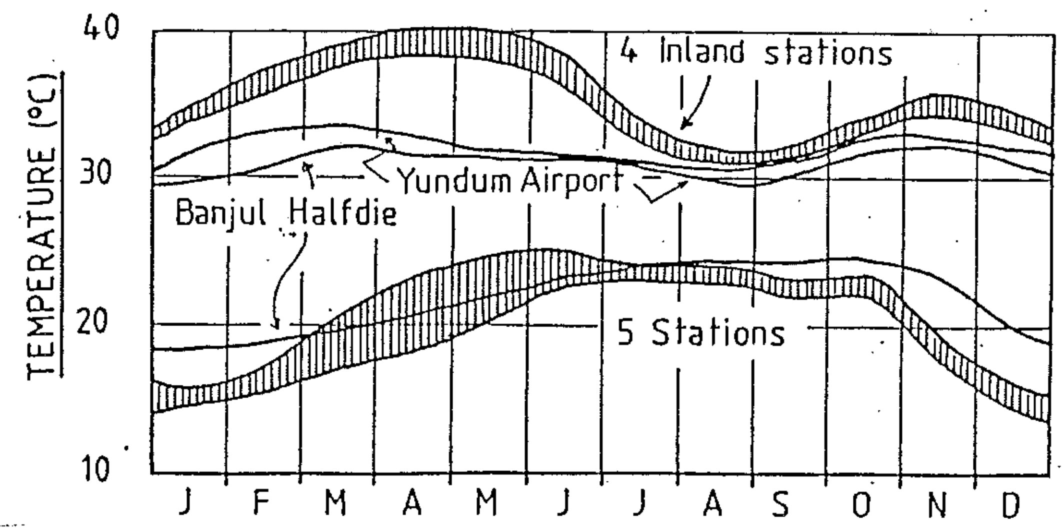


Table 6.: Mean daily maximum and minimum temperatures

Table 6. shows that all stations in The Gambia have a similar air temperature regime, although the amplitude of temperature variations of those stations along the coast (Yundum Airport and Banjul) are much reduced apparently due to their coastal proximity. Although extreme minimum temperatures as low as 7 C (Yundum Airport) have recorded during the night, they pose no harm to crop production (especially for rice) since they only occur in January; during the non-cropping season.

Table 7. shows estimates of monthly evaporation rates according three different methods for the stations Yundum Airport and Jenoi, covering the project area. Evaporation rates are evidently higher inland, due to higher daytime temperatures.

		J	F	M	A	M	J	J	A	S	O	N	D
Yundum Airport	(a)	175	183	233	235	218	210	176	166	159	175	163	164
	(b)	270	255	276	245	183	150	99	71	66	84	138	217
	(c)	233	224	251	258	220	201	211	183	171	167	177	193
Jenoi	(a)	209	193	234	253	247	220	185	194	178	180	169	154
	(b)	310	397	372	366	270	219	127	87	69	102	183	226
	(c)	267	260	326	351	381	222	186	140	126	211	147	158

Table 7.: Estimates of Evaporation using (a) Penman Formula, (b) Piche Evaporimeter and (c) Class "A" Pan

Soils

The traditional rice growing areas in the western part of The Gambia are either found on the topographical higher situated freely drained soils of the Continental Terminal, usually refered to with the local name 'Tendako'. Or on the lower situated soils of the alluvium/ colluvium of the smaller tributaries of the River Gambia (or tributary valleys of the Bintang Bolon) and the plains between the upland and the extensive mangrove swamps of the estuary ('Bantafaros').

Since the project has only covered rice growing areas in the latter only a brief description of the alluvial/colluvial soils will be presented below. For a comprehensive description of all soils covering The Gambia the reader is refered to [14].

The watertable is liable to limit the effective depth of the alluvial soils in the western part of The Gambia and in the lower reaches of its tributaries. The watertable is close to the surface throughout the year and often subject to tidal fluctuation. Elsewhere, especially in the upper reaches of the tributary valleys the watertable is deep during the dry season but may be close to or above the ground surface in the wet season.

Because of its depositional nature the soil texture in these alluvial soils differs widely and may even vary within a single profile. However, the lower situated profiles, in the valley bottoms and those comprising the terraces are usually heavier textured clay to sandy clay soils with a hydromorphic character with a moderate to high moisture retention capacity. Further up the slopes and in the upper reaches of the valleys the soils are much lighter, varying between sandy loams and loamy sands and basically free draining.

The soils comprising those areas subject to flooding by the tide are mainly young soils on recent fluvio-marine sediments normally colonised by a variety of mangrove species, mostly potentialy acid. The adjacent, slightly higher lying areas usually not flooded daily by the tide (only during spring tide) are normally completely devoid from vegetation and referred to as barren flats. These barren flats have predominantly very saline and extremely acid soils, difficult if not impossible to reclaim for agricultural purposes (see also [13]).

The bordering plains, often flat, low lying extensions of the tributary valley floors comprise better developed fine textured soils, hydromorphic and often, when subject to tidal flooding saline and acid during the dry season. These plains, when not cultivated have a variable cover ranging from sparse grasses like "Paspalum Vaginatum" to a tightly grazed sward often with scattered oilpalms fringing the uplands.

Compared to the 'upland' soils the alluvial soils are better off with regards to fertility, especially the heavier soils in the valley bottoms and the aforementioned 'plains'. Nonetheless, generaly speaking organic matter contents are low. In nutrients, these soils are low in phosphorus but with moderate nitrogen and usually have an adequat potassium content. Some organic matter (groundnut shells) is, traditionally, incorporated during land preperation. Fertilization, however, is hardly practiced mainly due to cost considerations.

3.5.2 Land Use

Of all Divisions, the Western Division is the most densly populated of The Gambia comprising the country's three main urban centres Banjul, Serekunda and Brikama. Land pressure is consequently extremely high and obviously in conflict with the traditional land use and land tenure systems.

The exploitation of the land is described as follows:

- food crops such as millet, sorghum, maize and to a lesser extend also rice on the well drained, lighter soils of the uplands
- groundnuts as the only cash crop also on the uplands
- rice is grown mainly in the lower situated tributary valleys of the River Gambia, Bintang Bolon or the upper reaches of those valleys draining south to the Casamance River in Senegal, the Allahein River and in valleys of a few streams dirctly draining in the Atlantic Ocean. The earlier mentioned floodplains in between the uplands and the extensive mangrove swamps used to play a more important role in rice production but are seriously affected by salt intrusion due to occaissional (spring tide) tidal floodings
- extensive lifestock (cattle) rearing on the uplands, woodlands and in the valleys only during the dry season
- intensive vegetable gardening is found during the dry season in valleys with a relatively high groundwater table which makes irrigation from shallow hand dug wells possible. Permanent gardens are found near the villages with permanent, often concrete lined watering wells. With informal organized market outlets to the main urban centres these gardens generate a considerable income for the women who take care of these gardens
- orchards (citrus and mangos) are found near main urban centres together with some commercial farms. An incpeasingly part of the production is exported; air-lifted to Europe (mainly U.K.) or sold to enterpreneurs from Senegal
- forests are partly protected as so called 'National Forest Park' and consequently not commercialy utilized. Non protected forest lands are increasingly more exploited for firewood or transferred into farmland. Mangroves are sometimes exploited for firewood but are generaly speaking not utilized.

The exploitation of agricultural land is traditionally extensive with long periods of fallow to regenerate the relatively poor soils. However, due to the aforementioned land pressure and especially around the villages the land is practically permanent i.e. yearly or in any case cultivated without a sufficient long spell of fallow. Soil fertility and its texture are therefore rapidly deteriorating and is consequently aggrevating soil erosion.

Animal drawn farm implements are widely used in The Gambia. Most farmers are equiped with a pair of oxen for this purpose. However, in rice cultivation animal traction is still uncommon, partly due to the nature of the soils but mainly because the women have no access to animal traction. If they do use implements together with traction they use them for seeding only and of their husband. Otherwise they 'rent' the equipment usually together with the owner/operator (see 4.4.4.).

Livestock rearing is, besides crop production an evenly important aspect of the total farming society. The major part exist of cattle, the trypano-tolerant N'dama and to a lesser extend also sheep,goat and donkeys. The latter are mainly used for traction. The exploitation is extensive and the main objective is a social one; status and a safeguard against crop failures and other catastrophies so that enlarging the herd is more important than improving the quality by selective rearing.

