REPUBLIC OF KENYA

BURA IRRIGATION SETTLEMENT PROJECT

MID - TERM EVALUATION 1984

DRAFT

NOVEMBER 12, 1984

BURA IRRIGATION AND SETTLEMENT PROJECT
MID-TERM EVALUATION

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SUMMARY AND CONCLUSIONS

i. Following a World Bank appraisal report in 1977 and subsequent planning reports by consultants, the Bura Irrigation Settlement Project commenced construction in 1979. An area of 6,700 ha on the west bank of the lower Tana River was to be settled by over 5,000 tenants in a four year period. This semi-arid area was to be irrigated by water from the river, abstracted in the first years by pumps, and then late by a weir (gravity-fed system). Tenants, settled on plots of 1.3 ha, were constrained to grow only those field crops designated by the project's managing authority, the National Irrigation Board (NIB). The designated crops were cotton, maize and various legumes, which had value either as marketable crops or as food crops for tenants. Settlement on the Bura project was to be supported with a range of infrastructure and services, from treated drinking water, to health care, fuelwood supplies, education, and administrative offices. Special consideration was also to be given to the local Orma pastoralists and the area's wildlife. At full development, the settlement's population was expected to reach 65,000; with this, the primary objectives of resettling of the landless, increasing agricultural output, creating jobs and populating a strategic area of eastern Kenya would have been achieved. Both in design and implementation, the Bura project was a very complex scheme. Not surprisingly, therefore, it ran into trouble at a very early stage.

ii. Prior to the appraisal and launching of the Bura project, the lower Tana River basin had been the subject of a series of irrigation and soil studies, which had often been controversial, but had usually expressed consensus about the poor quality of soils in the area and their doubtful suitability for irrigated agriculture. The feasibility study upon which the World Bank's appraisal report was based had not been able

to confirm suitable soils in the proposed project area. Economies of scale were to be gained, according to the feasibility report, by irrigating about 14,000 ha of the west bank from a fixed weir river offtake. It became apparent to the appraisal mission that soils in the area for this large project had been incorrectly upgraded in quality. Rather than reject the project as formulated on 14,000 ha, the World Bank appraisal mission modified it to a phase I project of 6,700 (the area of comparatively good soils) to be followed, if successful, by a phase II project of a further 6,000 ha (the area of poorer soils). Furthermore, the appraisal mission believed that an additional expanse of good soils was available on the east bank of the Tana, and proposed a pre-feasibility study to further development there.

iii. The paucity of soil information available at appraisal and the subsequent discouraging results of further soil surveys make it clear that the World Bank appraisal report, and the Bura project which evolved from it, were based on inadequate soil and design technical information. Not only were crop yields overestimated at appraisal, but many capital and recurrent costs were underestimated. Indeed, within four months of the issue of the appraisal report, a planning report for the project had reassessed the investment costs at 22 percent more than the appraisal report. Unfortunately, the appraisal report was used as the basis for financing the project, from both government and donor sources. The project therefore began its life seriously underfinanced.

iv. Further planning and design reports followed, during which the river offtake and certain main canal structures were re-designed to cater for the possibility of future west and east bank development. These design changes escalated costs and in the judgement of the donors, undermined the economic and financial viability of the project. Suggestions were made by the donors at this stage (1979) to halt the project, but the suggestions were rejected. In doing so the Kenya government expressed alarm at the rapidly rising cost of the project and made proposals for postponing certain contracts in order to reduce expenditure. However, costs continued to escalate. There was

procrastination and delay in starting work on the river offtake structure, while many of the less complicated elements of infrastructural works went ahead unhindered. Within a short time, it was apparent that the project would be permanently burdened with infrastructure designed to service a population of 65,000 whereas in fact, delays in irrigation and agricultural work suggested that only one half or less of that population would ever actually be settled on the project.

v. From the outset, managerial control of the project was kept firmly in the hands of the NIB officials in Nairobi. At appraisal, reservations had been made over the capacity of NIB to undertake the additional task of management of the Bura project. A recommendation to strengthen NIB by employing appropriate local staff with consultants to oversee project development and the appointing of specialised agricultural management consultants at Bura for at least six years was not carried out in full. The local staff and the consultants for NIB were hired, but the agricultural management consultants were not (except for six months in 1983, rather than six years). Overcentralized management has remained a major area of weakness, delaying the supply of essential materials, including fuel and spare parts, and preventing timely reactions to crises in the field. Delays in the release of funds by the Treasury to NIB have aggravated the already difficult management problems.

vi. Settlers began arriving at Bura in 1981, roughly two years behind schedule. By 1984, approximately 1850 tenants had been settled. The area planted corresponded roughly with the cumulative number of settlers on the project, growing from 200 ha in 1981 to 2,000 ha by 1984. The rate of settlement was about half of the planned rate, and crop yields and production fell short of expectation. Cotton yields averaged about 2.5 t/ha; maize yields about 2 t/ha. Legumes (cowpeas and groundnuts) had not been successfully grown on the project up to 1984. The low yields were partly due to water shortages caused by frequent breakdown of the water pumps, and partly due to poor soils and soil/water relationships. Both settler incomes and NIB's recurrent costs worsened as a result. By

