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The World Bank

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Report No. 8493

PROJECT COMPLETION REPORT

KENYA

BURA IRRIGATION SETTLEMENT PROJECT
(CREDIT 722-KE/LOAN 1449-KE)

MARCH 30, 1990

Agriculture Operations Division
Eastern Africa Department
Africa Regional Office

WEIGHTS AND MEASURES

1 Acre (ac) = 0.405 Hectares
1 Mile (mi) = 1.609 Kilometers
1 Pound (lb) = 0.453 Kilograms

GLOSSARY OF ABBREVIATIONS

BBF	-	Bura Building Force
CDC	-	Commonwealth Development Corporation
CLSMB	-	Cotton Lint and Seed Marketing Board
EDF	-	European Development Fund
FINNIDA	-	Finnish Aid Agency
GOK	-	Government of Kenya
ha	-	hectare
IRR	-	Internal Rate of Return
MADIA	-	Managing Agricultural Development in Africa
MALD	-	Ministry of Agriculture and Livestock Development
MMP	-	Sir M. Macdonald and Partners
MOA	-	Ministry of Agriculture
MOTC	-	Ministry of Transport and Communication
MOW	-	Ministry of Water Development
MOWD	-	Ministry of Works
MTER	-	Mid-Term Evaluation Report
NIB	-	National Irrigation Board
NPV	-	Net Present Value
ODM	-	Ministry of Overseas Development (United Kingdom)
O&M	-	Operations and Maintenance
PPR	-	Project Planning Report
SAR	-	Staff Appraisal Report
WFP	-	World Food Program

GOVERNMENT OF KENYA FISCAL YEAR

July 1 - June 30

THE WORLD BANK
Washington, D.C. 20433
U.S.A.

Office of Director-General
Operations Evaluation

March 30, 1990

MEMORANDUM TO THE EXECUTIVE DIRECTORS AND THE PRESIDENT

SUBJECT: Project Completion Report on Kenya
Bura Irrigation Settlement Project (Credit 722-KE/Loan 1449-KE)

Attached, for information, is a copy of a report entitled "Project Completion Report on Kenya: Bura Irrigation Settlement Project (Credit 722-KE/Loan 1449-KE)" prepared by the Africa Regional Office. No audit of this project has been made by the Operations Evaluation Department at this time.

Attachment

PROJECT COMPLETION REPORT

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BURA IRRIGATION SETTLEMENT PROJECT
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PREFACE

This Project Completion Report reviews the Bura Irrigation Settlement Project for which an IDA Credit of US$6.0 million and an IBRD Loan of US$34.0 million was approved in June 1977. The original closing date of June 30, 1984 was extended to June 30, 1986. The final disbursements for the Credit and the Loan were made in January 1984 and April 1987 respectively and US$5.1 million of the Loan was cancelled.

This report was prepared by a Bank mission that visited Kenya in February 1988. It is based on field visits to project areas and discussions with Government and other appropriate staff in Kenya. The report has benefited from a thorough mid-term evaluation exercise undertaken jointly by GOK and donors in late 1984 (report dated January 1985). It has also been guided by "A Review of the World Bank's Experience in Kenya, 1963 to 1986", "Managing Agricultural Development in Africa", a study undertaken as part of a larger Bank-sponsored stock-taking, and other studies. 1/

This PCR was read by the Operations Evaluation Department (OED). The draft PCR was sent to the Borrower and Cofinanciers on November 1, 1989, for comments by December 19, 1989, but none were received.

1/ e.g. W. de Leeuw. Bura Irrigation and Settlement Project: Not Even An Illusion of Development (1985).

PROJECT COMPLETION REPORT

KENYA
BURA IRRIGATION SETTLEMENT PROJECT
(CR 722-KE/LN 1449-KE)

BASIC DATA SHEET

KEY PROJECT DATA

Item	Appraisal Expectation	Actual or Current Estimate	Actual as % of Appraisal Estimate
Project Cost (US$ m)	98.4	105.0	107
Credit Amount (US$ m)	6.0	6.0	100
Loan Amount (US$ m)	34.0	28.9	85
Government of Kenya (US$ m)	20.6	35.5	172
European Development Fund (EDF) (US$ m)	12.0	12.6	105
Netherlands (US$ m)	8.8	8.5	97
United Kingdom (US$ m)	8.5	7.0	82
Commonwealth Development Corporation (US$ m)	8.5	-	0
Finland (US$ m)	-	2.0	-
World Food Program (WFP) (US$ m)	-	3.1	-
Japan (US$ m)	-	1.4	-
Date Physical Components Completed	12/31/82	6/86	
Proportion Completed by that Date (%)	100	70	
Economic Rate of Return (%)	13	Negative	
Institutional Performance	-	Poor	

CUMULATIVE ESTIMATED AND ACTUAL DISBURSEMENTS (US$ million)

1. Credit 772	FY78	FY79	FY80	FY81	FY82	FY83	FY84	FY85	FY86	FY87
Appraisal	-	5.2	6.0	6.0	6.0					
Actual	-	1.1	2.55	4.03	5.99					
Actual as % of Est.		21	43	67	100					
Date of Final Disbursement		January 1984								
2. Loan 1449										
Appraisal Est.	-	-	9.8	21.1	28.5	34.0	34.0	34.0	34.0	34.0
Actual	-	-	-	-	2.11	9.27	15.57	21.06	23.08	28.9
Actual as % of Est.			0	0	7	27	46	62	68	85
Date of Final Disbursement		April 1987								

PROJECT DATES

	Original Plan	Actual
First Mention in Files	-	10/72
Negotiations	-	4/77
Board Approval	-	6/77
Signing (Credit Agreement Date)	-	6/22/77
Effectiveness	9/77	6/27/78
Closing Date	6/30/84	6/30/86

STAFF INPUTS
(Staff Weeks)

	Total	FY76	FY77	FY78	FY79	FY80	FY81	FY82	FY83	FY84	FY85	FY86	FY87
Preappraisal	34.2	34.2											
Appraisal	131.3	76.2	55.1										
Negotiations	21.2		21.2										
Supervision	224.1		3.6	21.6	28.3	20.8	18.1	32.3	26.7	24.2	33.6	10.3	4.6
TOTAL	410.8	110.4	79.9	21.6	28.3	20.8	18.1	32.3	26.7	24.2	33.6	10.3	4.6

MISSION DATA

	Date (mo./yr.)	No. of Persons	Specialization Represented a/	Performance Rating b/	Trend c/	Types of Problem d/
Identification/Preparation	3/75	2	a-b	-	-	-
Appraisal	11/75	6	c-f-b(2)-h			
Re-Appraisal	10/76	7	c-h-a-b			
Supervision I	10/31/78	3	d-b-c	2	1	F
Supervision II	07/05/79	3	d-a-c	3	2	F
Supervision III	12/28/79	4	d-a-c-b	2	2	FM
Supervision IV	06/12/81	6	d-a(2)-b-c-e	2	2	FM
Supervision V	12/01/81	4	d(2)-a-b	2	2	FM
Supervision VI	07/28/82	4	d-a-c-f	2	2	FM
Supervision VII	01/03/83	5	d-a-c-f-b	3	2	FM
Supervision VIII	04/22/83	1	d	3	2	FM
Supervision IX	07/22/83	3	d-f-c	3	1	FM
Supervision X	01/24/84	3	d-a-c	3	2	FMT
Supervision XI	07/27/84	3	d-f-c	3	2	FM
Supervision XII	03/11/85	2	a-b	3	3	FMTP
Supervision XIII	06/07/85	3	a-b-c	3	2	FMTP
Supervision XIV	01/10/86	2	d-a	-	4	-
Supervision XV	06/30/86	3	d-a-g	-	4	-
Supervision XVI	11/27/86	2	d-g	-	4	-

OTHER PROJECT DATA

Borrower:	Republic of Kenya
Executing Agencies:	National Irrigation Board
Fiscal Year:	July 1 - June 30
Name of Currency:	Kenya Shillings (KSh.)
Exchange Rate at Appraisal:	1 US$ = KSh. 8.35
at Completion:	1 US$ = KSh. 16.23

a/ a = Agriculturalist
b = Engineer
c = Architect
d = Financial Analyst
e = Water Resources Management
f = Sociologist, Monitoring & Evaluation Specialist
g = Procurement Specialist
h = Economist

b/ 1: Problem-free or minor problems
2: Moderate problems
3: Major problems

c/ Before 1986:
1: Improving
2: Stationary
3: Deteriorating

4. After 1986: relating to
Available funds
Project Management
Overall status

d/ F: Financial
M: Managerial
T: Technical
P: Political
O: Other

PROJECT COMPLETION REPORT

KENYA

BURA IRRIGATION SETTLEMENT PROJECT
(CREDIT 722-KE/LOAN 1449-KE)

EVALUATION SUMMARY

Introduction

1. Irrigation is one of the few means for expanding the area of cultivable land in Kenya. About 40 percent of the country's irrigable area lies in the Tana river basin, perhaps one-third of that in the lower basin. Since World War II Kenya's rapid population growth has put increasing pressures on the land and created more landlessness. Under such conditions development of the lower Tana basin for irrigated agriculture was an almost inevitable consideration.

Objectives

2. The objectives of the Bura Irrigation Project were to settle about 5,150 landless families on an irrigated area of 6,700 ha net, create employment, and contribute to foreign exchange earnings by producing cotton and food (maize). Through technical assistance and training, the project was also expected to develop Kenya's capacity to manage future major irrigation projects.

Implementation Experience

3. The project failed to achieve its objectives. The objectives of creating jobs achieved to less than 40 percent and at a cost of about US$42,000 per ha or US$55,000 per settler. The economic rate of return is negative; annual operating and maintenance costs exceed benefits. Even with net farm income of about 40 percent of appraisal estimates in real terms, annual Government subsidies amount to about K Sh 17,000 (US$1,000) per settler. The project continues to suffer from an unreliable supply of irrigation water and delayed cultivation, and many buildings are threatened by foundation problems.

4. The reasons for this outcome include the following:

(a) Low yield. The Kenya Soil Survey regards the presently cultivated soils as only marginally suitable for irrigation. Yields have averaged about 70 percent (cotton) and 40 percent (maize) of appraisal estimates. Lack of water for irrigation and delayed planting have contributed to poor performance.

(b) Declining international prices. The prices of cotton and maize in the world market in 1987 were 60 percent and 47 percent of those prevailing at appraisal ten years earlier (in constant dollars).

(c) High costs. Some elements of the project (notably utilities and structures on the main canal) were designed to serve future expansion. Appraisal estimates were outdated within months. Subsequent design changes and rapid inflation contributed to a major escalation of costs.

(d) Financial constraints. Increased costs had to be borne by GOK, so it became necessary to reduce the scope of the project. The diversion weir was dropped and a temporary pumping capacity was made permanent. In retrospect this was a very damaging decision. For lack of water, the area cultivated was reduced from 6700 to 2500 ha although irrigation works, land clearing and levelling had been completed for the whole area. Utilities and staff houses built to serve a much larger project are now underutilized and in some cases unused.

(e) Managerial difficulties. Design changes were made without due consideration to economic and financial viability. Operational decisions had to be referred to the National Irrigation Board (NIB) management in Nairobi, which was not familiar with the problems and did not have the necessary capacity or sense of urgency to solve them quickly. Maintenance and operation of the pumping station and agricultural machinery became particularly problematic. Consultants were not employed to manage the irrigation works and agricultural operations (except briefly). Financial management was weakened by late and insufficient budgetary releases and payments from CLSMB. Responsibility was not properly transferred from the NIB to the Ministry of Agriculture.

(f) Lack of Financial Viability. Cost recovery from beneficiaries cover only a fraction of O&M costs.

5. A number of these issues were noted in the appraisal process (soils, high costs per settler, lack of financial viability, managerial constraints) but did not cause any real alarms to be sounded. The replicability of settlement at US$ 18,000 per settler and the ability of the Kenyan economy to absorb heavy recurring subsidies should have caused more concern (one cofinancier, CDC, withdrew over the latter issue).

6. Cost escalations (65%) by mid-79 had eroded the economic viability of the project and the Bank asked the Government to consider whether to proceed with implementation (no major contracts had been awarded). GOK replied in the affirmative and the Bank concluded it had no legal basis to press the issue.

7. A joint mid-term review outlined ways to ameliorate the situation and some progress was made but the basic problems were unresolved when the project closed in June 1987. Sustaining the project will require continuing drain on the budget unless remedial actions are taken. Those that should be considered are: (a)construction of a low cost gravity intake; (b) the subsequent expansion of the irrigated area; (c)

introduction of higher value crops; (d) commercial farming in the new area; (e) more secure tenure for settlers; (f) managerial autonomy; (g) the rationalizing and recouping of costs; and (h) larger tenant landholdings.

Sustainability

8. The current situation is not really sustainable. The management arrangements are unwieldy, government costs are high in relation to output, and the water supply remains vulnerable to mechanical breakdown.

Findings and Lessons

9. There was a lack of technical knowledge at the time of appraisal about the project area. This led to inappropriate technical design of housing and other project buildings, the erroneous estimates of soil fertility and yields, and the underestimation of project costs. If, as is normal Bank practice, loan approval had been delayed until detailed project preparation had been completed, that is, until final designs were available, the Bank would have become aware that, because of cost escalation, the project was no longer economically viable. Alternatively, if the project had been implemented as a succession of small, feasible investments, better adapted to local implementation capabilities, there might have emerged a sustainable irrigation system together with the kind of knowledge the Bank only now has about soil fertility and its load bearing properties. Ultimately, the Government, the Bank and other cofinanciers (except one which withdrew) ended up financing an oversized and doomed construction project which will require permanent budget subsidies unless some of its components are made financially sustainable. This experience is a reminder of the relevance of Bank policies on project readiness; of the need for thorough and reliable technical knowledge before carrying out economic and financial appraisal; or alternatively, of the usefulness of starting agricultural projects as a small pilot phase before their replication. The recently approved Kenya Rural Services Project, for instance, follows this approach.

PROJECT COMPLETION REPORT

KENYA

BURA IRRIGATION SETTLEMENT PROJECT
(CREDIT 722-KE/LOAN 1449-KE)

I. Background

1.01 The Kenya highlands are fully exploited; future growth there must come through intensification. The prospects for rainfed crop production in the arid and semi-arid areas that constitute 80 percent of the land area are marginal. Irrigation is one of the few means for expanding cultivation. About 40 percent of Kenya's irrigable area lies in the Tana river basin, perhaps one-third of that in the lower basin. Since World War II Kenya's rapid population growth has put increasing pressure on the land and created more landlessness. Under such conditions development of the lower Tana basin for irrigated agriculture was an almost inevitable consideration.

1.02 The objectives of the Bura Irrigation Project were to settle the landless, create employment, and contribute to foreign exchange earnings by producing cotton and food (maize). Through technical assistance and training, the project was also expected to develop Kenya's capacity to manage future major irrigation projects. The experience at the 850 hectare (ha) Hola irrigation scheme established 40 kilometers (km) south of Bura in 1956-57 served as a model for the Bura project. The yields at Hola (2700 kg of seed cotton per ha) were encouraging, although its small size prevented full cost recovery.

