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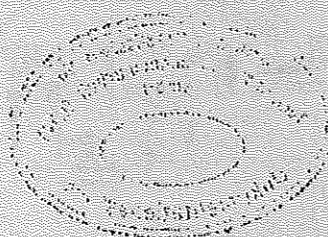
Improvement of Rainfed Rice Growing Areas in the
western part of The Gambia

PN 80.2135.4

- Final Report -

(01.01.85 - 30.09.88)

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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
ISRDI	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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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 (freshwater) 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' (ISRDI), 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 awareness and responsibilities among the villagers during project execution as to secure a long term engagement and involvement especially with regards to maintenance issues *the follow up?*
- 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 *→ regular*
- 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 *besorgen* *Attafouf Ussekin*
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. *Schmitt*

*Needs
Schlag*

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 negotiations 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 negotiations 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 transfer 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 so far 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 choices 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 densely 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".

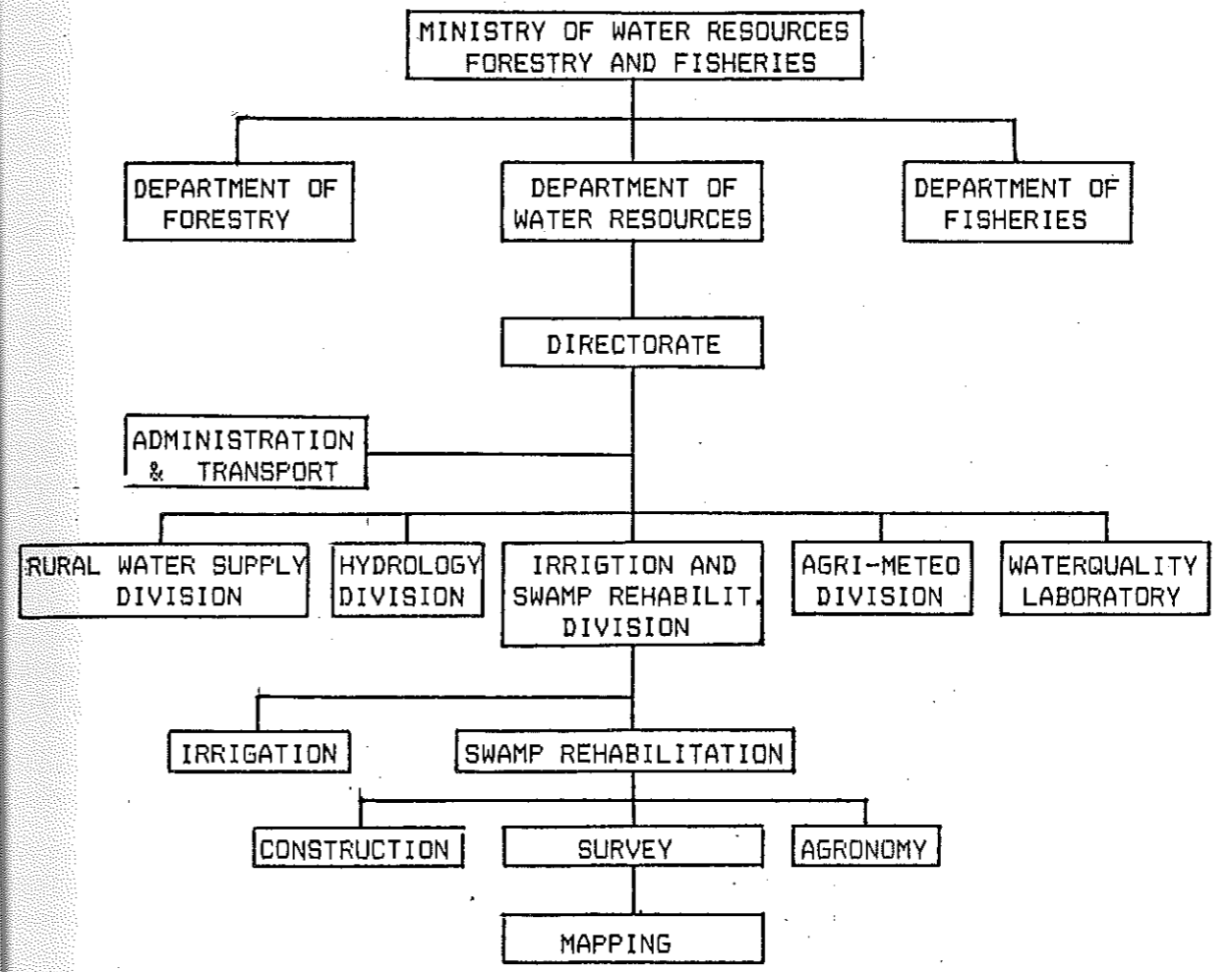
As a pilot project it was, by its nature, not expected to be consistent and rigid with the aim and targets originally formulated. It should rather be flexible to respond to findings and experiences during implementation. The freedom to adjust the goal, objectives and the envisaged activities was never 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.



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-Meteorological 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. Simultaneously with the start of the GTZ project the ISRD received a considerable consignment of earth moving equipment financed by the UNCDF (UNCDF-GAM/81/CO2) 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		1986		1987		1988		Total MM
		J	F	M	A	M	J	J	A	
Principal Irrigation Engineer/ Head ISRD	Planning									45
	ac. agreem.									
Mrs. Fatou Jasseh	Planning									45
	Actual	-	-	-	-	-	*****	-	*****	8
Agronomist	Planning									45
	ac. agreem.									
Famara Badjie	Planning									45
	Actual									43
Construct. Supervisor	Planning									45
	ac. agreem.									
Kebba Khan	Planning									45
	Actual									43
Works-Overseer	Planning									45
	ac. agreem.									
Alkali Badjie	Planning									45
	Actual									39
Works-Overseer	Planning									
	ac. agreem.									
Ibrahima Ceessay	Planning									
	Actual									18
Surveyor	Planning									45
	ac. agreem.									
Saikou Njie	Planning									45
	Actual									45
Total Man-months brought forward	Planning	60				60				225
	ac. agreem.									
	Actual	43				51				196

see continuation

Table 2.: Planned and Actual Involvement CP Personnel

Name & position		1985		1986		1987		1988		Total MM			
		J	F	M	A	M	J	J	A		S	O	N
Staffman	Planning	=====										45	
	ac. agreem.												
Fabala Camara	Planning	=====										45	
	Actual											45	
Staffman	Planning	=====										45	
	ac. agreem.												
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 12-months brought forward	Planning	60											225
	ac. agreem.												
	Actual	43											196
Total 12-months project period	Planning	84											315
	ac. agreem.												
	Actual	83											373

Counterpart seconded to UNCDF/UNSO Project

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

HEAD 15—MINISTRY OF AGRICULTURE—Contd.

DETAILS OF ESTABLISHMENT

Sub-Head	Numbers		Detail	Grade	actual number posted
	1987/88	1988/89			
06			(3) IRRIGATION		
			<i>Salaries (010)</i>		
(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 transferred to the DOA effective from 1st July 1988 according to 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 deteriorated more after a retrenchment exercise of government 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, preparation 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 bar chart of Table 2.

The additional technical personnel (four in number) attached to the project on a permanent basis was according to 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 responsibilities far beyond their grade and actual position within the ISRD.

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

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.

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

Climate

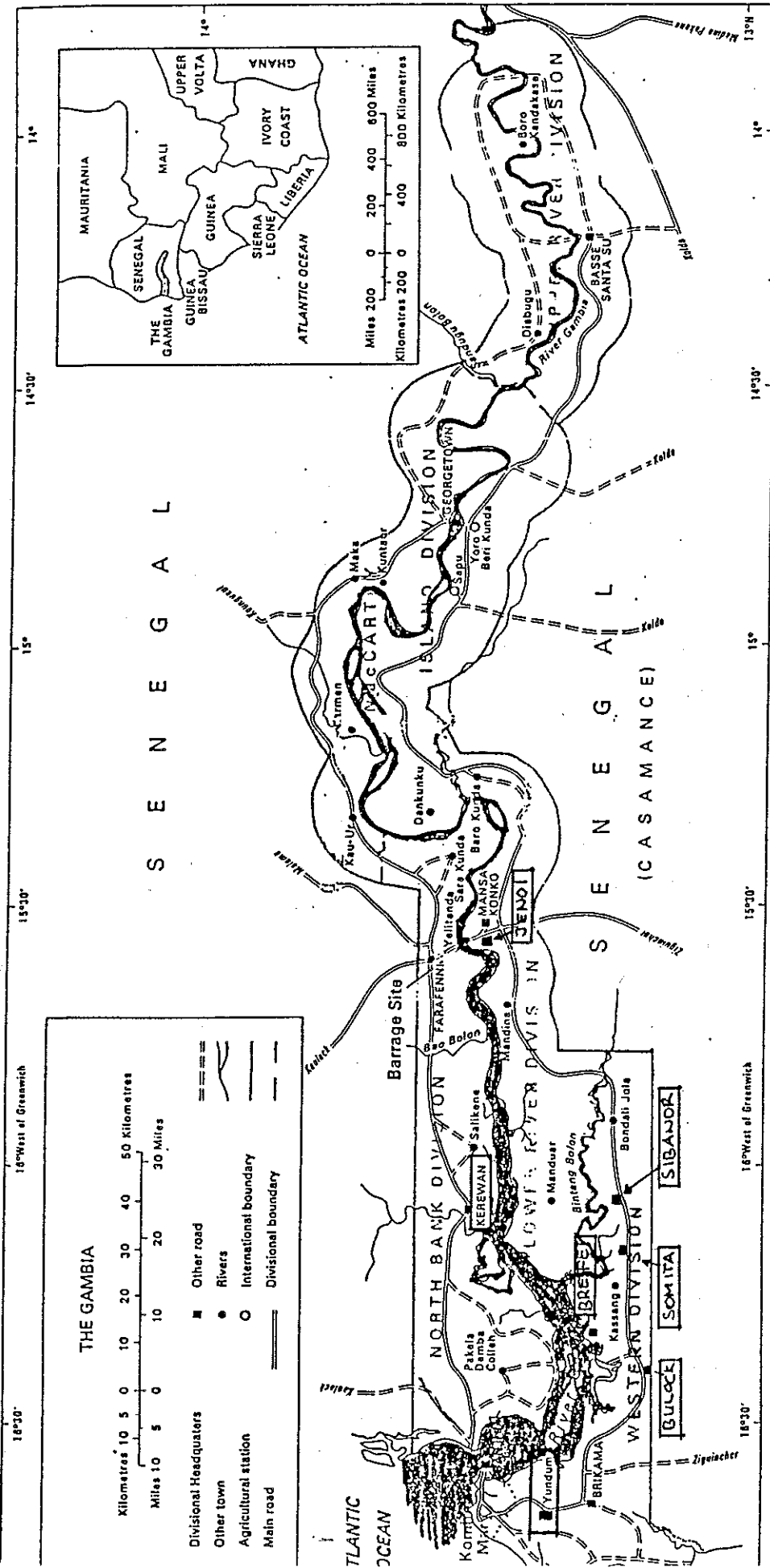
The dominant aspect of the climate of The Gambia is the juxtaposition of a five months period with rainfall (June - October) with seven months dry season. A comprehensive analyses of the climate in the Gambia is given in [8]. Only rainfall, air temperature and evaporation are briefly described below.

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 year 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	-	-	-	-
JENDI	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
	BULLOCK	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
	BULLOCK	10.0	27.5	209.5	477.8			
	BREFET	-	-	245.3	545.9			

Station Brefet records from 1st July 1988

Table 5.: Monthly Rainfall Totals in mm

On many occasions, 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 kilometers 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 Bullock, Ndemban and Brefet (see Map 2.) were each provided with a rain gauge 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 there 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 occurred 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.

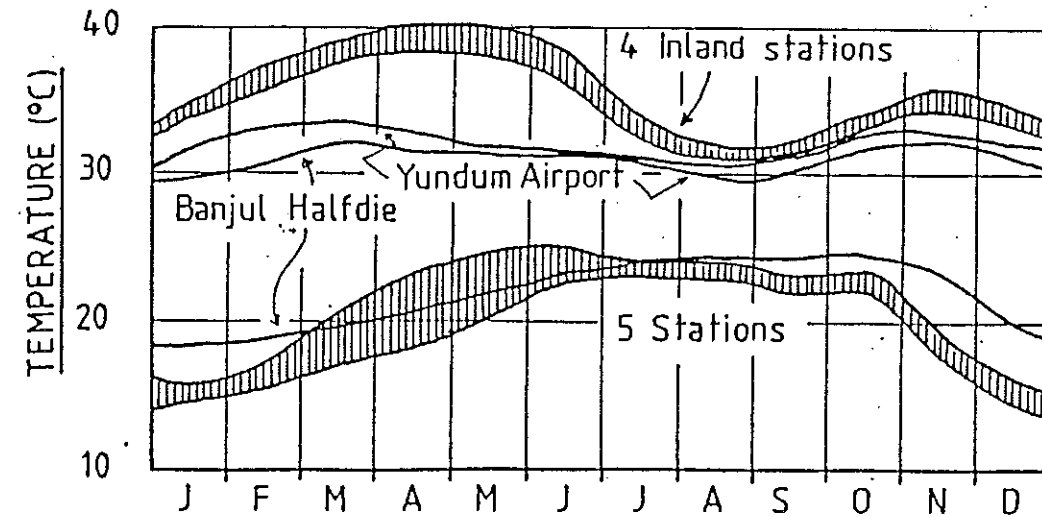


Table 6.: Mean daily maximum and minimum temperatures

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 referred 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 referred 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 potentially 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 Vaginatam" 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, generally speaking organic matter contents are low. In nutrients, these soils are low in phosphorus but with moderate nitrogen and usually have an adequate potassium content. Some organic matter (groundnut shells) is, traditionally, incorporated during land preparation. Fertilization, however, is hardly practiced mainly due to cost considerations.

3.5.2 Land Use

Of all Divisions, the Western Division is the most densely 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 extent 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 directly 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 occasional (spring tide) tidal floodings
- extensive livestock (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 increasingly part of the production is exported; air-lifted to Europe (mainly U.K.) or sold to entrepreneurs from Senegal
- forests are partly protected as so called 'National Forest Park' and consequently not commercially utilized. Non protected forest lands are increasingly more exploited for firewood or transferred into farmland. Mangroves are sometimes exploited for firewood but are generally 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 aggravating 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 experiances 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 actually 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 there was no simultaneous request from the villages cultivating a particular area together, the project has always tried to visit those others and to persuade 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 clearly 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 until 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, after all 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 continuously 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 tachymetric 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 Agriculture/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 tolerance 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 primary 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 impound 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.

Sluice gates and Spillways

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 totally 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 themselves 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 responsibilities 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 aggravating 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 consignment (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, equipped 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 consignment 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 awareness and responsibilities among the villagers during project execution 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 arduous task for the villagers and to be considered carefully beforehand.

None 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 none 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 staff that the envisaged measures would benefit them all and to an equal extent.

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 either to 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 to 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 successful 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 conducting 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 absolute minimum the project sought to tackle this problem by promoting a drought tolerant, short cycle variety. Already in 1984, during the first phase, small quantities (a few hundred kilos) of two s.c. varieties, '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 primarily 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 to 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 impounding). 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 (then 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 bartered for same quantities 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 preparation

Land preparation 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 preparation 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 preparation is conducted with the traditional hoe; 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 preparation. The results will be discussed in a separate 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 discussions 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 (impounding 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 emphasised 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 comparisions 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 categories were distinguished i.e. a part permanently 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 category 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 category two fields were selected in this way with four sample plots each. In non-project villages only the farmers were selected irrespective possible categories 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 mechanical equipment not available 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 continuous 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 forceful 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 caused 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, sluiceways 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, Rondali Jola 1985) to severe damages and even of impounded 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 impounded 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 impounding 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 successive 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 occasions 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 useful 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 impounding were not considered as a major problems.

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

- motorized levelling was considered too costly 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 themselves hardly leak thanks to rabbating the boards and because the timber swells to some extent 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 continuous washing out of soil material alongside the grooves leaking of gates could not be 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 impounding the rice fields. Any excess water was planned to be flushed by an operator by lifting the doors and to reduce the waterlevel to an optimum according to 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 occurring shortly after heavy storms. Despite the higher cost involved project management decided, mainly to lower the risk of dike ruptures to construct additional gates (Bullock, Ndemban, Bwiam Santamba) or to incorporate an additional drop spill-way as high as the maximum level of impounding (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 thought to impound 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 impounded 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 Pirang (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 land-users not owning 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 where opposite interest 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 deviation 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 successful 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 successful 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, initially guided by project staff to develop an optimum water management 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 extent that maintaining a certain depth of impounding 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 separate plan of operations has to be elaborated in close collaboration with the farmers. Points of concern in which farmers have to collaborate and agree beforehand are:

- time of land preparation, seeding and/or transplanting
- decision which fields are direct seeded and which are transplanted
- attune the use of certain varieties
- depth of impounding 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 water management. 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 water levels as optimal as possible. In certain schemes this led to serious conflicts between staff and farmers and among farmers themselves. At several occasions areas were drained by individual farmers without informing and without agreement of others. Especially timely land preparation caused serious problems among farmers when one individual farmer drained the area for land preparations 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 fulfilled their expectations. Salt water intrusion was effectively blocked whereas all dikes were able to impound fresh water according to the design.

In years with rainfall totals between 800 and 900 mm the dikes could impound 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 impounded 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 expectations and did impond sufficient water to create similar conditions as described before.
- Behind bunds constructed in valleys comprising permeable soils no significant impounding 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			REMARK
	CATEGORY OF FLOODING			
	A	B	C	
Bullock	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			REMARK
	CATEGORY OF FLOODING			
	A	B	C	
Kaimbujae			1200	
Bullock	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

- successful 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 common experience of similar projects countrywide. Other less successful 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 striking 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 surprisingly 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 preparation
- 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 hectareage 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.