1984, some settlers were earning barely enough to pay for their input costs and many were seriously indebted to the NIB. Surprisingly, desertion rates were not high, by national or international standards, even despite the delayed establishment of health care and the irregular supply of irrigation water.

vii. Rising expenditure forced yet more cuts in the project plans. An early victim was the forestry plan, designed to supply fuelwood and building poles to all settlers within about eight years of establishment. Shortages of wood were threatening the integrity of the unique riverine forest strip which was the home of Malekote and Pokomo people. Ministerial responsibility for water, forestry, and health has delayed some of these infrastructural aspects from being effectively organized. By July 1983, as a result of a review by a special interministerial committee, the project was officially reduced to 3,900 ha, from its original 6,700 ha, because of shortage of funds. The pumping station, which up until then had been a temporary device, pending the completion of a river offtake structure, became the project's permanent water source, with all the uncertainty which that entailed. The government's share of the project's development costs has risen from the initial 20 percent at appraisal to about 40 percent. The need now is for government to agree to proposals for the future of the project.

iiix. The evaluation mission has considered a number of development options for continued development of the project, ignoring sunk costs, and aiming to reduce government expenditure to tolerable levels while maintaining minimum target incomes for tenants on the scheme. In all, five basic options were examined, one of which had three variations. The major difference between the options was the method and scale of water abstraction from the Tana River. Using incremental investment costs for these development options, and conservative yield and production projections based on what has been achieved at Bura up to 1984, present values of total expenditure and economic rates of return were calculated.

ix. One of the options so evaluated was almost the same as the government's revised objective for Bura, namely a project of 3,900 ha with pumped water supply. The mission believes that this option is far from being the least cost option to the government, and should accordingly be reconsidered. Other more attractive options exist, including the participation of commercial farmers on land already prepared for agriculture. The success of all the options considered by the evaluation mission depends categorically on improved management of the scheme, through the appointment of proper consultants to manage it, with an appropriate degree of autonomy, including financial autonomy. All options however will involve a considerable annual subsidy from government, if unacceptably low tenant incomes are to be avoided.

x. The Bura Irrigation Settlement Project, measured against its original concept, can claim little success. The appraisal report was based on inadequate data, and with uncontrolled cost escalations and inappropriate management, the scheme has proved to be a costly venture likely to be of the order of US$30,000 per ha. The evaluation mission has reviewed the history of the project before and after appraisal. Drawing on project experience lessons have been highlighted and options to optimize the benefits from sunk costs and future investment and minimize recurrent costs have been presented. Continuation of the project must be realistic with attainable objectives. These, the mission believes, can only be achieved by the adoption of a range of recommendations which we have included in the text.

I. PROJECT CONCEPT

A. Introduction

1.01 Situated about 200 km north of the mouth of the Tana River, the small east bank village of Bura gives its name to the Bura Irrigation Settlement project. For many years, the local economy was based on small-scale settled agriculture in clearings in the riverine forest and pastoralism in the regions beyond the forest and the flood plain of the river. Apart from the narrow strip of forest and flood plain, this area of the lower Tana River basin is a semi-arid, sparsely populated region which traditionally supports the Orma pastoral nomads. With a carrying capacity of only one livestock unit per 25 ha, and a population density of one person per square km, the region was relatively undisturbed by the development process until the mid-twentieth century. By then, the first hesitant steps were being taken towards irrigated agriculture in the lower Tana basin.

1.02 About 80 percent of Kenya's land area is arid or semi-arid implying that expansion of the nation's agricultural area can only occur through irrigation. The Tana River is the major surface water source of irrigation of any size. Approximately 70 percent of Kenya's identified irrigable area lies in the Tana River basin, and of that, perhaps half is in the lower Tana basin. Since the Second World War Kenya's population has experienced rapid growth which has resulted in increasing pressure on land and a greater incidence of landlessness. Under such conditions, consideration of the development of the lower Tana basin for irrigated agriculture was almost inevitable. An alternative to irrigation in the region may have been the intensification of grazing through improvement of the rain-fed pasture. Although such a development course has not been explored, the probability is that it would have resulted in only marginal improvement to the area's productivity for the benefit of the local pastoralists. It would not have helped to solve the national problem of growing landlessness. Irrigated agriculture on the other hand appeared

to offer significant improvements in productivity as well as space for the growing landless population. With the specific objectives therefore of settling landless, creating employment, increasing agricultural production and saving foreign exchange, stimulating regional development and populating a strategic area of the nation the Bura Irrigation Settlement Project was conceived. The model for its development was the Hola irrigation scheme, 40 km south of Bura, originally established as a pilot program for irrigation of the lower Tana basin.

B. Early Irrigation Development and Reconnaissance Studies

1.03 Interest in the development of the water resources of the Tana River dates back to 1934 when Harris and Sampson published their "Report on the Tana River Expedition". In 1948, the colonial government published a report on two 40,000 ha irrigated projects in the upper Tana basin in the area between Bura and Grand Falls. One year later, a detailed analysis of these projects showed them to be uneconomic due to their remoteness and poor soils. In 1953, a rice project was initiated on the east bank of the Tana near Hola. Four years later, the project was abandoned. In 1956/57, the colonial government started the Hola Pilot Irrigation Scheme consisting of 200 ha on the west bank of the river. Originally intended as a camp for Kikuyu families, the project size is now approximately 850 ha.