1.03 The Bura project is situated just south of the equator on the west bank of the Tana, 200 km north of the river's mouth. An alluvial terrace with an even slope toward the river, the area is connected to Garissa (75 km) and Garsen (150 km) by a road that is often impassable during the rainy season. Rainfall is low (about 400 mm), bimodal and erratic. Temperatures are high, with little seasonal variation. The river supports a narrow strip of forest and small-scale flood-irrigated crop production. The area is sparsely populated by Orma pastoral nomads, with one person per square kilometer and a carrying capacity of about one livestock unit per 25 ha. The soils -- chiefly sandy clay loam and heavy cracking clays -- occur in a complex scattered pattern. Fairly shallow topsoils overlie saline-alkaline subsoils. Their suitability for irrigation has been a major bone of contention. The Tana river is a year round source of irrigation. During low season, flow depends on release from a series of reservoirs for hydroelectric generation but until recently were considered capable of sustaining a larger area of irrigation. In 1987 however, for a period of two months the river fell to a level that could barely sustain the Bura pumping. The management now regards the impounding of water necessary. This problem requires further study.

1.04 As part of the first phase in a larger development effort, the project was designed to develop about 6700 ha of irrigated land for the settlement of 5,150 landless families from all parts of Kenya. Plans were to fund the construction of a diversion structure on the Tana river, plus a temporary pumping facility, a 46 km supply canal, a 19 km main canal, water distribution and drainage systems, and land clearing and levelling to allow

irrigation in long furrows. Under the original project design a principal town and 23 villages were to be built for the settlers along with educational, social and administrative facilities and the physical infrastructure (roads, water, electricity) to support an estimated population of 65,000. The project was to provide for research, extension, mechanized cultivation, inputs, marketing and processing (ginning), forest plantations and the protection of wildlife and existing riverine forest as well as consulting services and feasibility studies for future irrigation development in the Region. The total cost was estimated at US$98.4 million with an ERR of 13 percent. Net farmer income was estimated at K Sh 7000 (US$840) after deducting land and water charges of K Sh 2800. These charges were limited by the farmers' ability to pay and did not allow the government full cost recovery.

1.05 The original sources of finance for the project were to be:

(a) IBRD (US$34 million) and IDA (US$6 million) for irrigation works, buildings, afforestation, ginnery, NIB operation and maintenance, stage II feasibility study and training;

(b) EDF (US$12 million) for irrigation works and buildings;

(c) Netherlands (US$8.8 million) for roads and airfields, village infrastructure and some machinery;

(d) ODM (US$8.5 million) for consultancy services, vehicles and equipment and public health; and

(e) CDC (US$8.5 million) for agricultural management, incremental inputs and farm development.

The rest (US$20.6 million) was to be financed by the Government of Kenya. CDC soon withdrew from the scheme but additional assistance was negotiated from FINNIDA (US$2 million) for afforestation, Japan for agricultural equipment and WFP for food to support settlers during an initial period.

1.06 The National Irrigation Board (NIB) was established in 1966 to take responsibility for the planning, construction, settlement and management of national irrigation schemes. At the time of appraisal it was a semi-autonomous body responsible to the Ministry of Agriculture and guided by a board that included the Directors of Agriculture and Water Development, the permanent secretaries of Economic Planning and the Treasury, the Chairman of the Water Resources Authority and provincial representatives. The Board appointed the General Manager. Each scheme was headed by a scheme manager who was guided by an advisory committee appointed by the Board. By 1974 the Board managed five schemes comprising 8500 ha and 4600 settlers. NIB's performance at appraisal was considered uneven; among the deficiencies noted were the absence of technical expertise, the organization's small size, frequent changes in management, the severe inadequacy of maintenance of agricultural equipment, and NIB's reluctance to coordinate with other ministries and the provincial administration. The difficulties imposed by the proposed Bura project were also noted. Its large size (equal to the sum of all existing projects), problematic soils, environmental problems (including serious health hazards) afforestation, wildlife conservation and complex cofinancing

arrangements created challenges of a kind not previously encountered. In view of its national mandate NIB was nevertheless entrusted with the implementation of the Bura Project provided that it:

(a) appoint additional staff, including the project coordinator;

(b) employ consultants to complete the design, supervise construction and assist in the coordination of implementation; and

(c) employ a firm (expected to be CDC) to manage settlement and agricultural production and train Kenyan staff for not less than six years.

1.07 Project implementation occurred during a time when Kenya was experiencing severe budgetary and balance of payments problems. GOK would probably have had difficulty financing its original share (20 percent) of project cost during this period and was soon to face much higher demands on domestic resources.

II. Project Formulation

2.01 The genesis of the project is analyzed in Chapter I of the Mid-Term Evaluation Report. That analysis will not be repeated here. Instead we will focus on some of the key design features that have affected the outcome of the project.

2.02 Soils. At appraisal there was a great deal of controversy about soil suitability and the consultants' criteria for classification. Because of the prevailing sodic subsoils, no soils could be regarded as highly suitable (Class I). The appraisal limited the project to 4500 ha of suitable soils (Class II) and 2200 ha of shallow soils (Class III). If the experience of these shallow soils was satisfactory, a second phase would be contemplated for the area (about 6000 ha) left out of the first project. It may be too early to evaluate the decision to proceed on a reduced scale. Cotton yields (2100 kg of seed cotton per ha) have been lower than appraisal estimates (3000 kg) but this has been partly because of managerial problems that resulted in irregular irrigation and delayed planting. Most of the better soils have yet to be brought into cultivation. Maize yields, which have not been systematically sampled but appear to be considerably below appraisal estimate (1700 vs 3700 kg/ha), have suffered even more from lack of water and possibly from intolerance of the sodic subsoils. Improved (hybrid) varieties have been introduced but perform badly under water stress. Some irrigation difficulties have been reported on the shallow soils. As levelling became difficult, irrigation had to be done on a steeper slope than was assumed in appraisal estimates. This, plus the limited infiltration on shallow soils, has made irrigation in long furrows inefficient on much of the land. More systematic evaluation may be justified but available evidence does not support the optimistic assumptions about yield made at appraisal. (See Annex 3).

2.03 Economies of scale. The consultant responsible for preparation claimed that only a large-scale project could justify the high costs of river diversion, canal construction and other infrastructure. The

appraisal team accepted this position and saw the project as the first phase of a larger development program on both the west and the east bank. Evidence to support such expansion plans was however weak and soon evaporated. Embracing the concept of a large-scale project prevented a clear focus on the minimum needs of the project at hand. Alternative intake arrangements could have been explored and development of the infrastructure scaled down and modified. Planning for a larger project burdened the project with excessive structures and made it necessary to postpone the gravity intake structure (to allow further feasibility studies) and introduce a temporary pumping capacity. This pumping arrangement was later made permanent in an effort to cut down investment costs and has become the source of the difficulties in providing a reliable water supply.

2.04 State of engineering. In view of the reduced scale of the project accepted by the World Bank, NIB commissioned consultants to review the original preparation report. After assurance from the consultants that SAR cost estimates were accurate, the Bank did not await the outcome of this effort and the appraisal report was issued two months ahead of the consultants' Project Planning Report (PPR). The PPR showed an increase in investment costs of 22%. The project was already seriously underfinanced only months after the appraisal report was issued.

2.05 Cost per settler. The cost per settler at appraisal was estimated at US$18,000. Within months this increased to US$22,000 and ultimately became about US $5,000. Although the project was not financially viable (the present value of future subsidies has been estimated at US$18 million, or US$3,500 per settler), the appraisal report contains no discussion of the replicability of the approach or the pros and cons of alternative means of creating employment. Nor does it refer to similar undertakings in other countries (e.g. Sudan - Rahad) supported by the Bank at the same time which show considerably lower cost per hectare. (See Annex 2).

2.06 Management. Considering the misgivings expressed about NIB, ways should have been explored to give the project more autonomy within NIB during construction and later, as was done for the Rahad project in Sudan.

2.07 Afforestation. This component appears seriously underdesigned in the appraisal report. Water requirements and costs, the management of block plantations, the sale of produce and cost recovery were treated only superficially.

III. Project Implementation

3.01 Chapter II of the Mid-Term Evaluation Report provides detailed analysis of project implementation through 1984. Some of the main conclusions and recommendations of that report are highlighted below.

A. Implementation Through 1984

3.02 Design modifications. The final design reports issued by the consultants early in 1979 featured significant changes to the engineering proposals that had been the basis for the appraisal and the Project Planning Report (para. 2.03). The consultants concluded that a weir would

have been satisfactory for diversion of water to the west bank but since the east bank was also to be developed (in the future) a more expensive barrage was now necessary. This and other physical changes caused costs to escalate. Total cost estimates were now 65 percent above those contained in the appraisal report. The revised designs were said to have the advantage of lowering maintenance costs. However, it was later discovered that the consultants had excluded certain costs. The economic rate of return had in fact declined to no more than 4 percent and the project was no longer economically viable. Donor concern about the situation resulted in a letter to the Kenya Government asking whether the project should be continued. GOK indicated its continued interest and its intention to solicit supplementary finance, and the Bank did not feel it had a legal basis to press the point. The earlier CDC withdrawal over the lack of financial viability had already created a financing gap. Donors could have insisted on going back to the original designs, or a total revision of the project concept, but this approach was rejected because of the delays it would entail. Instead attempts were made to reduce project costs by postponing river diversion works, reducing the forestry component to 600 ha and curtailing the staff housing and internal roads programs. Also, additional potential donors were identified and by mid-1982 agreements were negotiated with OPEC, Kuwait and FINNIDA. The OPEC and Kuwaiti assistance did not materialize.

3.03 Financial crisis. Project construction started in mid-1979 -- two years late -- and by 1982 was three years behind schedule. Kenya in this period was experiencing a rate of inflation much higher than the 8 percent that had been assumed in calculating the price contingencies at appraisal. The changing estimates of cost per ha are illustrated below:

		Costs per ha	
		Current K Sh	1986 Constant K Sh
1975	Preparation report (14,560 ha)	23,850	87,768
1977	Appraisal report (6,700 ha)	114,300	323,469
1977	Project planning report (6,700 ha)	139,700	395,351
1979	Final design stage (6,400 ha)	239,400	564,984
1982	Progress report (6,400 ha)	330,000	475,200
1983	Curtailed area (3,900 ha)	385,000	500,500
1987	Curtailed area (2,500 ha)	472,000	472,000

The additional cost caused by design changes, delays and rapid inflation and the withdrawal of CDC had to be borne by GOK whose share of total investment increased from 20 percent at appraisal to about 50 percent in 1982. An inter-ministerial committee was appointed to review the situation and calculated an ERR of 1 percent. It was decided to reduce the irrigated area to 3900 ha, and to cancel the barrage, the ginnery and the 132 kv transmission line. Total project cost after these reductions was estimated at K Sh 1504 million in 1983 prices, (the appraisal estimate had been K Sh 766 million including contingencies) and the GOK share was reduced to 40 percent. The Bank under its Special Action Program increased its disbursement percentages retroactively to ease the financial crisis. Nevertheless, GOK would have great difficulty meeting its obligations which caused further delays in implementation, inadequate maintenance, and ultimately further curtailment of the project in 1985. In 1983-1984 and 1984-1985 Bura expenditures amounted to 20-25 percent of Kenya's total public investment in agriculture.

3.04 Technical execution. Despite a delayed start, execution of the main civil engineering works was prompt, which allowed the first agricultural activities to begin in 1981. Progress is illustrated in the table below:

Year	No. of Settlers	--Cultivated area (ha)-- Cotton	Maize (est.)	----Yields (kg/ha)---- Cotton	Maize (est.)
1981	320	--	200	--	2800
1982	534	746	560	2,200	3100
1983	1,360	739	800	2,000	2300
1984	1,843	2,050	1,100	2,200	1700
1985	1,96B	2,478	1,200	2,100	1700
1986	1,968	2,373	500	1,800	1700
1987	2,139 a/	2,454	1,000	2,250	1700

a/ Some settlers have more than two plots but many have only one (0.625 ha).

The performance of the pump unit has been generally poor. Lack of trained operators and spare parts plus poor maintenance have caused frequent breakdowns and water supply failures. The unit was originally meant as a temporary measure pending construction of a gravity intake structure. The cancellation of this structure and the bad experience with the pumping station have been matters of serious concern for the entire life of the project. The cost of pumping in 1984 prices was K Sh 1500 ha for fuel alone.1/ Technical constraints include problems with furrow irrigation (see para. 2.02), the difficulty of maintaining and operating agricultural machinery in remote areas and maintenance of the irrigation and drainage systems.

3.05 Settler income and cost recovery. In the period between the appraisal (1977) and the mid-term review (1984), cotton prices (in real terms) deteriorated and maize prices improved slightly. Using rather high estimates of cotton yields (2500 kg/ha), the mid-term review estimated the net cash income of the settlers at only K Sh 7400 or in real terms 55 percent of the appraisal estimate. From this, a NIB land and water charge (including cultivation cost) of K Sh 3000 per settler had then been deducted. The actual NIB costs for operation and maintenance were estimated at K Sh 7500 per settler. The annual subsidy for operation and maintenance of the project (excluding interest on invested capital) in 1984 thus amounted to K Sh 8 million (US$500,000). Actual farm income varied considerably and some settler families experienced tremendous difficulties. Delays of up to four months in payments for cotton delivered contributed to their hardship.

1/ The total cost of pumping in 1987 was estimated at K Sh 3200 per ha; half of that was fuel costs.

3.06 Health. At appraisal it was recognized that malaria infection and general health conditions at Bura made it necessary to install a well-functioning health service before settlement. The health center was finished in 1981, but lack of equipment and financial constraints prevented its opening until mid-1983. In 1982, some 150-200 persons are believed to have died of malaria. Even after the commissioning of the health center the situation remained unsatisfactory. The two health subcenters and the village health posts were dropped from the project and inadequate transport and lack of drugs prevented an effective outreach program. Programs put in place by the Catholic Mission and WFP offered some relief. Apart from malaria, the main health problems encountered in 1984 were malnutrition and diarrheal diseases. Many of the safeguards originally planned to counter schistosomiasis had not been implemented but the snail vector was not yet established in the canals.

3.07 Environmental problems. Three major concerns were expressed in the mid-term evaluation report. (1) After the initial clearing of land, the main source of wood had been the riverine forest. The delay in establishing irrigated forest plantation for poles and fuel wood could mean prolonged reliance on and a threat to the riverine forest. (2) The long supply canal could mean that wildlife was cut off from the river. The watering pools that had originally been planned were not functional. The consequences had not been fully analyzed. (3) Pest control in cotton production involved eight aerial sprayings which could become a health hazard. The report suggested a switch to tractor spraying and research on integrated pest control.

3.08 Settlement issues. There were few reports of friction among settlers from different tribes and areas and between settlers and existing residents. Desertion was high in 1982 (25 percent). It had decreased subsequently, but many settlers were reported to have left behind, or sent away, their families. The original intention in project design was to help settlers build their own houses, at an estimated cost to the project of K Sh 4000. This required careful timing of arrivals that did not occur. The first 1,428 houses were instead built by NIB on force account at an average cost of K Sh 26,000 but the quality was poor and in 1982 the project decided to use a contractor instead. Some 455 houses needed rehabilitation. This was entrusted to the contractor. The cost of these houses after rehabilitation was K Sh 43,000. Subsequently 762 houses were constructed at a cost of K Sh 26,700 per house. By the time Government decided to limit the scope of the project to 3900 ha (and 23,000 people instead of 65,000) construction contracts for irrigation works, water supply and sewerage had been awarded and most of the work completed. In the initial design, villages were to share public standpipes (12 houses per standpipe). This design had been modified to provide water to each house at considerably higher cost. Because of water shortages and financial constraints (O&M cost at half capacity was estimated at K Sh 1.5-2m) the water system was not put in use and the project continued up to 1986 to rely on the temporary facilities provided for the construction phase. No consideration had been given to cost recovery in 1984. Settlers operated their holdings as tenants on an annual lease and had little influence on their farming operations. Since houses belonged to the project, settlers had generally not provided adequate maintenance.