3.6 Other Projects

In recent years a number of pilot projects have been initiated to investigate the possibilities of exploiting and/or improving the rainfed and tidal influenced rice ecologies of The Gambia. Four more on-going projects have been field-testing different non-pump technical designs for 2 to 5 years; each with a different development strategy and ecology within they have worked. These projects are briefly summarized below:

- Soil and Water Management Unit (Department of Agriculture), sponsored by USAID -- construction of water retention and anti-salinity dikes for improved water control in the transitional and rainfed rice growing areas. Similar to the GTZ Project described in this report
- Freedom from Hunger Campaign (NGO, but responsible to the Ministry of Agriculture, sponsored by DWHH, German Agro Action) -- construction of causeways, footpaths and bridges to improve access to farmers of rice fields in tidal swamps
- Jahally Pacharr Tidal Irrigation Project (responsible to the Ministry of Agriculture, sponsored by a variety of donors) -- construction of canals, gates dikes and natural waterways together with levelling to improve watercontrol in freshwater tidal swamps (apart from the pumped irrigated small holders scheme of the same project)
- Womens Irrigated Rice Project/Prufu Bolon (Department of Agriculture ex Department of Water Resources), sponsored by UNCDF/UNSO -- construction of a diversion weir, primary, secondary and tertiary canals for supplementary irrigation of an approx. 100 ha rice growing area. Project under construction; no field expierences yet.

For a detailed description of the first three above mentioned projects the reader is referred to a seperate study comparing these three and the GTZ project [5].

4 PROJECT EXECUTION

4.1 Technical Aspects

4.1.1 Village Selection

At the onset of the project no concrete requests from villages or groups of farmers, as to look in certain problems encountered or suspected in their rice growing areas were available. The project had therefore the freedom to select areas itself just to be able to start somewhere and to make its activities recognizable to the farmers, other surrounding villages and the local authorities.

The approach decided to follow was to select rice growing areas being cultivated and actualy belonging to a particular village, as much as possible matching the criteria already mentioned in section 3.6. Not always the entire area, as a hydrological unit was cultivated by farmers of one individual village only but by farmers of two or sometimes three villages. In cases their was no simultaneous request from the villages cultivating a particular area together, the project has always tried to visit those others and to pursuade the farmers to participate as well. This approach has been a compromise; it would have been more sound to consider the entire catchment area as the hydrological unit to work with. However, rice growing areas are clearly defined and easily recognizable sub-hydrological units within the total catchment. Keeping in mind the project's objective to concentrate on rice growing areas and to develop measures to improve conditions in these within the framework of a pilot project this approach was considered acceptable.

Together with the Department of Water Resources it was decided to start the activities in the village Bondali Jola, its rice growing area claerly suffering from salt intrusion and poor water retention in the upper reaches.

Followed by projects in the villages Bwiam and Pirang the activities initiated became well known through mouth to mouth communication among villagers and relatives. Enough 'requests' reached project staff to select additional areas on the basis of these requests. A total number of 16 schemes were initiated; 10 more than initially envisaged. All schemes are briefly described together with a review of the constructed infrastructure in Annex 5.

4.1.2 Reconnaissance Surveys

After a request was received project staff made a first orientative visit to the village to make an appointment with the village head and/or elders for them to call a village meeting. In some cases this was followed by a brief visit to the rice growing area in question but was preferably postponed untill after the village meeting as to have more farmers around with consequently more (unbiased) opinions.

Project staff always made clear that those meetings should not be attended by the village leaders and elders only. The participation of the women, afterall those cultivating the rice was regarded as very important. During these meetings the following subjects were discussed:

- actual or suspected problems of reduced rice production
- possible solutions brought forward by the villagers
- aim and procedures of the project
- anticipated village contribution
- expected results by the villagers vis a vis results expected from project staff
- incentive system applied

During the following field visit it was tried to discuss the following:

- severness of salt intrusion in the lower reaches of the area
- water retention problems in the whole area
- cultural practices and varieties used
- possible solutions, technical as well as agricultural
- village participation expected by the project
- possible time planning
- payment of incentive

During the whole exercise project staff is contineously stressing the importance of farmers participation and the willingness to do so is probed. If certain guarantees, by the villagers can be given appointments are made as when to start the survey and construction activities.

4.1.3 Topographical Surveys

A topographical survey was conducted with the aim to produce a detailed map containing the following features:

- all existing plot/field boundaries
- perimeter of the area i.e. boundary with the upland and barren flats
- other, typical features such as roads, tracks, gullies, isolated spots with oilpalms and so forth

The entire area was levelled related to an assumed height (due to the absence of official Gambia Datum Benchmarks nearby) with one or more spot heights per plot.

The survey was referred to temporary benchmarks (pegs). Fieldpoints and spotheights were measured according the tachyometric levelling method recording height, distance and bearing.

The survey team comprised one 'on-the-job' trained surveyor, two staffmen and temporary labourers according the need. Assistance from the villagers was expected for cutting pegs, carrying equipment to and from the field and accomodating the survey team.

4.1.4 Mapping

Raw survey data were elaborated either by the draftsman or members of the survey team.

All areas were mapped on scale 1 : 500 indicating all temporary benchmarks, plot boundaries, spotheights and other typical features as mentioned above. Printed maps are, because of their number and size not included in this report but available at the project's office at the Department of Agricultue/SWMU.

4.1.5 Design

The technical measures developed, tested and meant to improve the growing conditions entail three type of structures:

- dikes, to prevent tidal flooding and further salt intrusion in the lower reaches of the area, simultaneously retaining surface run-off (also called 'anti salt dikes')
- contourbunds, to retain surface run-off in the upper reaches
- sluice gates and spillways (or combinations of these two), to regulate waterlevels upstreams of these structures and to drain excess water out of the entire area

The project embarked on a high level of village participation especially during the construction. Consequently the designs had to be simple enough to be built by unskilled labour.

Dikes

According a statistical analysis of the riverlevel-gauging stations Banjul and Yelitenda (near Farafeni) maximum spring tide levels with a return period of 100 years are to be expected approximately 35 to 40 cm above mean high water level. The latter level is easily assessable in the field since it marks the boundary of the barren flats and the arable (flood)plains and uplands. Other features such as a distinct salt crust and salt resistant vegetation also indicates up to where, on the average, 'normal' high tide penetrates. The dikes were constructed 100 cm above this level as to have enough freeboard in cases of exceptional high (spring) tides and to have some tolerence in settling of the material the first year after construction. The lay-out of the dike was also established in the field taking the extend of the salt crust, certain vegetation ('Sesuvium', 'Paspalum' and species of 'Cyperaceae' and 'Junaceae'; recognizable on aerial shoots) and the extend of still productive and abandoned rice fields into consideration. A typical cross-section of the dikes constructed is given in Annex 3.

Contourbunds

Contourlines were established on the maps mentioned in section 4.1.4. with intervals of 50 cm, the natural outlet of the area as lowest reference. The lay-out of the contourbunds was based on these contourlines. However, to avoid

- devision of (often already small sized) plots causing
- conflicts among farmers (users and/or owners) and
- unnecessary loss of land

the lay-out of the bunds was as much as possible following the existing plot boundaries and matching the natural contours (an example is given in Annex 3.). A primaraly lay-out was drawn on the maps and used as a basis. The final lay-out was established in the field incorporating (micro) topographical features not reflected on the maps.

Basically the contourbunds were constructed approx. 70 cm above the natural contour. With a structure spilling excess water at a level of 50 cm maximum into the next area section. The bund is able, theoretically, to impond the area upstreams from maximum 50 cm to 0 cm near the next, higher situated bund. A typical cross-section of a contourbund and a field lay-out are given in Annex 3.

<u>Sluice gates and Spillways</u>

Since most rice growing areas in the Western Division are situated at the lower reaches of a catchment area it is obvious that all structures blocking and eventually retaining surface run-off (dikes and countourbunds) have to be provided with some sort of a device able to spill-over excess water and to regulate water levels.

To guarantee a durable structure it was decided to use concrete and cement blocks as the principal construction material, despite the higher cost. Alternatives like gates totaly made out of timber were rejected; good, durable timber is not that easaly available and always needs maintenance. So called 'gabions' (stones stacked in a wire mash mould) are no option since solid boulderstones are not found in The Gambia. Natural spillways as developed by the Soil and Water Management are low in cost but miss the possibility to regulate waterlevels and/or to drain, on demand the area completely, which is considered very crucial to optimize growing conditions.