1.04 The consultants ILACO (Netherlands) and ACRES (Canada) carried out the lower Tana River basin study from 1963 to 1967. Their report[1/] estimated the irrigation potential of the lower Tana basin based upon resettlement of farmers and others from densely populated areas. They concluded that constructing reservoirs and hydro-power development in the upper Tana basin would make the regulation of flow in the lower Tana possible. A minimum of 100,000 ha would need to be irrigated to achieve an economic rate of return of 10 percent. The consultants analysed the possibility of establishing two alternative projects on the west bank of the lower Tana, both of which were large scale (i.e. 100,000 and 120,000

1/ Survey of the Irrigation Potential of the Lower Tana River Basin, ILACO/ACRES, 8 Volumes, 1967, and revised Vol. 1 published by FAO, 1968.

ha respectively) and which required an average capital investment of KSh 44,800 per ha as a minimum. Implementation was expected to take between 20 to 30 years. Significantly, the economic rate of return would rise to 25 percent if the projects included agro-industry. Although large scale irrigation of the lower Tana was technically feasible, the consultants had doubts about the economic viability of the project, calling it a "marginal economic development . . . with no clear-cut conclusion for or against irrigation of the lower Tana". Among the consultants' main recommendations in 1967 were to create a Tana River Irrigation Authority, to rehabilitate the Hola pilot project, to commence detailed studies of soils, agro-economy and sociology of the region, to construct a research and training center in the area[1/] and to reassess large-scale irrigation settlements within the framework of the national development plan. At least two of these recommendations were actually carried out when Hola was later expanded and given the additional status of a permanent research, demonstration and training center.

1.05 The disappointing results of the lower Tana River basin survey led to an upper Tana River basin survey in 1970/71, funded by the Dutch government and conducted by ILACO. Reporting in 1971[2/], the consultants identified an irrigation potential of 100,000 ha, scattered over the catchment area of the upper Tana. They proposed that this potential could be developed as a series of small-scale projects at lower development costs than in the lower Tana. Higher economic rates of return would be achieved, at 10 to 25 percent, but development of the upper Tana would reduce potential development in the lower Tana by about 30,000 ha because of water shortages. The study's major recommendations were that Kenya should develop the irrigation potential in the upper Tana River basin before it commenced large-scale irrigation in the lower Tana basin; that development in the lower Tana basin should be postponed for 15 years; the National Irrigation Board, the body responsible for over-seeing irrigation development, needed strengthening, or

1/ The area originally recommended by ILACO/ACRES for research and training eventually became the first of their feasibility studies (1971).

2/ Upper Tana Catchment Survey, ILACO, 1971.

alternatively a special Tana River Authority should be established; and that a master plan for the whole of the Tana basin was needed and feasibility studies must be the basis for selecting suitable projects. With this last recommendation, two feasibility studies were commissioned in 1971, namely the upper Tana (Masinga) study and the first Bura study, covering an area of 4,000 ha in the lower Tana (later extended to 14,560 ha in a second Bura study). Both studies were again financed by the Netherlands and undertaken by ILACO. The Bura studies conducted by ILACO are of particular relevance to evaluation of the Bura irrigation project which ultimately materialised, and will be reviewed below. A number of comments however on the ILACO surveys of the lower and upper Tana basins can be made at this stage, by way of summary.

1.06 The overall scale of a 100,000 ha or more development over a 30 year period for the irrigation projects proposed was clearly unrealistic given the consultant's reservations about the available institutional and managerial capacity to implement such projects. Projects costs were extraordinarily high and would have absorbed the whole of the Ministry of Agriculture's development budget for 40 years, if the projects had been implemented. Doubts about soil suitability in the lower Tana reinforced ILACO's conclusion that irrigated settlement in the region would be only marginally beneficial. Although a master plan for the irrigation development of the Tana basin was recommended, and would presumably have given consideration to all these points, such a plan was never realised.

C. The Bura Irrigation Feasibility Studies

1.07 ILACO presented the first of its two Bura feasibility studies in 1973. The proposal in the first study was to irrigate 4,000 ha and to settle over 3,000 tenants on 1.2 ha each. Cotton and groundnuts were the favored crops, giving a cropping intensity of 140 percent in the opening years, rising to 180 percent after 15 years. On the basis of information in their 1967 report, ILACO classified the project area's soils as 750 ha class I (very suitable), 1,800 ha class II (suitable) and 1,450 ha class III (moderately suitable). Pedologists in Kenya were known to have

serious doubts about class III soils, and their inclusion in this 4,000 ha project was questionable. Other criticisms of the project as proposed centered around the crops chosen. At the time, it was believed that sugar cane should have been considered as an alternative crop. The investment per ha required for the project was lower than that indicated in ILACO's 1967 report, but only after excluding infrastructural costs such as education, health, road improvements, housing etc. In view of this understated investment cost, the reported economic rate of return of 13.5 percent was clearly optimistic.

1.08 In 1973 ILACO was asked to extend their study to 14,000 ha. In seeking further Dutch funding for this study, the Ministry of Agriculture argued that new irrigation projects would assist in ameliorating unemployment problems. The Ministry admitted that progress of irrigation development proposals elsewhere in Kenya (Yala, Masinga, Kano Plains) had been disappointing in the short-term, but that encouraging results at Hola, the inclusion of more class I and class II soils at Bura and the admission that the 4,000 ha of the first Bura study were not selected on soil quality alone[1/] justified a new study. With better soils in an enlarged area, greater yields could be expected. An enlarged area would mean lower capital costs per ha. The combined result would be an improved economic rate of return.