3.09 Management. NIB was not sufficiently strengthened to take on the new tasks. The technical and particularly the accounting department should have been reinforced. The General Manager was overburdened so there were long delays in decision making. In a 1981 study, the Directorate of Personnel Management, suggested appointing two assistant general managers. However, by the end of 1984, seven years after project signing, NIB's organizational structure was largely unchanged and the weaknesses identified at appraisal and in 1981 remained and were reinforced by the financial crisis. Late and inadequate releases of funds from the Treasury created severe cash flow problems. The project design also relied on a high degree of interagency cooperation, which failed to materialize. Completed infrastructure was not taken over by the appropriate institutions and insufficient funds were budgeted for operations. The interministerial committee was a constructive force, but resolution of these problems required a higher level steering committee.

3.10 To help the NIB manage the irrigation system and agricultural operations, the Development Credit Agreement (Section 3.02) called for use of an experienced management firm for not less than six years, starting January 1979. Such a firm was in fact employed for only about six months in 1982-83. This breach of covenants, which was due to disagreement on the role of the consultants, contributed to operational delays and failures and poor maintenance of civil works and equipment. Lack of managerial delegation was another problem. Almost all procurement decisions, even for day-to-day supplies, had to be referred to Nairobi, where the NIB had neither the staff nor the sense of urgency to attend to so many requests for spare parts, farm inputs, fuel, casual labor and the like. NIB had some degree of autonomy but was poorly managed. It was not provided with the technical and managerial assistance originally envisaged. Consequently, it lacked the capacity to review consultant proposals and monitor the economic and financial viability of the project; also, it had little influence on the decisions of other ministries and agencies.

B. The Mid-Term Review

3.11 The basic options for future operations identified in the mid-term evaluation are outlined in the following table. There was no zero investment option as the pumping station was in urgent need of rehabilitation. Thus option 1 represents the minimum investment requirement. The donors agreed to pursue this option for the immediate rehabilitation of the scheme while at the same time investigating the feasibility of option 4b through studies of gravity intake, commercial farming and cotton pricing.

Table: Mid-Term Review Investment Options (1985)

Option	Type of water Supply	Total Area (ha)	Area (ha) of commrcl farming	Investmemt million K Sh	ERR %	NPV of govt. subsidy million K Sh	Project risk
1	4 pumps	2500	-	154	11	238	Medium
2	6 pumps	3900	-	217	18	282	Medium high
3	6 pumps	3900	110	191	18	261	Medium high
4a	8 pumps	5040	1840	240	22	269	High
4b	Gravity intake +5 standby pumps	5040	1840	291	22	234	Low
4c	Gravity intake +6 standby pumps	5040	-	366	18	318	Low
5	Weir & 6 pumps during constr.	5040	-	533	12	368	Very low

Notes:

1) The subsidy calculation assumes a target net farm income of K.Sh 10,000 (incl. subsistence crops) per settler. The subsidy is based on the prevailing market price for seed cotton. The mission also proposed a 20 percent price increase, in which case the NPV of Government subsidy would decrease to K Sh 183 million and 166 million for options 1 and 4b respectively.

2) The subsidy and ERR were calculated after deduction of receipts from import duties and other taxes estimated at 15 percent of costs.

3) Project risks refer mainly to security of water supply.

3.12 On the basis of the recommendations in the mid-term evaluation report the donors took the following positions in 1985:

A. Ineffective management has become the overriding problem at Bura. Unless management can be improved immediately, the cofinanciers see little future for the scheme and no justification for further investments. Ineffective management affects all works and maintenance at Bura as well as agricultural and pump station operations. Every action needs approval from NIB Headquarters, with priorities set in Nairobi. Although this is a time of crisis management there is no evident sense of urgency about the purchase of spares, clearance of the management agreement, the processing of documents, or reaction to the many issues raised in the mid-term evaluation report.

They proposed:

- that management assistance be provided without delay. The World Bank is prepared to provide financing until the EDF financing becomes effective. The contract should provide for effective management responsibility for the management team, including consultant staff. The consultants would provide the head of the management team; and

- that a steering committee of senior officials be established, as recommended in the mid-term evaluation report.

B. Persistent interruptions in the water supply have severely limited yields. The water supply for irrigation has to be assured.

They proposed:

- that work begin immediately on rehabilitation of the pump station (estimated cost K Sh 10 million);

- that NIB contract with a reputable firm to manage the pump station for two years;

- that NIB carry out a program to ensure pump station operation and management (e.g., renting extra pumps, spares, housing, and a workshop); and

- that no expansion of pumping capacity be undertaken at present.

C. The scheme was short of funds and had little financialautonomy. Scheme management was dependent on the NIB for all but trivial money decisions. The Cotton Board had not yet paid farmers for cotton delivered in August 1984 so farmers were not interested in clearing their fields and producing cotton in 1985.

They proposed:

- that the Cotton Board be instructed to pay farmers and NIB the K Sh 26.5 million due for the 1984 crop;

- that the NIB, on behalf of farmers, negotiate a contract on commercial terms with the Cotton Board, or seek alternative marketing arrangements for 1985 and after;

- that Government issue an advance of up to K Sh 20 million to form a working capital fund for the scheme; and

- that the NIB implement at Bura the decentralized accounting system proposed by Coopers and Lybrand.

D. The scheme will require heavy Government subsidies throughout its life (over K Sh 20 million a year).

They proposed:

- a review of the price of Bura cotton. The true economic value of Bura cotton is at least K Sh 1 per kg higher than the present price of K Sh 4.80 per kg. If this price were paid it would bring the scheme closer to break-even;

- a review of how to maximize benefits from the present developed area by leasing currently unused areas to commercial farmers;

- a review of savings possibilities (on both capital and recurent costs);

- setting up groups to review these questions and report by April 30, 1985. Donors were prepared to participate in these groups. These reports were to be reviewed by Government and cofinanciers and decisions made by May 31, 1985, (including discussions about increases in the cotton price); and

- that Government immediately release the proposed NIB financial controller from his other duties.

E. Unless all of the above points are resolved, the future of the scheme is bleak. The cofinanciers are prepared to finance investments necessary to maintain the scheme and carry out the above, provided that Government agrees and that NIB can perform adequately.

They proposed:

- that no further settlement for smallholder cultivation take place under the present project;

- that only investments necessary to bring into cultivation the area irrigable with present pumping capacity be undertaken now;

- that NIB performance be carefully monitored against a detailed action program, with regular three-monthly reviews; and

- that, subject to certain conditions, including the review of NIB performance, cofinanciers would make the amendments to legal agreements needed to complete the above program.

3.13 GOK agreed in February 1985 to a time bound action program to pursue these points. After some delays NIB started implementing the program. Then in April 1985 it postponed further implementation pending final decisions on a GOK initiative to transfer management responsibilities from NIB to the Ministry of Agriculture and Livestock Development (MALD). In a letter to the Bank dated July 2, 1985, the Finance Secretary outlined

the following terms:

(a) The project would be consolidated at 2500 ha;

(b) The 5000-ha option would be further investigated. Terms of reference for a study of gravity supply were being drawn up. Proposals for long-term financial viability would be communicated to the Bank by the end of 1985;

(c) The management unit within MALD would report to a Steering Committee and be constituted as a separate legal entity. It would have great autonomy within an approved work program and budget and would have its own Bank account, on which an advance of K Sh 20 million would be deposited. A 3-year management contract with NEDECO was signed on June 28, 1985;

(d) Arrangements for improved pump station operations were in hand. Bids for the spare pumping unit would be sought with a view to have it operating by the end of March 1986;

(e) Arrangements to assure timely payment of cotton would be negotiated with CLSMB;

(f) The water works and health facilities would be funded and handed over to the appropriate ministries; and

(g) The closing date would be extended to June 30, 1986; arrangements for funding of NEDECO and cancellation of US$3 million were requested.

Corresponding amendments to the loan and credit agreements were communicated by the Bank on July 29 and signed by GOK in December 1985.

3.14. The Bank's sentiments at this stage were illustrated by its statement in connection with the Fall 1985 project implementation review:

> "The major objective now is to establish an effective organization and management system which can operate the large investment already established years in the right direction. The risk for failure is high due to the essentially poor project concept. However, given the high sunk costs, the negligible additional investment required, and the dependency of 20,000 people now living on the scheme, the only acceptable option is to provide limited assistance to keep the project running on an increasingly efficient basis".

C. Project Completion

3.15 In December 1985 a supervision mission reviewing progress against the July 2 letter from the Finance Secretary (para. 3.13) noted that:

(a) The setting up of a new management unit within MALD was far from complete. The opening balance, legal and financial status, organization and degree of autonomy remained unclear. Key staff were not appointed, the advance payment of working capital had not been made, and no budget and work program had been prepared. However, the steering committee had started functioning and the three-person NEDECO team was in place.

(b) Pump station functioning remained higaly erratic. No measures for preventive maintenance had been taken; procurement of spare parts was delayed and backup pumping capacity would not be in operation by March 31, 1986. The mission recommended that irrigation should continue to be restricted to 2500 ha.

(c) Delays in payment for cotton had worsened.

(d) Some progress was noted in the handing over and funding of the operation of water works and health facilities.

(e) Terms of reference for the gravity intake study had been finalized but bids had not yet been invited. The mission recommended investigating a commercial nucleus estate approach to management of the scheme and using the 3000 ha that are prepared for irrigation but now remain fallow.

The mission recommended and the Bank agreed to extend the closing date to June 30, 1986.

3.16 President Moi, who visited the project in January 1986, called it a failure. He considered the maize crop extremely poor and the pumping of water to be very wasteful. The president expressed concern about farmers not being paid for the cotton, was shocked by the squalid condition of the settler houses and said he would appoint an independent team to disentangle the mess, restructure the project and manage it from the site. In the wake of the president's visit, a new management committee was appointed, headed by the provincial commissioner of the Coast Province. A new general manager reporting to the Office of the President was also appointed and stationed at Bura.

3.17 The observations of the December mission and the subsequent upheavals led the Bank to address a letter to the Chief Secretary in which for the short term it was suggested "that Government explore options for creating an institutional structure which, within work programs and budgets agreed with its board, would have maximum authority for decision taking - on hiring and firing, on procurement and on financial management. Plans for establishing such a structure were well advanced under previous management and it is recommended that a rapid review and decision be taken on these plans." For the longer term the Bank recommended that the Government review alternative management structures (e.g., a nucleus estate with outgrowers) that could provide services for the whole scheme, including water distribution. In a pointed response on April 2, the Chief Secretary expressed his confidence in the new management team and did not address the autonomy question. Subsequent discussions focussed on supervision of ongoing contracts and the completion of disbursements by March 1987, with little emphasis on the managerial structure and sustainability.

3.18 A limited supervision mission in May 1986 noted that the project status had improved slightly since December 1985 thanks to an active management committee and the presence of a quite effective general manager resident at Bura. However, the project was still grossly understaffed and transfers from the Treasury had fallen far short of needs. Difficulties with pumping persisted and resulted in limited (2500 ha) and delayed

plantings and insufficient watering. Water supplies were uncertain for the forestry plantations that were about to start. The gravity intake study that ODM would finance had not yet been launched. The mission expressed concern about the health situation and the lack of transport. Delayed audits were a recurring theme in all supervision reports.

3.19 The last Bank input was a one-day supervision mission in November 1986. The mission noted that the management committee had been instrumental in mobilizing support from different institutions but had been hampered by frequent changes of chairman. Organization and personnel of the management unit were still under review and progress was still hampered by an acute shortage of upper and middle level managers. Procurement was slow as decisions were still made outside of the management unit. Finance was no longer a constraint but accounting was still rudimentary, with no prospect of an audit. Pumping remained erratic and no progress on the gravity intake study had been noted. The maize crop had been scaled down to 500 ha (from 1250 ha). Efforts to establish forestry plantations for fuel wood continued to be frustrated by a water shortage. Lack of transport and drugs frustrate the health program and the water works had not been taken over by the Ministry of Water Development (MOWD) as promised.

D. Position in early 1988

3.20 In February 1988, when the PCR mission visited Bura, the project had 2,139 settlers. A few settlers were reported to have more than two plots (a plot = 0.625 ha) but many had only one plot. Project design calls for two plots per settler which, if implemented, would mean 1963 settlers cultivating the 2454 ha of cotton that were planted in 1987. Project management is trying to rectify the settler situation. The yield of cotton reached a record level of 2250 kg/ha. Information about area and yield of the maize crop continues to be inadequate. An estimated 1,000 ha were planted. No crop sampling had been carried out in 1986 or 1987 but the yield was expected to be below average (average having been 1,700 kg/ha). The main constraints are water supply and timely cultivation. Cotton crops got 5 to 6 waterings instead of the optimum 7 and the maize crop got only 2 to 3 waterings instead of the 6 planned. A tractor shortage (only 12 to 13 are operational) hampers timely land preparation. Damage to crops by wildlife and livestock is reported. Some settlers seem to have acquired livestock, and given the availability of water and such services as schools and health care, the local pastoral population has increased which may result in both overgrazing and crop damage. The small vegetable plots would benefit from more attention from the extension staff.

3.21 A farmer with the prescribed two plots plus a small vegetable area would derive an income of about K Sh 8000 after having paid for project services and hired labor. Land and water including cultivation charges remain unchanged at K Sh 3000 per settler; fertilizers and spraying cost amounted to about K Sh 4425. Settlers also get housing and treated drinking water. By comparison, a casual laborer earns about K Sh 7200 annually. The problems of late payment for cotton appear to have been resolved. The farmers now receive an advance at the time of picking, and then an intermediate and final payment.

3.22 The water works were commissioned in 1986 and treated water is being delivered to all the villages. Wastage is a problem because the settlers tend to let the water flow freely to trees and vegetables around the house. Electricity and sewer systems for the project center are also operating. The project is now fully integrated into the MOA, is expected to operate within the civil service, and lists 515 posts. There is still an acute shortage of accounting staff. The NIB audit for 1984-1985 was completed in October 1987; the accounts for later years remain unaudited. Eventually the responsibility for operation and maintenance of the water works and buildings are expected to be handed over to the Ministry of Water and the Ministry of Works, respectively.

3.23 The health center still reports some difficulties with transport and occasionally drugs but the Catholic mission is still operating and the health situation appears to have stabilized. Malaria is still a major problem and a few cases of bilharzia are treated monthly. Cases of malnutrition are rare. The FINNIDA-supported forestry component is taking off. Some 103 ha of irrigated and 176 ha of rainfed plantations have been established and are expected to reach 600 ha in 1988. Amenity trees in the villages have been promoted with the help of village nurseries. The outcome on rainfed plantations is still uncertain but appears promising. Attempts are being made to establish plantations by using the water in the drains. A policy for managing the plantations and disposing of fuel wood still needs to be established. Forestry staff do not report any major damage to the riverine natural forest. The elimination of flooding through regulation of the Tana River upstream of Bura is probably the largest threat to the forest. The water level at the Bura intake is now seasonally very low. The watering ponds for wildlife are not operational but livestock and wildlife both appear to use the main canal as a source of water. Aerial spraying of cotton is still standard practice.

E. Economic Viability

3.24 It was difficult to determine project cost because the handover from NIB to MOA was inadequate and many of the personnel involved at earlier stages had left. If the project is defined as having ended in June 1987, total project cost including operating and maintenance expenditures (K Sh 152 million) amounts to K Sh 1.2 billion or US$105 million. This is lower than the K Sh 1.5 billion estimated in the mid- term evaluation report because contractors were not allowed to continue beyond the agreed upon completion date. Thus some of the irrigation works, road construction and village water supplies in the extension area were cancelled.