Project benefits 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 result of a reduced risk 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 assumption 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 incremental cost 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	674.00									
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 PAID 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	2133.57	5008.38	4336.21	5720.55					
NPV @ 15% 2	342.26	296.17	3110.95	2439.78	3023.13					
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%	57%					
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 investment and operating cost

The NPV is the present value of the net benefit stream generated by the project (by subtracting year-by-year costs from the benefits) discounted at an interest rate which 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 hectareage 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 investment. If the IRR is 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 technical 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 assess 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 positive for all three yield scenarios. An average yield of 1.5 t/ha is sufficient to result in an attractive 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	2.0	3.0	4.0	5.0					
TOTAL PROJECT COSTS (TPC)	TPC WITH PAID LABOR	TPC WITHOUT TECH. ASST.	TPC WITH DECREASING OVERHEAD	TPC WITH DECREASING T.A., DECR. OVERHEAD	TPC WITH DECREASING T.A., DECR. OVERHEAD					
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

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

After a considerate review of the interventions and their respective impact in 16 schemes implemented during this project period the following points have been observed:

The technical interventions taken have resulted in

- * blocking of tidal flooding otherwise causing serious salt intrusion on arable, productive plots
- * impounding, for prolonged periods part of the areas in question
- * allowing active watermanagement i.e. waterlevel regulations and draining on demand of the impounded area according growing stage of the crop

An intensive agricultural follow-up, concentrated solely on project areas has resulted in

- * widespread acceptance of improved agricultural practices like direct- and animal drawn seeding
- * growing awareness of the importance of the cultural calendar e.g. timely land preparation, weeding etc.
- * introduction of high yielding varieties adapted to the changed conditions due to the aforementioned technical interventions

To keep the construction costs of the necessary infrastructure low, the project has opted for

- simple designs
- construction involving appropriate technologies with a maximum input of manual labour

However, low cost structures (often) go hand in hand with a higher risk with regards to safety and durability of the structures in question.

To assure the durability and sustainability of project interventions and to lower the risk as much as possible the project has embarked on the commitment of the direct beneficiaries to be involved and to participate in:

- planning and implementation (construction) of the infrastructure
- agricultural follow up
- scheme operation
- repair and maintenance work on a regular i.e. yearly basis

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

Project management has also come to the conclusion that the other factors, mentioned in Chapter 5. contributing to the success or failure of project interventions (e.g. environmental and design factors) are, compared to the rate of village participation of minor importance.

Relating these conclusions to the project objectives, as mentioned in section 3.1 one could conclude:

- that the project has met the target to:

"develop and test 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"

Hereby fulfilling the project objective being:

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

and contributing, albeit limited to the project goal:

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

7.2 Recommendations

Referring to the discussed implications of the critical factors on project execution and the subsequent conclusions the following recommendations are presented for consideration.

Concerning village participation, emerged as the most critical factor contributing to success or failure it is recommended:

- to establish a system whereby pre-project conditions are thoroughly assessed. Issues like socio-economic relations, land use and land tenure could provide clues whether a village is willing to commit themselves to participate and cooperate for a prolonged period or not. The initial investment to sort this out certainly pays off later
- to reduce and eventually refrain from an incentive system
- to suspend interventions as soon village participation fails

Concerning design and construction of structures it is recommended:

- to incorporate detailed soil and hydrological studies to optimize designs
- to incorporate additional drop spillways in all schemes to lower the risk of damages

Concerning scheme operation and management it is recommended:

- for the building institution to bear the responsibilities of scheme operations and management for the first two years
- to develop and test, in close collaboration with the farmers and the agronomy section a local management system gradually to be handed over, during these two years to a body at village level
- to incorporate a program of internal monitoring and evaluation including technical as well as socio-economic factors

General recommendations, also mentioned in other reports are:

- mapping of potential development sites in the various rice growing ecologies
- embark on a strongly interwoven agronomy - extension service

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CONTENT ANNEXES

- ANNEX 1. Project Agreement
2. Definition Rice Growing Ecologies
3. Design Dikes and Contourbunds
4. Typical designs sluice gates and spillways
5. Summary constructed infrastructure
6. Project Costs 1986

ANNEX 1. PROJECT AGREEMENT (GAMBIAN-GERMAN)

MEA/6125/Vol.8/(242-EAD)

Excellency,

I have the honour to acknowledge receipt of your letter dated 29th January 1985, referring to the Arrangement of 30th March 1981/13 July 1981, as well as to the Agreement of 5th March 1976 between our two Governments regarding Economic and Technical Co-operation and ~~to~~ propose on behalf of the Government of the Federal Republic of Germany that the following Arrangement concerning the project "Advisory assistance in rice-growing techniques" be concluded.

1. The Government of the Federal Republic of Germany and the Government of the Republic of The Gambia shall continue their co-operation in the promotion of rice growing until the end of 1987. The aim of the project in accordance with this Arrangement is to develop and enable working units of the Ministry of Water Resources and the Environment and of the Ministry of Agriculture to

- increase self-supply in rice
- carry out activities for the production of rice dependent on precipitation, in projects involving small farmers or groups of farmers.

2. The Government of the Federal Republic of Germany shall make the following contributions:

(1) It shall

- (a) second one expert in cultivation techniques and hydraulic works for up to 36 man/months and short-term experts in various fields for up to 6 man/months;
- (b) supply a requisite amount of material necessary for carrying out the proposed activities.

(2) It is ready to provide further training in rice growing and the provision of advice for up to 3 months in an appropriate project or institute in West Africa for one staff member of the Gambian Ministry of Agriculture who shall be assigned to the project upon his return and advise the farmers on rice growing.

(3) It is also prepared to

- (a) meet the cost of accommodation for the seconded expert and his family;
- (b) meet the cost of official travel by the seconded expert within and outside the Republic of The Gambia;
- (c) meet the cost of transport and insurance to the project site for the material referred to in subparagraph 1 (b) above (this shall not include payment of the charges and storage fees referred to in paragraph 3 (2) (a) below);
- (d) make available an amount of DM 60,500 (sixty thousand five hundred Deutsche Mark) for the promotion of self-help activities connected with the project. Contributions for individual activities in this connection shall be limited to DM 10,000 (ten thousand Deutsche Mark). Eligibility for promotion shall be decided upon jointly by the Department of Water Resources and the expert seconded by the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ).

3. The Government of the Republic of The Gambia shall make the following contributions:

(1) It shall make available

(a) four experts in cultivation techniques, surveying, planning and construction as well as two assistants for land improvement activities, immediately, if possible, or by 1 July 1985 at the latest;

(b) office space for the seconded adviser and his Gambian staff.

(2) It shall

(a) exempt the material supplied for the project on behalf of the Government of the Federal Republic of Germany from licences, harbour dues, import and export duties and other public charges, as well as storage fees, and ensure that the material is cleared by customs without delay. The aforementioned exemptions shall, at the request of the implementing agency, also apply to material procured in the Republic of The Gambia;

(b) afford the seconded experts any assistance they may require in carrying out the tasks assigned to them and make available all necessary records and documents;

(c) ensure the provision of the contributions required to implement the project, insofar as these are not provided by the Government of the Federal Republic of Germany pursuant to this Arrangement.

4. (1) The seconded expert and his Gambian counterparts shall have the following tasks:
- repair and maintenance of dykes insofar as technically and economically feasible,
 - planning and implementation of land improvement activities on six pilot plots outside the area now thought to contain saline soil of sulphuric acidity,
 - identification of further areas for rice growing suitable for improvement, and, where necessary, implementation of the necessary activities,
 - preparation and implementation of a long-term work and advisory programme for the Department of Water Resources,
 - provision of advice to villages seeking assistance in questions of cultivation techniques.
- (2) The seconded expert shall within the framework of the tasks described in paragraph 1 above work as a consultant for the Department of Water Resources.
5. The material supplied for the project on behalf of the Government of the Federal Republic of Germany shall become the property of the Republic of the Gambia on arrival in the Gambia. The material shall be at the unrestricted disposal of the assisted project and the seconded expert for the fulfilment of his tasks.
6. (1) The Government of the Federal Republic of Germany shall charge the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, 6236 Eschborn, with the implementation of its contributions.

- (2) The Government of the Republic of the Gambia shall charge the Department of Water Resources at the Ministry of Water Resources and the Environment with the implementation of the project.
- (3) The agencies pursuant to sub-paragraphs 1 and 2 above may jointly agree on details of the implementation of the project in a plan of operations or in some other appropriate form, adapting them as necessary in line with the progress of the project.

7. In all other respects the provisions of the aforementioned Agreement of 5 March 1976, including the Berlin clause (Article 9), shall apply to the present Arrangement.

I have the pleasure to confirm on behalf of the Government of the Republic of The Gambia the foregoing arrangements and agree that Your Excellency's letter under reference and this reply shall constitute an Arrangement between our two Governments to enter into force on today's date.

Accept, Your Excellency, the assurance of my highest consideration.

L.K. JABANG

Minister of External Affairs

His Excellency
Dr. Norbert LANG
Ambassador of the Federal
Republic of Germany
Dakar
Republic of Senegal

cc: Secretary General
P.S.M.E.P.&I.D.
P.S.M.Agriculture
Mrs Corr ✓
G.H.C. Dakar

(Handwritten signature)

ANNEX 2. RICE ECOLOGIES IN THE GAMBIA

INTRODUCTION.

This paper sets out to: (i) clarify the definitions of rice ecologies presented to the task force on 2nd March, 1987,
(2) compare the task force's classification with those of previous studies, and
(3) present preliminary estimates of the area covered by each ecology.

1. DEFINITION OF RICE ECOLOGIES.

The rice task force classification sub-group has identified five ecologies namely; (i) saline swamps, (ii) fresh water swamps, (iii) transitional, (iv) upland and (v) pump irrigated. The principal criterion of differentiation is source of water supply. Each ecology's position on the toposequence is illustrated in figure 1.

(i) Saline swamps are those low lying areas close to the river Gambia and its tributaries, to the west of **Carrol's Wharf (M.I.D.)**. These areas are subject to the intrusion of salt water during the dry season; their cultivation must therefore wait until after the rains and an increased flow of fresh water in the river has leached out the salt.

Saline swamps can be divided between those that are vulnerable to salt intrusion on a daily basis, due to tidal influences, and those only seasonally effected. These sub-divisions correspond to soil associations 14 and 16 respectively¹. Daily flooded areas are rarely cultivated at present as reduced rainfall has resulted in increased salinity.

(ii) Fresh water swamps are the lowlying area along the river Gambia and its tributaries to the east of **Carrol's Wharf**. These can be divided between those that are mainly river flooded and those that are slightly higher and mainly rainfed. The rationale for this distinction is the hypothesis that river flooded areas have a more assured water supply (fouta Djallon watershed), than directly rainfed areas (run off from the immediate plateau areas).

Freshwater flooded areas can be sub-divided between those that flood daily due to tidal influence on the river, corresponding to soil associations 15, 16 and 17 in MID², and those that only flood during the rainy season. It is not possible to identify a soil association which corresponds specifically to this latter sub-division. Rather seasonally river flooded freshwater swamps share the slightly elevated soil associations of rainfed swamps namely no. 21, where the depth of water is less than 50cm., and no's. 18 and 22 where water depths equal or exceed 50cm. The rationale for the distinction between 'deep' and 'shallow' fresh water swamps is that this factor will influence varietal selection. They correspond to the local terms 'Gibafaro' and 'Bafaro' respectively.

(iii) Transitional ecologies are solely rainfed areas that are gentle slopes such as tributary valleys. They can be differentiated in terms of soil texture, which influences the ease with which they can be worked. For example, valley bottom soils tend to be finer and heavier than those further up the slope. This will affect varietal selection and the potential for introducing animal drawn implements to this ecology. Transitional areas correspond to soil association 13; they are spread throughout the country. 'Banta faro' appears to be the equivalent local term.

(iv) The only truly upland ecology is known locally as 'tendaco', (meaning newly cleared). It is found mainly in W.D., which has the highest divisional rainfall, in natural depressions. These areas correspond to soil associations 4 and 5 in W.D. 'Tendaco' is a shifting cultivation system: one or two years of cultivation are followed by four to six years fallow; it is entirely rainfed. The fallow requirements of this system inhibit the expansion of upland rice cultivation on a sustainable basis. Because none of these stumps are removed, in order to help maintain soil fertility, the use of animal traction is inappropriate.

(v) Pump irrigated areas are a sub-set of freshwater swamps located in MID and URD. These areas are the result of specific project interventions; they have already benefited from a great deal of agronomic research :

2. COMPARISON OF RICE ECOLOGY CLASSIFICATIONS.

There are essentially two alternative classification systems for rice ecologies: they are (i) the system used by PPMU in the NASS, and (ii) those that are based on LRS22 soil associations.

In the NASS, PPMU present production statistics for rice ecologies classified as either: irrigated, upland or swamp. It is difficult for the research task force to utilise the NASS data to influence research priorities. The main difficulty here is that the PPMU'S classification swamp rice, aggregates three separate ecologies. In addition, there are some inherent difficulties in collecting rice production data.³ Despite these qualifications, the NASS provides the only source of data on the area of rice cultivation per year. By taking divisional estimates, it is possible to estimate area cultivated for the five main ecologies identified in part 1. This is done in part 3.

There are three classifications of rice ecologies based directly on LRS22 soil associations: that of LRS 22, FAO 1983 and Euro-consultant 1986. Essentially, these classifications represent attempts to improve a common set of definitions. The definitions adopted by the task force are the next step in this process, taking the best features of the existing systems as a starting point. For example, by following FAO 1983's lead in combining transitional and tributary valleys as a single category, and by following the Euroconsultant report in differentiating between seasonally and tidally flooded fresh water swamps.

The pre-existing classification systems provided the basis for allocating soil association numbers to the ecologies defined by the task force, which in turn are the basis for calculating the potential area for each ecology. Upland ecologies proved to be the major problem here; FAO 1983 defined them in terms of parts of soil associations 1 and 2.⁴ After discussions, it was decided that the hydromorphic soils or associations 4 and 5 are more representative of the ecology. They have therefore been used to calculate the potential area of the upland ecology.

3. ESTIMATES OF CULTIVATABLE AREA FOR EACH ECOLOGY.

As noted above, allocated soil associations provide the basis for estimating the potential area of each rice ecology; other information used here include: the extent of salt water penetration upstream during the dry season, and inter-division variations in rainfall. The resulting ecology area estimates are summarised for the whole country in Table 1, and for farming systems focus areas in Table 2. Only seasonally flooded saline swamps were not available in the farming systems focus areas.

The figures in the tables must be treated with extreme caution; they do not represent cultivated areas. For example, nationally saline swamp daily flooded is the largest ecology but almost none of it is actually cultivated at present. Upland ecologies cover an estimated 25,000ha. but due to its fallow requirements, only a fraction of this will actually be cultivated. PPMU data indicates that on average, total rice cultivated area was 21,000ha. between 1974 and 1985.³

Broken down into the constituent ecologies, the means and co-efficient of variations are as follows:

Saline swamps	mean 5,000 ha.	cv 46%
Fresh water swamps	mean 9,200ha.	cv 47%
Transitional	mean 3,600ha.	cv 25%
Upland	mean 1,500ha.	cv 52%
Pump irrigated	1,900ha.	cv 41% (Table 3)

It is not possible to identify long term trends in cultivated area. Inter year variations in cultivated area reflect those in precipitation.

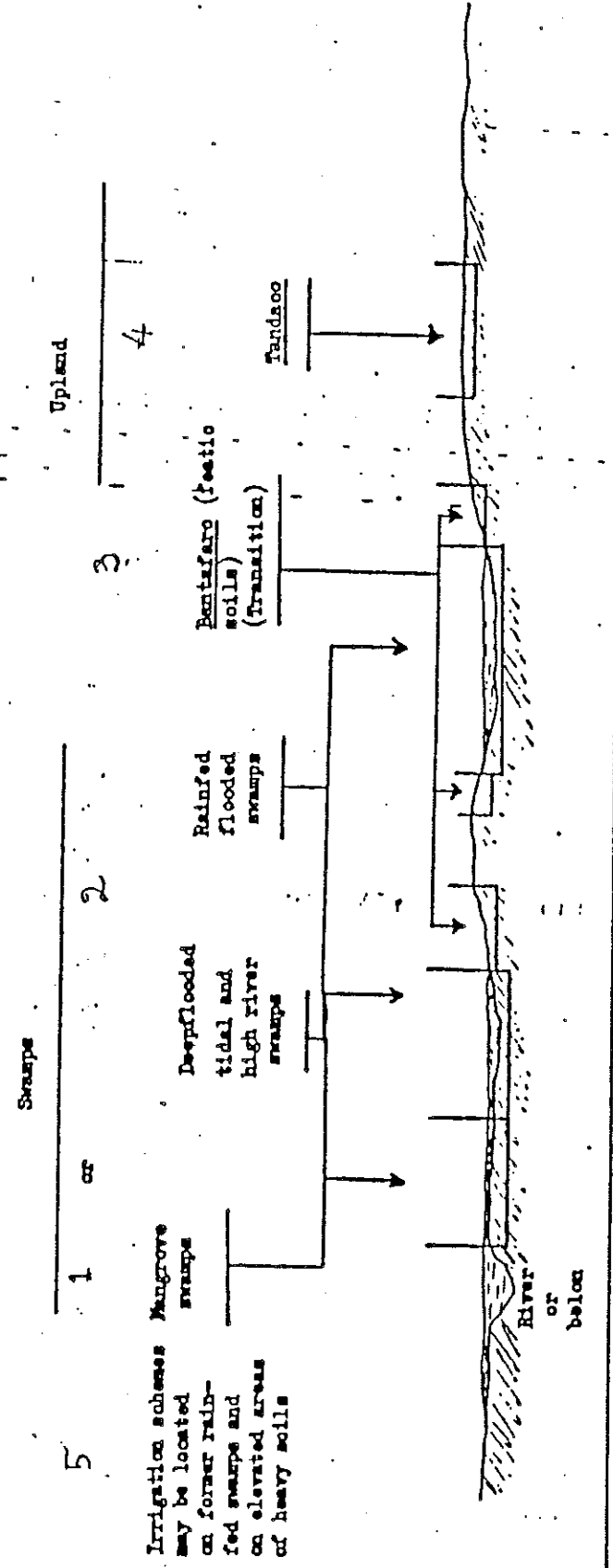
CONCLUSION:

Of all the rice ecologies outlined in part 1, only seasonally flooded saline swamps are not included in the 1986 Farming systems focus areas. Selection of a site in this ecology, possibly close to Jenoi Agricultural Station should therefore be considered. Priority should be given to research on fresh water swamp and transitional rice ecologies, as these combine to cover half the potential rice growing area and are apparently under-utilised at present.