1.09 The second Bura feasibility study, covering an extended area, was commenced in 1974 by ILACO. Their final report on the study was issued in June 1975. This report forms the base of the Bura Irrigation

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1/ The soils were originally selected for research purposes as representative of the area.

Settlement project which eventually materialised. The Netherlands' government agreed to fund the second study only if there was support for the project should it be feasible. It was at this point that the World Bank became involved in the Bura project

1.10 After consultation[1/], the World Bank considered that the soil information used in the 1973 report, taken from the ILACO/ACRES report of 1967, was insufficient for a project of extended scale. Further soil investigations were requested and were duly written into the terms of reference for the extended Bura study. By the end of 1974, the first results of the soil surveys became available. Soil suitability was worse than expected. A decision to continue the project had to be made at that point. It was accepted that the actual performance of similar soils at Hola had given encouraging results and that agricultural production did not depend solely on soils -- good management for example could compensate for soil deficiencies. It was therefore decided that the project should continue provided that further soil surveys south of the Laga Hirama produced better results. The feasibility study was published before the soil survey was completed. The study gave only tentative estimates of project soil suitability, which were class I, 3,450 ha, class II 8,040 ha and class III 3,090 ha. Thus 21 percent of soils appeared to be of class III.

1.11 In their report, ILACO contended that irrigation of an extended area of 14,000 ha was only feasible if water supply was secured through a weir. Project investment costs consequently rose from KSh 13,600 per ha (in ILACO's 1973 study, which assumed a gravity intake supply of water) to KSh 23,850 per ha after including the costs of a ginnery, road improvements, consultancy services and social and institutional infrastructure. Implementation of ILACO's proposals would take 11.5 years and would produce an economic rate of return of about 16 percent. With special powers granted to the implementing authority through a supra-ministerial body under the Office of the President, the project could be constructed in 6.5 years, giving an improvement in the economic rate of return. The project would settle nearly 11,000 families at an investment cost of KSh 32,000 per family. Family income on the

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1/ Source: IBRD internal memorandum from J. K. Coulter, August 5, 1974.

project would commence at about KSh 4,200 a year and rise to KSh 6,250 a year with increases in cropping intensity.

1.12 Despite the evident doubt that existed about the suitability of soils in a large proportion of the project area, the ILACO feasibility report of 1975 was optimistic. It was the substance of this report which was used during the following 18 months of appraisal and reformulation.

D. Project Evolution from Appraisal and Planning Reports

1.13 Soon after the publication in 1975 of the ILACO feasibility report on the extended Bura project, the Kenya government presented a project proposal to the World Bank, based on ILACO's report, using the short duration implementation of 6 1/2 years. An appraisal mission from the World Bank visited Kenya in November 1975. Eighteen months later, i.e. in May 1977, their final appraisal report was issued.[1/]

1.14 The results of the soil survey received in late 1975 cast doubts on the viability of a 14,000 ha project because the soils south of the Laga Hirama proved to be worse than had been anticipated. In order to retain a 14,000 ha project, ILACO had reduced the original criterion of a problem-free top soil (the A horizon) was reduced from 20 cm to 18 cm to 15 cm and finally to 10 cm. With this reclassification 20 percent of the project area with top soils of between 10 and 15 cm were upgraded to class IV and a further 30 percent with top soils of between 15 and 20 cm were upgraded to class III. The Kenya Soil Survey and the World Bank appraisal mission could not agree with this new soil classification and ILACO undertook a comparative study of soils at Hola, to judge the performance of shallow soils. However, from the evidence of only two years cultivation of shallow soils at Hola, no conclusion about Bura soils could be reached. At this point in the appraisal, there were probably sufficient grounds to declare the proposed project unacceptable.

1/ Source: World Bank Appraisal Report, May 1977, Annex 2.

1.15 This did not happen. With the proposal on the verge of collapse, the appraisal mission made a rapid assessment of suitable soils to see whether or not a different project could be formulated. About 4,500 ha of suitable soils were identified which enclosed about 2,000 ha of shallow soils. Of the 4,500 ha of suitable soils, 48 percent were included as class I[1/]. According to the United States Bureau of Reclamation, class I soils are highly suitable if there are no limitations. ILACO considered class I soils highly suitable if the non-saline, non-alkali top soil (A horizon plus a portion of the B horizon) had a thickness of 20 cm or more[2/]. According to the Kenya Soil Survey however, there were no class I soils on the Bura west project area, since all soil units there have serious limitations due to their sodic subsoils[3/]. The 4,500 ha of suitable soils and the 2,100 ha of shallow soils were combined and a first phase project of 6,700 ha evolved. If results on the shallow soils proved to be favorable, then a second phase project of a further 6,000 ha of mainly shallow soils (class III and class IV) could be developed. In essence, phase I if successful would justify the development of phase II. Other factors such as the availability of financial resources for the project and the desirability of a short implementation period also supported the project's reduced scale, from 14,000 ha to 6,700 ha in its first phase. The World Bank appraisal mission, as well as devising phases I and II for the Bura project, also introduced for the first time a stage II, which was irrigation development on the east bank of the Tana. Although the appraisal report proposed an east bank pre-feasibility study, conducted by the government and assisted by consultants, the proposal was based entirely on an optimistic and erroneous interpretation of a 1974 exploratory survey carried out by the Kenya Soil Survey (KSS). While the appraisal report speaks of a "reconnaissance survey" (Appraisal Report, Annex 2) and of a "preliminary reconnaissance soil study", the KSS exploratory survey only states that "...it appears that approximately 60,000 ha of moderately suitable soils" are available at 28 km east of