3.25 At the present level of operation (2500 ha) the project is yielding a negative rate of return. Annual operating costs (about K Sh 53 million in 1987-88) exceed benefits (about K Sh 33 million) and are likely to continue doing so at reduced levels even if there is enough irrigation water and yields of both cotton and maize are improved to 2500 kg/ha. International prices for cotton and maize have deteriorated; in 1987 they were only 62 and 47 percent, respectively, of prices that prevailed at appraisal.

F. Sustainability

3.26 At reduced operating levels, the Bura Project is plagued by enormous overhead for staff and facilities. The annual cost of operating the project, less cost recovered from farmers, leaves about K Sh 34 million to be covered by Government (i.e., K Sh 17,000 or US$1,000 per settler). Some rationalization of costs and increased cost recovery may be possible but a major increase in charges to farmers must await improved water availability and yields. On the positive side, two new pumps are being installed which should allow a more reliable supply of water, the irrigation network is being maintained with the help of WFP supplies, settlers appear to be more rooted, and there are few signs of tribal conflict. However, many buildings suffer from deteriorating foundations, which are costly to repair. Many settler houses have collapsed and others are threatened as farmers do not feel responsible for maintaining them. Spare parts for most equipment is costly and not readily available, so equipment may need to be replaced early. Salinity does not appear to be a major problem but its effects on yields may be compounded by the effects of water shortages and difficulties in cultivation. The project still enjoys such privileges as a separate savings account, the carry over of balances from one year to another, retention of revenue earned and relaxed procurement rules. Incomplete integration of the Bura project into the MOA could threaten the efficient operation of the project.

IV. Possible Remedies

4.01 The mid-term review listed a number of remedial options (para. 3.11). The unreliability and cost of pumping make gravity intake a requisite for rehabilitation. Terms of reference for a low cost gravity intake study were prepared in 1985 but the study was never commissioned. The reasons for the recent low levels of the river Tana at certain times of the year need further analysis. If its flow cannot be remedied by improving the operation of upstream reservoirs, some impounding of water should be considered. Secondly, the area under cultivation should be expanded to 5,400-6,000 ha to make the project more financially viable. Such expansion is possible in the area south of Bura, where irrigation works were constructed, land was cleared and levelled, village sites were prepared, drinking water provided and staff houses constructed. The project engineer estimates that rehabilitation of these facilities will cost about K Sh 40 million. Recent reviews also reveal that the Pumwani and Masabubu commands (see Annex 3) are more suitable to irrigation than the areas presently under cultivation.

4.02 Awarding the settlers more security of tenure (freehold for house site and vegetable plot and a long-term lease on agricultural land) should help resolve maintenance problems and improve farming. Proposals to improve the legal status of settlers have been submitted to Government. Given the high costs of operating and maintaining the scheme, it might pay to "import" maize for the settlers and grow higher value crops, such as oil crops, citrus, or bananas. Such an option should be considered.

4.03 Basing area expansion on commercial farming rather than settlement would result in more rapid development, higher yields and less cost to the Government. One suggestion is to turn the whole scheme in its expanded

form over to a commercial entity to be operated as a nucleus estate with the present settlers as outgrowers. Such an arrangement would be ideal if the financial viability can be restored to attract private enterprise. Increasing the area allocated to each settler may over time improve cost recovery.

4.04 There is an acute need to introduce more commercial principles, more attention to cost efficiency and cost recovery, and more freedom in staffing, procurement and financial matters. It is clear that a scheme of this size and complexity cannot be operated by a unit within MOA or any other Ministry. If privatization is not possible, then a public corporation or a joint venture must be contemplated.

4.05 Considering previous investments as sunk costs, the mid-term review team found that some of these options might offer a reasonable rate of return. However, some of its assumptions about yield and operating costs have not proved true; the reduced flow of the Tana River may necessitate costly remedies; and with the passage of time unused facilities have deteriorated further, more project buildings have developed serious foundation problems, and some equipment will have to be replaced (para. 3.26). Thorough feasibility studies - economic as well as financial - should be done on a range of options.

4.06 Apart from requiring that additional investments produce a satisfactory economic rate of return, any rehabilitation program should also substantially reduce recurring Government subsidies. If further study confirms that this cannot be achieved, one option would be to close down the scheme. A study of future options should include consideration of the implications of such a decision.

V. Principal Conclusions

5.01 The risks of the Bura irrigation and settlement project were well known at the time of appraisal. A Bank-issued paper on the settlement of agricultural lands[2/] was drafted at the same time as the appraisal report. Some of the conclusions in this study were:

(a) Government-assisted settlement of new lands can contribute substantially to a rural development program, important objectives of which are accelerated growth of agricultural output and creation of jobs. But this requires a larger settlement program than most countries undertake. Such a program must be replicable and therefore have low unit costs.

(b) The Bank's involvement in future settlement activity is likely to be small in relation to total investment needs. Bank-assisted projects, which should be viewed as prototypes to develop approaches, can be justified only if costs per beneficiary are relatively low.

2/ World Bank Report No. 1670, June 1977.

(c) Major common problems are inadequate management, staffing and organization, overambitious physical targets, underestimates of development costs and difficulties with cost recovery.

As the MADIA study points out (para. 1.08), the dangers of this type of project in the Tana basin had already been described in 1973:

> "There is a sharp danger in the lower Tana of irreversible commitment which given the heavy risks that normally attend organized irrigation might ... (be) on a scale which would be a national disaster. In general the larger the project is, the higher the cost, the larger the number of people involved and the more publicity it receives. The danger is that if the major Tana irrigation project were implemented with heavy inve investment in a barrage, irrigation works, and the establishment of settlers settlers, it would be extremely difficult to disband. The risks are not simply that such a project would fail but that it will remain a permanent millstone weighing down the national economy...." [3]

5.02 The following questions will be addressed in this section:

(a) Should the project have been given a green light before it is technically ready?

(b) Should the project have been stopped in 1979?

(c) Were the mid-course adjustments well conceived?

5.03 Project Readiness. There was a lack of technical knowledge at the time of appraisal about the project area. This led to inappropriate technical design of housing and other project buildings, the erroneous estimates of soil fertility andyields, and the underestimation of project costs. If, as is normal Bank practice, loan approval had been delayed until detailed project perparation had been completed, that is, until final designs were available, the Bank would have become aware that, because of cost escalation, the project was no longer economically viable. Alternatively, if the project had been implemented as a succession of small, feasible investment, better adapted to local implementation capabilities, there might have merged a sustainable irrigation system together with the kind of knowledge the Bank only now has about soil fertility and its load bearing properties. Ultimately, the Government, the Bank and other cofinanciers (except one which withdrew) ended up financing an oversized and doomed construction project which will require permanent budget subsidies unless some of its components are made financially sustainable. This experience is a reminder of the relevance of bank policies on project readiness; of the need for thorough and reliable technical knowledge before carrying out economic and financial appraisal; or alternatively, of the usefulness of starting agricultural projects as a small pilot phase before their replication. The recently approved Kenya Rural Services Project, for instance, follows this approach.

5.04 The 1979 Review. During the 1979 review, Bank staff had

3/ Chambers and Moris (eds.) Mwea: An irrigated settlement in Kenya. Munich, 1973

considered the option of cancelling the loan/credit. However, the Government wanted to continue with the project, and the Bank does not have the legal basis to force cancellation on grounds that the project is uneconomic. Proposals to insert a clause in legal documents empowering the Bank to do so have been discussed at the Bank's Board several times and rejected. Another option was to redesign the project. However, the revisions made at this stage were marginal. They did not question the basic design or make the project more economically viable.

5.05 Midcourse corrections. Three aspects of implementation in particular compounded the effect of the design flaws. First, GOK failed (except briefly) to employ a management firm to manage operation of the irrigation system and agricultural services (para 3.10). Upon recommendation of the mid-term review, the Government moved cautiously to implement greater autonomy in staffing, procurement and financial management, the appointment of a management firm (NEDECO), and the reconstitution of a more powerful steering committee. However, progress was set back by the changes in management responsibility in 1985 and again in 1986.

5.06 The second major decision, made in 1982, was to base the future supply of water not temporarily but permanently on pumping. This led to a reduction of the cultivated area, delay of the forestry component, disruptions of water supply and a reduction in yields. That decision was made in response to a financial crisis, without sufficient attention to the long-term consequences. The high cost of pumped water has reduced the scheme's financial viability.

5.07 The third factor was to have been the decision to put the initial settlers on the worst rather than the best soils. The water shortage prevented subsequent exploitation of the better soils. The extent to which farming can be sustained in parts of the Chewele command is questionable.

VI. The Future Role of Irrigation

6.01 The Bura project did not contribute to the objective, expressed at appraisal, of developing Kenya's capacity to manage future major irrigation projects. On the contrary, the experience discredited development of irrigation as a tool to achieve agricultural growth and employment. The Bank's Agricultural Sector report of 1986 [4] states, under the heading of irrigation (para. 69):

> "Under present conditions, we believe that further development of rainfed agriculture in the high-potential areas offers considerable relative advantages in terms of the economical use of financial, technical and administrative resources. Yields in some of these areas can be significantly increased with strategic investments in improved agricultural services and key policy changes. This option is far less expensive than a major irrigation development program, a critical factor given Kenya's scarce financial resources; it is also less management intensive, another important criterion. This strategy would assist in

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4/ Report NO. 4629-KE of January 7, 1986

developing agricultural services to support irrigated schemes in the medium and longer terms; lack of services, incentives, and research at present will significantly reduce the potential benefits from investment in irrigated agriculture. In the medium and longer terms, however, Kenya will need to explore the options for developing irrigation. Because of the significant costs and technical assistance associated with large-scale schemes, and the disappointing record of these projects to date in Kenya, we recommend the following course of action, in order of priority.

(a) define a clear strategy for irrigation development, taking account of current financial and administrative constraints, and the costs and benefits of irrigation versus other means of intensifying production;

(b) assemble available information on water availability and water management, and classify potential irrigation areas as to their economic value;

(c) improve institutional coordination and clarify institutional responsibilities for irrigation;

(d) address key problems of existing schemes to develop them into self-sustaining operations, while closing uneconomic schemes;

(e) organize and implement manpower training programs; and

(f) cautiously pursue new projects, with a focus on less costly small-scale irrigation and drainage schemes."

6.02 Rapid population growth and the associated problems of unemployment and landlessness that prompted the Bura project have an even higher profile today and necessitate a continued review of the prospects for opening new land through irrigation and settlement and for finding more cost-effective and managerially efficient implementation strategies. This chapter discusses the irrigation potential and options for exploiting it, the objectives and constraints that must guide the establishment of investment priorities in the agricultural sector (rainfed and irrigated) and the issues that need to be addressed in defining an irrigation strategy.

6.03 A recent study of "options and investment priorities in irrigation development" [5] in Kenya gives the following estimates of existing potential and irrigation.

5/ Forms part of a larger study commissioned by the World Bank, financed by the Dutch Government and conducted by Euroconsult. The Kenya report is dated April 1987.

Basin	Existing irrigation (ha)	Potential irrigation (ha)
Tana	16,000	90,900
Athi	8,400	49,500
Lake Victoria	2,800	57,400
Kerio	2.000	31,200
E. Ngiro	800	15,700
TOTAL	30,000	244,700

Existing irrigation is underestimated as it does not include all private development. Estimates of potential are based mainly on figures for water availability which have been translated into area on the basis of certain assumptions about irrigation efficiency and about cropping patterns and irrigation intensity in different zones. In areas such as the middle and lower Tana the availability of suitable land may be more of a constraining factor than availability of water, so the total potential would be smaller. On the other hand, the possibilities for lift irrigation from Lake Victoria may be underestimated. The prospects for using ground water for irrigation are considered very limited in this and earlier studies. Moreover it will not be economically feasible to exploit the full potential (see para. 6.05).

6.04 Analysis of ongoing and planned projects to exploit this potential produced a list of 299 items. Among planned projects there was enough technical and other information to estimate and compare costs and benefits for 59 of the projects (using the same prices, updating cost estimates and to some extent homogenizing yields and cropping patterns by major agro-ecological zones).

6.05 Estimated performance on these projects was measured against Government objectives of economic growth (expressed as NPV and IRR) employment generation (in man-years) and food security (in calories) and against their demands on scarce resources (development funds) and managerial capacity. The analysis showed that:

11 projects have an IRR above 20%
24 projects have an IRR between 10 and 20%
15 projects have an IRR between 0 and 10% and
9 projects have a negative IRR.

Nine projects are consistently among the 15 top projects whatever weights are attached to the above objectives and resource constraints. Eight of these projects are small (below 600 ha) and one is large (above 7000 ha). GOK would review the data on which the study is based before deciding on investment priorities.

6.06 Based on the Bura experience, an irrigation strategy should address the following issues:

(a) The role of the private sector in irrigation. The private sector has been more successful than the public sector. How can small and/or large-scale private investment be promoted?

(b) Financial viability. Should one of the criteria for public

investment be that a project generate enough returns to provide farmers with an adequate income and to cover at least operating and maintenance costs? This would ensure sustainability.

(c) High costs of irrigation and settlement. Can designs and policies be modified to lower cost? What is the international experience?

(d) Institutional fragmentation. The present division of responsbilities may not allow the definition of implementation of an effective irrigation strategy and may not be cost-effective.

(e) Management. The Bura experience clearly points to the need for more local autonomy in implementation. Can this be achieved within a public corporation or through other means?

(f) Capacity. According to the task force on irrigation development, the present capacity allows the addition of only 400 ha of irrigated land annually in the public sector. How can this capacity be enhanced? What is the role of training and technical assistance? How can managerial expertise and experience be acquired?

ANNEX 1

PHYSICAL IMPLEMENTATION

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PHYSICAL IMPLEMENTATION

I. GENERAL OBSERVATIONS

A. Cost Escalation

1.01 The SAR was completed early in 1977 at which time the cost estimates were based on prices and exchange rates prevailing in January 1977. Project construction started two and a half years later, in mid-1979. Then and in the years following actual costs rose substantially above the SAR estimates due to domestic inflation, escalating international prices, the declining value of the Kenya shilling in relation to the U.S. dollar, and changes in designs. Some of these factors are reflected in the table below:

Year	Annual Domestic Inflation Rate		Exchange Rate K Sh-US$	Cumulative % rise in Domestic prices	Cumulative % rise in International Inflation
	SAR	Actual			
1977	9	14.9	8.35	BASE	BASE
1978	9	16.9	7.73	16.9	9.7
1979	9	8	7.45	26.2	23.4
1980	8	13.8	7.42	43.7	42.9
1981	8	11.8	9.05	60.7	63.1
1982	8	20.4	10.92	93.4	83.4
1983	8	11.5	13.31	115.7	107.5
1984	Not given	10.2	14.41	137.7	138.4

Source: International Financial Statistics, IMF.

1.02 The Project Planning Report (PPR) that was issued within months of the SAR entailed a 22% cost increase. When final designs emerged in April 1979 the total cost of the project had increased 65% in real terms. As a consequence of these and subsequent cost increases, the scope of the project was reduced several times in the following years. In the end, total project cost in KSh was about 44% above appraisal estimates. Physically about 70% of what was planned at appraisal was achieved. However, many of the constructed facilities remain unused.

II. THE ROLE OF CONSULTANTS

2.01 ILACO had been involved in conducting studies and making recommendations about possible irrigation schemes on the Lower Tana Basin since 1967. The Bura Irrigation Project materialized from their 1973 studies.