Both structures were designed keeping the following in mind:

- solid and simple to construct
- easy to operate and to maintain
- standard 'units', dimensions based on available construction material
- low costs

To simplify the design as well as the construction the available construction material was used to determine the principal dimensions. A casted concrete slab forms the basis of the gates and spillways. Since the available reinforcement mash wire (known as 'BRC')is available in the sizes of 2m x 5m and 2m x 6m it determined the standard size of both structures. Examples of typical designs are presented in Annex 4.

For the design of the sluice gates in Pirang, a modified Curved Number method was used to estimate surface run-off using a 10 years return period. Since the rice growing area itself has a considerable storage capacity, especially in combination with contourbunds, and a short period of flooding does not harm plant growth the discharge capacity of the gates finally chosen has been a compromise in relation to the maximum capacity theoretically desired. In a later stage of the project the spill-over capacity of the structures, initially only provided by the doors themeselves was increased by incorporating more spillways. Experience of the 1988 season, with an exceptional high rainfall and very intensive short storms has dictated that additional spill-over capacity has to be incorporated in most of the schemes to avoid damages (see also chapter 5).

To regulate waterlevels and for complete drainage all sluice gates were equiped with simple sliding doors, each made of boards of locally purchased timber.

The type, determined by the number of doors per sluice gate and the total number of sluices per dike was depending on the amount of expected run-off and number of natural outlets (depressions, gullies) of the area. Basically every contourbund was provided with one spillway each fitted with a number of boards on top of each other to regulate waterlevels and to be able to drain the area upstream. Excess water, beyond the capacity of the spillway was expected to spill over the contourbund or via temporary, make shift outlets.

4.1.6 Construction

Dikes and contourbunds

To engage the villagers with the project and to raise awareness and resposibilities among the beneficiaries the construction of both dikes and contourbunds was organized together with the villagers and executed entirely manual. The way this exercise was organized is discussed more in detail in section 4.2.

Before the actual construction started the final lay-out of the structure cross-sections were staked out with the help of pegs, prepared by the villagers. For the anti-salt dikes an interval of 25 metres was used whereas an interval of 10 metres was used for staking out the contourbunds. Each centre peg was levelled and marked according the correct construction height. The in this way staked out 'chains' of 25 m and 10 m respectively also formed the basis of the incentive system discussed in section 4.3.

Dikes and bunds were constructed from compacted earth. Initially the material was scooped, with the help of spades from ditches alongside the dike. Although a fast construction method it soon became clear that after filling by the tides, (salt)water seeped from the 'downstream' ditch into the 'upstream' ditch thus in fact aggrevating salt intrusion instead of blocking it. To tackle this problem it was decided to bring the material from pits outside the protected area with the help of wheel barrows, buckets, pots and pans and with so called headpans.

Contourbunds have been constructed, throughout the project period in the manner first mentioned i.e. from shallow ditches alongside the bund in question. The loss of land appeared to be less severe as initially anticipated. Even during the first cropping season after construction both stretches were cultivated and enhanced land-levelling practices.

As mentioned before, all these structures were constructed by hand using simple tools like spades, pick-axes, wheel barrows and head pans (shallow bowls with two grips, carried on the head). These tools were provided by the project on a loan basis and rotated among different construction sites.

Construction work was supervised either by project staff (work supervisors) or by somebody selected from among the villagers and guided by project staff. These people usually became the contact person of the village and often also those responsible for operating the sluice gates and spillways.

Sluice gates and Spillways

The construction of the sluice gates and spillways was entirely managed, implemented and paid for by the project. The construction team, consisted of one or two qualified mason(s) employed on a daily basis and a varying number of daily paid labourers. The team was headed by a construction supervisor, trained 'on the job' in the project and in the course of the project assigned to be fully responsible for the construction of gates and spillways. This included the purchase of material and equipment, transport, selecting and employing additional labour and administrative matters.

To ease transport of construction material the project accepted an offer from the ISRD to use one of the tractors of the UNCDF consignement (see section 2.1) provided the GTZ project would cover all the running cost. A qualified driver from the Department of Works ('Public Works') was assigned to the GTZ project on a permanent basis. The tractor, equiped with a 3 tons tipper trailer was solely used at fieldlevel to ferry construction material (cement, steel, moulds, mixer etc) from stores in the villages, sand and gravel from nearby pits and fresh water to the construction sites.

The concrete slabs were casted in steel moulds and reinforced with a varying number of sheets of 'BRC'. The super-structure was erected from simple, solid cement blocks (40 x 20 x 20 cm), plastered and coated with bituminus paint. Grooves to fit the sliding doors were chipped out or, later, integrated in moulds to cast the concrete pillars. From the same aforementioned UNCDF consignement a simple 200 litre concrete mixer and a portable vibrating tamper for earth compaction were used by the project.

A summary of all structures constructed per village is given in Annex 5.

4.2 Village Participation

As mentioned before village participation was considered crucial in project implementation. Basically the idea was:

- to involve the villagers in the planning process right from the beginning rather than imposing certain ideas and interventions
- to raise awarness and responsibilities among the villagers during project executiQn to secure a long term engagement and involvement especially with regards to maintenance issues
- to involve the villagers during construction in planning the follow -up, with emphasis on agriculture related issues like adapted varieties, water management etc.
- to economize construction cost

Already during the first contacts and during the village meetings participation, expected involvement and output from the farmers and responsibilities of project and villagers were discussed. Contrary to other projects (e.g. SWMU) the GTZ project embarked on a fully manual construction of the necessary infrastructure which is a time consuming and ardeous tasks for the villagers and to be considered carefully beforehand.

Non of the projects were therefore initiated without discussing this issue at length during village meetings, in personal encounters with village leaders and with individual farmers. Consequently non of the projects started without certain guarantees from the villagers and with confidence among project staff that the intentions and promises given were genuine.

4.3 Incentive system

The use of and type of incentive system differs widely among similar projects in The Gambia. It ranges between a fully compensated partly food partly cash for work system (e.g. practiced by the FFHC project) and no compensation at all i.e. completely relying on voluntary contributions (as practiced by the SWMU). Despite numerous arguments against it the GTZ project decided to introduce a cash incentive system. The main argument to do so was to compensate not only for the labour invested by each individual participant (opportunity cost) but also to compensate for some sort of uncertainty; inevitable due to the nature of a pilot project. It was considered unfair to expect commitment and hard work from farmers during a period traditionally meant for e.g. compound repairs and social events without the guarantee, from project staf that the envisaged measures would benefit them all and to an equal extend.

The system practiced was that for every 'chain' (as mentioned in section 4.1.5) completed, according pre-set standards a certain amount was paid. The amounts were paid eitherto individuals or as a lump sum to the village leader. The villagers were free which option to choose.

Experiences, negative as well as positive will be discussed in Chapter 5.

4.4 Agricultural Follow-up

4.4.1 Organisation

According the project agreement a qualified rice extension agronomist was assigned to the project as from the 1st of March 1985. Being trained in The Gambia, Liberia, Sierra Leone and Taiwan in rice production techniques and extension related subjects followed by a Diploma Course in General Agriculture in Nigeria together with a remarkable motivation and commitment he proved to suit very well in his job. All programs were proposed, implemented and managed by the agronomist with any additional help and funding from the project he deemed necessary. All activities were reported to the GTZ Expert in weekly meetings. During the dry season, with very few agricultural related activities the agronomist was equally involved in attending village meetings, organizing village participation and overseeing project implementation in the various villages.

The Department of Water Resources has no formal links with the service rendering sections e.g. the Extension Aids Unit (EAU) of the Department of Agriculture. This made an integration of the agricultural section of the project with these services difficult in practice. Although every village in theory is dealt with by a Village Extension Worker (VEW) of the EAU, in practice it appeared difficult to rely on these people if it concerned project matters in general and rice extension in particular. Most VEW's are dealing with only part of their assigned villages due to lack of transport. In general rice production only receives limited attention of the EAU in relation to groundnuts and cereals as the most important cashcrop and foodcrops respectively. All agricultural related activities within the project were therefore executed by the agronomist himself with, during the course of the project more and more assistance from the other project staff. The assignment of members of the survey team to the agronomy section during the cropping season was a rather successfull temporary re-allocation of available manpower. This was possible since survey work used to be suspended during the rainy season due to inaccessible fields. The surveyor and one of the staffman became very engaged in executing part of the agronomy program like coducting trials, yield surveys, monitoring of crop performance, seed multiplication and in dealing with general extension questions.