Footnotes:

[1]	LRS 22; <u>The Agricultural development of the Gambia.,</u> 197
[2]	Euroconsultant: <u>Assesment of the possibilities for tidal irrigation along the Gambia River</u> 1
[3]	OMVG. <u>Technical document 3. The Gambia in graphs,</u> 1986.
[4]	FAO. <u>The rice industry in the Gambia,</u> Vol.2. Technical Annexures 1983

Figure 1: Schematic Diagram of Main Rice Production Systems



Irrigation schemes may be located on former rain-fed swamps and on elevated areas of heavy soils

- 1/ Mangrove swamps (*Rhizophora* spp.) which are subject to more irregular saline tidal inundation are variously suffering from acid sulphate toxicity. These are called leo swamps in the Gambia.
- 2/ Deepflooded freshwater swamps are located close to the river in those reaches beyond the saline tidal flows in both the wet and dry season, i.e. beyond Carroll's Mbarf, often supplemented by rainfall, especially early in the season.
- 3/ Rainfed flooded swamps are located on the periphery of river flooded areas and rely almost entirely on rainfall, or may be shallow depressions further inland entirely dependent on rainfall catchment runoff, supplemented in some areas by local flooding from tributary streams.

TABLE 1. THE POTENTIAL AREA OF RICE ECOLOGIES DEFINED BY RICE RESEARCH TASK FORCE - 1987.

ECOLOGY	SUB-CATEGORY	SOIL ASSOCIATION ¹	LOCATION	AREA (000Ha) ²	%	COMMENTS
Saline Swamp	Daily flooding	14	WD, NBD, LRD, MID	99	36%	Rarely cultivated in recent years. These soil associations are unsuitable for cultivation in LRS 22, P241
	Seasonally flooding	16	NBD, LRD	14	5%	
Fresh Water Swamp	River flooded	Tidal	MID	33	12%	Euroconsultant report 1986 estimates 28700ha is potentially tidal irrigable, 1600ha in the near future 2700ha has the potential to be double cropped. 'Giba faro' 'Bafaro'
		Seasonal				
	Rainfed	21 18,22	MID, URD.	22 14	8% 5%	
Transitional	By soil texture	13	Nationwide	70	25%	'Banta faro'
Upland		4,5	WD	25	9%	'Tendaco'. WD has the highest average annual rainfall among the Divisions; 1974-85=840mm per year
Pump irrigated		subset of 18,22	MID, URD	2.5	1%	Approximately 15000ha is currently cultivated, 600ha by the Jahally Pacharr Project.
				277		Euroconsultant report 1986

1] Defined in LRS22;1976, pp.238-9

2] Area given are potential maximums. FAO 1983 estimates 28,000ha to be the area of rice actually cultivated. p.60

TABLE 2. THE POTENTIAL AREA FOR RICE ECOLOGIES IN THE FARMING SYSTEMS FOCUS AREAS-1986

ECOLOGY	SOIL ASSOCIATION	Farming system focus area							
		WD SOMITA Area (000ha)%	NBD C. BADIBU Area (000ha)%	MID FULADU Area (000ha)%	URD FULADU EAST Area (000ha)%				
Saline swamp	14	11	6.8%	4.1	82%				
	16								
Fresh water swamp	15,16,17 21 18,22			1.7	12%				
				0.5	4%	7.8	57%		
				6.1	49%	2.6	19%		
Transitional	13	2.5	15%	0.9	18%	4.1	33%	3.3	24.1%
Upland	4,5	2.6	16%						
TOTALS:		16.1	100	5	100	12.4	100	13.7	

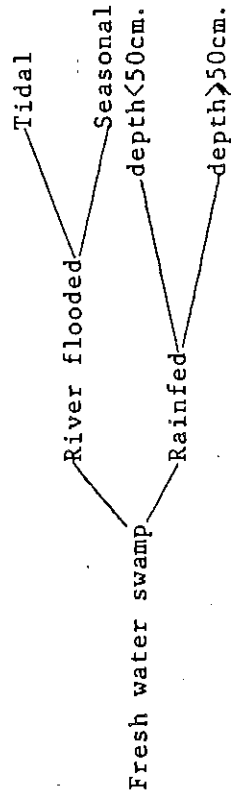
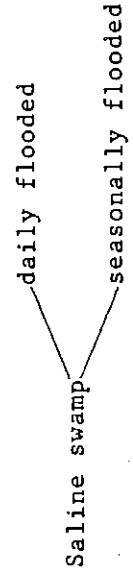


Table 3. Method used to disaggregate PPMU classifications to comply with those of the rice research task force

PPMU Classification	Western Division	North Bank Division	Lower River Division	McCarthy I. Division and Upper R. Division
Swamp	Transitional	50% Salt water swamp 50% transitional	Salt water swamp	Fresh water swamp
Upland	Tendaco	Transitional	Transitional	Transitional
Irrigated	-	-	-	Irrigated

ANNEX 3. ANTI SALT DIKE AND CONTOURBUND

- Fig 1. Cross section anti salt dike
- Fig 2. Cross section contourbund
- Fig 3. Plot boundaries and fieldlevels according topo survey
- Fig 4. Natural contours
- Fig 5. Natural drainage way
- Fig 6. Lay-out contourbunds and location spillways