2.02 In their 1973 report on Bura, ILACO wrote that extended irrigation of 14,000 ha at Bura was feasible only if water was secured through a weir and developed over a period of 11 years, which could be reduced to 7 years through super powered project implementation. When Bura Irrigation Project

was prepared, ILACO was engaged to do the detailed designs for irrigation networks and project roads as well as tender documents for international competitive bidding (ICB). ILACO's near-complete designs and reports were used to compute data and project costs in the appraisal report. However, NIB employed a UK-based firm, Sir M. Macdonald and Partners (MMP)[1/] as project consultants for project implementation. Besides being responsible for engineering and procurement services, MMP's Terms of Reference included reviewing ILACO's design and preparing feasibility studies for Tana River East Bank Development.

2.03 In engineering assignments, different consultants approach the tasks in different ways. In reviewing ILACO's designs, MMP made significant changes in river works and canal hydraulic structures, thus invalidating the original design concepts and cost estimates. Both MMP and the World Bank agreed that ILACO's weir design for the west bank was technically sound. Because MMP was given a chance to review ILACO's designs and the possibility of extending the project to the east bank, it appears they had a mandate to alter the original river works design from weir to barrage, a change of substantial significance. Unlike the World Bank and other donors, ILACO, or the Government, MMP felt that the success of Bura West Irrigation was linked to development of the east bank.

2.04 A reliable and inexpensive-to-maintain source of irrigation water was the foundation of the Bura Irrigation Project; development of the west bank was, according to the SAR, not dependent on development of the east bank; and the east bank development was not scheduled for the foreseeable future so it is still not clear why the consultants ignored the idea of a simpler-than-barrage gravity offtake for the west bank. The consultants focused intently on construction of a barrage to serve east and west banks and gave the Government no option of a simpler-than-barrage gravity off take.

2.05 In 1978 MMP redesigned and prepared bidding documents for a barrage instead of the relatively cheaper weir for the west bank provided for in the appraisal report. They also modified hydraulic structures alongside other engineering items. The high cost of the barrage that appeared in MMP's report of 1979 alarmed the Government; hence its postponement of the river works and their cancellation in 1983.

2.06 The consultants were prompt in implementing the project, the major part of which was engineering works and procurement of plant and equipment. By August 1980, the following major construction contracts were let (costs in K Sh million):

1/ It appears that because funding for consulting services was provided by ODM (UK), consultants had to be selected from the UK. Hence, the replacement of ILACO by MMP.

Contract description	Contract Sum	Final Cost	Commence-ment Date	Initially Contracted Completion	PPR Completion Date	Actual Complet. Date
1. Temporary water Supply	15.88	18.64	12/78	12/79	12/79	12/79
2. Workshop, 14 houses; catering unit	13.79	19.85	2/79	6/80	6/82	6/80
3. Supply canal earthworks	45.16	45.50	1/80	2/83	12/79	12/80
4. Main canal, land preparation (bush clearance)	61.70	58.86	5/80	12/84	12/79	12/85
5. Pump station, hydraulic structures and drainage and irrigation canal network	197.60	275.81	1/80	3/83	3/82	3/84
6. NIB houses	80.00	205.74	5/80	6/84	2/82	12/84
8A. Water supply and sewers	-	120.43	3/81	6/83	2/82	6/84
8B. Village water supply	-	38.99	3/81	3/84	6/82	3/84
13. Roads and airfield	57.00	52.95	10/80	3/84	6/82	6/85
14. Supply contracts	-	19.00	-	9/79	6/81	6/85
15. Supply mangrove poles	-	2.60	6/79	4/80	6/81	6/85
19. Site investigation	1.00	1.00	3/79	5/79	-	-
20. Prefab houses (10)	2.00	2.01	5/79	9/79	-	-
21. Tenant houses BBF [a]/		49.10	6/80	-	12/82	12/83

[a]/ BBF - Bura Building Force, an internal NIB building team.

2.07 Because of the thinness of NIB's management capabilities in engineering, procurement and finance, project implementation was left entirely in the hands of MMP.

2.08 By 1983, even with the reliability of water sources uncertain, most contracts for infrastructure were complete or nearing completion to cover the project's 6,700 ha irrigation area, a tenant population of 5,000 families and an overall population of 64,000 people at Bura. Because of the promptness of awarding contracts, phased development and/or cheaper designs were not considered.

2.09 The consultants followed the physical assumptions in the Appraisal Report, and to a large extent the designs in the PPR, but it appears they did not propose or institute any measures to control the overall budget.

2.10 Promptness of implementation to some extent appears to have fuelled cost escalation because:

(i) So many reasonably sized packages were awarded on the basis of orders variation that contract figures for contracts 5 and 6 rose considerably. Variation orders not subject to competition may result in higher prices;

(ii) Water and power utilities were over designed and water systems for tenant villages over expanded;

(iii) The construction mode for tenant houses was changed from "tenant builds own house" to construction by force account or contract, which resulted in higher costs. In the SAR, K Sh 20 million was allocated for 5,150 houses. In fact, K Sh 75.50 million was spent to build 2,190 houses;

(iv) Soil and environmental investigations appear to have been done in a hurry. As a result, designs do not seem to have taken into account soil problems in relation to foundations, the environmental effect of insects and bats on buildings, durability and recurrent maintenance costs;

(v) No efforts seem to have been made to control costs.

III. PROCUREMENT

3.01 During project implementation, all procurement for engineering, plant and equipment was in the hands of MMP. Except for delayed contracts that were being carried out by National Youth Service (NYS), no substantial delays emanated from private contractors.

3.02 The average cost of tenant houses was ultimately K Sh 34,500. According to the Appraisal Report, tenant houses were expected to be constructed by the tenants with materials lent by the Bura Management. The K Sh 4,000 per tenant house allowed in the SAR was far too little and there

were land tenure issues to be sorted out in order to allocate plots to tenants on an owner/occupier basis, it was not prudent for both NIB and the consultants to decide to build tenant houses by contract, to the extent that each house cost about K Sh 31,000. This contributed to the escalation of project costs. Government should have sorted out the land tenure issue and the K Sh 4,000 per tenant house should have been reviewed.

3.03 The actual position of construction of tenant houses was as follows:

		Average cost (KSh)	Total Cost (KSH)
1. No. build by BBF	1,428	30,635	43,746,780
2. Materials left unused, most of it now rotten			5,387,042
3. No. built by contract	762	26,720	20,360,640
4. No. of houses built by BBF and rehabilitated by contract	455	13,187	6,000,000
TOTAL			75,494,462

In summary, a house built by:

	Was worth: (K Sh)
- BBF	31,000
- Contract	27,000
- BBF and rehabilitated by contract	44,000
(Average Cost per house)	34,500

Worst of all, of the 2,190 houses that were built, 20% have collapsed and according to visual estimates about 50% of the rest are expected to collapse within the next two years.

3.04 Bura was expected to have been managed by a strong management team. This team was supposed to be in place in 1978 but was appointed only late in 1982, during which period the first settlers had arrived and had a first crop. The team was constituted of consultants, NEDECO, who for reasons not clear left by mid-1983. After NEDECO, a weak internally formed management team existed at NIB headquarters. Neither this internal team nor NEDECO were given authority to procure and pay suppliers directly. Procurement was over centralized in Nairobi at NIB headquarters. As a result, supplies of essential items and services required in the field were often delayed. Field officers continued to operate under difficult conditions, particularly as they could not react appropriately to crisis situations. Problems started surfacing substantially when Bura Management began taking over such infrastructure facilities as the irrigation network, buildings, and utilities at which time the field officers had few personnel, a minimal budget and no authority to procure items to keep the

facilities functional. Because of this weak NIB management, all major contractors presented large claims arising from delayed payments and extended contracts. By 1985 these claims amounted to K Sh 240 million out of which Government opted to settle K Sh 25 million. Some of the contractors have lodged disputes with Government for unpaid claims.

IV. PRESENT PROCUREMENT ARRANGEMENTS

4.01 Bura Management is not autonomous; the General Manager reports directly to the Permanent Secretary in the Ministry of Agriculture (MOA). For all practical purposes, the management functions like any other MOA Department. Currently a Bura Management Committee headed by the Coast Provincial Commissioner plays only an advisory role; it has no executive powers like a Board of Management of a parastatal organization.

4.02 Except for urgent cases, the General Manager of Bura Project follows prescribed GOK procurement procedures. Because of a staff shortage, the Manager does not have a supplies department. The management staff is still thin in supplies and accountancy. The General Manager, his Deputy, the Head of Engineering and the Accountant comprise a committee that deals with all matters of procurement and supplies.

4.03 Depending on the item to be procured and the urgency within which a decision is required, the General Manager decides whether to refer it to the Tana River District Tender Board, Ministerial Tender Board (MOA) and/or the Central Tender Board. For very urgently required items, the General Manager occasionally refers the matter to the Bura Management Committee. Although the Committee does not have the authority to approve award of contracts, it is understood that they approve procurement of urgently required items, which is an arrangement reached between the present General Manager and the Bura Management Committee (on which the MOA is heavily represented).

4.04 Procurement of minor items and urgently required items does not pose a problem to Bura Management because the Management operates its own account. It has authority to write checks and make payments independent of the District Commissioner's Paymaster and MOA Headquarters. Bura Management is therefore not subjected to the bureaucratic delays usually encountered when payments have to go through DC's office or MOA Headquarters. However, the accounts of Bura Management are audited by the Auditor General, like any other GOK Department. It is understood that Government intends to bring Bura accounts in line with other service Departments of MOA, which will, due to foreseeable payment delays prevalent in service Ministries, bring Bura Management considerable difficulties in terms of procurement and supplies.

B. PHYSICAL ACHIEVEMENTS

4.05 The physical facilities of Bura Irrigation Project fall into three major categories:

(1) Irrigation networks
(2) Buildings, services (utilities) and other infrastructure
(3) Plant and equipment

IRRIGATION NETWORKS

5.01 Generally, apart from the river works (weir or barrage); substantial irrigation works have been carried out on all the commands to cover 6,700 ha of cultivable land (except for secondary canals and land preparation for about 1,750 ha, most of which covers Masabubu Command), and 600 ha of afforestation. The supply, main and branch canals, associated roads and all hydraulic structures are completed. An irrigation network is outstanding for only 1,660 ha.

5.02 Bush clearing was done for 6,450 ha. Of 5,040 ha readied for irrigation, only 2,500 ha is now in use, which leaves 2,540 ha standing unused. Because of the long period that this readied land has remained unused and unattended, the irrigation network and land preparation has deteriorated enough to require rehabilitation work before it can be used for agriculture. The Project Engineering Section estimates that this rehabilitation will cost roughly K Sh 40 million. Cultivable areas are presently distributed as follows:

(i)	Land under cultivation	2,500 ha
(ii)	Land readied for cultivation but not used	2,540 ha
(iii)	Land requiring fresh preparation for cultivation and installation of irrigation network	1,750 ha
	Total	6,700 ha
(iv)	Land readied for afforestation	600 ha
(v)	Land requiring fresh preparation for afforestation	3,300 ha
	Total	3,900 ha

5.03 The main features of the present irrigation works compared with the SAR estimate are summarized below:

Item	Quantity In SAR	Estimated Cost, SAR (K Sh '000)	Quantity Completed	Cost of Completed Item (K Sh '000)
1. River works	Item	59,000	Nil	-
2. Temporary pump station[a/]	Item	4,680	Item	28,640
3. Supply canal - drains, earthworks	46 km	31,563	33 km	45,500
4. Main canal, drains, and earthworks	19 km	8,047	25 km)	58,860
5. Farm development	6,700 ha	23,126	5,050 ha)	
6. Hydraulic structures for all canals, drains, roads	Item	14,022	Item)	275,810
7. Irrigation network	6,700 ha	24,535	5,040 ha)	
8. Wildlife conservation	Item	1,512	Item	2,180
9. Roads and airfield	Item	15,204	Item	52,950
Total		181,787		463,940

a/ Including contract 16/4 for new pumps.

REDUCTION OF IRRIGATION WORKS

6.01 In 1979, because of likely cost escalations, the Government decided to postpone river works and reduce the forestry component from 3,900 ha to 600 ha in order to cut down on overall project costs. In terms of SAR estimates, these items would reduce the cost by K Sh 59.1 million for river works and K Sh 10 million for irrigation networks. By 1979 the estimated cost of these two items was about K Sh 83 million, which figure progressively rose to about K Sh 350 million for river works. The cost escalation reflected in 1979 designs made the project economically unviable. One donor withdrew its contribution of K Sh 71 million, which GOK had to bear, together with additional costs arising out of design modification and inflation.

6.02 In 1982, GOK signed an agreement with the Kuwait Fund for Arab Economic Development for river works. By that time, project costs were projected to be about 50% above the Appraisal Report. An Interministerial Committee was formed in 1982 to advise on how to reduce costs. In their 1983 report, they recommended a project area of 3,900 ha and cancellation of barrage, thus leaving the temporary pumping station as a permanent source of water.

6.03 In 1983, because of the project's rising costs, the Government decided to exclude from the project's irrigation works among other items, the river works (barrage) and restrict the development of 3,900 ha. by cancelling the river works, GOK lost Kuwait funding. At that stage most of the contracts for irrigation works to cover 6,700 ha had been let, so only about K Sh 30 million was saved by way of omissions from ongoing contracts. These omissions were on irrigation network and land preparation for 1,750

ha, and on project roads. These reductions were possible only because the contractors for the works were not able to complete their works by the agreed upon contract completion dates (November 1982 for project roads and July 1983 for irrigation networks and land preparation).

PRESENT SITUATION OF IRRIGATION WORKS

7.01 River Works. Government has not yet made a decision about construction of a weir or barrage. A study has yet to be done to establish the type, actual position, cost, and benefits of the river works to be constructed. Government has drawn up Terms of Reference for the study and is exploring possibilities for getting a donor to fund the river works. A figure of K Sh 330 million has been included in the Forward Budget for Bura river works (gravity offtake).

7.02 Pumping Station. The present pumping station, commissioned in 1982, was expected to last up to 1985. It has four inclined pumps, two small ones (expected to deliver 1.075 cm/sec each) and two big ones (expected to deliver 2.10 cm/sec each). These pumps are expected to deliver 6.35 cm/sec when all four are working but because of their age and occasional change of static head when the level of river water falls, these pump sets rarely deliver more than 40% of installed capacity. Although the operators and mechanics are now housed at the pump station and have on site a store for immediately required and fast moving spare parts, there is continuing difficulty maintaining these pump sets because of (1) lack and untimely delivery of spare parts; (2) frequent breakdowns; and (3) too few mechanics. Frequent breakdowns have caused water supply failures which have in return caused reduction of yields. Two more pumps are being installed with a total capacity of 5.4 cm/sec. These are expected to be in operation by April 1988. Once the two pump sets are in place, theoretically irrigation could expand to 3,900 ha. In reality it will remain at 2,500 ha because:

(a) the inlet channel from which the pumps are drawing water may not have enough water to pass through all the pumps;

(b) the old pumps can be maintained only as stand-bys and cannot be relied on as sources of water; and

(c) except when the river level is low, the pumps are expected to reliably supply adequate irrigation water for 2,500 ha and 600 ha forestry at all times.

7.03 There is a growing fear that because of the high silt content in Tana River water, and because the Tana River water level is increasingly likely to be lower than critical levels required for the pumps to operate efficiently, the water output from these pumps may also in future not be a reliable source for meeting the full water requirements for irrigation purposes.

7.04 Fuel accounts for the largest share of operating costs at the pumping station - about K Sh 80/per 1,000 cubic meters at the pump station compared with K Sh 160/per 1,000 cubic meters of overall operating cost for

the station. Due to water losses on supply, main and branch canals, the cost of fuel alone is about K Sh 100/per 1,000 cubic meters at the irrigation field. The total operating budget of the pump station is about K Sh 8 million a year. This works out to about K Sh 3,200/per ha a year, half of which is for the cost of fuel.