Programs executed over the years were dealing with a variety of issues, each being discussed more in detail in the following sub-sections.

4.4.2 Varieties

A major problem of those farmers in the western part of The Gambia growing rainfed rice was the wide spread use of local varieties with a cycle of 130 to 140 days. These varieties were obviously no longer suitable in view of a changed rainfall pattern. Moreover, the agricultural practices were clearly not adjusted to the changed conditions e.g. the majority of the rice is still transplanted from nursery beds early September or simply broadcasted.

Due to shorter periods of flooding of those plots in the valley bottoms timely and repeated weeding, formerly hardly practiced became of paramount interest. The higher situated fields, either transplanted or broadcasted also suffered severely from weeds and moisture stress towards the end of the season. Yields were consequently modest and averaged a meagre 800 kg per ha. Only fields with a prolonged period of flooding had the potential of producing up to 2.5 tons per ha in the traditional way but were clearly regarded as exceptions.

With the country facing decreasing amounts of rainfall with 1983 recording an absolut minimum the project sought to tackle this problem by promoting a drought tolerant, short cycle variety. Already in 1984, during the first phase, small quantaties (a few hundered kilos) of two s.c. vatieties, 'Barafita' and 'Aiwu' were distributed among the farmers of the villages Bondali Jola and Kalimu. Although their performance was regarded as excellent 'Barafita' was rejected because of an apparent bad taste.

Following the recommendations of the Department of Agriculture the project opted in 1985 for the variety 'Peking'. This 90 days variety was primeraly meant for the higher, non- or only temporary flooded fields facing moisture stress soon after the last rains. Nonetheless it was widely used, even in the low lying flooded fields of the valley bottoms and became immensely popular. Yields were according expectations and varied between 1000 - 1200 kg/ha on non flooded fields and up to 3 tons (and more) on permanently flooded fields (direct seeded around the 15th of july and harvested towards the end of September, still during the rainy season).

However, project interventions clearly created different, improved conditions (water availability and extended periods of imponding). Moreover, a gradual improving rainfall pattern over the years called for better adapted varieties with cycles between 100 and 120 days.

During field trials several promising varieties have been tested some of which are now recommended and ready for distribution at village level (see section 4.4.5).

4.4.3 Seed Distribution and Multiplication

In 1986 the project ordered 4 tons certified seed of the recommended variety 'Peking' from the (than still existing) Seed Multiplication Unit at Sapu. This lot was distributed among all project villages and 3 non-project villages on a loan basis. Besides, in 11 villages seed multiplication programs were set up.

These small scale seed multiplication programs were initiated to test if a self contained multiplication program in combination with a distribution program, all within one village would be viable. Mainly due to an insufficiently rigid quality control most of these programs failed. Traditional farmers were difficult to convince to clear 'strange' plants and to follow very strictly the advice of the agronomist to assure pureness and quality seed to be recovered.

After recovering the total distributed amount of 4 tons plus an additional 4.3 tons barterd for same quantaties of clean rice the project had well over 8.3 tons of seed of the variety 'Peking' in hand. This amount was re-distributed among additional (new) project villages and a number of non-project villages during the 1987 cropping season. Further recovery and re-distribution was not considered necessary. At least all project villages were sufficiently provided. Besides a remarkable exchange among relatives and neighbouring villages had taken place without interference from the project.

4.4.4 Agricultural Practices

With regards to improving the agricultural practices in a predominantly traditional farming society the agronomy section of the project has tried to put emphasis on a number of issues described below.

Land preperation

Land preperation traditionally starts long after the first rains usually only during the course of August or even later. The main reason is because the common type of soils are extremely hard and difficult to prepare when dry. Besides, most women simply do not have time earlier because they either have to assist the men in planting the 'upland crops' or they take care of their own upland fields first. Nonetheless, the project has stressed the importance of timely land preperation followed by planting immediately after the first rains with the argument to make an optimum use of the, relatively short period with rains. Despite repeated meetings and fieldvisits the agronomist and staff did not succeed in every project village to convince the women to start their operation earlier. However, in other villages and especially in Kaimbujae, Kaponga, Brefet, Kayenga and Kalimu the response has been very encouraging and more important, an early start was repeated in the years after (see also section 5.1.4).

Land preperation is conducted with the traditional how; animal traction with mould board plows and/or harrows is not practiced. During the 1988 cropping season trials have been initiated as part of the GARD project with various type of animal drawn implements in rice-land preperation. The results will be discussed in a seperate document of the GARD project.

Seeding

Concerning seeding practices the project has embarked on two issues. First to promote drilling of seed in rows (30/40 cm apart) on fields traditionally broadcasted and secondly to encourage the women to make use of the animal drawn 'Super Eco Seeder' in their rice fields. To encourage the latter long discussion were held because as aforementioned women have difficult or no access to animal traction since this is clearly the domain of the men. With training session before the cropping season with contact farmers and repeated visits to the villages in question the project succeeded to get animal drawn seeding as the most widely used method, especially in the villages Kaimbujae, Brefet, Kayenga, Bwiam and Kalimu.

Drilling replaced for a great deal the traditional broadcasting method on higher situated, non flooded fields. In those fields formerly already flooded during the rainy season or being flooded as a result of project interventions (imponding by dikes and bunds) transplanting was recommended. Demonstrations have been conducted with transplanting in rows with a fixed interval between the seedlings in stead of transplanting 'at random' as traditionally practiced (Brefet 1988).

Weeding

The importance of timely and, preferably twice weeding during the growing cycle can not be over emhasised as a way to increase yields. Easier weeding when planting in rows could be made clear to many in farmers' demonstration fields.

However, weeding at all and especially weeding a second time often comes into conflict with other obligations of the women e.g. assisting in weeding the upland fields. Likewise other issues it will take some years before contineously given advise and demonstrations will pay off.

4.4.5 Trials and Demonstrations

During the 1985, '86 and '87 cropping season trials were conducted in collaboration with the FAO Fertilizer Demonstration Project. The main objective was to test different application rates in combination with different varieties. These trials were seen both as a demonstration towards the farmers and as an exercice in conducting trials for the project staff. All the results were handed over to the FAO project.

Simple demonstrations comparing the application full rate, half rate and no fertilizer (with rates according the recommendations of the FAO project) were conducted in three villages during the 1987 season.

In collaboration with the GARD project the use of animal drawn implements during land preperation was tested in the village Brefet. On the same plots simple comparisons were made between varieties and fertilizer applications.

Also in collaboration with the GARD project variety trials were conducted with the aim to select varieties suitable for permanent and/or temporary conditions and with a 120-130 days growing cycle. Promising varieties, e.g. BG 90-2 with potentials of producing 5 tons paddy per hectare were tested under different conditions and management.

4.4.6 Yield Surveys

Yield surveys were executed during the 1986, '87 and '88 cropping seasons.

In principal yield surveys were repeated in the same villages surveyed in the previous year(s) with additional villages each year according increasing project sites. For reasons of comparison a number of non-project villages were included.

In each project area three catagories were distinguished i.e. a part permanenetly flooded, a part only temporary flooded and fields not flooded at all or only for very brief periods (not longer than a day). From each catagory a farmer was selected (from a list or in the village) after which two, triangular shaped sample plots of 2 sq. metres in her field were at randomly identified (by throwing a stick). Per catagory two fields were selected in this way with four sample plots each. In non-project villages only the farmers were selected irrespective possible catagories of flooding.

Samples plots were whenever possible harvested by the survey supervisor himself (the agronomist or assistant). After weighing the sample was returned to the respective farmer.

The results are discussed in section 5.2.3.

4.5 Maintenance

The project has faced considerable problems in establishing sustainable maintenance procedures. This experience is unfortunately not unique and similar to that of other projects (SWMU, FFHC).

Initially, maintenance was carried out on similar terms as the original construction. Repair and maintenance on sluice gates and spillways was carried out by the project since it involved skilled labour and sometimes the use of machanical equipment not avialable at village level.