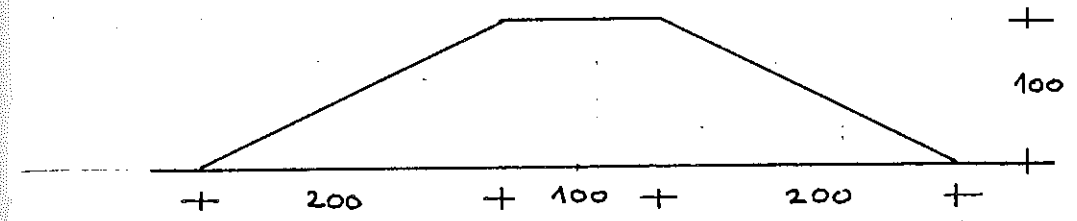


Fig 1.: Cross section Anti Salt Dike

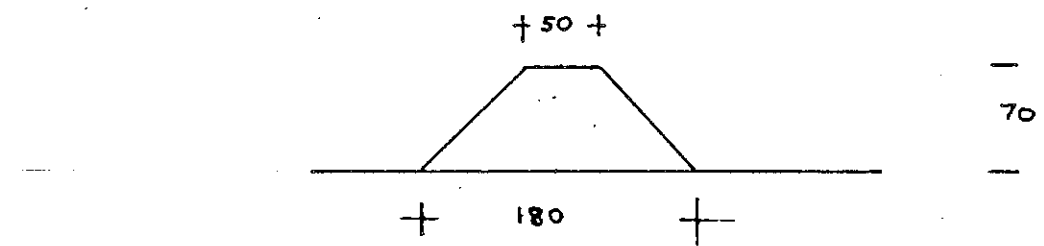


Fig 2.: Cross section Contourbund

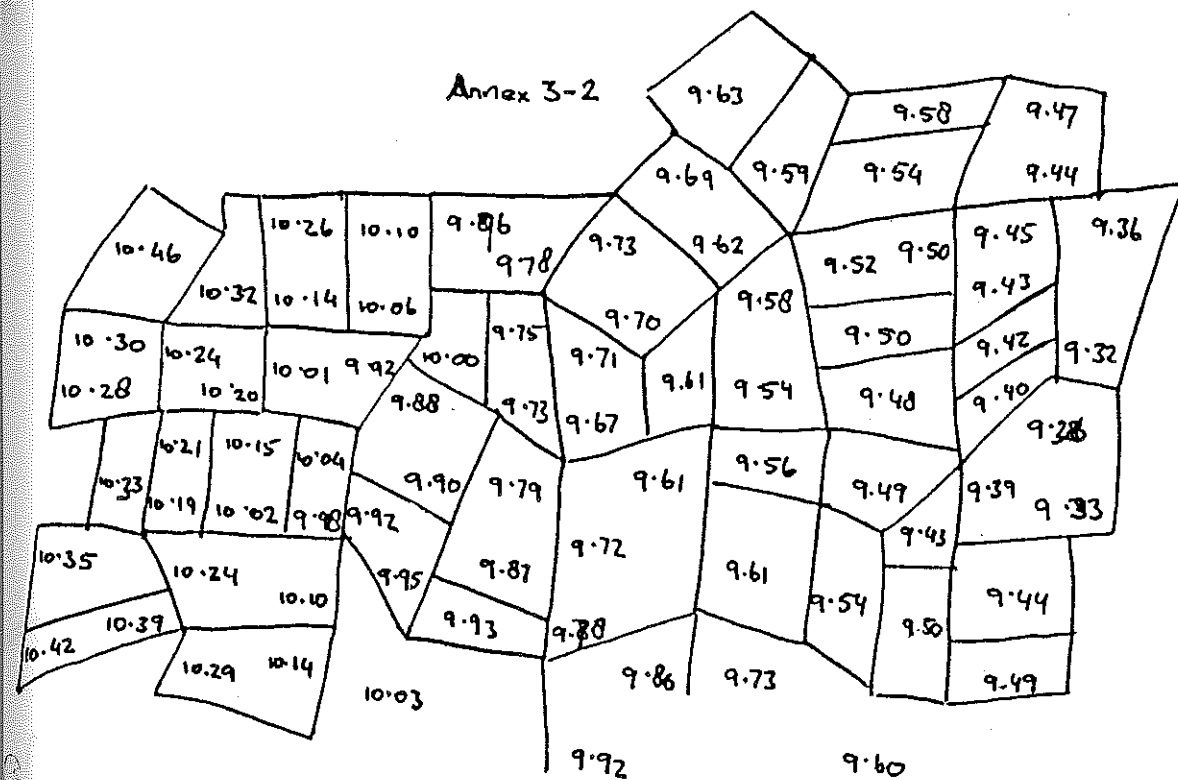


Fig. 1.: Plot boundaries and fieldlevels; mapped according topo-survey

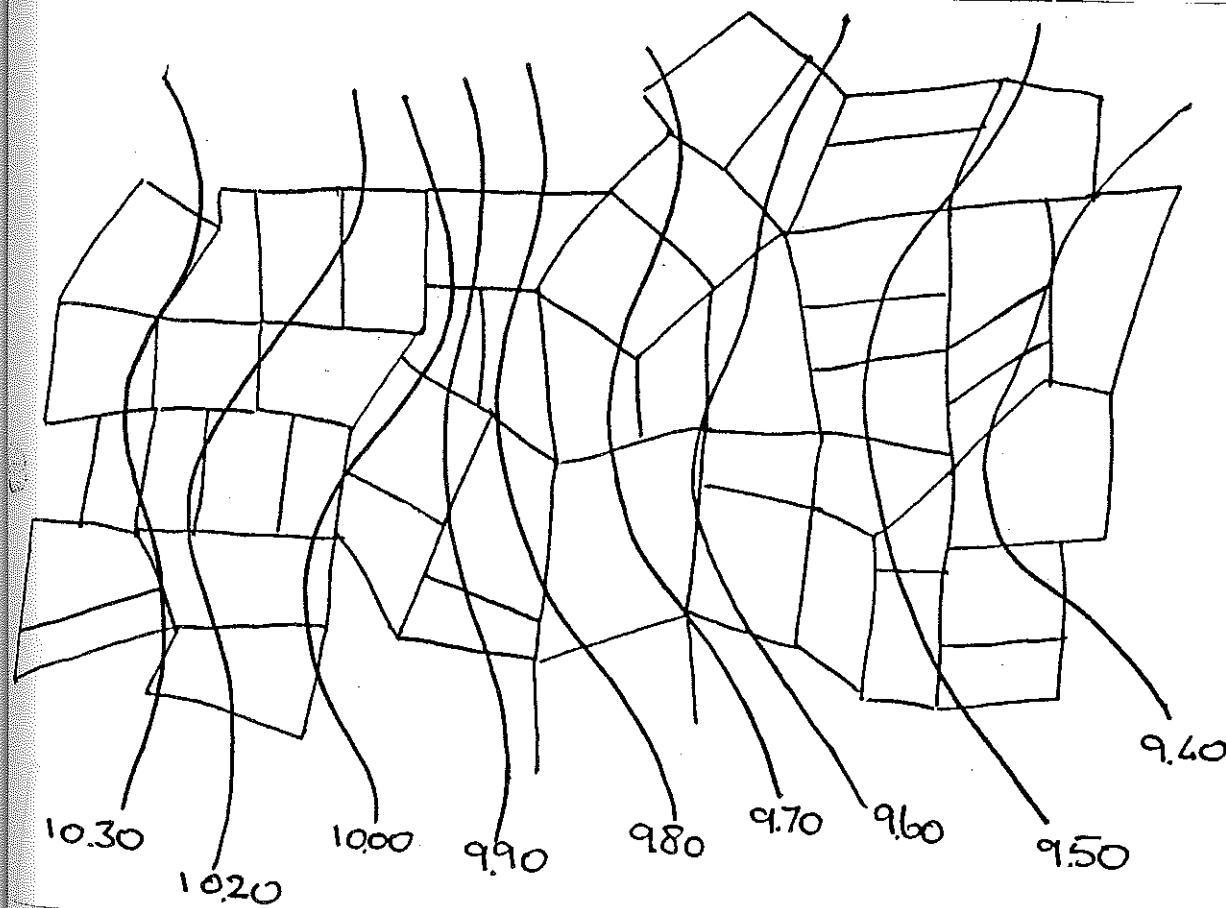


Fig. 2.: Natural contours

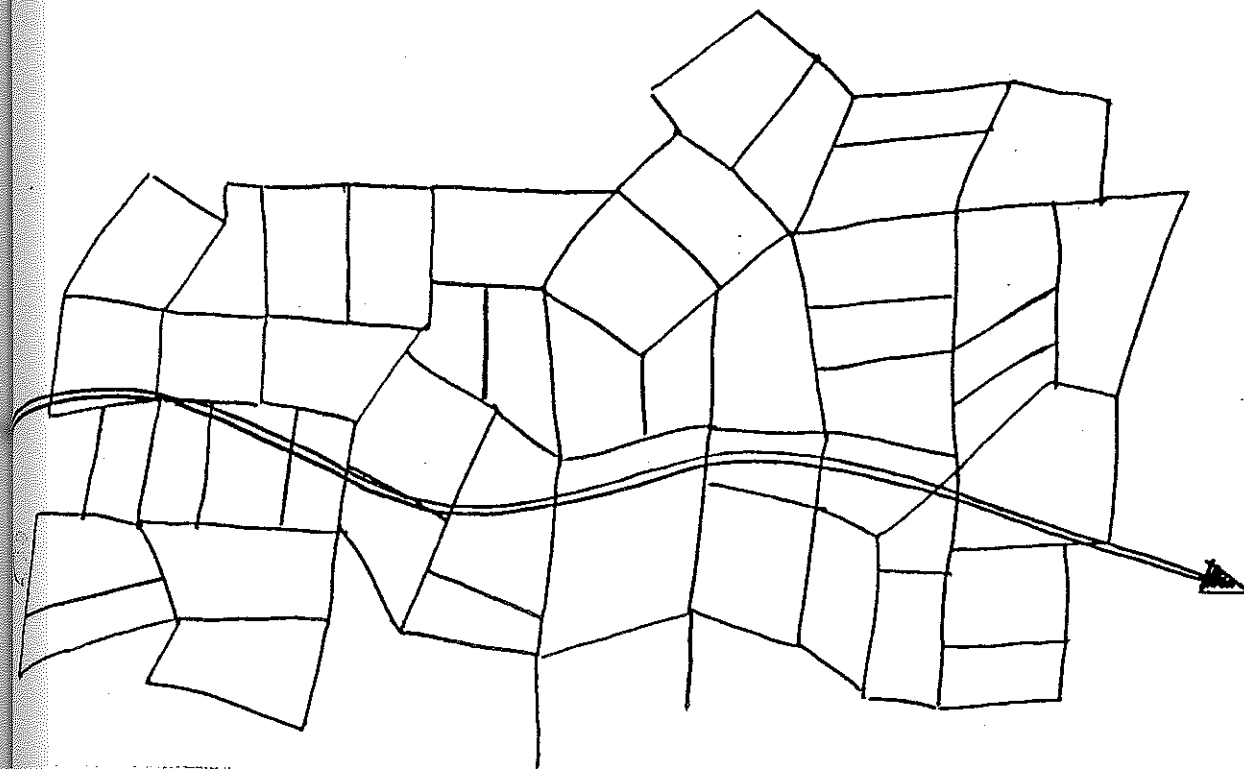


Fig 3.: Natural drainage-way

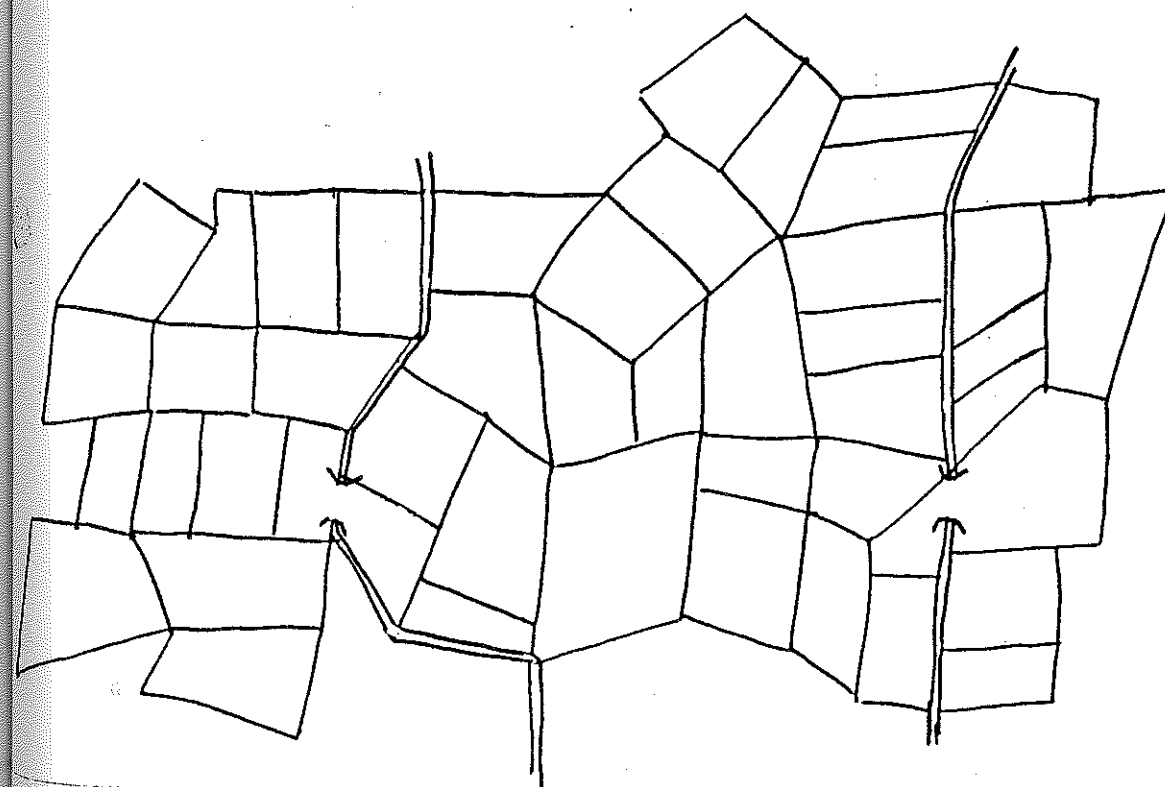
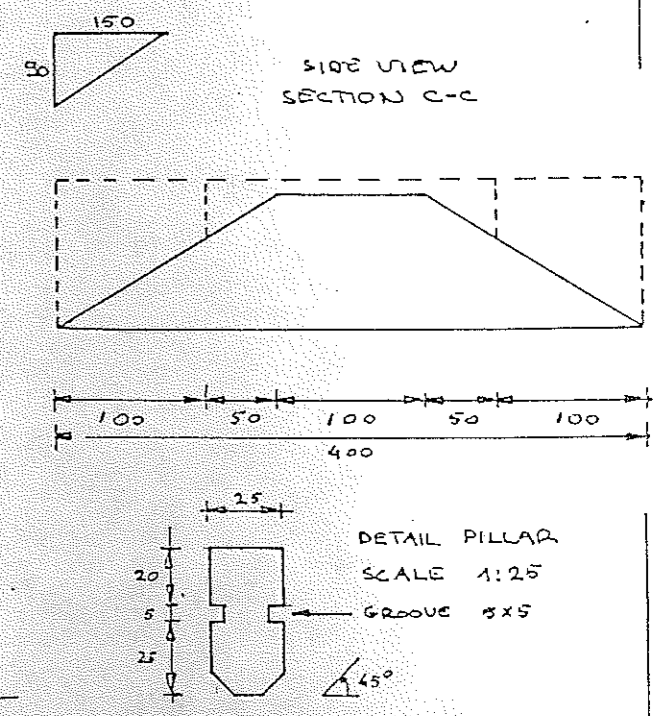
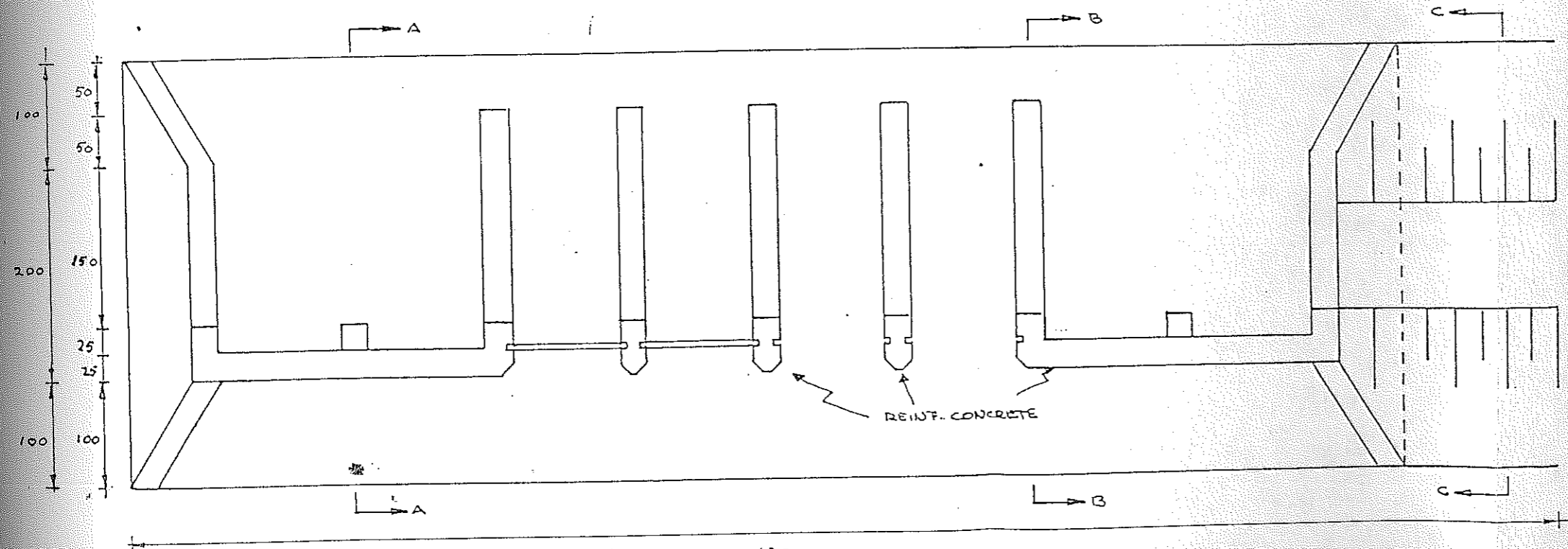
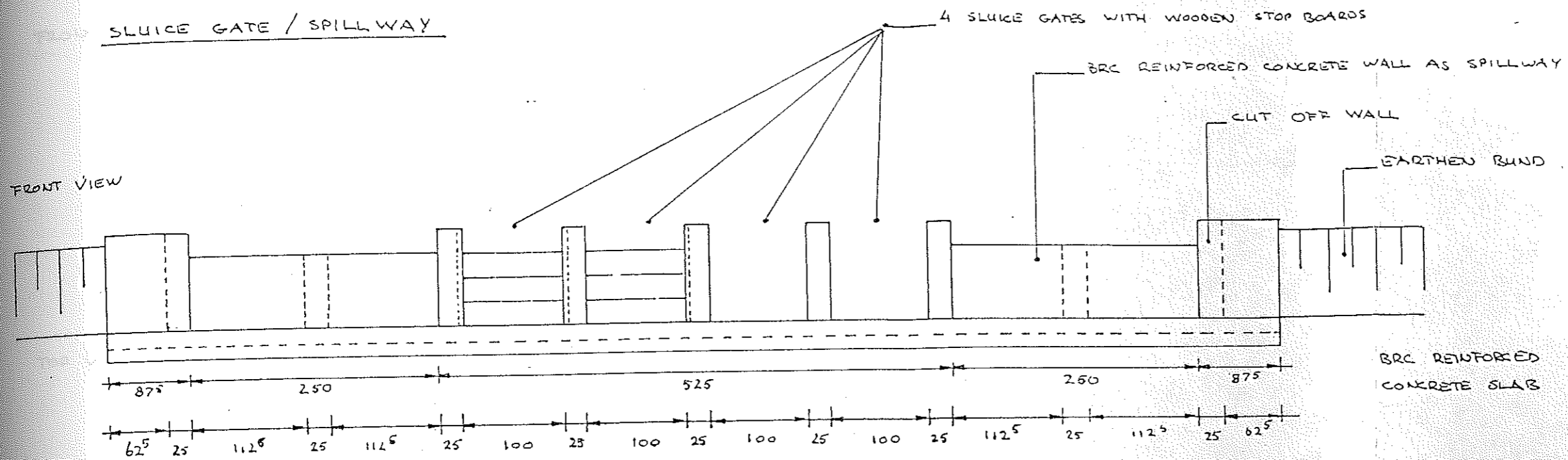


Fig. 4.: Lay-out contourbunds plus location spillways

ANNEX 4. TYPICAL DESIGNS OF SLUICE GATES AND SPILLWAY

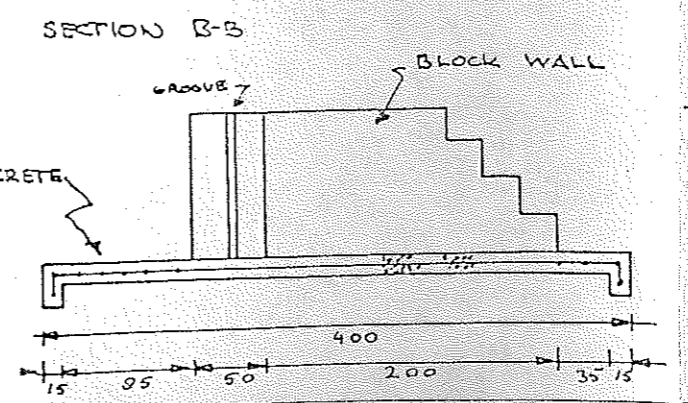
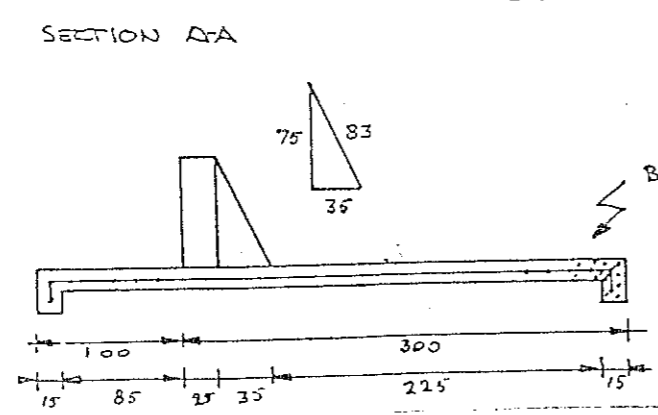
- A. Sluice gate/Spillway Pirang
- B. Sluice gate/Spillway Brefet
- C. Sluice gate Bwiam
- D. Spillway

SLUICE GATE / SPILLWAY



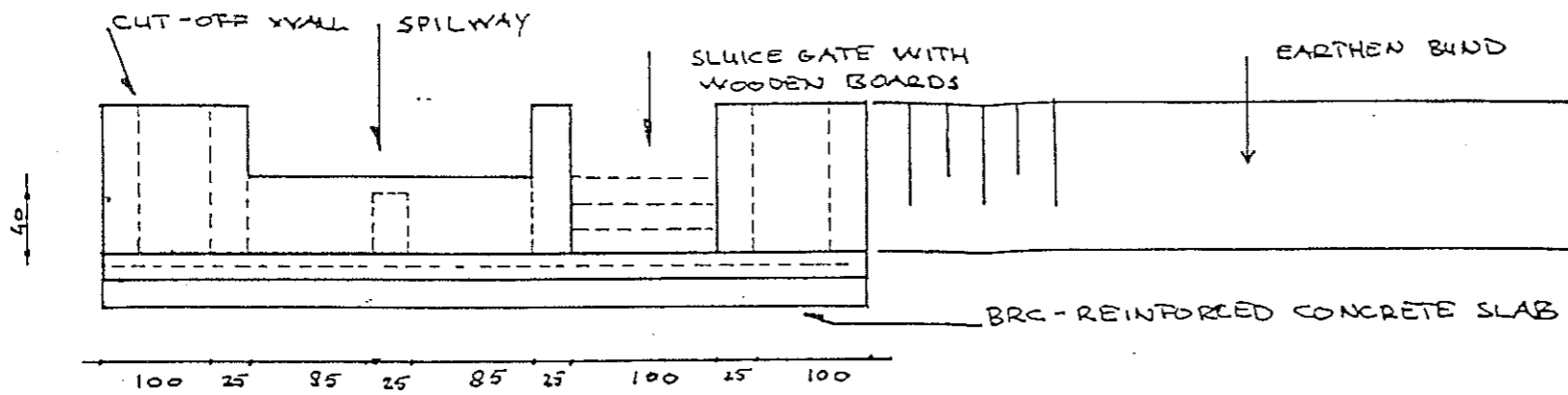
TOP VIEW

SIDE VIEWS



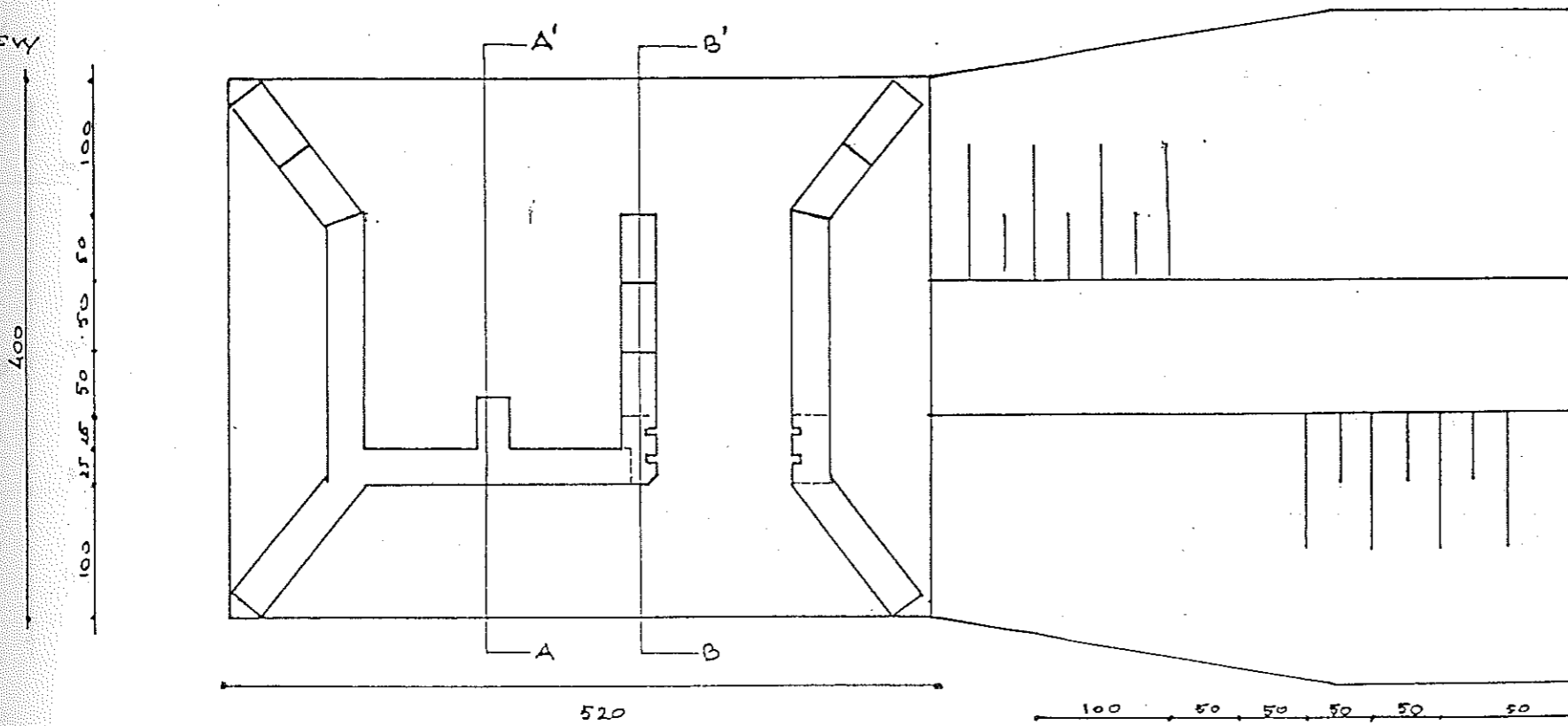
DEPARTMENT OF WATER RESOURCES	
-GTZ-	
SWAMP IMPROVEMENT	
PROJECT	PIRANG - SWAMP
SCALE	1:50 (IN CENTIMETERS)
DATE	MARCH 1985
DESIGN/ CHECKED	<i>WIC</i>