1/ Source: IBRD, Bura Appraisal Report 1977.
2/ Source: Bura Appraisal Report Annex II page 4.
3/ Source: Personal communication, Kenya Soil Survey, November, 1984

the village of Bura. To provide information required for final design of the weir at Nanigi, the proposed east bank study would need to be completed by October 1978. Before investment decisions were considered for a stage II development, the study would have to be updated to full feasibility standard (Appraisal Report, section 4.45). The introduction of this feasibility study and a proposed stage II ultimately had significant repercussions on the concept of the Bura project and the design of the river water abstraction.

1.16 The Bura Irrigation Settlement project which emerged from the World Bank's appraisal report of May 1977 envisaged the irrigation and settlement of 6,700 ha on the west bank of the Tana River. The required studies of the east bank and the reallocation and redesign of the river works would cause delay in the supply of gravity-fed water so a pump station was introduced to temporarily secure the water supply for a period of two to three years pending the construction of a weir or barrage. Over a five year period, 5,150 families were to be settled in 23 villages. Physical and social infrastructure would be provided for settler and satellite population of 65,000 within seven years. All was to be supported from the agricultural production based on cotton, maize, groundnuts, other legumes and vegetables. The total investment cost of the project was estimated at KSh 766 millions (US$91.7 m) or KSh 114,300 (US$13,700) per ha. By the standards prevailing in 1977, the Bura project was one of the most expensive irrigation and settlement projects in the world. The economic rate of return was calculated at 13 percent. Unfortunately, the appraisal report was not the last word on project costs or rates of return.

1.17 Before the publication of the appraisal report, the NIB had sought the services of consultants through special tender, to prepare

an implementation report on the Bura project with the specific objectives of reviewing the ILACO 1975 study, reformulating the project at a reduced scale and providing essential data for the appraisal report. A consortium led by Sir M. MacDonald and Partners of the United Kingdom was awarded this consultancy contract, and their Project Planning Report was issued in August 1977, about two months after the issue of the World Bank's appraisal report. The consortium's Project Planning Report (PPR) doubted the feasibility of developing the phase II area on the west bank but like the World Bank, was optimistic about stage II on the east bank. The ILACO-designed and tested weir[1/] proposed in the World Bank's appraisal report was considered inadequate for supplying water to both the west and the east banks. MacDonald therefore redesigned the river offtake structure. Though regular consultations were held between the World Bank and the consortium, the PPR showed an increase of investment costs of 22 percent over the appraisal report, due mainly to greater expenditure on consultancy fees and irrigation works. Within three months therefore, the estimated cost of the project had risen from KSh 766 million to KSh 936 million (US$112.1m) and the Kenyan government contribution to project investment had risen from about 21 percent to about 30 percent.

1.18 As well as increasing the project costs by 22 percent, the PPR had estimated project benefits to be marginally lower than those appearing in the appraisal report. The expectation would therefore be a lower economic rate of return on the project, compared to the 13 percent postulated in the appraisal report. However, when calculated on a similar basis to the appraisal report, the PPR had exactly the same economic rate of return of 13 percent. In this calculation the investment costs excluded selected portions of the costs of river diversion works and main canal works attributable to future east bank development and future phase II west bank development. By claiming that the river offtake works would ultimately serve 37,000 ha on both east and west banks, only those costs of river offtake attributable to 6,700 ha

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1/ Tested in 1975 in Delft Hydraulics Laboratory.

(i.e. 18 percent) were applied to the rate of return calculation. Similarly, the main canal on the west bank would ultimately serve 12,000 ha after completion of phase II. The costs of that canal applicable to the rate of return calculation were therefore be only 56 percent (i.e. 6700/12000).

1.19 There is no methodological justification to this method of calculating the economic rate of return. When in due course either the phase II project or the east bank stage II project came to be designed and appraised, those appraisals could, and probably would, exclude all sunk costs from their calculation of rates of return. By then, the river offtake works and the west bank main canal would be indisputably sunk costs. By excluding part of the present investment costs from the present rate of return calculation, they are thus excluded forever. In the absence of information which would allow estimation of the full costs and benefits of phase II and stage II development, it would seem prudent to include the full costs of water offtake works and main canal construction in the rate of return calculation shown in the Project Planning Report. Using the information given in that report to adjust the economic rate of return to correspond with the comments above, the adjusted economic rate of return for the project as described in the Project Planning Report is under 10 percent.