Later, from 1987 onwards the project has tried to phase out paid for maintenance. However, to establish clear procedures at village level appeared to be an arduous task and unfortunately failed in most cases. It was necessary to visit the village repeatedly and call upon the cooperation of the village leaders, elders or other influential individuals to try and organize the villagers to carry out maintenance and repairs. To ensure a contineous pressure and to avoid or at least to be alert on indifference and slackness among the users of the improved rice growing area in question the project usually posted a staffmember for an undefined period in the village. He helped to remove difficulties by calling meetings or by approaching influential persons. On top he could provide the necessary tools and supervise maintenance work on the spot.

Despite all these efforts it became inevitable, to avoid a complete failure of certain projects to propose an incentive system. It was not considered fair to expect the villagers to pay for repair and necessary maintenance on structures in cases due to design or construction failures. Paying regular maintenance was still regarded a better solution to keep the infrastructure in good shape than to face a complete failure.

5 EXPERIENCE AND RESULTS

5.1 Experience

Experience has shown that a number of factors have, individual or in combination with each other contributed to the success or failure of project interventions. During project implementation four categories have been identified which are described below.

5.1.1 Environmental Factors

An important category of factors with a high impact on success or failure of project intervention were environmental of nature and for the greater part beyond control of project management. One factor with dramatic consequences for project outcome has been rainfall. Within the project period (from January 1983 up to September 1988) The Gambia experienced the driest year (1983) ever recorded and years with extremely high rainfall amounts, locally such as on the 4th of August 1986 in and around Bwiam and countrywide in 1988 with the highest recorded total since 1948 (see also 3.7).

Storms with an extremely high intensity caused a lot of damage due to unpredicted high and forcefull peakflows, clearly beyond the capacity of the structures constructed (see next section). Examples are the already mentioned heaviest rain in living memory in Bwiam of which its flood over-topped the project dikes which eventually broke and, for the greater part washed away.

High intensity storms (between 75 and 125 mm within 12 hours) on three successive days caysed a total destruction of a sluice gate in Brefet in September 1988. Total saturation of the top soil, no storage capacity left in the scheme itself and untimely (another heavy storm the next day was not expected) drainage caused this disaster.

On the other hand, due to poorly, geographical distributed rainfall other villages e.g. Kayenga in 1986 suffered from a local dry pocket resulting not only in low yields but also in disappointed farmers reluctant to plant the same hectarage the next season.

Another point of much concern is the siltation of certain schemes or parts of it. Before dike and bund construction took place most of the eroded soil material from the uplands found its way, carried by the surface run-off into the river. Due to project intervention i.e. dikes and bunds the surface run-off is trapped consequently causing siltation. This phenomena is clearly visible in the upper reaches of the schemes near the villages Kaponga and Bajana and to a lesser extend in Bwiam.

This also shows that the approach of this type of interventions can not be confined to the rice growing areas only. A catchment approach, simultaneously incorporating soil and water conservation measures on the surrounding uplands is clearly preferable.

Soil quality has been an under estimated feature in project design. Lack of manpower forced the project to reduce or even refrain from detailed soil surveys covering the entire area. Water retention measures constructed in areas comprising permeable soils do not result in an envisaged flooding of the rice fields in question. They do, nonetheless, improve the soil moisture situation and hence plant production potential. However, these lighter soils are also prone to erosion and the water retention structures also aggravate siltation as discussed in the previous sub-section. These factors should be weighed before any intervention takes place and based on more detailed (soil) surveys.

Although salt intrusion could be blocked effectively in a majority of the schemes it could not be avoided that the lowest lying plots of certain schemes were flooded with salt water after breakage of dikes. This happened in Bwiam (1986), Ndemban (1987), Kayaborr (1987,88) and Brefet (1988).

5.1.2 Design Factors

All the designs, of dikes, bunds, sluicegates and spillways are a compromise of construction cost vis-a-vis an acceptable level of risk. In general, with a low level of risk built into the design, the infrastructure will be more complex to construct requiring skilled labour and machinery making project cost (unacceptable) higher. A higher acceptable risk permits simpler designs and makes project cost consequently lower. For every type of structure the following problems and (possible) solutions are described below:

Dikes

Most problems encountered with the anti salt dikes were a result of the manual construction. To mention the most important ones:

- poor compaction, resulting in
- excessive settling of the construction material

Manual compaction with the help of the tools used (spades) and wooden sticks appeared to give an unsatisfactory result. Project management, however realized that in fact no alternative exists but motorized compactors. Despite a clear advantage out of a soil mechanical point of view it was decided not even to test such equipment but to opt for lower construction costs i.e. with a high input of unskilled labour and to stress the need for regular maintenance. The latter, as discussed in section 4.5 did not work out as anticipated in each project village.

Excessive settling causes a diminishing embankment height, even lower than the spill-over level of the sluice gates. This could and has led (Pirang 1985, Bondali Jola 1985) to severe damages and even of imponded water over-topping the structure. Topping up of the entire dike up to design height should be carried out by the farmers on a regular, preferably yearly basis.

The use of construction material from nearby pits on the barren flats causes:

- the use of non-homogeneous construction material, varying between pure clay and pure sand
- erosion ('melting') during the rainy season due to washing out of the coarser material (sand)
- difficulties in establishing a vegetation cover, at least the first year due to
- the use of saline soil as construction material

All above mentioned problems can be avoided by ferrying (or carrying) proper construction material (non saline clay soils) from outside the area to the construction site. This would mean either an arduous or near impossible (manual) carrying of material from remote situated pits or the use of tractors and trailers. The latter had to be rejected simply because the project could not provide such transport nor were the villages in the position to provide or to finance it.

A compromise, recommended to test, is to construct the core of the dike with material from nearby pits. This core made out of saline, non homogeneous soil should than be covered with a 20 to 30 cm thick layer of non saline clayey soil. This soil material allows a quick establishing of a vegetation cover; stabilizing the embankment and preventing erosion.

The construction height was choosen 70 to 80 cm above mean high tide. This proved to be ample sufficient; non of the dikes was ever over-topped by 'river' water. The lay out, however is often a compromise. In some cases more land, previously cultivated but abandoned due to salt intrusion could have been reclaimed/improved by constructing the dike further 'downstreams'. With regards to leaching processes very little is known as yet. This would mean taking the risk of leaving parts of the protected area uncultivated as a result of intolerable high soil salinity contents. Moreover, dissolving salt could cause a higher salt content of the imponded water, preventing plant growth on flooded but still arable plots. The construction of an anti salt dike further 'downstreams' would also mean the construction of additional contourbunds to reach the same level of imponding over the entire area.

One attempt has been made, in 1988 to 'reclaim' an abandoned rice growing area near the village Brefet. Although the soils were clearly visible affected by salt the farmers were willing to accept the risk of waiting possibly one or more seasons to have the soils sufficiently leached. Thanks to a favourable rainfall the area could be flushed three times before transplanting. Soil tests revealed a decreasing salt content which was confirmed by the first seedlings performing well and obviously not suffering from a too high salt content. Unfortunately heavy rains during three succeccive days caused a total destruction of the sluice gate (as described above) resulting in freely intruding tidal (spring) floods spoiling the crop.

Minor dike ruptures have been reported in virtually all schemes, except in Kaimbujae and Bulock. The damages, as described earlier in Bwiam and the neighbouring village Santamba were of such a magnitude that the villagers were not able to repair those immediately and during the same rainy season. In all other villages and on all occaissions of dike ruptures the villagers were able to repair, with assistance from the project the damage at least temporary. The common method was to fill the gap as quickly as possible with sand bags and soil from nearby pits to prevent the immediate danger of salt intrusion. Afterwards the embankment was neatly re-shaped in its original state. Empty nylon bags have proven to be a very usefull tool for these emergency repairs.

Contourbunds

The manual construction of the contourbunds also caused:

- insufficient compaction
- excessive settling
- uneven embankment

The construction material from ditches alongside the bund is usually of a better quality compared to the material used to construct anti salt dikes. Moreover, since it comprises fertile topsoil the bunds are covered with a dense vegetation cover soon after the first rains. This clearly helps stabilizing the embankment and to prevent erosion.

The bunds, as mentioned in section 4.1.5 are basically following the (topographical) contours but as much as possible along existing plot boundaries. The consequently different depths of imponding were not considered as a major problems.

Depth of imponding could have been improved by land levelling. Levelling has not been practiced during this project period because:

- motorized levelling was considered too costy and only possible when denying existing plot boundaries
- hand levelling is not seen as an alternative because of the tremendous amount of labour involved
- disturbance of an already fragile top soil

Sluice gates

The major problems encountered with the gates were:

- leaking doors
- difficult operation of the doors

Leaking of doors is mainly caused by uneven and/or too wide grooves. The doors themeselves hardly leak thanks to rabbating the boards and because the timber swells to some extend when wet. Also due to badly chipped out grooves the doors are often difficult to move.