FRONT VIEW

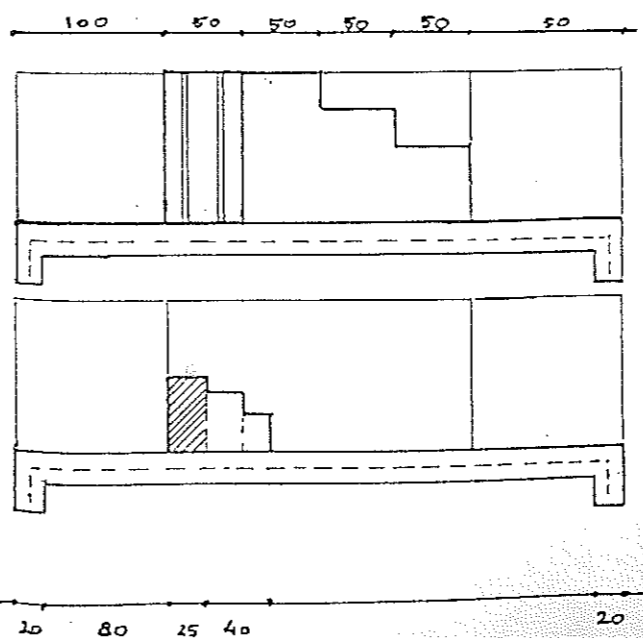
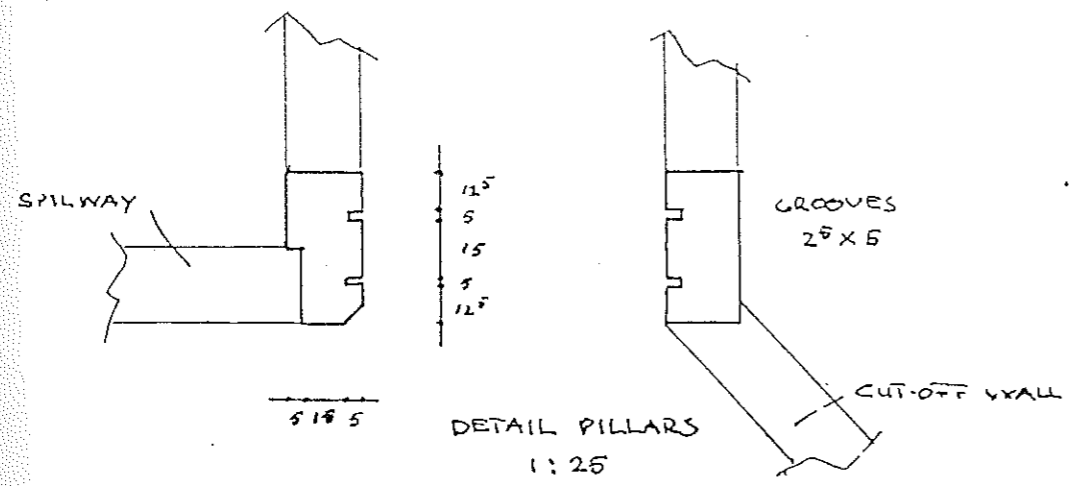
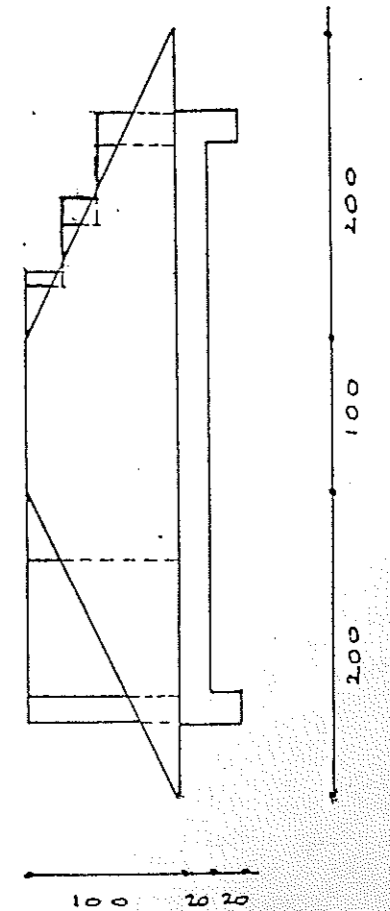


- TOP BUND
- SPILLWAY-LEVEL
- SPRING TIDE LEVEL
- GROUND LEVEL

TOP VIEW

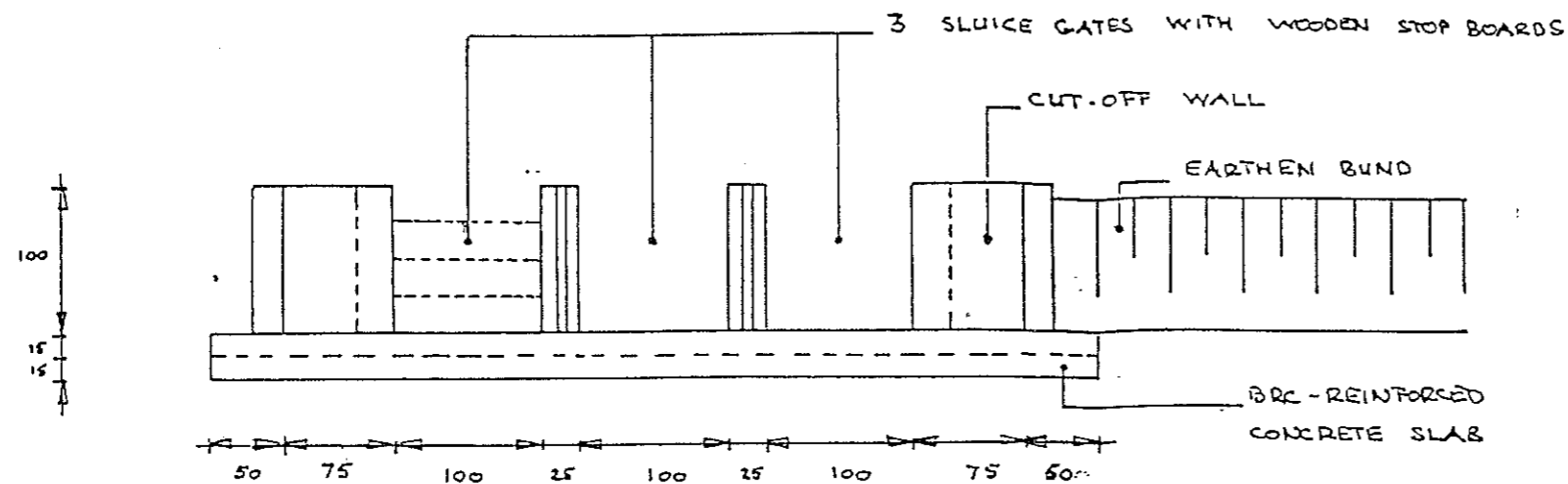


SIDE VIEW



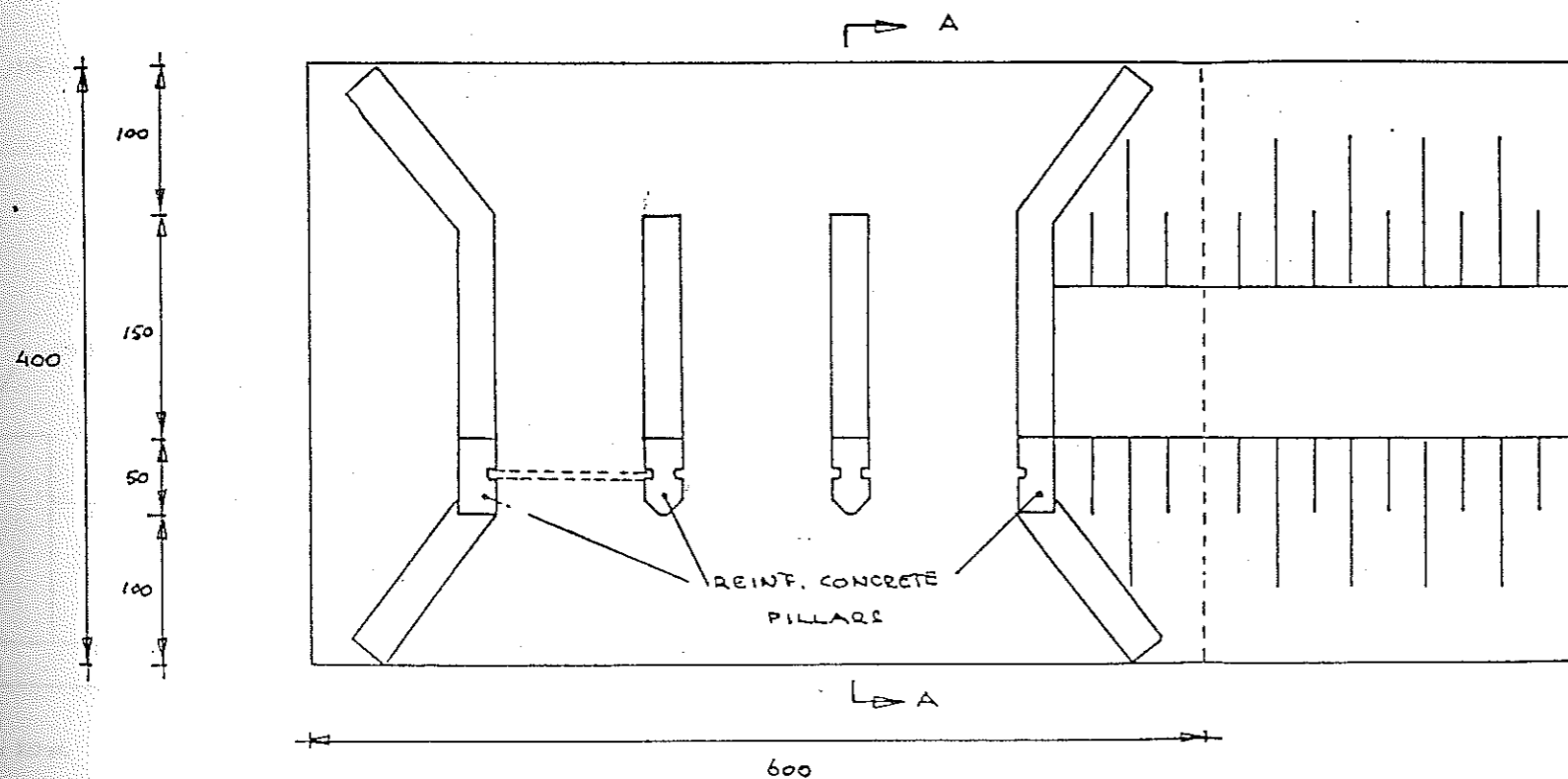
DEPARTMENT OF WATER RESOURCES -GTZ-	
SWAMP IMPROVEMENT SLUICE-GATE + SPILLWAY	
PROJECT	BREFET (W-D)
SCALE	1:50
DATE	NOV. 87

FRONT VIEW

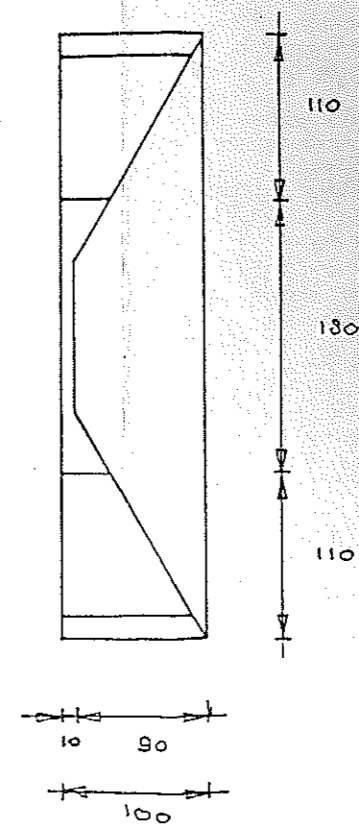


- TOP RUND
- FLOOD LEVEL
- SPRING TIDE LEVEL
- GROUNDLEVEL
- TOP SLAB

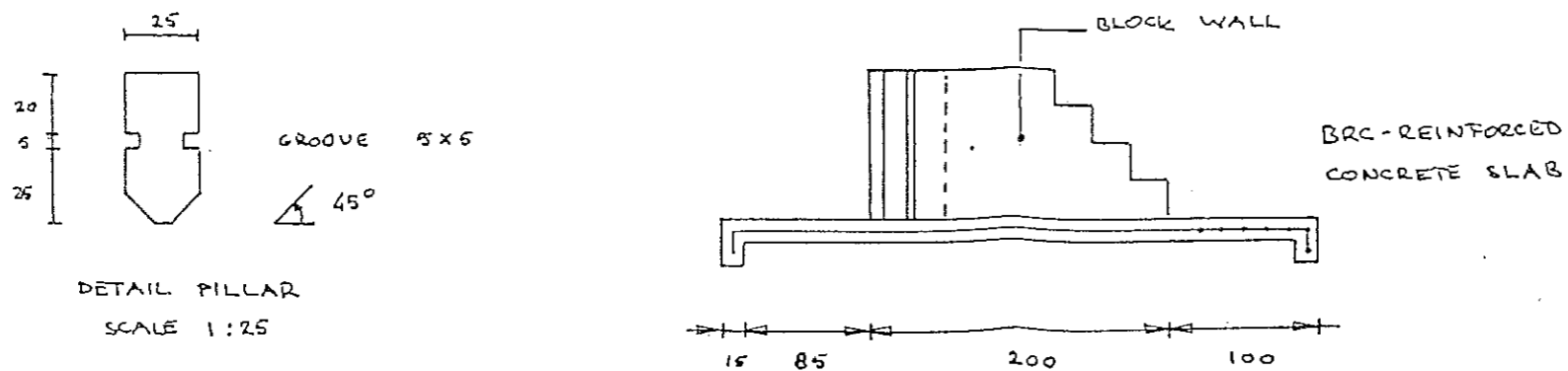
TOP VIEW



SIDE VIEW

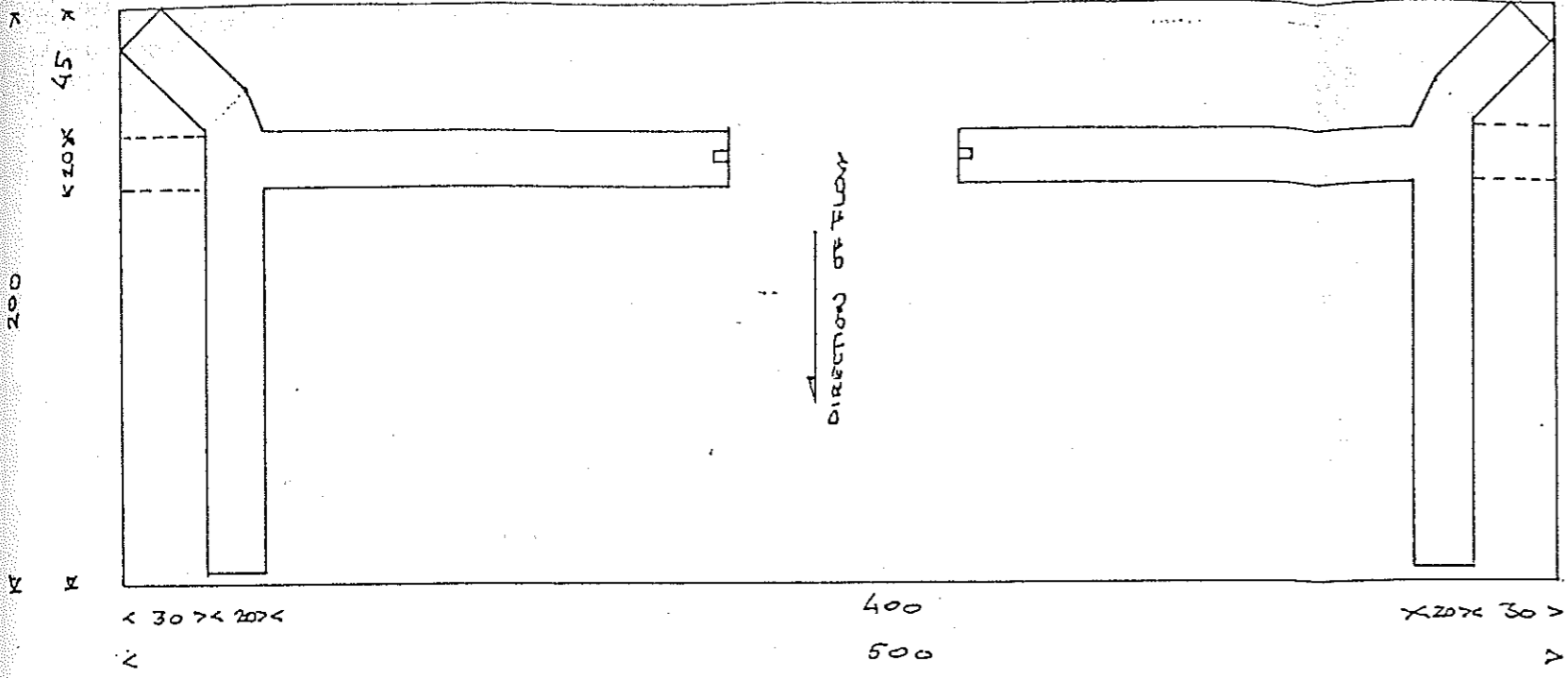


SECTION AA

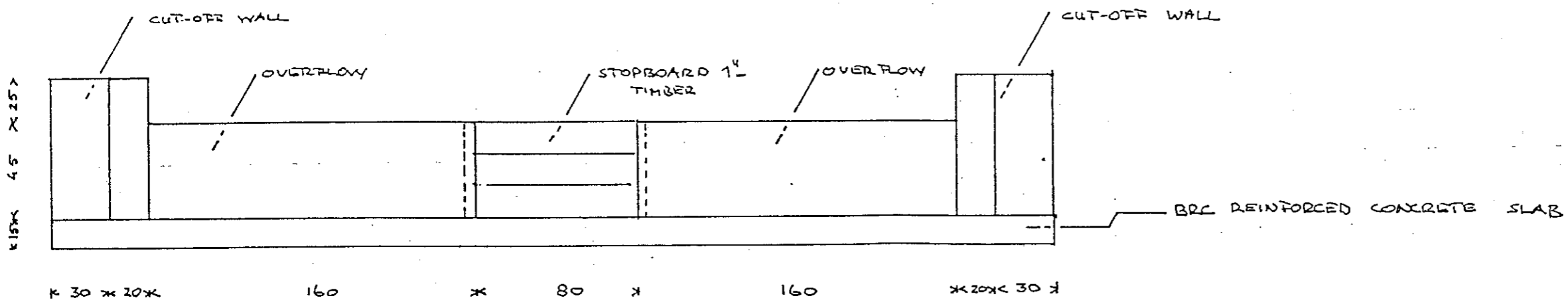


DEPARTMENT OF WATER RESOURCES	
- GTZ -	
SWAMP IMPROVEMENT	
PROJECT	BWIAM - SWAMP
SCALE	1:50 (IN CENTIMETERS)
DATE	MAY 1985
DESIGN/ CHECKED	<i>W.D.</i>