7.05 Irrigation Canals. The silting basin is adequately maintained. It is desilted twice a month during rainy seasons and once a month during dry seasons. A dredger, a dragline and a dozer are normally used for this purpose.

7.06 Except for the 10 km of main canal that were desilted last year (May-November 1987), the supply and main canals have not been attended to since they were built. The canal banks are eroded in some areas. Because of the poor design of feeder pipes to animal watering holes, the pipes are blocked and the holes are empty.1/ Because of the unavailability of water in the watering holes and the distances between them, and because nomads find it easier and more comfortable to graze near the canal and Bura itself, animals drop to the canal for their water requirements, thus causing further deterioration of canal banks and silting of the canal beds. this is a problem that Bura Management will have to live with because it is difficult to police 46 km of open canal in bushland.

7.07 Except for the unit feeders, all irrigation canals are designed so that they require desilting and the banks need reinstatement every five years. Farmers are supposed to clean the unit feeders continuously themselves except in case of major damage. Last year farmers were encouraged to clean the feeders with the help of the World Food Program (WFP). Regular maintenance of the canals is restricted to removing weeds and greasing gate structures.

1/ The Bank supervision mission of March 1985 summarized the position of watering holes as follows:

> "This mission reviewed the current status of the ponds constructed to provide drinking water for wildlife and livestock west of the main canal. Of all the wildlife-related subjects in recent Bura history, the drinking ponds probably have received the most attention. Present evidence makes it seem clear that the ponds were flawed both in concept and design. They were unnecessary and a waste of money because both wildlife and livestock easily and perhaps even preferentially drink at the nearby main canal. Their design was doomed because silt blocks the underground feeder pipe from the canal, and perhaps most fatally because of the location of the pipe outlet at the bottom of a pond where it is certain to get blocked with silt from the sides of the pond. No further effort and not a cent more should be spent on the drinking ponds. They probably cannot be made to work properly, and they are not necessary anyway."

7.08 Since all of the canals were completed by or before 1983, they are due for five-year maintenance. So far with the help of WFP the management has desilted all irrigation networks (branch block and minor canals, and unit block and main drains) for the irrigated area of 2,500 ha. This was done in 1987, and took 12 months. Work on the main and supply canals was started in May 1987. It took 6 months to do 10 km using 2 machines, at which rate it was realized it would take another 24 months to complete work on the remaining 30 km. This was done with the two excavators that are also normally used for clearing blocked drains and/or irrigation canals. The two machines were breaking often and constantly required spare parts. To save these machines for emergency work in the irrigation areas, it was decided that maintenance of the main and supply canal and night storage reservoirs (which require special machines) should be subcontracted to private contractors. MOA has been asked to make funds available for this work. The supply and main canals appear to function, but unless the maintenance work of desilting and reinstating banks is done within the next two years, serious irrigation water problems may occur.

BUILDINGS

8.01 Data about the constructions for Bura are summarized in the table below. The total appraisal estimate for buildings was K Sh 132 million. The actual cost is estimated to be about K Sh 400 million to complete about 80% of the appraisal estimates.

Item	SAR Estimates	Actual
1. Tenant houses	5,150	1,836
2. Offices and workshop	Yes	Yes
3. Collection centers	No	8
4. Multipurpose halls	24	0
5. Police station	1	1
6. Police posts	3	0
7. Post office	1	0
8. Health centers	1	1
9. Health subcenters	-	0
10. Primary schools	25	6
11. High school	1	1
Housing		
12. Type A house	-	1
13. Principal/staff houses (type C, D)	10	14
14. Senior staff houses (type D, E)	44	84
15. Junior staff houses (type F, G)	732	414
16. Guest house (club)	1	1
17. Water treatment	Yes	Yes
18. Sewers (rural center)	Yes	Yes
19. Power (rural center)	Yes	Yes

TENANT HOUSING

9.01 The design of tenant houses was based on typical mud-and-mangrove poles as practiced in coastal Kenya. Important components in this form of construction are strong poles and protection of walls from rain water. Where walls have to be plastered, adequate quantities of coral or stone or pebbles are required. Mud disintegrates when wet, so mud walls must be protected from rain water so that it does not fall off the walls. These standards were not followed in most tenant houses at Bura. Thin poles were used, pebbles were inadequately used (and most altogether omitted in villages 1-4 built by BBF). Roof structures are weak and eaves do not offer walls adequate rain water protection. Consequently the surface cement/sand mortar layer is liable to peel off the walls. In some cases roofs have been blown off by wind, because trussing has not been strong enough. Every rainy season, walls get wet and some fall off; tenants try to remud but as these houses do not strictly belong to them, they are not keen on repairing them. Houses with weak poles collapse when walls become wet and heavy. Of the 2,179 houses that were built, 343 houses have already collapsed, and their debris has been moved off-site.

9.02 Mud houses can last for more than 20 years if the roofs are maintained and the walls protected from water and repaired whenever damage appears. This maintenance is achievable only where the owner is the occupier. In Bura, houses have not yet been transferred to tenants and it is still unclear when this will be done. Many houses are dilapidated. Unless the ownership issue is resolved, because Bura Management no longer carries out regular maintenance on the houses, significant losses will continue. In 2-3 years, an estimated 50% of the houses will be lost. The situation is as follows:

Village	Number Built	Number Lost	Number Existing	No. of Houses in Reasonable State Maintenance
Village 1	244	60	184	70
Village 2	244	11	233	140
Village 3	254	56	198	100
Village 4	228	46	182	100
Village 5	263	69	194	120
Village 6	247	88	159	50
Village 7	184	6	178	70
Village 8	184	2	182	130
Village 9	208	5	203	100
Village 10	123	0	123	90
TOTAL	2,179	343	1,836	970

SANITATION IN THE TENANT VILLAGES

10.01 At least every one or two houses are provided with a pit latrine. When it rains, the latrines get filled with water and the contents spill off the surface ground of the villages. Efforts have been made to lift

latrine hut floors above ground level with timber but this is not satisfactory. The basic technology of constructing pit latrines in black cotton or alluvial silt soils was not used. Tenants are therefore exposed to a health hazard, particularly when it rains.

10.02 Most of the latrines have been lost by being blown off by the wind, being filled up and not replaced, or by being filled up by rain water and soil. It is estimated that only about 30% of the originally erected 1,000 pit latrines are still in place. Again, maintenance and rebuilding of the latrines depend on tenant ownership of plots.

JUNIOR STAFF HOUSES

11.01 Junior staff houses (types F and G), are built of mud and mangrove poles. They have thick walls and concrete slabs and appear more solidly built than the tenant houses. However, they are subject to serious cracks and in one or two sections of walls have collapsed. Because of the thick concrete floor slabs (which are not provided in tenant houses), these building are affected by the heaving effects of black cotton soil, wind and the seepage of rain water into the walls. Maintenance problems are frequent, expensive and in some cases totally impossible. Termite attack was not noticed as a problem. How many of these houses will remain intact for use, and how long, will depend on how frequently and long maintenance is carried out, expensive as it may be.

SENIOR STAFF HOUSES

12.01 There are two kinds of senior staff houses:

(a) Timber prefabricated houses with raised timber floors standing on timber posts. Many defects were noticed in these houses. Most of these houses (about 10 in number) are about to complete their economic life.

(b) Concrete block houses. These houses ought to be solid and permanent. Surprisingly, many of them have developed cracks due to structural failure. Even with frequent repairs and maintenance by the Bura Building team, three houses are already deemed too risky to live in and have been vacated. Even the General Manager's house, which was erected at a cost of K Sh 1 million, is not habitable. The GM lives in one of the smaller houses.

It appears that the builders decided to protect foundations from surface or rain water by use of peripheral concrete paving or aprons and sloping grounds away from the houses. In each of the affected houses, broken paving has allowed water to pass into the houses' foundation. The effect of rain water under foundations and concrete floor beds in Bura soils (reinforced or not reinforced) can be disastrous. Most houses have developed bad cracks, floors have heaved up, doors and windows have jammed, and so forth.

12.02 As with the junior houses, maintenance is frequent and expensive, yet is not solving the problem. No attempt was made to estimate the cost of permanent remedial measures. A Bank supervision mission reviewed this pathetic situation in May 1986 and agreed with Bura Management that MOW supervisory staff (who were in charge of technical supervision of contracts 12A, 21 and 16/A) would prepare a program for rehabilitating these buildings. The Bank was prepared to consider financing such rehabilitation in order to keep the enormous investment from vanishing. By the time the project closed, no such program had been presented to the Bank for consideration. One thing is clear: unless something is done, most houses will be useless in about five years.

12.03 Contracts were let and implemented for all villages. Some villages have staff houses that are unoccupied because the cropping areas have not been extended that far. These are as follows:

Village	Type F Houses	Type E Houses	Other Structure
1. 12/13	27	2	Collection center
2. 15/17	7	2	Collection center, water storage tank base
3. 16/18	6	2	Collection center
4. 19/20	27	2	Elevated water tank
5. 21	4	2	Elevated water tank
6. 22/23	6	2	Elevated water tank

12.04 Except for Type E houses in Village 16/17, all of these unoccupied buildings appear to be in a good state of repair. Most likely this is partly because they are unoccupied and partly because they appear to be in areas where soils are better or firmer.

Houses are distributed as follows:

LOCATION	TYPE							
	A	B	C	D	E	F	G	PREFAB
1. Rural center	1	14	18	18	24	132	146	10
2. Village 1/2					2	7		
3. Village 3/4					2	27		
4. Village 5/6					2	6		
5. Village 7/9					2	7		
6. Village 8/11					2	6		
7. Village 10/14					2	6		
8. Village 12/13					2	27		
9. Village 15/17					2	7		
10. Village 16/18					2	6		
11. Village 19/20					2	27		
12. Village 21					2	4		
13. Village 22/23					2	6		
TOTAL	1	14	18	18	48	268	146	10
NUMBER NOT USABLE	1	2	2	-	-	10	6	0
% IN GOOD REPAIR	0	10	10	10	30	50	50	0

EFFECT OF BATS

13.01 Bura has a lot of bats, and senior staff houses with flat ceilings were not designed to be batproof. As a result most houses have a lot of bats near the ceilings. Removing the bats has proved difficult unless major construction modifications were made. These bats have made houses smelly, noisy and generally uncomfortable. The droppings collect in the ceilings, their urine flood and rot the ceilings. Ceilings on three houses have collapsed, the only benefit of which was a pick-up load of manure. The problem is by no means simple to resolve.

BUILDING STRUCTURES

14.01 Bura Club Center and Swimming Pool. This complex generally looks well looked after. It consists of a swimming pool, main club house (hall, kitchen, store, ablution block) and 14 cottages.

14.02 Administration Offices for Bura Management. These are three blocks of two floors each. The buildings do not show any structural failure or major defects. They are in fairly good repair.

14.03 Mechanical Carpentry Workshops. These are generally intact.

14.04 Collection Centers (N 8). A collection center (one large store and a block of three offices) is where cotton is collected from farmers, settlement and extension officers meet farmers and payments to farmers are made. These buildings are all intact. Their massive structures appear to be overdesigned. Three of them are not in use as they are in areas of unoccupied villages.

14.05 Police Station. The houses for police (No 30) and police station are built the same way as the staff houses, types A-E. The problems are similar. On the day this report was compiled, two walls of the police station were dangerously cracked, so about 30% of the station was unoccupied. Major rehabilitation is required. Otherwise the station will be fully evacuated within an estimated two years.

14.06 Health Center. The health center looks intact. Available information indicates that two years ago the center showed serious cracks on floors, walls and external aprons. They were repaired then and no further problems have surfaced. If the aprons fail again and no immediate repairs are done, the cracks will also appear again.

14.07 Other Buildings. The Nanighi pump station, offices for the engineering section, the research station, and administrative offices are all prefabricated timber houses that were taken over from contractors and consultants. These buildings seem to have completed their economic life and cannot be expected to last much longer.

14.08 Schools. There are six primary schools and one day high school. Three primary schools were completed in 1983; the other three and the high school opened this year. The latter three primary schools and the high school are relatively new, built of concrete block walls and galvanized

sheet roofs, and show no defects. The older three primary schools are constructed of mud and mangrove post walls, plastered with cement/sand mortar on both sides. All schools appear well maintained. The management of the schools has been successfully passed on to the Ministry of Education and the schools are therefore being run and maintained by the Parents/Teachers Associations (PTAs). The PTA has plans to extend and build new schools. They also intend to erect boarding facilities for the high school. In other words, Bura Management no longer needs to construct and/or maintain schools. If the other villages are opened up, it looks as if PTAs will be formed and will, through "harambee", build and manage schools to cater for their children.

14.09 Building Maintenance. Building maintenance is still in the hands of Bura Management. The Ministry of Works' long-awaited takeover of this function has not yet taken place and there are no indications when it will. The maintenance staff at Bura is very slim; it does not normally engage in maintenance of such Government buildings as that of police and the GOK administrative buildings. The annual amount allocated for this work is K Sh 2.40 million which is about 10% of what is needed to keep the buildings in a good state of repair. But even if the budget of K Sh 20 million were made available, the present staff and equipment would not be able to handle the work. As a result, many buildings are in bad shape. The maintenance staff consists of:

Foremen	3 (supervisors)
Masons	13 (9 are casual)
Carpenters	12 (8 are casual)
Clerks (store)	3
Painters	5 (all casual)
Unskilled Laborers	15 (all casual)

14.10 This team requires more and better qualified supervisory staff and more tradesmen.

14.11 Cost Comparison. Swahili-type construction on the Coast normally seems cheap because the sticks, straw, mud, and pebbles are all within easy reach of the owner-builder at practically no cost. Such construction at Bura is not cheap because all materials (except mud) have to be bought and transported to Bura and contractors have to be employed to do the actual construction work. Buildings with thin concrete block walls and those with mud-mangrove walls cost about the same. This was demonstrated by contractors but not pursued by the consultants. Permanent tenant houses, primary schools and junior staff houses that required minimal maintenance probably could have been built at the same cost, if not for less. There was no vigorous cost plan, so this fact did not surface.

UTILITIES

15.01 Commercial Center. The area generally referred to as "Manyatta" is developing into an active commercial center. It has well constructed permanent structures as well as temporary structures of all forms, an open air market, religious buildings and primary school and seems to be growing fairly fast. Bura Management need not worry about developing a commercial center.

15.02 Post Office/Telephone Station. No post office building exists but it is understood the Kenya Posts and Telecommunications Corporation (KP&TC) has been allocated a plot to develop this building. A telephone repeater station has been constructed by KP&TC and is in operation.

15.03 Water Treatment Works, Water Distribution and Sewage. This complex was designed to serve 67,000 people in 23 tenant villages, a rural center and the commercial center. The current population of Bura is about 20,000. This complex, which was built at a cost of K Sh 120.40 million, is operating at less than 30% capacity. Although Bura's current water requirements are more than the output from the Water Treatment Works, the plant is operated at reduced capacity an average 3 hours a day, to reduce overall operating costs and because the staff is slim. The current budget for operating the plant is K Sh 3.40 million, which at full capacity could be well over K Sh 10 million. No recovery measures for consumed water are in place. The long-awaited takeover of the plant by the Ministry of Water Development (MOWD) has not occurred.