An attempt to minimize leakage has been to provide all newly built (from 1987 onwards) and most of the old gates with a double set of grooves and two doors approx. 20 cm apart. The gap filled with compacted clay should assure a waterproof structure. Unfortunately, due to contineous washing out of soil material alongside the grooves leaking of gates could not stopped entirely. Some leakage of fresh water is not considered very serious. On the other hand, intrusion of salt water during spring tide should be avoided by all means and a redesign of grooves is therefore strongly recommended.

Initially the doors were designed to retain water to a level equal to the maximum level acceptable for the anti salt dikes. This is in fact well above the optimum depth of imponding the rice fields. Any excess water was planned to be flushed by an operater by lifting the doors and to reduce the waterlevel to an optimum according the growing stage of the rice at that moment. In practice this idea failed. Operators came too late after heavy rains or did not show up at all, especially during the night. To tackle this problem the height of all doors was reduced by 10 to 15 cm by removing the topmost board. In this way the optimum waterlevel was maintained automatically; excess water spilled over without intervention from an operator. Simultaneously it reduced the risk of over-topping dikes and possible ruptures. The risk of salt water over-topping the doors was considered minimal.

The design capacity of the gates appeared to be too low to spill over 'automatically' the peak flows occuring shortly after heavy storms. Despite the higher cost involved project management decided, mainly to lower the risk of dike ruptures to construct additional gates (Bulock, Ndemban, Bwiam Santamba) or to incorporate an additional drop spill-way as heigh as the maximum level of imponding (Bwiam). Some gates constructed after 1987 were constructed with an extra spillway included (Brefet (2x), Ndemban and Dobong).

Spillways

For the spillways basically the same applies as for the above discussed sluice gates. Initially no spillways were planned at all (like Kayenga still is). The bunds were thaught to impond the area gradually whereafter excess water would spill over the bunds. However, this requires a very strict construction with special attention to the construction height. In practice the bunds do meet the design height but with a certain inevitable tolerance. This results in peak flows finding their way out via the slightly lower spots causing serious damage or even complete destructions. To guide these destructive flows solid spillways were constructed in the natural depressions or gullies.

Although all spillways constructed during the project period functioned well the capacity was not always sufficient to guide all the run-off within a relatively short period to the next section. Water is still spilling over the earthen bunds only with less force.

A point of concern, in view of regular maintenance are the damages caused by cattle crossing the bunds. To find procedures to avoid this is near impossible since most of the herds are roaming around freely during the dry season.

The small 80 cm wide gate in every spillway functioned well. It not only gave the possibility of draining the impondéd area entirely but it also made an active water-level control possible by taking out (or replacing) the individual stop-boards (Bajana, Kayaborr).

5.1.3 Village Participation

A time consuming, often frustrating affair but nonetheless with encouraging aspects has been the organisation of the village participation as discussed in section 4.2.

Experience has learned that village participation depends on a complex of often related factors. To mention the most important ones:

- influence of village leadership
- existing land tenure system
- incentive system offered

An influential village leader, elder or other respective individual (e.g. chief or former chief) can have a strong effect on the level of village participation. Good examples in this respect are the villages Kaimbujae, Brefet, Kayenga, Bwiam Santamba and Dobong. Conflicts, between a village leader (or village leaders) and the villagers initially denied or not recognized by project staff has caused considerable problems to keep village participation at a satisfactory level. In the villages Firang (two leaders), Bulock, Ndemban, Bwiam and Kayaborr these conflicts paralysed any communal activity (not only project implementation).

Only after repeated visits and meeting and by applying a lot of patience (especially by the agronomist) villagers and/or their leaders could be convinced to cooperate and assist in implementing the project according planning.

One of the main reasons to abandon participation found its roots in the existing land tenure system i.e. land-owners versus land-users. Many lande-users not owing the land were, or soon became, reluctant to participate because of their fear losing their (user's) right to the original owner after the area being improved. This was obvious in the village Bulock were opposite intersest between a few land'lords' and farmers with traditional user rights completely paralysed project execution shortly after construction work had started. This subject and other similar cases are comprehensively described as case studies in [5].

Although initial promises and commitment seemed to be genuine in many villages it soon became clear that the village only had agreed to participate because of the cash incentive offered. A clear sign to that respect is the devision of construction work among a few individuals or small teams without further interest from the direct beneficiaries. Examples of these were Pirang (construction work entirely 'sub-contracted' to seasonal labourers from Guinee-Bissau), part of Bulock and Bwiam. In other villages e.g. Bajana, Kayaborr, Kalimu and Bondali Jola the people were very reluctant to participate with repair and maintenance work after a rather successfull initial construction (see also section 4.5).

In general participation strongly depends, as said, on village leadership and performance of schemes. In the villages Kaimbujae and Brefet the villages requested additional project interventions after a successfull season (1987). During a second phase the participation was no problem at all; the benefits had been clearly visible and experienced the season before.

To keep participation at a constant level appeared to be an extremely difficult task. Social events traditionally left for the dry season such as circumcision, weddings etc. often caused considerable delays and difficulties in planning the logistics and supervision.

5.1.4 Scheme Operation

Despite the higher cost involved the project opted for the construction of solid sluice gates and spillways. It would enable the farmers, initialy guided by project staff to develop an optimum water mangement system in their respective rice growing areas.

The original idea of having one or more persons per scheme responsible for the operation of sluice gates and spillways was met with difficulties. As described above the project gradually opted and has changed designs to such an extend that maintaining a certain depth of imponding and draining excess water needs a minimum of intervention and happens more or less 'automatically'.

However, regulating water depth and/or complete drainage of the scheme still needs intervention from outside. Procedures applicable for each scheme could not be developed within the project period. Experience has shown that for every individual scheme a seperate plan of operations has to be elaborated in close colaboration with the farmers. Points of concern in which farmers have to collaborate and agree beforehand are:

- time of land preperation, seeding and/or transplanting
- devision which fields are direct seeded and which are transplanted
- attune the use of certain varieties
- depth of imponding during growing stage
- time of complete drainage before harvest

But above all it should be clear to every farmer and user of the 'improved' area who or which body (e.g. a 'village committee') will be responsible for operating the gates and spillways. It is obvious that this process will take time and close guidance from the project over a prolonged period.

In practice scheme operation in virtually all project villages has been the responsibility of project staff. Due to a complete lack of experience and knowledge about the impact of project interventions there was in fact no other option. Only during the 1987 and 1988 cropping season the first attempts have been made to be actively involved with watermangement. In the schemes of Kaimbujae, part of Bulock, Bajana, Brefet, Bwiam Santamba and Bondali Jola project staff has tried to 'manage' the structures and to regulate waterlevels as optimal as possible. In certain schemes this lead to serious conflicts between staff and farmers and among farmers themeselves. At several occaissions areas were drained by individual farmers without informing and without agreement of others. Especially timely land preperation caused serious problems among farmers when one individual farmer drained the area for land preperations while other farmers already seeded or even transplanted the crop (Bulock 1988, Brefet 1988).

5.2 Results

5.2.1 Impact of Structures

In schemes without major dike ruptures (Kaimbujae, Bulock, Brefet phase 1, Bwiam Santamba, Dobong, Kalimu and part of Bondali Jola) the structures fullfilled their expectations. Salt water intrusion was effectively blocked whereas all dikes were able to impond fresh water according the design.

In years with rainfall totals between 800 and 900 mm the dikes could impond enough water for a sufficiently long period to enable the farmers:

- to transplant crops on those fields permanently flooded
- to look for high(er) yielding varieties with a cycle of 120 days
- to reduce weeding

Experience with rainfall totals above 'normal' of 1100 to 1200 mm or more during the 1988 rainy season revealed the possibilities and potential:

- to flush imponded areas more than once (up to 4 times in Brefet 1988)
- to regulate, on demand, water levels according growing stage

Contourbunds did not perform in all schemes as expected.