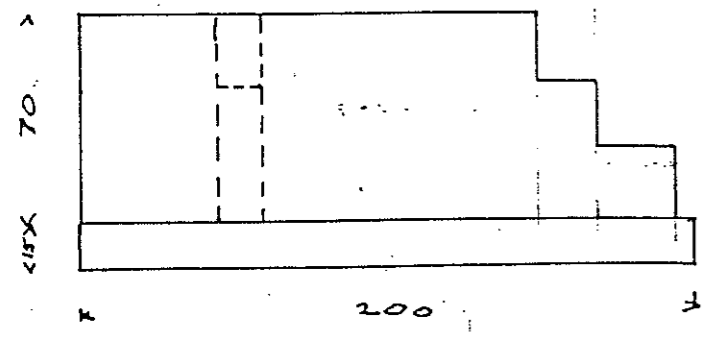
SPILOWAY BAJANA



TOP VIEW

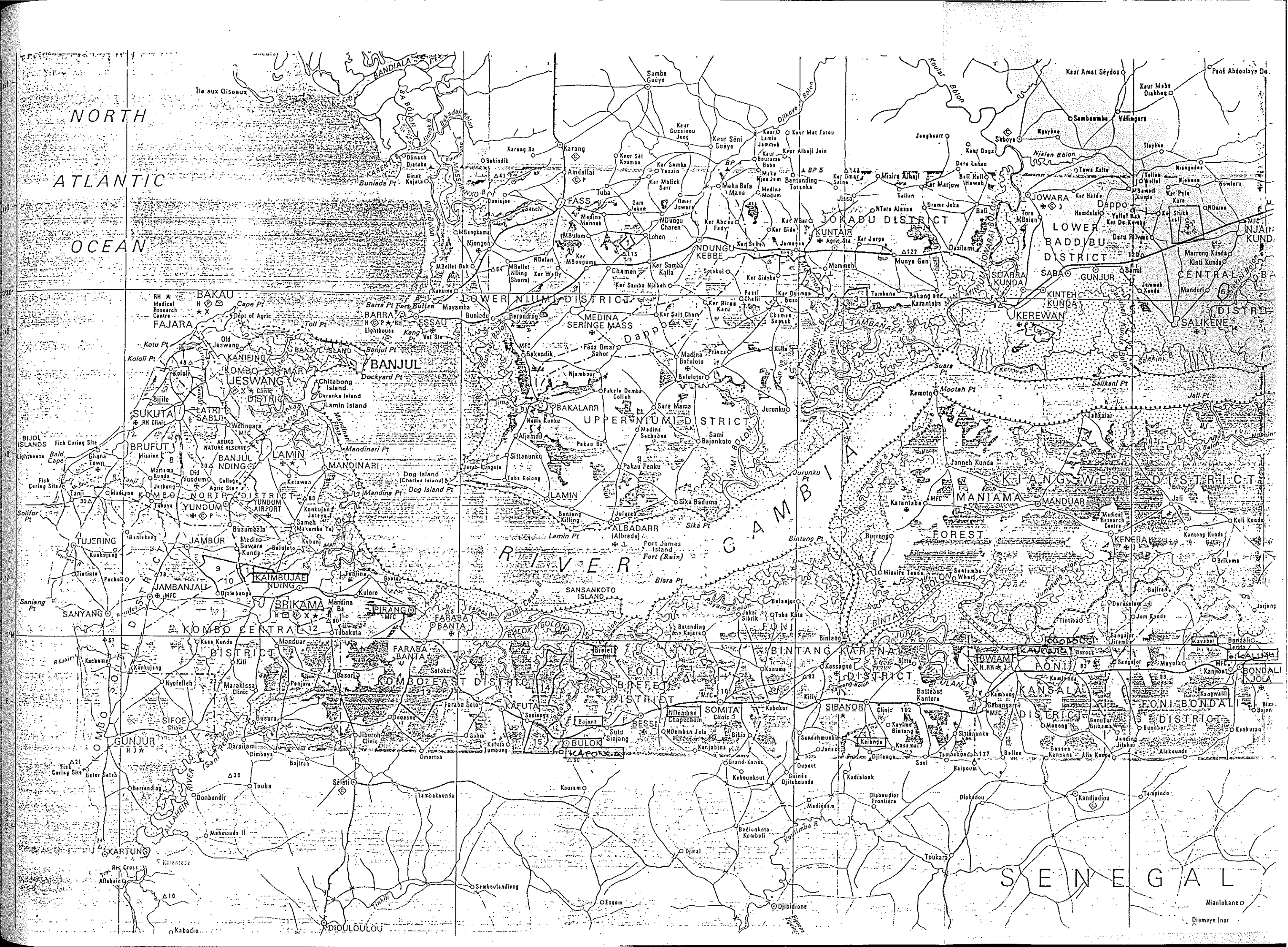


FRONT VIEW



SIDE VIEW

DEPARTMENT OF WATER RESOURCES	
- GTZ -	
SWAMP IMPROVEMENT	
PROJECT	BAJANA
SCALE	1:25
DRAWN	MD



NORTH
ATLANTIC
OCEAN

RIVER
GAMBIA

SENEGAL

Map labels and district names including: BAKAU, FAJARA, BANJUL, KANIEBING, JESWANG, SUKUTA, BRUFUT, BANJUL NOING, LAMIN, MANDINARI, YUNDUM, KAMBUJAE, JAMBUR, JAMBANJALL, SANYANG, KUMBO CENTRAL DISTRICT, BIKAMA, FARABA BANTA, KUMBO EAST DISTRICT, FONI BEEFE DISTRICT, BULOK, KAPOZA, SIFOE, GUNJUR, KARTUNG, DILOULOU, SANSANKOTO ISLAND, FASS, MEDINA SERINGE MASS, DAPPO, KUNTAR, JOKABU DISTRICT, LOWER BADDIBU DISTRICT, JOWARA, DAPPO, KINTEH KUNDA, SABAR, GUNJUR, KEREWAN, MANIAMA, MANDUAR, FOREST, KENEBA, BINTANG, KARENA, BINTANG DISTRICT, SIBANOR, KANSALAI, FONI BONDALI DISTRICT, BONDALI JOLA, and many other smaller locations and points of interest.

ANNEX 5.

=====

SUMMARY of watercontrol structures constructed by the DWR - GTZ Project "Rainfed Rice Improvement in the Western Gambia", GTZ PN 80.2135.4-09.100 during the period January 1985 up to July 1988 and specified per project village.

The structures are subdivided in 2 groupes:

1. Anti-salt dikes and contourbunds

Purpose : prevention of salt intrusion and water retention

Construction: manually with compacted earth excavated from nearby pits or superficially excavated alongside the structure

2. Sluice gates and spillways (different types and combinations)

Purpose : water level control

Construction: blockwork on a casted reinforced concrete slab provided with wooden doors and/or stop-boards

Including a short description of the scheme with:

- location
- interventions
- village participation
- performance
- problems/solutions

Project villages from west to east:

1. Kaimbujae
2. Pirang
3. Bulock
4. Kaponga
5. Bajana
6. Brefet
7. Ndemban
8. Kayenga
9. Bwiam Santamba
10. Bwiam
11. Kankuntu
12. Dobong
13. Kayaborr
14. Kalimu
15. Kanwally
16. Bondali Jola

1.

Village name : Kaimbujae/Kombo Central District/Western Div.
=====

Approx. Population : 1900
Rice growing area involved: 20 ha
Village Participation : Excellent, women participate in constr. (majority)

Description	Finished	Quantity	Condition
Anti Salt Dike	June 87	600 m	good
Contour bund	March 88	560 m	good
Single Sluicagate	Febr. 88	2	good

The improved area is situated 2 Km north east of the village; intensively used for rice cultivation in the rainy season and for vegetables, irrigated from shallow hand dug wells in the dry season. Before project intervention a fringe of approx. 100 m was seriously affected by salt intrusion, most likely to continue spoiling more land. Earlier attempts to protect area; remnants of small bund still visible. Failed due to bad design and lack of maintenance.

Excellent participation from villagers, promoted and pushed by former chief. Sluice gate construction delayed. Draining of area in '87 by means of small trench cut through dike. Affected area ploughed before '88 cropping season. Formerly affected and abandoned area for the greater part brought back into cultivation. Satisfactory impounding by contourbund. However should be provided with preferably two spillways. Widely use of the variety 'Peking'. Good yields.

2.

Village name : Pirang/Kombo East District/Western Div.
=====

Approx. Population : 1200
Rice growing area involved: 75 ha
Village Participation : poor, women did not participate in construction

Description	Finished	Quantity	Condition
Anti Salt Dike	Feb 85	775 m	fair
	March 86	200 m	fair
Contour bund		-	
Single Sluicagate		1	good
Spillways/Sluicagate with 4 gates		2	fair

Rice growing area situated 500 m south east of the village. Broad (200/300 m) valley bottom with gullies as main drains. Lower parts affected by salt intrusion. Water retention in upper reaches poor. Valley bottom prolonged flooded, partly due to high groundwater table. Productive rice growing area in rainy season. Vegetable growing on parts with easy access to groundwater during the dry season.

Participation poor; weak village leadership. Construction executed mainly by 'Balantas' from Guinea-Bissau attracted by incentives offered. Maintenance on similar terms. Male population not available due to competitive employment in nearby urban centres and at large scale shrimp breeding farm in Pirang. Contour bunds partly destroyed due to lack of spillways, forcefull run-off in gullies and absolute lack of interest among farmers, never rebuilt.



SANSANKOTO ISLAND

BOLON

ABOLO

Jetty

Brefet

BULO

OTOE

BOLO

NDemban Ba
53
CS 64

NDemb
Chapoc

BESSI

Tuba

Jarju
Kunda
Maimehi

Bajana

Jagel

NDemban
Jola
Kaur

Sutu Sinjang

CS 46
81
A

BULOK

Kapongah

Kanjiramba

90 A
PM 14

105
124/GA/10

124/GA/10
098

F O R E S T

3.

Village name : Bulock/Foni Brefet District/Western Div.
 =====
 Approx. Population : 1050
 Rice growing area involved: 14 + 6 ha
 Village participation : poor, women participate in constr, (50/50)

Description	Finished	Quantity	Condition
Anti Salt Dike	Feb. 86	600 m	poor
	March 86	275 m	fair
Contour bund		60 m	fair
Single Sluicagate		2	good

First area situated about 2 Km north of the village. Seriously affected by salt intrusion, poor water retention. Anti salt dike constructed with initially good participation. Problems arised due to fear of land users to loose land to the original owners. Afterwards contineous difficulties to mobilize farmers to participate in constr. and maintenance. Area not used (but suitable) for vegetable growing.

Salt intrusion effectively blocked and excellent water retention. Yields as high as 3.5 t/ha measured (1987). Dike in bad shape due to lack of maintenance. Narrow fringe; contourbunds not necessary. Watermanagement feasible provided good coordination among farmers. Bad experience with one farmer draining total area for land preperation while other fields planted.

Second area (6 ha) protected by single dike; no sluice gate. Area possibly affected by iron toxicity; no cultivation even after prolonged flooding. Good example of construction because of incentive offered. Project interference suspended.

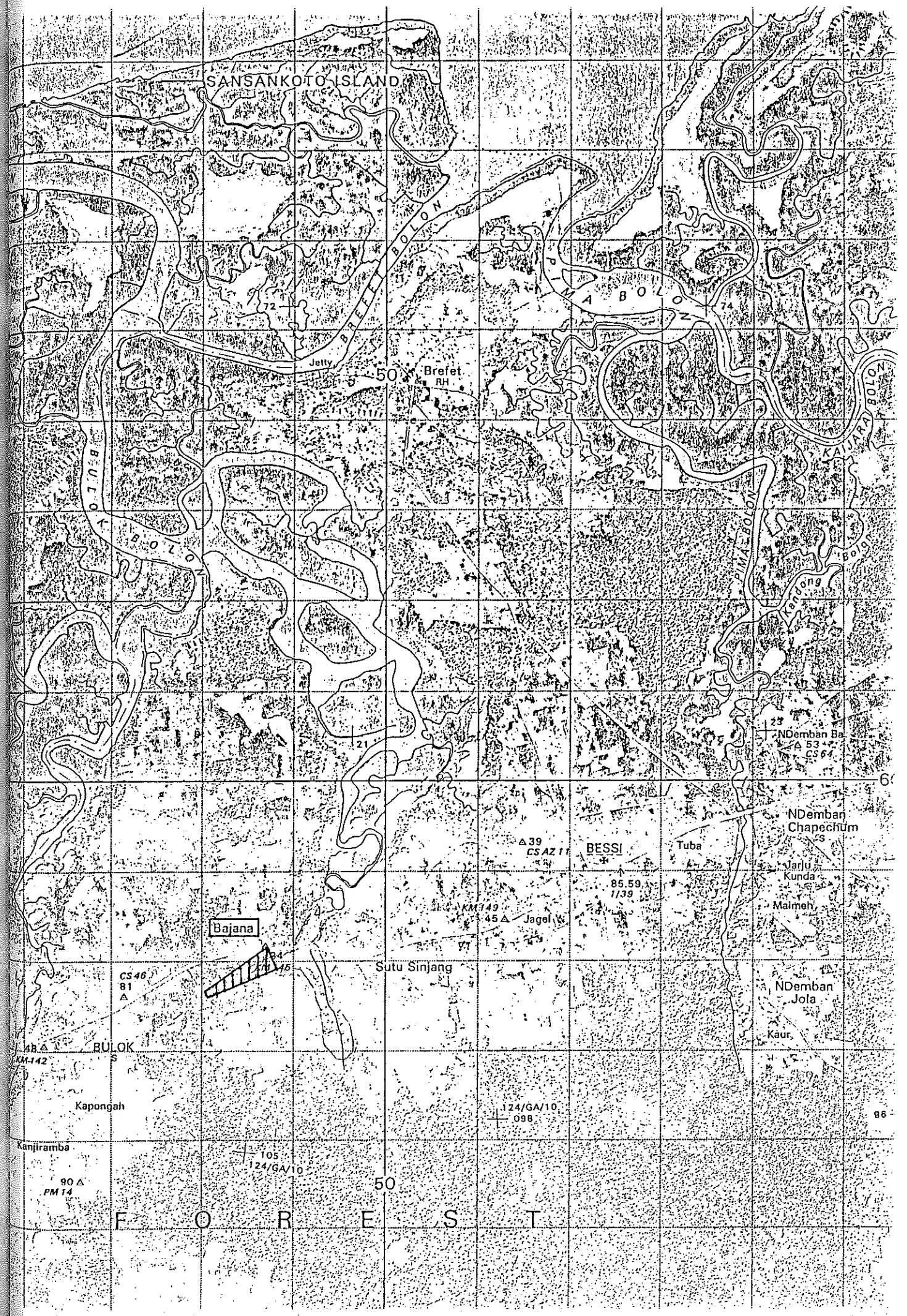
4.

Village name : Kaponga/Foni Brefet District/Western Div.
 =====
 Approx. Population : 250
 Rice growing area involved: 15 ha
 Village participation : good, women participate in constr. (50/50)

Description	Finished	Quantity	Condition
Anti Salt Dike		-	
Contour bund	June 86	150 m	good
	April 87	150 m	
Spillways	March	6	good

Area situated in upper reaches of narrow valley approx. 1 Km west of the village. Sandy loam soils with high permeability. Six contourbunds constructed. Reasonable water retention but no prolonged standing water. Area heavily affected by siltation. Good cooperation from village thanks to active contact farmer. Area sparsely used for vegetables.

Initially no spillways. Contourbunds destroyed during '86 rainy season, rebuilt in '87 including spillways. Minor problems afterwards.



SANSANKOTO ISLAND

BOLON

BOLON

Brefet
RH

BULOK

Bajana

CS 39
AZ 1

BESSI

Tuba

NDemban Ba

NDemban Chapechum

Jarju

Kunda

Maimah

NDemban Jola

Kaur

CS 46
81
A

Sutu Sinjang

BULOK

Kapongah

124/GA/10
098

Kanjiramba

105
124/GA/10

50

F O R R E E S T

5.

Village name : Bajana/Foni Brefet District/Western Div.
=====

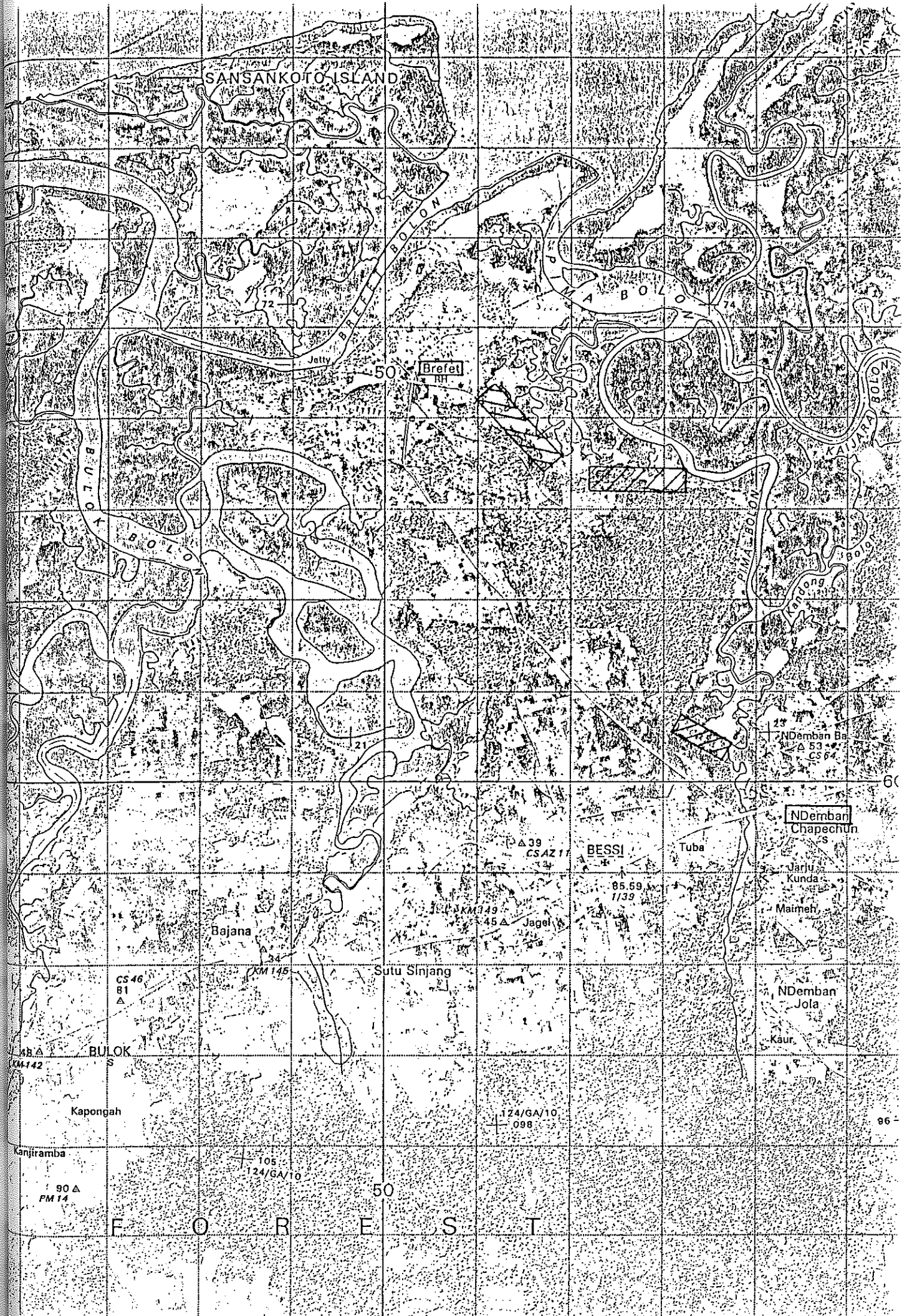
Approx. Population : 450

Rice growing area involved: 10 ha

Village participation : fair, women did not participate in construction

Description	Finished	Quantity	Condition
Anti Salt Dike		-	
Contour bund	June 86	830 m	good/fair
Spillways		7	good

Area situated in narrow valley 150 m south of the village. Getting wider and flatter towards the river. No salt intrusion; tidal flow blocked by main road. Heavy loss of run-off due to steep gradient of valley bottom. Contour bunds in lower part cause excellent water retention. Water level actively managed by stopboards in gate. Excellent yields with local, transplanted varieties; over 4 t/ha. Bunds in upper reaches of valley suffer from forceful peak flows. Repeated bund ruptures. Additional spillway in upper most bund solved problem for that bund. Valley clearly too narrow for water retention structures because of concentrated, forceful peak flows.