15.04 Treated water had been distributed to all the villages, the rural center and the manyatta. The villages were supplied with a tap for each house as opposed to one common tap for every 12 houses as in the SAR. The villagers use this water to irrigate trees and vegetable gardens (no other sources of water exist) so some of it goes to waste. Consideration should have been given to running a raw water canal through each village for watering gardens and trees. To reduce excessive use of water, management supplies water to the villages 2-4 hours per day. Other ways to reduce waste must be explored. One option may be to sell water at selected outlets.

15.05 The distribution system was extended to all villages, even unoccupied villages 11-23. In villages 11-18, standpipes and wash slabs for each tenant house (to be erected later) stand like crosses in a graveyard. The water to unoccupied villages has been cut off and the system will have to be rehabilitated before it can be put to use. No attempt was made to estimate the cost of such rehabilitation. It will depend on the extent of damage at the time of rehabilitation.

15.06 The sewage (which serves only the rural center) is a pumped system; the treatment works consist of oxidation ponds. Effluent is discharged into the adjacent laga. The management and maintenance of this system is done together with treated water supply. One thing that is not yet in place is periodic checking of the effluent to ensure that raw sewage is not discharged into the laga. This should be taken up by the Ministry of Health.

15.07 Power Supply. The power supply has been centralized. It is not yet complete but it is expected that all its four gensets will be completed by the end of March 1988. The plant consists of four gensets, two of 250 KVA each and two of 130 KVA each. The plant, which can produce one megawatt, looks overdesigned because at present daily consumption is about 150 kilowatts. No recovery measures have been instituted, so a lot of power is wasted. Even when the power is extended to manyatta, and the water treatment plant works to capacity, there will still be idle capacity.

The management is exploring (1) the possibility of selling and handling the power supply over to Kenya Power and Lighting Company (KPL) and (2) the possibility of transferring it to MOW, which would maintain it and institute recovery of costs from the consumers. At present Bura Management (which uses the vote from MOA), is giving power and water free to staff, police, the health center and administration, thus subsidizing the parties who operate in Bura under different GOK votes. The current budget for operating the power supply was not ascertainable because it falls under several categories, including but not restricted to staff emoluments, the purchase of supplies like diesel, and plant maintenance. The power system has only two attendants to maintain it.

PLANT AND EQUIPMENT

16.01 The procurement of plant and equipment was as prompt as procurement of infrastructure. Present plant and equipment at Bura include:

Item		Number	No of Item In Working Order	Extra Required	Total Required	Shortfall In Operations
1.	Excavators	5	5	3	8	3
2.	Dragline	1	1	0	1	
3.	Dredger	1	1	0	1	0
4.	Wheel loader	1	0	1	2	2
5.	Dozers	0	0	0	0	0
6.	Graders	2	2	2	4	2
7.	Trucks	9	7	3	12	5
8.	Heavy duty compressor	1	1	1	2	1
9.	Water trailer	1	1	1	2	1
10.	Water tanker	1	2	3	3	2
11.	Fuel tanker	1	1	0	1	0
12.	Mobile workshop	1	1	0	1	0
13.	4-WD utility vehicles	27	22	12	0	17
14.	Motorcycles	0	0	0	0	0
15.	Bicycles	52	52	20	72	20
16.	Low loader	1	1	1	1	0
17.	Tractors	20	20	15	35	15
18.	Plow	10	10	5	15	5
19.	Harrows	10	10	5	10	5
20.	Ridgers	9	9	6	14	6

16.02 Shortfalls in equipment (is is estimated that plant and equipment should be increased about 20%) make it difficult to keep agricultural operations and the irrigation network in optimum working order. The last column of the above table indicates the number of each piece of equipment

that needs to be procured. A number of items like the Isuzu trucks (5), the mobile workshop (1) and the Kubota tractors (12) are the only ones of their type in Kenya, so local service backup and spare parts are not available. It is therefore becoming difficult and expensive to keep them in operation. These items will probably not be maintainable for more than another two years. It costs the management about K Sh 5 million to maintain the present complement of equipment. A mobile crane and workshop tools, worth about K Sh 1 million, are needed immediately.

CONCLUSIONS AND RECOMMENDATIONS

17.01 Land tenure changes that will allow tenants to own their plots are needed. Owner-occupants are more likely to maintain their houses and compounds and to plant trees around their plots. This will relieve management of maintenance costs, encourage tenants to maintain their houses and avoid further losses, and enable tenants without houses to build their own houses, thus increasing the stock of tenant houses.

17.02 The structural failure of staff houses and the police station is worsening, a problem which in time is likely to affect also the health center, clubhouse and other buildings. To protect the heavy investment in these facilities, major rehabilitation work is needed.

17.03 It is understood that the service ministries are to take over the maintenance of buildings (MOW); power, treated water, and sewage (MOWD); and roads and the airfield (MOTC). If this happens it will reduce the operating budget of Bura Management, and improve the likelihood of cost recovery from consumers.[1/] However, if the service ministries are underfinanced, maintenance and utilities may not be run optimally, to the detriment of the project. The implications of such a handover should be carefully thought through, and it should be done only if it will work.

1/ It does not appear possible to recover 100% of the cost; particularly for water supplied to tenants.

ANNEX 2

Comparison with the Sudan - Rahad Project

The Bura project shares many characteristics with the Sudan-Rahad Project. Both projects were implemented in the seventies and early eighties (Rahad about four years ahead of Bura) during times of great national economic crisis. Both promote irrigation and settlement under arid conditions with cotton as the main cash crop. The project descriptions feature the same components: river diversion, main canals, irrigation and drainage works, levelling and furrow irrigation, processing and storage facilities, settlement with necessary infrastructure (e.g., roads, water, electricity, health, and education) and agricultural services (research, mechanized cultivation, extension). Some characteristics at project completion are summarized below:

	Bura	Rahad
Area irrigated (ha)	2,500	105,000
Cropping intensity (%)	125	83
Number of settlers	1,923	14,000
Area per settler (ha)	1.3	9.25
Yield of seed cotton (kg/ha)	2,100	2,000
Total project cost (US$ million)	105	396
Actual cost per ha (US$)	42,000	3,750
Actual cost per settler (US$)	55,000	28,000
ERR (%)	Neg	20

A more detailed analysis of the reasons for such differing performance could provide useful insights for future project design.

Land Suitability

The soil conditions and the irrigation suitability in the Lower Tana Region is the subject of a recent dissertation submitted by the Director of the Kenya Soil Survey 1/. The soil characteristics are summarized on the enclosed map. The land suitability evaluation is the assessment of the suitability of land for specific kinds of uses. Six types of uses are assessed for cotton, maize, rice, sugarcane, cowpeas and groundnuts. Each mapping unit (see legend) is rated on the basis of such essential characteristics as:

capacity for water retention
absence of salinity
absence of sodicity
availability of oxygen for root growth
conditions for germination (seed bed)
availabity of nutrients
availability of foothold for roots
workability (ease of tillage)
drainage ability
ease of land clearing
freedom for layout of field plans

The response of each crop to these characteristics is used to determine the land suitability for growing this crop. The following suitability classes were used:

S_1 Highly suitable
S_2 Moderately suitable
S_3 Marginally suitable
NS_1 Provisionally not suitable for sustained production. Limitations may be surmountable with the development of new technology.
NS_2 Permanently not suitable

The results are given in the following table.

1/ F.N. Muchena, Soils and Irrigation of Three Areas of the Lower Tana Region, Kenya (A comparative study of soil conditions and irrigation suitability), Wageningen, 1987.

Land suitability classes for the various LUTs.

Mapping Unit	Area in Hectares	Land utilization type C- irrigated cotton	Land utilization type H- irrigated maize	Land utilization type M- irrigated mixed crops	Land utilization type B- irrigated sugarcane	Land utilization type F- irrigated cowpeas	Land utilization type G- irrigated groundnuts
(a) Bura East area							
Ps1.1	7780	NS2	NS2	NS2	NS2	NS2	NS2
Ps1.2	8400	NS2	NS2	NS2	NS2	NS2	NS2
Ps1.3	1500	NS2	NS2	NS2	NS2	NS2	NS2
Ps2.1	930	S2	S2	S2	S2	S2	S2-S3
Ps2.2	1150	S2	S2-S3	S2	S2	S2-S3	S2-S3
Ps2.3	1310	S2	S3-S3	S2	S2	S2-S3	S2-S3
Ps2.4	3000	S2	S2-S3	S2-S3	S2-S3	S2-S3	S3
Ps2.5	2210	S2-S3	S2-S3	S2-S3	S2-S3	S3	S3
Ps2.6	4080	S3	S3	S2-S3	S3	S3	S3
Ps2.7	2200	S3	S3	S2-S3	S3	S3	S3
Ps2.8	2420	S3	S3	S3	S3	S3	NS1
Ps2.9	13700	NS1	NS2	NS1	NS2	NS2	NS2
Ps2.10	3770	NS1	NS2	NS1	NS2	NS2	NS2
Ps2.11	3260	S3	NS2	NS1	NS2	NS2	NS2
Ps2.12	9750	NS1	NS2	NS1	NS2	NS2	NS2
Ps2.13	2700	NS2	NS2	NS1	NS2	NS2	NS2
Ps2.14	1590	NS2	NS2	NS2	NS2	NS2	NS2
Ps2.15	4960	NS2	NS2	NS2	NS2	NS2	NS2
Ps2.16	570	NS2	NS2	NS2	NS2	NS2	NS2
Ps2.17	1280	S3-NS2	S3-NS2	S3-NS2	S3-NS2	NS2	NS2
Ps3.1	4140	NS2	NS2	NS1	NS2	NS2	NS2
Ps3.2	960	NS2	NS2	NS2	NS2	NS2	NS2
Total	81630						
(b). Bura West area							
Pf1.1	20	NS2	NS2	NS2	NS2	NS2	NS2
Pf1.2	3050	NS2	NS2	NS2	NS2	NS2	NS2
Pf1.3	185	NS2	NS2	NS2	NS2	NS2	NS2
Pf2.1	2845	S2	S2	S2	S2	S2	S2
Pf2.2	2620	S3	S3-NS2	S3-NS2	S3-NS2	S3-NS2	NS2
Pf2.3	1730	S3-NS2	NS2	NS2	NS2	NS2	NS2
Pf2.4	1210	NS2	NS1	NS2	NS2	NS2	NS2
Pf2.5	600	NS2	NS2	NS2	NS2	NS2	NS2
Pf3.1	450	S3	S3-NS2	S3-NS2	S3-NS2	S3-NS2	NS2
Pf3.2	1710	S3	S3-NS2	S3-NS2	S3-NS2	S3-NS2	NS2
Pf3.3	35	NS2	NS2	S3-NS2	S3-NS2	NS2	NS2
A1	485	NS2	NS2	S3 *	NS2	NS2	NS2
Total	14890						
* If the risk of inundation is taken into account this unit would classify as NS2.							
(c). Hola Irrigation Scheme.							
Pt1-I		S2	S3	S2-S3	S3	S3	S3
Pt1-NI	270	S3	S3-NS2	S3-NS2	S3-NS2	S3-NS2	NS2
Pt2-I		S3	S3-NS2	S3-NS2	S3-NS2	S3-NS2	NS2
Pt2-NI	175	S3	NS2	NS2	NS2	NS2	NS2
Pt3-I		S2-S3	S3	S3	S3	S3	S3
Pt3-NI	495	S3	S3-NS2	NS2	NS2	NS2	NS2
Pt4-I		NS2	NS2	NS2	NS2	NS2	NS2
Pt4-NI	50	NS2	NS2	NS2	NS2	NS2	NS2
Pt5-I		S3	S3-NS2	S3-NS2	S3-NS2	S3-NS2	NS2
Pt5-NI	175	NS2	NS2	NS2	NS2	NS2	NS2
Pt6-I		S3	S3	S3	S3	S3	S3
Pt6-NI	40	NS2	NS2	NS2	NS2	NS2	NS2
Pt7-I		S3	S3	S3	S3	S3	S3
Pt7-NI	45	NS2	NS2	NS2	NS2	NS2	NS2
Pt8-I		S2-S3	S3	S3	S3	S3	S3
Pt8-NI	135	S3-NS2	NS2	NS2	NS2	NS2	NS2
Pt9-NI	335	NS2	NS2	NS2	NS2	NS2	NS2
Total	1720						

I - Irrigated
NI - Non-irrigated

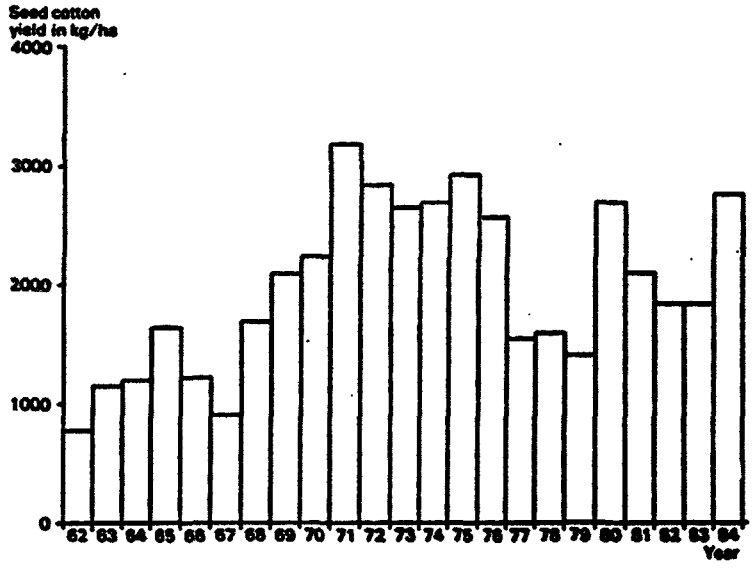


Fig. 18a Average seed cotton yields at Hola Irrigation Scheme (source: National Irrigation Board Annual reports).