1.20 These fundamental changes in project costs and acceptability in the Project Planning Report came too late to influence funding agreements prepared and signed in June 1977 between the World Bank and the Kenya government. The agreements were based on the costs described in the World Bank appraisal report of May 1977. In effect, the Bura Irrigation Settlement project began its life seriously under-funded for the scale of project contemplated. By designing the project as they did, MacDonald & Partners linked its economic success with future possible developments not only on the west bank but the east bank as well. As so little was known about soils on the east bank and so much doubt had been expressed about the phase II soils on the west bank, a very high degree of uncertainty must have attached to the future developments on which the expanded project was based.

1.21 Table 1.1 below traces the evolution of selected project figures, from the ILACO 1975 feasibility report to the Project Planning Report of 1977. Most significantly, total investment per ha increased nearly sixfold

Table 1.1 Selected Unit Cost Measurements from Bura Project Reports 1975 - 1977

		ILACO 1975	IBRD 1977	MacDonald PPR 1977
Area proposed	ha	14,560	6,700	6,700
Investment per ha	KSh	23,850	114,300	139,700
	US$	3,400	13,700	16,700
Total Settler Families		10,785	5,150	5,150
Investment per family	KSh	32,200	148,680	181,700
	US$	4,500	17,800	21,800
Economic rate of return		16%	13%	13% (before adjustment)

Source: Bura Irrigation Scheme Feasibility Study ILACO, June 1975; Kenya: Bura Irrigation Settlement Project Appraisal Report; World Bank, May 1977; Bura Irrigation Settlement Project, Project Planning Report, Sir M. MacDonald & Partners, August 1977.

during the interval between these reports, from KSh 23,850 to KSh 139,700 (US$3,400 to US$16,800). Investment per settler family increased at a similar rate, from KSh 32,200 to KSh 181,700 (US$4,500 to US$21,800).

E. Role of Agricuture and Infrastructure

1.22 The Bura Irrigation Settlement project cultivates and populates a semi-arid region. The project designers had to propose crops which would not only feed and fuel the settler and satellite population, but also raise enough revenue to pay for the many services and inputs which were necessary. Among those services were housing, water, health, education, communication and energy, for without them there would be difficulty in attracting settlers to the project.

F. Agriculture

1.23 All three reports from which the Bura scheme evolved are in broad agreement about objectives. They are to increase agricultural production and

to create employment opportunities. Differences occur in the reports in the way these objectives can best be achieved. All the reports agree that cotton should be the main cash crop, grown between February and October, and that other field crops such as maize, groundnuts and cowpeas should be grown on some of the area after cotton.

1.24 Settlers were to be allocated yearly tenancies on land totalling 1.3 ha, of which 1.25 ha were for field crops and 0.05 ha for garden vegetables. High levels of production were to be achieved through fully mechanised soil preparation, adequate and timely supply of all inputs including water, credit facilities, agricultural research (which would include extending the range of high value crops to improve farmer incomes), extension services, marketing services and the inclusion of stall-fed animals in the farming system. Tenant activity on field crops was to be confined to hand sowing, irrigating every 14 days, weeding and harrowing.

1.25 Yield estimates of all crops were based on experience at Hola. Seed cotton yields were expected to start at 2.5 t/ha and increase steadily to 2.9t/ha by the fifth year. Maize yields were expected to increase even faster, from an initial 2 t/ha to 3.4t/ha by the fifth year. Cowpeas and groundnuts respectively, were to rise from an initial 0.5 and 1.4t/ha to 0.9 and 2.0 t/ha by the fifth year.

1.26 Total area covered by these crops was to be dependent on the rate of settlement and the cropping intensity. The appraisal report envisaged settlement over four years culminating in 5,150 settlers by 1982 (see Table 1.2). The PPR proposed a cropping intensity of 148 percent. Using the settlement and area development given in Table 2, seed cotton production over the first four years of the project would have commenced at about 2,000 tonnes and would have risen to 18,700 tonnes by the fourth year. By the same token, maize production would be about 400 tonnes by the first year and would rise to about 4,000 tonnes by the fourth year.

Table 1.2 Rate of Settlement and Net Area Development

Year	Number of Tenants		Net Area Developed (ha)	
	in Year	Cumulative	in Year	Cumulative
1979/80	1,125	1,125	875	875
80/81	1,800	2,925	2,035	2,910
81/82	1,800	4,725	2,625	5,535
82/83	425	5,250	1,165	6,700

Source: Kenya: Bura Irrigation Settlement Project Appraisal Report, World Bank, 1977.

1.27 Given the serious doubts about the quality of soils on the phase I area, the maize yields in particular appear to be optimistic, especially as a well-suited variety had not been identified at the time of project appraisal. Farmers unfortunate enough to have their 1.25 ha field plots situated on doubtful soils would be hard pressed to achieve subsistence and surplus grain which was needed to bring family target income to the KSh 5,000 to KSh 6,000 of the appraisal and planning reports.

1.28 The $500m^2$ of irrigated garden allocated to each tenant family was intended to be the source of fresh vegetables for consumption by the family or for sale. Other than watering, the garden was not to be subject to the same strict regime of fixed crops which applied to the field crop area. Although the appraisal and planning reports disagreed on garden crop yields and prices, there was consensus on the value of the facility.