SANSANKOTO ISLAND

Brefet
RH

NDemban
Chapechun

Bajana

BESSY

Sutu Sinjang

NDemban
Jola

BULOK

Kapongah

90 Δ
PM 14

F O R E S T

6.

Village name : Brefet/Foni Brefet District/Western Div.
=====

Approx. Population : 375
Rice growing area involved: 45 ha
Village participation : excellent, women participate in constr.(majority)

Description	Finished	Quantity	Condition
Anti Salt Dike	May 87	900 m	good
	April 88	775 m	good
Contour bund		250 m	fair
Single Sluicagate		3	good
Spillway/Sluicagate with 1 gates	March 88	2	good
Spillway	March 88	1	good

Two separate areas situated 1 and 2 Km east from the village respectively. Areas solely used for rice cultivation; sandy clay soils on rather flat alluvial/colluvial soils. Salt intrusion and poor water retention indicated as initial problems. Anti salt dike effectively blocks tidal intrusion and retains fresh water on a approx 150 m wide fringe up to contourbund. Prolonged impeding; excellent conditions for transplanted 120 days varieties. S.C variety 'Peking' yielded over 3 t/ha. Most successful scheme thanks to excellent village participation and full commitment.

Second area abandoned for more than 10 years due to salt intrusion. Despite doubt about timely leaching project executed. Construction of single dike and two sluice gates. Sufficient rainfall in 1988 to allow flushing the area three times before transplanting; soil salinity sufficiently decreased. Capacity of gate insufficient to allow timely draining run-off of three heavy storms (between 75 and 125 mm) within 3 successive days; single door sluice gate washed away followed by salt intrusion and loss of crop.

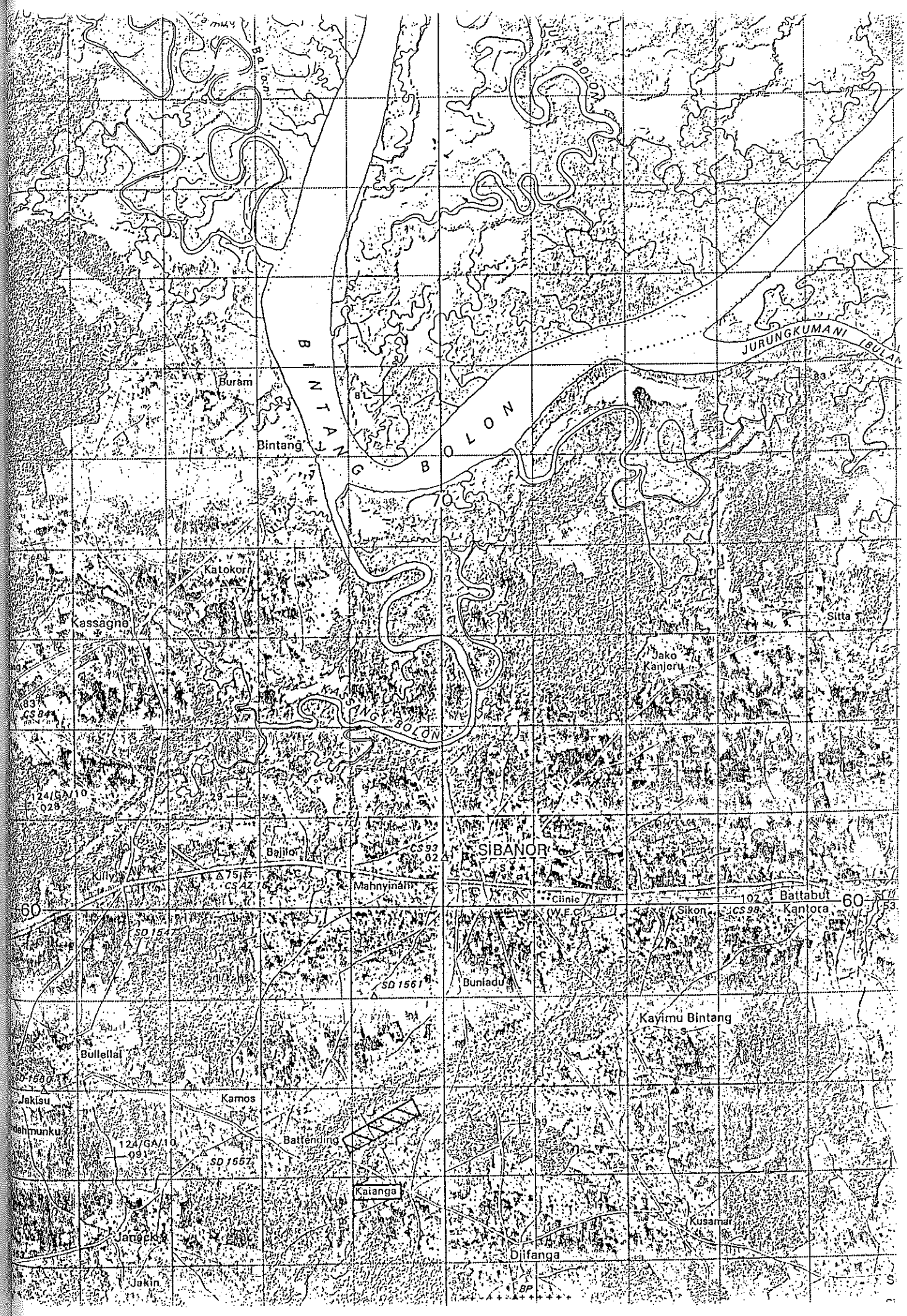
7.

Village name : Ndemban/Foni Brefet District/Western Div.
=====

Approx. Population : 310
Rice growing area involved: 15 ha
Village participation : Fair, women participate in construction (50/50)

Description	Finished	Quantity	Condition
Anti Salt Dike	Feb 86	775 m	good
Contour bund		-	
Spillway/Sluicagate with 1 gates	April 88	1	good

Area situated 1 Km north west of the village, bordering upland. Salt affected with poor water retention. No vegetable gardening during the dry season. Construction of single dike initially without sluice gate. Sluice gate/spillway combination constructed in '88. Participation reasonable. Area affected by heavy flooding in 1988 causing dike rupture; additional spillway(s) necessary.



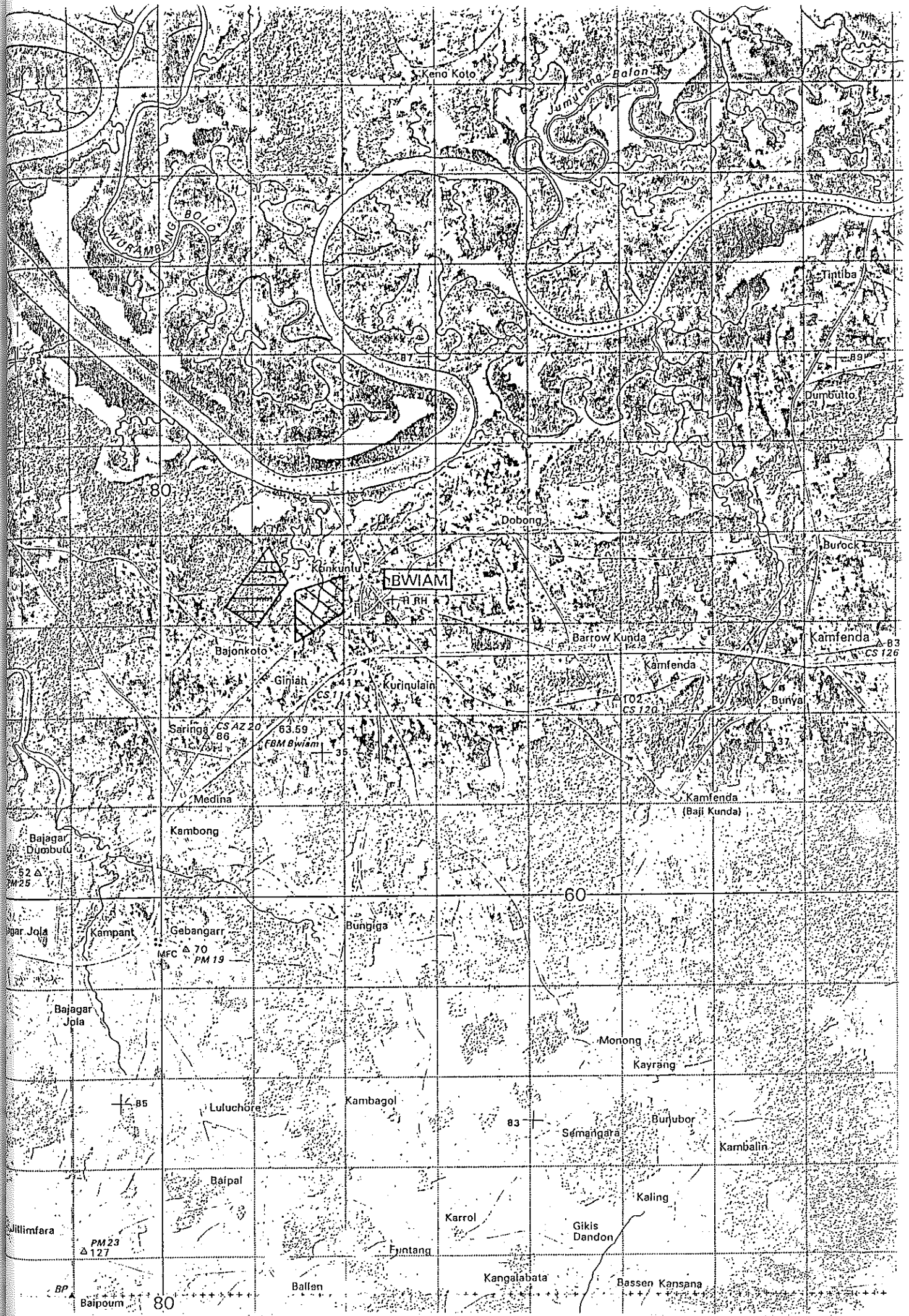
B.

Village name : Kayenga/Foni Karanai District/Western Div.
=====

Approx. Population : 150
Rice growing area involved: 10 ha
Village participation : good, women participate in constr. (minority)

Description	Finished	Quantity	Condition
Anti Salt Dike		-	
Contour bund	May 86	680 m	good

Area situated 1 Km north of the village on the upper most reaches of a valley eventually draining into the Casamance, Senegal. Sandy loam soils with poor water retention. Area practically abandoned due to wide spread water stress and lack of adapted varieties. Contourbund construction to induce water retention and forced seepage to improve soil moisture conditions. Introduction of S.C. variety ('Peking'). Total cultivated area in 86 was approx 8 ha; a 400% increase to the estimated 1.5 ha in foregoing years. Due to local dry pocket in rainfall distribution area suffered from water stress consequently discouraging farmers to plant same area. 1987 showed good yields. In 1988 about 10 hectares was cultivated again with encouraging results. With estimated 1200 mm of rain crop performance is good. Entire area planted with short cycle variety. Yields reasonable; around 1.5 t/ha. Contourbunds, for two seasons unaffected without spillways are in need of simple drop structures to avoid damage during extreme peak flows as experienced in 1988 with a yearly total well above 1200 mm.



9.

Village name : Bwiam Santamba/Foni Kansala District/W.Div.
 =====

Approx. Population : 180
 Rice growing area involved: 15 ha
 Village participation : good, women participate in constr. (minority)

Description	Finished	Quantity	Condition
Anti Salt Dike rebuilt	March 85 March 87	450 m	good
Contour bund	May 87	420 m	fair
Double Sluicgate		1	good
Spillway		4	good

Area cultivated by farmers from minor settlements west of Bwiam, referred to as Bwiam Santamba, situated 1.5 Km west of Bwiam. Rice fields initially affected by salt intrusion and suffering from poor water retention. Construction of one anti salt dike with good participation of the farmers. Dike was heavily damaged in August 86 when the heaviest storm in living memory hit the area. Dike only rebuilt in 87 together with 4 additional contourbunds. Provision of double sluice gate and 4 spillways. Water retention by dike and bunds excellent. Satisfactory production in 1987 and 1988. Increase in Production by using 120 days varieties in permanent flooded zones. Reasonable commitment from farmers concerning maintenance. Good prospects for successful project.

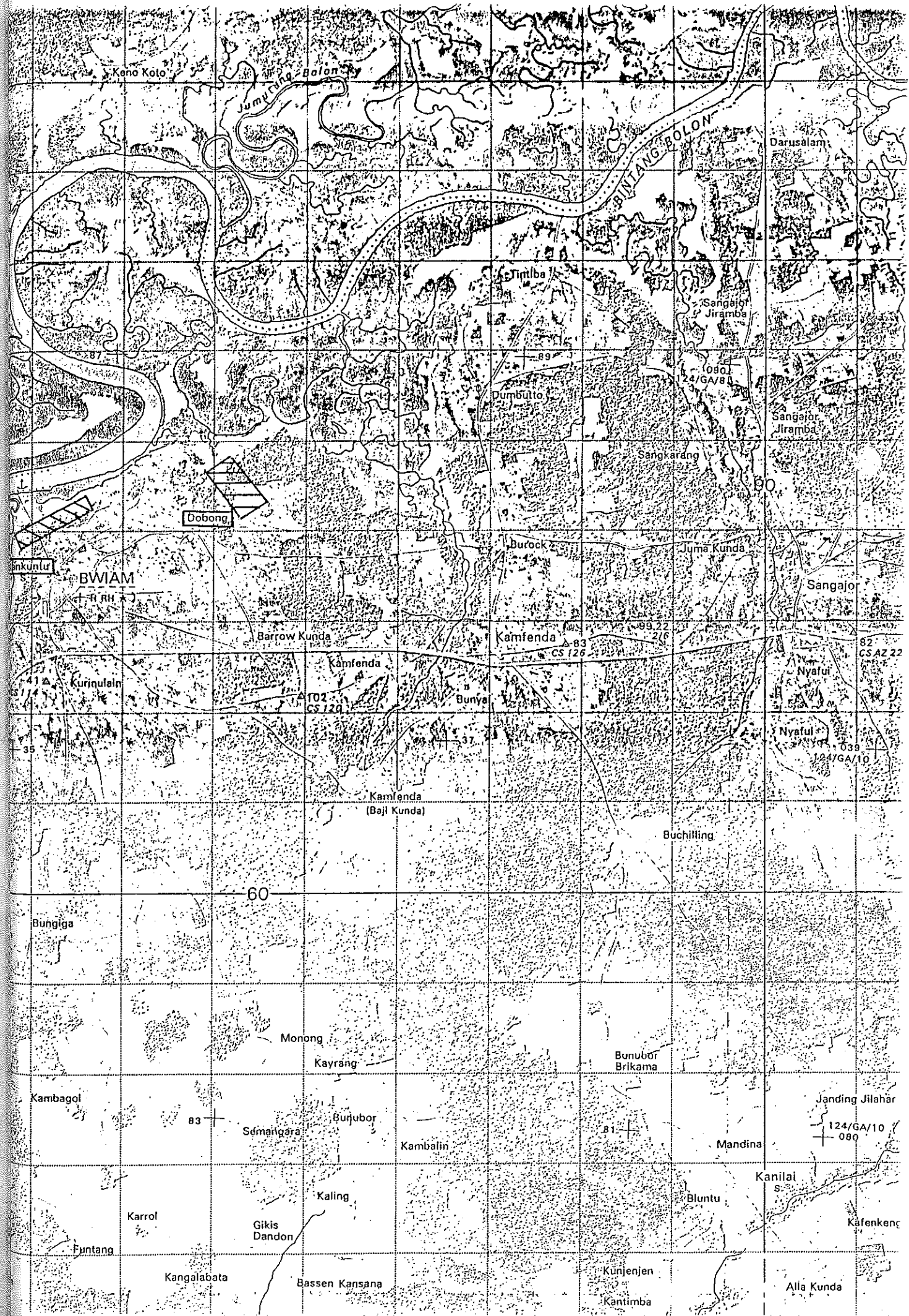
10.

Village name : Bwiam/Foni Kansalla District/Western Div.
 =====

Approx. Population : 1700
 Rice growing area involved: 20 ha
 Village participation : poor

Description	Finished	Quantity	Condition
Anti Salt Dike rebuilt	March 85 May 87	200 m	good
Contour bund		-	
Spillway/Sluicgate Combination with 3 gates		1	good

Situated 200 m west of the village; flat productive rice growing area, sparsely used for vegetables. Seriously affected by salt intrusion. Anti salt dike with sluice gate with three doors not able to withstand peak flow after heaviest rainfall in living memory in August 86. Discouraging experience. Farmers afterwards difficult to motivate for repair and maintenance work. Misty village leadership and internal division among villagers caused problematic continuation of project. Because of dissapointing cooperation project refrained from rebuilding destroyed contourbunds. Dike still not satisfactory repaired; repeated ruptures despite increased spill-over capacity. Nonetheless, area with high potential with skilled farmers. High yielding plots, even with local varieties.