- Bunds constructed in narrow valley bottoms (Bajana, Kayaborr) have to cope with forcefull peak flows of collected run-off from the entire catchment area. These peak flows cause damages or complete destructions too often for the farmers to carry out emergency repairs time after time.
- On areas directly adjacent to the uplands with a relatively small catchment (Kaimbujae, Brefet, part of Bulock), contourbunds fullfilled the expactations and did impond sufficient water to create similar conditions as described before.
- Behind bunds constructed in valleys comprising permeable soils no significant imponding occured. Nonetheless they do help to improve soil moisture conditions

Sluice gates have proven to be an indispensable tool to improve watermanagement. The operation is easy and it is believed that it could be carried out at village level after training and sufficiently long guidance and supervision by project staff.

The type of spillways constructed in contourbunds is often not able to guide all surface run-off safely to the lower section. It needs carefull consideration to incorporate extra structures or (bigger and more expensive) structures with a higher capacity or to refrain completely from constructing spillways in contourbunds.

5.2.2 Impact of Agricultural follow-up

Although arbitrary and difficult to assess in figures the agricultural follow-up has resulted in:

- widely i.e. all project villages except Bajana, acceptance and use of the short cycle variety 'Peking'
- timely land preperation and early seeding in all project villages except Pirang, Bulock, Bajana and part of Bwiam
- acceptance and use of the animal drawn Super Eco Seeder in Kaimbujae, part of Bulock, Kaponga, Brefet, Kayenga, Bwiam and Kalimu
- re-introduction of transplanting techniques in areas permanently flooded due to project interventions in Kaimbujae, part of Bulock, Brefet, Bwiam Santamba and Bondali Jola

PROJECT VILLAGE	YIELD KG PER HA CATEGORY OF FLOODING A	B	C	REMARK
Bulock	1575		550	
Bajana	4260			
	3200			
Ndemban			500	
			800	
Kayenga			940	
			550	
Bondali		1750		
		1225		
NON PROJECT VILLAGES (in 1986)				
Sifoe			625	
			1700	
Mandinary			1600	
Brefet		2575	1610	Project village 1987
Dobong	2550	1525		Project village 1988
Kanwally	3225	2500		Project village 1988

Table 9.: Summary Yield Survey 1986

PROJECT VILLAGE	YIELD KG PER HA CATEGORY OF FLOODING A	B	C	REMARK
Kaimbujae			1200	
Bulock	3125	2125	850	
Bajana	3250		750	
Brefet	2950	1700	1325	
Ndemban	2175			
Kayenga			750	
			1400	
Kayaborr	1650	3250	675	
Kalimu			1500	
Bondali	2375	1950		
NON PROJECT VILLAGES (in 1987)				
Mandinary			950	
Sutu Sinyang	2800	1625		
Dobong		2200		Project village 1988
Kanwally		2725		Project village 1988

Table 10.: Summary Yield Survey 1987

- successfull introduction of direct seeding instead of broadcasting on higher, non flooded fields in virtually all project villages
- increase in cultivated hectarage in virtually all project villages with spectacular results in Brefet and Kayenga
- yield increase as discussed in the following section

The project failed, despite demonstrations to achieve a widespread use of fertilizer; an otherwise commen experience of similar projects countrywide. Other less successfull but nonetheless important issues were:

- timely and repeated weeding
- promotion of sickle harvesting instead of time consuming hand-picking
- pest and disease control

5.2.3 Yield Surveys

The results of the yield surveys conducted in 1986 and 1987 are summarized in table 8. and table 9. respectively.

With regards to the yields measured in 1986 it is stricking that non project villages had significant higher yields in relation to project villages. It was realized that the approach of that particular yield survey had been wrong. Comparing project and non project villages without consideration whether the growing conditions of a particular sample plot have been changed or not, was considered not correct. 'Coincidentally' the yields of non project villages turned out to be higher; possibly due to a biased selection of sample plots.

During the next season yields measured in one scheme but on plots without changed conditions and on plots with conditions changed due to project interventions. Only changed conditions with regards to water management have been considered; the availability of improved variety and access to the extension services are supposed to be equal for all farmers within one scheme.

Not suprisingly it appeared that the yields on permanently flooded fields and fields intermittent flooded turned out to be higher than the fields not flooded at all; a condition valid for other 'improved' plots before project intervention. Conservatively one could conclude that the structures alone improve the water availability and growing conditions for rice in general and thus result in higher yields. Or at least, it has shown the potential.

5.2.4 Potential

The yield surveys have clearly indicated the potential of the traditional rainfed rice growing areas in the western part of The Gambia improved with simple water retention and regulation structures in combination with a sound agricultural follow-up.

Conservative estimates, confirmed by aforementioned surveys and trials indicate that:

- on permanently flooded fields yields as high as 3.0 tons of paddy per hectare can be reached with the presently used local and/or provided short cycle varieties (e.g.'Peking')
- yields of 4.5 tons and more per hectare are possible with recently selected and tested medium long (120 days) varieties (e.g. BG 90-2)
- yields around 2 ton per hectare are feasible on temporary flooded fields using short or medium long cycle varieties
- yields varying between 1.0 and 1.5 tons per hectare on non flooded fields using 90 days short cycle varieties

These productions are only feasible provided:

- sufficient (at least 850 mm/year) and equally distributed rainfall (but beyond control)
- timely land preperation
- transplanting on permanently flooded fields
- direct seeding on temporary and non flooded fields
- timely and sufficient weeding
- watermanagement

Reliable figures are not available concerning the potential hectarage of presently used, recently abandoned or never used areas suitable to be improved or brought back into cultivation with the type of interventions described in this report. The only figure mentioned and used in other papers speaks of a net potential area of 56.000 ha. This figure should be regarded as a very rough estimate since it is based on a certain soil association mentioned in the Land Resources Development Centre Study 22 [..]. and has not taken into account criteria like topography, hydrology, present vegetation, accessibility etc.

6 ECONOMIC ANALYSES

A comprehensive economic analyses has not been carried out under the auspice of the GTZ project during this reporting period.

However, as part of the 'Study of Water-Controlled Rice Production in The Gambia' [5] under the auspice of the GARD project, a detailed cost-benefit analyses has been conducted with the aim to assess the economic returns to the investements in rice land development. A seperate analysis has been undertaken for four similar projects (SWMU, FFHC, Jahally Pacharr Tidal Irrigation and DWR/GTZ). A summary of the results, for the GTZ project only and for the greater part quoted from aforementioned study is presented below.

Beforehand it must be stressed that a cost-benefit analysis clearly has its limitations. It depends heavily on the accuracy of the information gathered and used and of the validity of the assumptions made. To be realistic the analysis has been conducted for a range of cost levels and production increases that a project might experience. Moreover, issues like social implications of the project and income distribution effects have not been considered.

Three type of cost have been incurred:

- initial land development cost
- recurrent cost of maintaining the structures
- incremental cost

Total development cost on a per scheme basis could not be determined. Instead the average development cost per hectare have been calculated by summing the development cost incurred during 1986, devided by the area improved during that same period. These cost include technical assistance, national staff, office cost, vehicles, fuel, equipment, construction materials and village labour. Foreign exchange costs, such as technical assistance are converted into Dalasis at average 1986 exchange rate. Vehicles and fuel are costed free of duty and tax. Project costs over the year 1986 are given in Annex 6.

The oppertunity cost of labour used in construction must be included in the analysis. This is estimated to be Dalasis 2.50 per man-day, 45% of the average daily wage during the growing season when demand for labour is high.

A provision of 10% of key cost items (staff, vehicles, tractor, truck, fuel) is made for maintenance cost during the first year. For the succeeding 9 years an allowance of 5% is made for for the average annual maintenance.

<u>Project benefits</u> are determined by the quantity of additional rice produced as a result of land development and its economic value. The increase in rice production is determined by yield gain per ha and the area over which this is obtained. No attempt has been made to derive the benefits of improved food security as a results of a reduced riks associated with rainfed rice production.

As mentioned in section 5.2.2 experience has shown that an expansion of the area cultivated is to be expected to follow land development. The assumtion that 75% of the area improved was cultivated before, and 100% afterwards is considered reasonable and representative.

Yields before project interventions were estimated to be 0.8 ton/ha. Taking into account that 75% of the area was cultivated before development, the average yield per hectare over the whole area subsequently utilized was 0.6 ton/ha.

Three yield scenarios were projected, presented in Table 10.