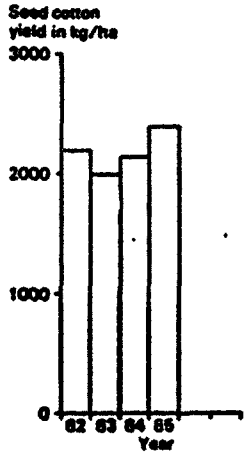
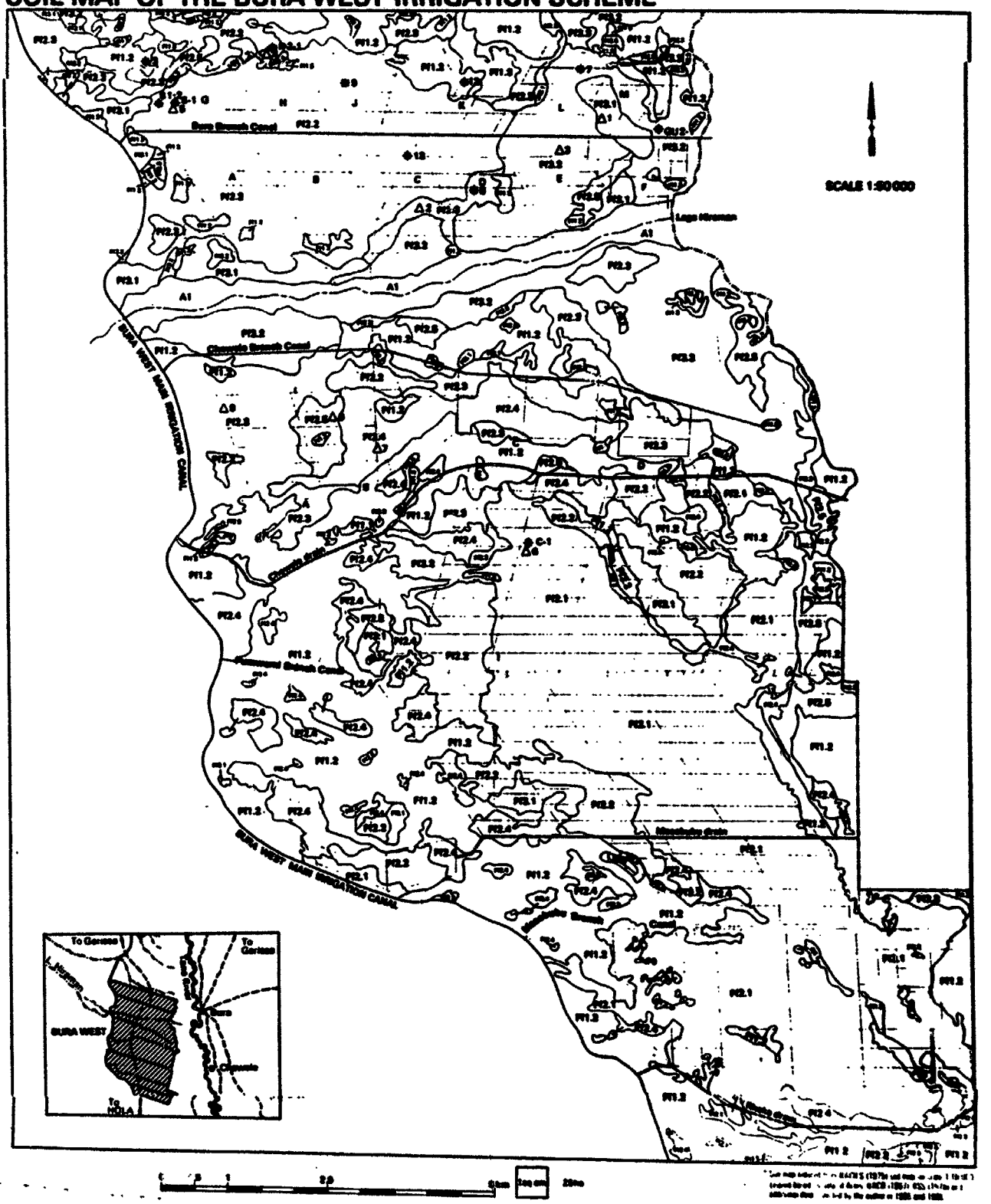


Fig. 18b Average seed cotton yields at Bura West Irrigation Scheme (Source: National Irrigation Board Annual reports)

SOIL MAP OF THE BURA WEST IRRIGATION SCHEME



LEGEND

SYMBOL	GENERAL DESCRIPTION		CALCAREOUSNESS		SALINITY		SODICITY		CLASSIFICATION		
	SUBSOIL	TOPSOIL	NON-CALCAREOUS	CALCAREOUS	NON-SALINE	SALINE	NON-SODIC	SODIC	FAO-UNESCO (1974)	FAO-REVISED (1987)	SOIL TAXONOMY (USDA, 1975)
P PLAINS											
Pf SEDIMENTARY PLAIN OF LARGE ALLUVIAL FANS *All soils are developed on Old Alluvial deposits*											
Pf1 SLIGHTLY HIGH – LYING LAND											
Pf11	well drained to moderately well drained, very deep, brown to dark brown, firm, sandy clay loam to clay with a clear hardpan	50-90cm of dark reddish brown to dark brown, loose sand to sandy loam	0-60cm	>60cm slightly to moderately calcareous	0-70/115cm	>70/115cm slightly to strongly saline	0-50/90cm	>50/90cm moderately to strongly sodic	Orthic SOLONETZ partly saline phase	Haplic SOLONETZ partly salic phase	Typic NATRARGIDS
Pf12	moderately well drained to imperfectly drained, very deep, dark reddish brown to dark brown, firm, sandy clay to clay	15-40cm of dark red to reddish brown, loose sand to sandy clay loam	0-15/40cm	>15/40cm moderately to strongly calcareous	0-15/40cm	>15/40cm strongly saline	0-15/40cm non to slightly sodic	>15-40cm moderately to strongly sodic	Orthic SOLONETZ saline phase	Calcari-haplic SOLONETZ salic phase	Typic NATRARGIDS
Pf13	moderately well drained to imperfectly drained, very deep, dark brown to dark greyish brown, firm, sandy clay to clay	2-15cm of dark red to dark brown, loose to friable, loamy sand to sandy clay loam	0-10/15cm	>10/15cm moderately to strongly calcareous	0-10-15cm	>10/15cm strongly saline	0-10/15cm non to slightly sodic	10-15cm strongly sodic	Orthic SOLONETZ saline phase	Calcari-haplic SOLONETZ salic phase	Typic NATRARGIDS
Pf2 SLIGHTLY LOW—LYING LAND											
Pf21	well drained, very deep, dark reddish brown to dark brown, friable, sandy clay to clay	10-30cm of dark red to reddish brown, friable, sandy clay loam to sandy clay	0-15/50cm	15/50cm slightly to moderately calcareous	0-100/125cm	>100/125cm slightly saline	0-60-125cm	>60-125cm slightly to strongly sodic	Haplic XEROSOLS partly sodic phase	Chromi-calcaric CAMBISOLS partly sodic phase	Typic CAMBORTHIDS
Pf22	well drained, very deep, dark red to dark reddish brown, friable to firm, sandy clay to clay	20-30cm of dark red to reddish brown friable, sandy clay loam to sandy clay	–	moderately to strongly calcareous throughout	0-20/40cm	>20/40cm moderately to strongly saline	0-20-40cm non to slightly sodic	>20-40cm moderately to strongly sodic	Haplic XEROSOLS saline-sodic phase	Chromi calcaric CAMBISOLS salic sodic phase	Typic and Natric CAMBORTHIDS
Pf23	As Pf 2 2	As Pf 2 2 but 10-20cm deep	–	As Pf 2 2	0-10/20cm	>10/20cm moderately to strongly saline	0-10-20cm non to slightly sodic	>10-20cm moderately to strongly sodic	Haplic XEROSOLS saline-sodic phase	Chromi calcaric CAMBISOLS salic sodic phase	Typic and Natric CAMBORTHIDS
Pf24	well drained to moderately well drained, very deep, dark reddish brown, firm clay	15-30cm of dark reddish brown friable, sandy clay loam to sandy clay	0-15/30cm non to slightly calcareous	>15/30cm moderately to strongly calcareous	0-60/70cm	>60/70cm strongly saline	0-15-30cm	>15-30cm strongly sodic	Orthic SOLONETZ saline phase	Calcari-haplic SOLONETZ salic phase	Typic NATRARGIDS
Pf25	well drained to moderately well drained, very deep, reddish brown to dark reddish brown, firm clay	10-15cm of reddish brown to brown, friable, sandy clay loam to sandy clay	0-10/15cm non to slightly calcareous	>10/15cm moderately to strongly calcareous	0-40/50cm	>40/60cm moderately to strongly saline	0-10/15cm	>10/15cm strongly sodic	Orthic SOLONETZ saline phase	Calcari-haplic SOLONETZ salic phase	Typic NATRARGIDS
Pf3 LOW—LYING LAND											
Pf31	moderately well drained to imperfectly drained, very deep, dark reddish brown to dark brown, firm, cracking clay	15-30cm of reddish brown to dark brown, friable, sandy clay to clay	–	strongly calcareous throughout	0-20/60cm	>20/60cm moderately to strongly saline	0-20/30cm	>20/30cm moderately to strongly sodic	Chromic VERTISOLS saline-sodic phase	Chromi-calcic VERTISOLS salic sodic phase	Typic TORRERTS
Pf32	moderately well drained to imperfectly drained, very deep, dark reddish brown, firm to very firm, cracking clay	10-15cm of dark reddish brown, friable, sandy clay to clay	–	strongly calcareous throughout	0-15/30cm	>15/30cm moderately to strongly saline	0-10/15cm	>10-15cm moderately to strongly sodic	Chromic VERTISOLS saline-sodic phase	Chromi-calcic and Chromi haplic VERTISOLS salic sodic phase	Typic TORRERTS
Pf33	imperfectly drained to poorly drained, very deep, dark brown to dark greyish brown, firm to very firm, cracking clay	15-20cm of dark brown, friable sandy clay to clay	–	strongly calcareous throughout	0-50/70cm	>50/70cm moderately to strongly saline	0-15/25cm	>15/25cm strongly sodic	Chromic VERTISOLS saline-sodic phase	Chromi calcic VERTISOLS salic sodic phase	Typic TORRERTS
A FLOODPLAIN (low-lying lands of the Tana Floodplain) *Soils developed on Young Alluvial deposits*											
A1	imperfectly drained, very deep, dark brown to brown, firm to very firm, stratified, cracking clay	15-20cm of dark brown to brown, friable, sandy clay to clay	0-20-30cm non to slightly calcareous	>20-30cm slightly to moderately calcareous	0-70-100cm	>70/100cm slightly to moderately saline	0-20/30cm non to slightly sodic	>20-30cm moderately to strongly sodic	Calcaric FLUVISOLS sodic phase, in places saline phase	Vertic calcaric FLUVISOLS sodic phase, in places salic phase	Vertic TORRIFLUVENTS

KEY TO DEPTH CLASSES

thickness soil in cm	symbol * over rock	symbol * over petro-plinthite	name
0-50			shallow
50-80			moderately deep
80-120			deep
>120			very deep

KEY TO SALINITY CLASSES

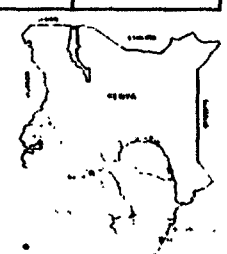
ECe (mmhos/cm)	EC (1:2.5) (mmhos/cm)	salinity classes
0-4	0-0.9	non saline
4-8	0.9-2.0	slightly saline
8-16	2.0-4.0	moderately saline
>16	4.0	strongly saline

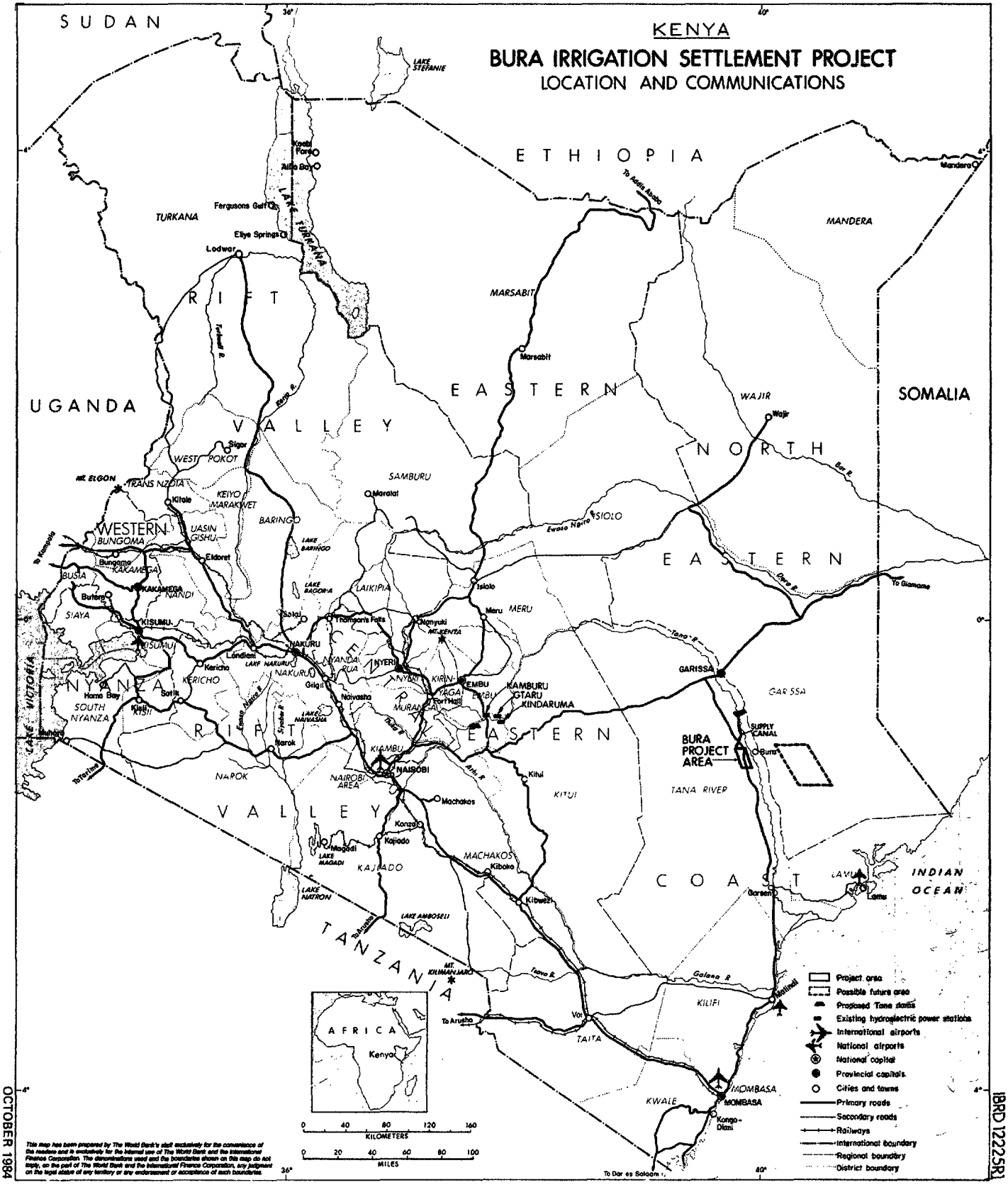
KEY TO SODICITY CLASSES

ESP	CLASS
0-5%	non-sodic
5-10%	slightly sodic
10-15%	moderately sodic
>15%	strongly sodic

KEY

- Pf2 1 — soil mapping symbol
- road
- soil boundary
- boundary of study area
- canal
- river
- drain
- Profile with number
- Sampling area for off data





OCTOBER 1984

IBRD 12225R1

IBRD 12226R1

KENYA

BURA IRRIGATION SETTLEMENT PROJECT

PROJECT FEATURES:

- National Irrigation Scheme Boundary
- Irrigated Area
- Irrigation Canals
- Siphons
- Protection Dikes
- Culverts
- Road Realignment
- Irrigated Afforestation
- Forest Reserves

EXISTING FEATURES:

- State Land / Trust Land Boundary
- Roads with Bridge
- Irrigation Canals
- Seasonal Watercourses
- Old River Bed
- Rivers
- Contours in Meters
- Riverine Forest

STATE LAND

TANA RIVER

MAY 1977

LAINI PUMP STATION

TRUST LAND

TO GARSEN, MALINDI & MOMBASA

MILALULU BLOCK

BURA

TRUST LAND

STATE LAND

TANA RIVER

PROJECT H.Q. TOWN

SUPPLY CANAL

MAIN CANAL

NANIGI DIVERSION STRUCTURE

ACCESS ROAD TO NANIGI

GYPSUM MINING ZONE

TO GARISSA AND NAIROBI

Tula

Galmathi

Bibil

Waiesa

Hiramon

STATE LAND

TRUST LAND

522

1448

1372

1296

1219

1143

1066

991

914

762

610

457

305

152.4

121.8

The boundaries shown on this map do not imply endorsement or acceptance by the World Bank and its affiliates.

0 5 10 KILOMETERS

0 5 MILES

SUDAN

ETHIOPIA

Lake Turkana

UGANDA

SOMALIA

K E N Y A

Lake Victoria

Tana

Garissa

LOCATION OF PROJECT

NAIROBI

ATH

INDIAN OCEAN

TANZANIA

International Boundary

Malindi

Mombasa