11.

Village name : Kankuntu/Foni Kansala District/Western Div.
=====

Approx. Population : 400
Rice growing area involved: 30 ha
Village participation : poor

Description	Finished	Quantity	Condition
Anti Salt dike	85,86 and 88	725 m	fair
Contour bund		-	

Area situated 300 m north of the village. Promising rice growing area unfortunately seriously affected by salt intrusion. Dike construction started encouraging but was soon left to a few individuals without any cooperation from the villagers. Construction of dike was stopped after completion of 400 m due to discouraging participation. Despite the construction of an additional 325 metres in '86 and '88 but only after considerable efforts from project staff to convince village leadership to improve the rate of participation, project management decided to refrain from any additional interventions in Kankuntu.

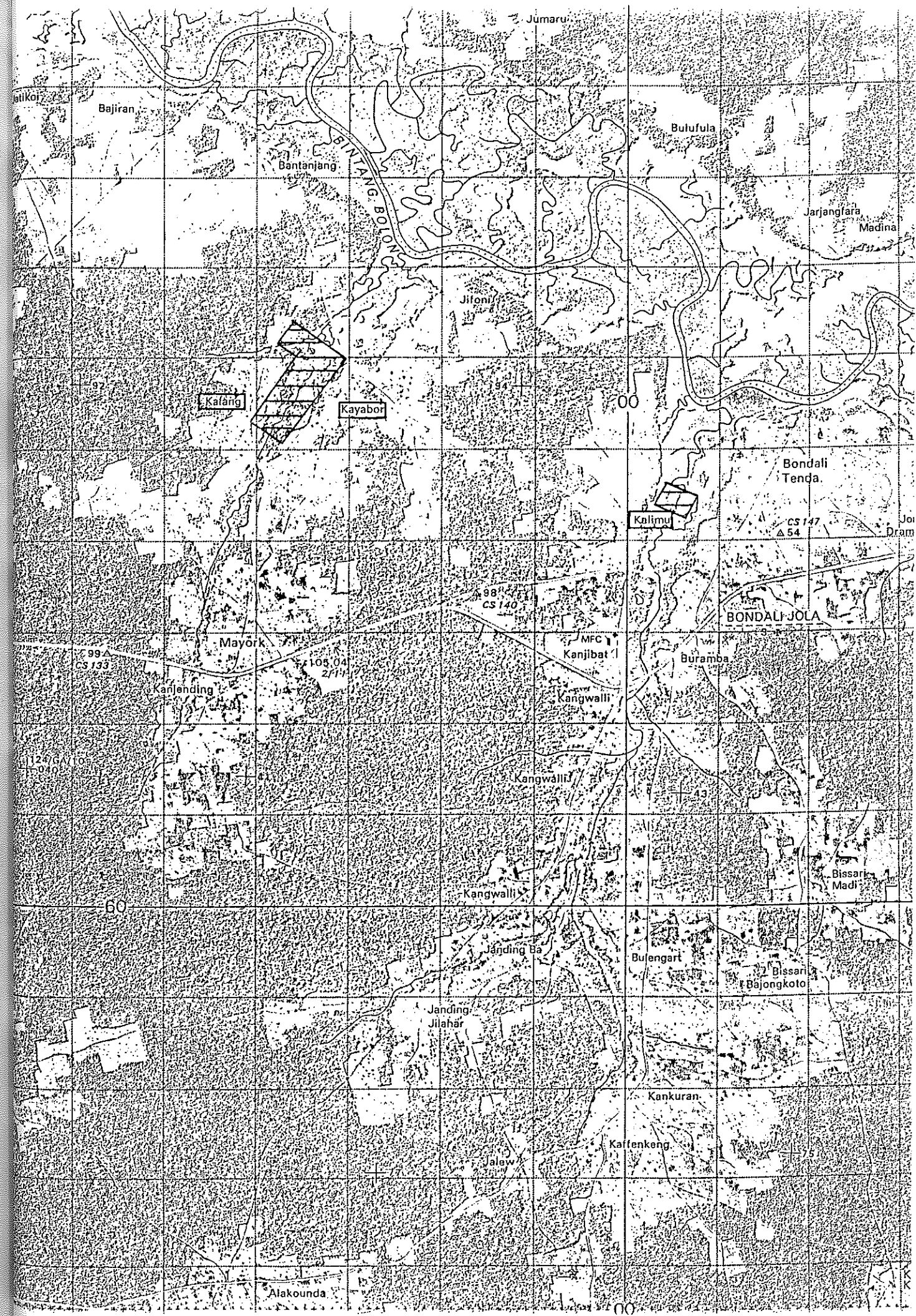
12.

Village name : Dobong/Foni Kansala District/Western Div.
=====

Approx. Population : 300
Rice growing area involved: 15 ha
Village participation : good, women participate during construction

Description	Finished	Quantity	Condition
Anti Salt Dike	April 88	250 m	good
Contour bund		-	
Spillway/Sluiceway Combination with 1 gates		1	good

Rice growing area situated 200 m north east of the village on rather wide and flat valley bottom. Not used for vegetable production. Lower fringe affected by salt intrusion; upper reaches with poor water retention. Dike construction completed with satisfactory participation. Provision of sluiceway/spillway combination. No major problems during 1988 rainy season. Area with high potential with high yields. Sufficient impounding to allow 120 days transplanted varieties.



13.

Village name : Kayaborr/Foni Bondali District/Western Div.
 =====

Approx. Population : 200
 Rice growing area involved: 40 ha
 Village participation : fair/poor, women participate in constr.(minority)

Description	Finished	Quantity	Condition
Anti Salt Dike	May 86	350 m	fair
Contour bund	June 86	540 m	good
Double Sluicagate		1	good
Spillway		8	good

Rice growing area situated in narrow valley 400 m west of the village and shared with the village Kalang further east. Project referred to as Kayaborr. Lower reaches protected by a dike constructed in 1983 under auspice of the Aereal Council. However, this structure imponds extremely saline and acid and unproduvtive soils. To make better use of impounded surface run-off a dike was constructed at the fringe of the non-affected area, provided with a double sluice gate. 3 contourbunds constructed in 86, initially without spillways were damaged by peak flows and therefore provided with drop spillways in 1987 together with 5 additional bunds and spillways in the upper reaches. Village participation was good in the beginning but faded away. Complicated village leadership parting the village and social commitments resulted in poor maintenace and reluctance in participation.

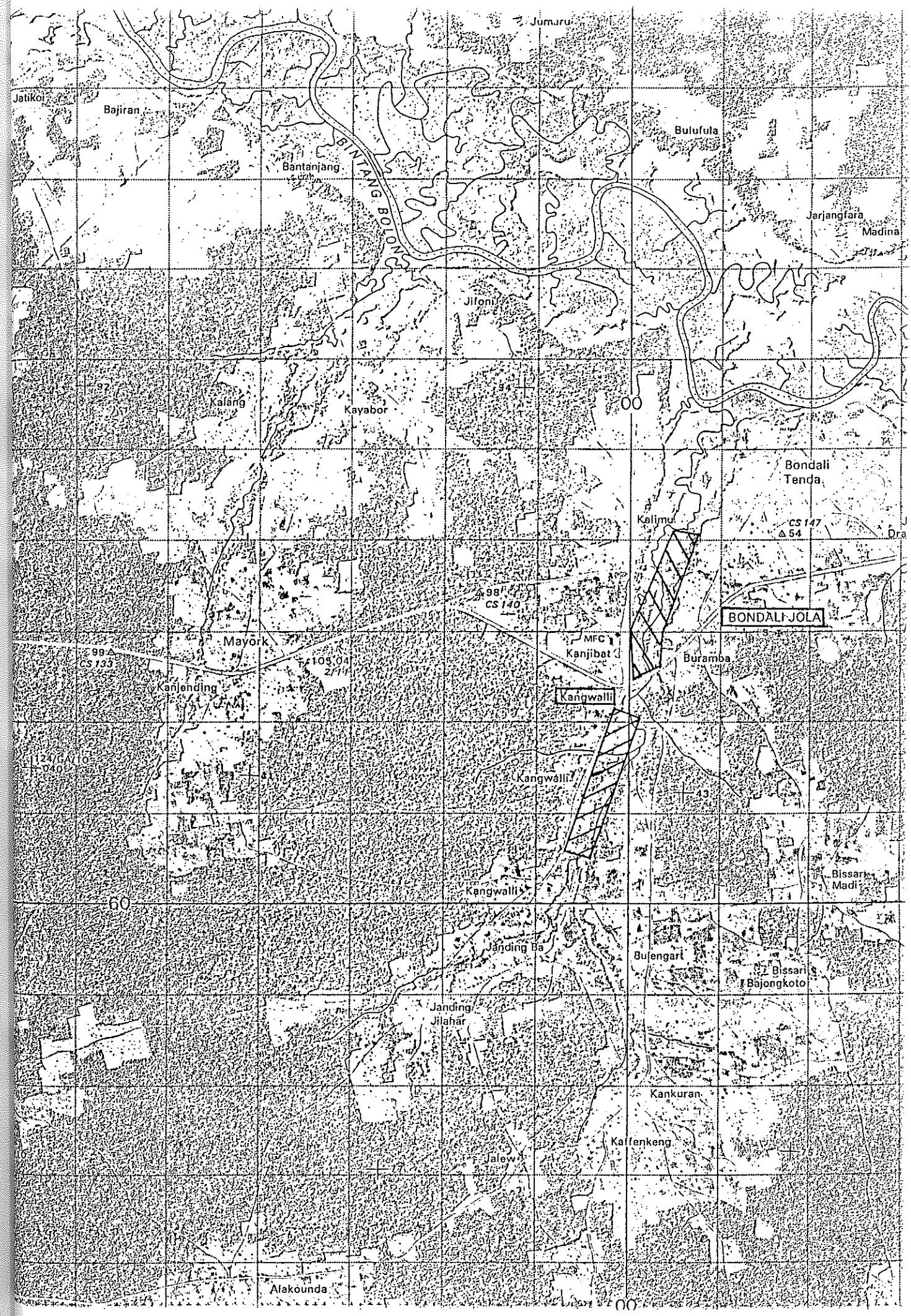
14.

Village name : Kalimu/Foni Bondali District/Western Div.
 =====

Approx. Population : 150
 Rice growing area involved: 8 ha
 Village participation : fair, women did not participate

Description	Finished	Quantity	Condition
Anti Salt Dike	Jan 85	575 m	good
Contour bund		-	
Single Sluicagate		1	poor

Small area bordering the upland 200 m north east of the village. Not used for vegetable production. Area initially affected by salt intrusion and suffering rapid depletion of impounded surface run-off. Protection by single dike provided with one sluice gate. Effectively impounding the lower part of the area for a prolonged period. Siutable for high yielding transplanted varieties. Highly skilled rice farmers. Widely use of animal drawn seeder and only project village using the sickle for harvesting. No contourbunds constructed. Sluice gate needs major overhaul. Village commitment has slightly faded away over the years but still sufficient to count on.



15.

Village name : Kanwally/Foni Bondali District/Western Div.
 =====

Approx. Population : 300
 Rice growing area involved: 20 ha
 Village participation : good, women participate in constr. (50/50)

Description	Finished	Quantity	Condition
Anti Salt Dike		-	
Contour bund	June 88	830 m	good
Spillway		6	under constr.

Productive area situated south east of the village in the middle reach of an extended narrow valley. Contourbund construction with satisfactory participation from villagers. Spillway construction suspended due to sudden leave of construction supervisor. Experience gained during 1988 season not yet available

16.

Village name : Bondali Jola/Foni Bondali District/W. Div.
 =====

Approx. Population : 650
 Rice growing area involved: 25 ha
 Village participation : from good to poor, women participate (majority)

Description	Finished	Quantity	Condition
Anti Salt Dike	Dec 84	350 m	good/poor
Contour bund	April 85	680 m	poor
Single Sluicgate		3	fair
Double Sluicgate		1	fair

Area situated 600 m west of the village, shared with farmers from Kanjibat and Santamba to the east. Productive area with a high potential when improvements. First project initiated. Lack of experience resulted in poor lay-out of anti salt dikes; this has been adjusted before the cropping seasons of 1987 and 1988. Dikes suffered from insufficient maintenance and were overtopped regularly. Capacity of sluice gate, draining the main area should be increased with a drop spillway. Contourbunds were never provided with spillways; instead farmers made simple outlets with mud. Main drainage way (gully) should be provided with solid structures to prevent regular damages to the bunds. Disappointing village participation despite contineous pressure from project staff and involvement of district chief.

ANNEX 6. PROJECT COSTS

GTZ/DWR Rainfed Rice Improvement, Water-Controlled Rice Production

Project Development Costs

Table 6.2 of the main report summarizes the project cost items (given on a per hectare basis) which were used in the economic analysis of GTZ/DWR. This summary is reproduced below and is followed by an explanation of each cost item. The total hectareage developed during the period was 98 ha.

Project Costs
GTZ/DWR

<u>Item No.</u>	<u>Description</u>	<u>Total Cost (D)</u>	<u>Cost per ha (D)</u>
1.	Technical assistance	312,000	3,184
2.	Office costs (supplies)	6,262	64
3.	Staff costs	45,099	460
4.	Vehicles	68,019	694
5.	Tractor	12,448	127
6.	Truck	9,600	98
7.	Fuel	15,164	155
8.	Equipment	21,202	216
9.	Construction material	28,804	253
10.	Village labor	<u>26,950</u>	<u>275</u>
	TOTAL PROJECT COST	541,548	5,526

Explanation of Project Development Cost Items

1. Technical Assistance:

The GTZ technical assistant spent 80% of his time on activities related to water-controlled rice production.

$$DM 130,000 \times 80\% = DM 104,000 \times D 3.00 = D 312,000$$

2. Office costs: D 6,262 is a GTZ estimate.

3. Staff costs: Salaries = D 38,379
Allowances = 11,731
D 50,110

90% of staff costs attributed to rice-related activities:
D 50,110 x 90% = D 45,099

4. Vehicle Costs:

Two vehicles were used full time on rice-related activities.

Assumptions:-- Cost of one vehicle = D81,000.
-- Life of vehicle is 100,000 km.
-- Depreciation per vehicle = D 0.81/km.
-- Maintenance/spare parts = D 0.50/km.
-- Cost/km without fuel = D 1.31.
-- Mileage/vehicle/year = 25,000 km.
-- Total 4-wheel vehicle cost/year for rice-related activities = D 65,500 (i.e. D 1.31/km x 25,000 km x 2 vehicles)
-- One motorcycle is used full time for rice-related activities: cost/motorcycle = D 7,557.
Life of motorcycle = 3 years.
Total motorcycle cost/year - D D 2,519
-- Summary of total vehicle costs:
4-wheel vehicles = D 65,500
Motorcycles = 2,519
D 68,019

5. Tractor/trailor:

1 tractor at D 104,000 / 7 years = D 14,857/year
1 trailor at D 19,000 / 20 years = 950/year
D 15,807
5% maintenance = 790
= D 16,597
75% use per year = D 12,448

6. Truck: Borrowed for 24 days/year for 200 km/day
Depreciation -- D 2/km
Total truck cost -- 2 x 200 x 24 = D 9,600

7. Fuel:

For 2 vehicles -- 9.09 km/litre
-- 25,000 km /vehicle/year = 50,000 km
-- 5,500 litres x D 1.47/litre = D 8,085

For motorcycle -- 20 km/litre
-- 10,000 km/year
-- 500 litres x D 1.47/litre = D 735

For tractor and truck -- total estimate = D 6,344

Total fuel cost -- 2 vehicles = D 8,085
motorcycle = 735
tractor/truck = 6,344
D15,164

8. Equipment/tools: GTZ estimate = D21,202
9. Construction material: GTZ estimate = D 32,148
10. Village labor:

GTZ did not keep records of total man-days required to develop one hectare. However, D 20,965 were paid out as incentives to laborers to complete the 98 hectares. GTZ estimates that each laborer received approximately D 2/day.

$$D 20,965 / D 2 = 10,483 \text{ man-days} / 98 \text{ ha} = 107 \text{ or } 110 \text{ MD/ha}$$

The opportunity cost of this labor is assumed to be D 2.50/day.
(i.e. 110 MD/ha x D 2.50 x 98 ha = D 26,950)

Alternative Project Cost Structures for GTZ

1.0 -- Total project costs with village labor used in construction valued at its opportunity cost: D 5,526/ha

2.0 -- Total project costs with village labor used in construction costed according to the financial incentives or daily wage actually paid. GTZ paid a total of D 32,148 in incentives:

$$\begin{aligned} \text{Cost items 1-9} &= D 5,251/\text{ha} \\ D 32,148 / 98 \text{ ha} &= 328/\text{ha} \\ &D 5,579/\text{ha} \end{aligned}$$

3.0 -- Total project costs less technical assistance costs:
D 5,526 less D 3,184 = D 2,342/ha.

4.0 -- Total project costs less 50% of overhead costs incurred in both development and maintenance:
Assumption: 33% staff costs were direct costs; 66% were indirect.
Project cost items 1,2,3(66%),4,5, and 6 at 50% = D 2,237.50/ha
Project cost items 3(33%),7,8,9, and 10 at 100% = 1,051.50/ha
D 3,289.00/ha

5.0 -- Total project costs less technical assistance and 50% of overhead costs incurred in development and maintenance:
Total project cost with decreasing overhead = D 3,289/ha
Less remaining 50% of technical assistance 1,592/ha
D 1,697/ha

Maintenance Costs/ha

Project cost items 3,4,5,6, and 7 = D 1534/ha
Year 2 -- D 1534 x 10% = D 153
Year 3 onwards -- D 1534 x 5% = D 77

Maintenance Costs/ha with Decreasing Overhead Costs

Project cost items 3(66%),4,5, and 6 at 50% = D 613.50
Project cost items 3(33%) and 7 at 100% = 307.50
D 921.00

Year 2 -- D 921 at 10% = D 92
Year 3 and onwards = D 921 at 5% = D 46