1.29 Tenant farm inputs for field crops were to be supplied by the project's managing authority, namely the National Irrigation Board (NIB). Seeds, fertilisers, pesticide sprays, mechanical cultivation and collection of produce after harvest, and of course water, were all to be under the control of NIB, to whom the tenant would pay directly for these services. Mechanical cultivation and water charges were to come under a standard land

and water charge of KSh 2,800/ha. As a tenant, the farmer would perform the few functions which were expected of him (i.e. irrigation, sowing, weeding and harvesting) to maximise his income. Provided all inputs were supplied on time, the farmer appeared to have an incentive. Good management of inputs by NIB could contribute as much as, if not more than, the labor of the tenant farmer, towards crop productivity. Conversely, bad management by NIB would significantly reduce crop productivity, but the tenant farmer would bear the full cost of that reduction, i.e. lower yields and lower gross income which would not be matched by lower costs. NIB's ability to charge for inputs regardless of timely delivery may therefore promote inefficiency. The flat rate land and water charge particularly could have been linked to production, so that NIB shared some of the burden of poor input management.

G. Forestry (see Forestry and Fuelwood Annex for further details)

1.30 Settlers require fuel as well as food. The first four year's supplies of fuel were to be met from the cleared brushwood accumulated during project construction. Subsequent supplies were to be met from a designated forest area to the southeast of the project until supplies from the scheme's own planted forest came on stream. Three existing blocks of riverine forest were to be strictly conserved through gazettement while 3,900 ha net of forest plantation were established on the periphery of the project. This forest plantation was expected to yield 15m^3/ha annual increment of solid wood, to be clear felled and replanted every 7 years, with two coppicings[1/] before that. A minimum of irrigation would be provided (between 600 mm to 980mm) from residual water after meeting agricultural needs. A nursery for establishing seedlings for the

1/ Regrowth after felling from shoots or root suckers.

plantation would be set up. To improve the rather desolate village landscape, shade and amenity trees were to be established near settler houses. The forestry program included a research element to determine the most suitable species of trees for plantation and village. The plantation would reach full production eight years after planting. The forestry plantation would be established at a capital cost of about KSh 8,000/ha with recurrent and capital costs being met from plantation revenue once the forest was productive. Although pumped water was expected to be used during the opening years of the plantation, the marginal cost of this water would not be a significant burden to the forestry program.

H. Services and Infrastructure

1.31 Up to the formulation and implementation of the Bura project, no public services of any kind existed in the project area. Public health, clean water supply, tenant housing, education and administration were to be provided within the scope of the project.

1.32 Public health would pose a formidable problem. Based on experience at Hola, malaria, urinary schistosomiasis, intestinal schistosomiasis and tuberculosis would emerge as prominent causes of morbidity, aggravated and complicated by possible dietary deficiencies and differing degrees of tenant immunity in the opening years. Action to promote public health was seen in three phases: protection of construction workers and early settlers, minimising the introduction of diseases to new settlers and the introduction of a basic health service providing preventive, promotive and curative care to the project and surrounding indigenous population. A health center would be provided at the project headquarters (rural center), three health sub-centers would be provided at "market center" villages, and village health units would be provided in all other villages. Particular attention would be paid to location of villages so that they were sited away from canals and possible sources of disease vectors. House latrines would be designed to minimise mosquito and other insect infestations.

1.33 A central water treatment works at the rural center with 48 hours storage capacity would distribute treated drinking water by gravity to

villages. Two showers and two taps with washing slabs would be provided for every twelve tenant houses, while in the rural center, each house would have its own water connection. A full water-borne sewage system would operate in the rural center, because of its higher population densities.

1.34 The high proportion of young children expected in the project would necessitate one primary school per village and two primary schools at the rural center. In addition, a secondary school would also be constructed. In all, therefore, 26 schools would be established on the project. The village schools would be constructed through "harambee" self-help programs, as would village houses.

1.35 While newly arrived tenants constructed their own houses and schools, they would initially be housed in accommodation provided by the project management. They would then return home to bring their families to Bura. Three prototype tenant houses were originally constructed at Hola, using mud and wattle or mud and bricks. This experience indicated that similar building materials used in a harambee construction program at Bura would result in low cost for village buildings (KSh 4,000 per tenant house, principally for materials). The project management was then expected to recover the cost of each house from the tenant over a ten year period.

1.36 Certain administrative officers would be established in the rural center. A senior district officer with an administrative assistant would reside in the center, while village committees and a local council would service the settler and other population. A police post was also included, as were post and telegraph services, Ministry of Labor offices, agricultural extension services and co-operative extension services.

1.37 Other infrastructure features included 188 km of road improvements and 36 km of realignment of the main Garissa-Garsen road, 480 km of internal roads and 22 km of roads leading to the river offtake. Rural center cotton ginnery and workshops were to be supplied with electricity generated by a 2000 KVA unit. The cotton ginnery, run possibly on a cooperative basis, was to be located on the project to process seed cotton production.

1.38 The project design recognized the needs of the wildlife and the Orma livestock in the area. Watering pools were to be constructed at convenient intervals along the main canal and ecological studies were included to determine the project's effect on aquatic and terrestial ecological systems. To some extent, surplus crop residues from the project were also expected to provide animal feed for the Orma pastoralists.