	Yield without project(t/ha)	Yield with project(t/ha)	Yield increment (t/ha)
Scenario 1	0.6	2.5	1.9
Scenario 2	0.6	2.0	1.4
Scenario 3	0.6	1.5	0.9

Table 10.: Project Yield Scenarios

Yield increments are not assumed to be achieved immediately but at a maximum rate of 0.5 tons per hectare per year.

The economic value of rice is based on World Bank farmgate price projections.

With regards to the <u>incremental cost</u> of rice production it should be noted that in rainfed rice production in The Gambia labour and seed are the only inputs used. Using a labour requirement of 270 man-days [LRDC] for each hectare cultivated, 25% of this is assumed to be the increment to bring 100% of project affected land into cultivation. This is costed at the average 1986 daily wage of Dalasis 5.50. A corresponding increase in seed requirement is costed i.e. 25% of the recommended rate of 80 Kg/ha at a cost of Dalasis 1.20/Kg.

The analysis is used to derive two measures to value the project to the national economy. These are the Internal Rate of Return (IRR) and the Net Present Value (NPV).

ECONOMIC ANALYSIS OF WATER - CONTROLLED RICE PRODUCTION
GTZ/DWR RAINFED RICE IMPROVEMENT PROJECT

YEAR	1	2	3	4	5	6	7	8	9	10
INCREMENTAL RICE OUTPUT										
ICR. YIELD/HA (ton/ha) SCENARIO 1	0.50	1.00	1.50	1.90	1.90	1.90	1.90	1.90	1.90	1.9
ICR. YIELD/HA (ton/ha) SCENARIO 2	0.50	1.00	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.4
ICR. YIELD/HA (ton/ha) SCENARIO 3	0.50	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.9
D /TON	1023.00	1140.00	1202.00	1278.00	1348.00	1346.00	1345.00	1341.00	1337.00	1333.0
TOTAL INC. INCOME/Ha SCENARIO 1	515.00	1140.00	1803.00	2428.00	2561.00	2557.00	2556.00	2548.00	2540.00	2533.0
TOTAL INC. INCOME/Ha SCENARIO 2	515.00	1140.00	1683.00	1783.00	1887.00	1884.00	1883.00	1877.00	1872.00	1866.0
TOTAL INC. INCOME/Ha SCENARIO 3	515.00	1026.00	1082.00	1150.00	1213.00	1211.00	1211.00	1207.00	1203.00	1200.0
INCREMENTAL PRODUCTION COSTS/Ha (I.P.C.)										
LABOR	371.00	371.00	371.00	371.00	371.00	371.00	371.00	371.00	371.00	371.00
SEED	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00	24.00
TOTAL INCREMENTAL PRODUCTION COSTS/Ha	395.00	395.00	395.00	395.00	395.00	395.00	395.00	395.00	395.00	395.00
PROJECT COSTS/Ha										
TECH ASSISTANCE (T.A.)	3184.00									
OFFICE COSTS	64.00									
STAFF COSTS	460.00									
VEHICLES	634.00									
TRACTOR	127.00									
TRUCK	38.00									
FUEL	155.00									
EQUIPMENT	216.00									
CONSTRUCTION MATERIALS	253.00									
VILLAGE LABOR	275.00									
1.0 TOTAL PROJECT COSTS (T.P.C.)	5526.00									
2.0 T.P.C. WITH PAID VILLAGE LABOR	5573.00									
3.0 T.P.C. WITHOUT T.A.	2342.00									
4.0 T.P.C. WITH DECREASING OVERHEAD (D.O.)	3289.00									
5.0 T.P.C. WITH D.O. & WITHOUT T.A.	1697.00									
MAINTENANCE COSTS/Ha	0.00	153.00	77.00	77.00	77.00	77.00	77.00	77.00	77.00	77.00
MAINTENANCE WITH D.O. COSTS/Ha	0.00	92.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00	46.00

10 YEARS

	1.0 T.P.C.	2.0 T.P.C. WITH PAYED VILLAGE LABOR	3.0 T.P.C. WITHOUT T.A.	4.0 T.P.C. WITH D.O.	5.0 T.P.C. WITH AND WITHOUT T.A.
NPV @ 15% 1	2239.60	2133.53	5008.38	4336.21	5720.55
NPV @ 15% 2	342.26	296.17	3110.95	2439.78	3823.13
NPV @ 15% 3	-1956.96	-2003.05	811.73	139.56	1523.91
IRR 1	25%	25%	59%	44%	79%
IRR 2	17%	17%	47%	34%	67%
IRR 3	3%	2%	25%	16%	40%

Table 11.: Economic Analysis

The IRR is the maximum rate of interest that a project could afford to pay for the resources used and still break even after recovering the investement and operating cost

The NPV is the present value of the net benefit stream generated by the project (by substracting year-by-year costs from the benefits) discounted at an interest rate wich reflects the opportunity cost of capital to the economy. For The Gambia this discount rate is 15%.

In the cost benefit analysis table, the NPV is given on a per hectare base. By multiplying with the total hectarage per area to arrive at the NPV of the project. So long as the IRR exceeds the discount rate of 15% the NPV per hectare is positive and indicates an acceptable investement. Is the IRR lower than 15% the NPV per hectare becomes negative.

Above mentioned measures are calculated under all three production scenarios to test the sensitivity of project economic returns to the level of yield increase per hectare achieved. It is also necessary to test the sensitivity of economic returns to possible changes in project cost. Altogether five project cost structures are examined and their impact on IRR and NPV.

1.0 total project cost with village labour used in construction valued at its opportunity cost (T.P.C.)

2.0 total project cost with village labour used in construction costed according financial incentives or daily wage actually paid (T.P.C. with paid village labour)

3.0 total project cost less technicall assistance costs (T.P.C. without T.A.)

4.0 total project cost less 50% of overhead costs incurred in both development and maintenance (with experience more land can be developed with same personnel and equipment) (T.P.C. with D.O.)

5.0 total project cost less technical assistance and 50% of overhead cost incurred in development and maintenance (T.P.C. without T.A and with D.O.)

The results of the calculations of NPV and IRR for the three yield scenarios and five possible cost structures are presented in the Tables 11. and 12.. Additional analysis has been carried out to asses the impact on returns if potential risks should pull yields below the scenario 3 level.

The economic analysis shows that for cost structures 1.0 and 2.0 (Total Project costs with labour valued at opportunity cost and amounts actually paid respectively) the NPV is positive and IRR greater than 15% for yield scenarios 1 and 2. Under scenario 3 (yield increase of 0,9 t/ha) the IRR falls to 3% and 2% with negative NPV's. To sustain these levels of project cost and remain economically viable a yield of 2 t/ha is required.

For cost structures 3.0 and 4.0 (Total project Costs without technical assistance and with 50% decrease in overheads respectively) the NPV are all postive for all three yield scenarios. An average yield of 1.5 t/ha is sufficient to result in an atractive economic return. The prospects of decreasing overhead is regarded as realistic since the experience gained during a pilot phase could result in more efficient use of manpower and equipment. Cost structure 3.0 is equally valid as technical assistance is intended to be withdrawn in the near future.

In general as project costs decrease the IRR's increase and the project can remain viable under a lower yields scenario. A fall in yields of almost 30% below scenario 3 can be absorbed before the NPV becomes negative. An average yield of 1.3 t/ha will still provide an acceptable return.

GTZ/DWR RAINFED RICE IMPROVEMENT PROJECT
ECONOMIC ANALYSIS OF WATER-CONTROLLED RICE PRODUCTION
TEN YEAR DISCOUNT PERIOD

	1.0 TOTAL PROJECT COSTS(TPC)		2.0 TPC WITH PAID LABOR		3.0 TPC WITHOUT TECH.ASST.		4.0 TPC WITH DECREASING OVERHEAD		5.0 TPC W/O T.A.,DECR. OVERHEAD	
	NPV	IRR	NPV	IRR	NPV	IRR	NPV	IRR	NPV	IRR
SCENARIO 1	+	25%	+	25%	+	59%	+	44%	+	79%
SCENARIO 2	+	17%	+	17%	+	47%	+	34%	+	67%
SCENARIO 3	-	3%	-	2%	+	25%	+	16%	+	40%
SCENARIO 3 (-10%)	-		-		+	19%	-	11%	+	32%
SCENARIO 3 (-20%)	-		-		-	12%	-		+	23%
SCENARIO 3 (-30%)	-		-		-		-		-	14%
SCENARIO 3 (-40%)	-		-		-		-		-	

Table 12.: Economic Analysis; 10 year discount period