I. Management

1.39 Overall responsibility for carrying out this complex and difficult project was to rest with the National Irrigation Board (NIB). A Bura Project Coordinator's Office was to be set up within the NIB to coordinate the activities of the various ministries and agencies involved in the project and execute its implementation. Because its experience and implementation capacity were limited, NIB had to be strengthened in a number of areas. Additional staff, where necessary, were to be employed. A group of consultants was to be retained to complete the design of the project, while a second group of consultants was to be employed to manage the agricultural production for a period of not less than six years. During this process, Kenyan counterpart staff were to be trained. As already discussed, the NIB was to supply agricultural inputs to settler farmers. It would also purchase farmer's crops, including seed cotton. After ginning in the project's ginnery, the NIB would market cotton lint and seed through the Cotton Lint and Seed Marketing Board.

1.40 With the help of the Ministry of Lands and Settlement and the Ministry of Local Government, the NIB would establish a settlement section to make the final selection of tenants for the scheme. Settlement committees in each district would make preliminary selection of tenants on the basis of three criteria, i.e. district population and the land area, opportunities for alternative employment and adaptability of candidates to Bura's agricultural activities. Throughout selection, there would be a preference for people from the Tana River catchment area. Unemployed or underemployed, landless families were to be sought who could supply the equivalent of four adults for family farm labor. Heads of households were

to be between the ages of 25 - 45, of good character, fit, and socially acceptable. A migration officer under the project coordinator's office was to organize the actual transport and selected tenants, according to a phased programm over a 3 1/2 year period. The ultimate mix of tribal groups in villages was to be determined after a sociological survey, as this was known to be an issue where social difficulties might arise. Similarly, acknowledgement was also made of possible social difficulties if women were neglected in the distribution of family income. The sociological survey would cover this difficult area.

J. Observations on the Bura Project Concept

1.41 This chapter so far has attempted to trace the process through which the Bura project was identified and ultimately defined. Because the project proposes nothing less than the colonisation of a semi-arid sparsely populated region, it must rank as a great pioneering project. However, unlike many pioneering projects, considerable resources had been expended on reducing some of the uncertainty which surrounded the venture. In particular, soil surveys in the area had shown even before project appraisal that soils on the west bank of the Tana were of low quality making it uncertain whether they could support high levels of agricultural production. As agriculture lay at the base of the project, the rest of the project's structure was only as strong as the agricultural performance and management on which it rested.

1.42 Critical conceptual decisions were made in 1975 and 1977, after the ILACO feasibility study had been issued and during the course of the World Bank appraisal mission, when soil surveys indicated that land suitable for the project was much less than was at first thought. ILACO had claimed throughout their studies in the lower Tana basin that only large scale irrigation projects could justify the high cost of river diversion and canal construction. As the area of suitable land on the west bank of the Tana began to diminish, the prospect of the Bura project having economies of scale also began to shrink.

1.43 The hope that the project could ultimately gain these economies of scale by expanding to the east bank in due course was founded on very little information about soil conditions there. Nevertheless, in the belief that economies of scale lay in that direction, the Project Planning Report substituted a more expensive investment plan than that of the appraisal report to eventually exploit the development options on the east bank. With the benefit of hindsight, this decision can now be questioned. Alternatives existed which were either rejected or not considered at the time. One such alternative was to employ a gravity feed system for the west bank only. When development on the east bank became feasible, an appropriate river offtake could then have been designed, depending on the size of that development.

1.44 Given that there were doubts about a large proportion of the soils on the west bank, the appraisal and PPR should have proposed a new feasibility study covering the enlarged concept of development on both east and west banks. Failing that, these reports should have suggested priorities for certain major works, with agricultural development given first priority and infrastructural development, appropriately scaled to meet actual project requirements, given lower priority. Until water supplies were secured and the soil performance was known, interim arrangements should have been made for clean water distribution, rural center sewage and electricity, cotton collection centers and project roads.

1.45 Although reservations were expressed by ILACO in their Bura project feasibility study and again by the World Bank in the appraisal report about the capacity of NIB to carry out the Bura Irrigation project in all its complexity, no consideration was given in the appraisal report to a longer period of implementation. By performing the work more slowly, NIB would have had a better chance to learn of the problems and to seek lasting solutions. Supporting services would have been given a better opportunity to grow only as the project grew and only as the demand for those services increased with settler and satellite population. The economic and financial criteria for projects are usually improved if implementation is completed in as short a time as possible.

II Project Implementation

A. Engineering Design Modification

2.01 In accordance with the World Bank's appraisal report of 1977, the National Irrigation Board and Sir M. MacDonald & Partners (and associated firms[1/]) were to enter into an agreement to complete the design and to supervise construction of river works structures immediately after the loan and credit agreements between the Kenya government and the World Bank had been signed. These agreements were signed in June 1977 and about 10 months later, MacDonald and the NIB formalised an agreement on consulting services. The design reports issued by MacDonald[2/] during the first three months of 1979 featured significant changes to the engineering proposals which had been the basis of the appraisal and planning reports.

2.02 In their Project Planning Report, and in subsequent discussions with the World Bank and ILACO, MacDonald & Partners had made it clear that they had reservations about the ILACO-proposed weir and the structures on the supply and main canals. They advised that the arrangement of a fixed weir was a relatively economical means of diverting water for irrigation on the west bank only, but that it was unsatisfactory for the diversion of irrigation water to the east bank. Although major modifications to the structures on the supply and main canals were required, in MacDonald's view, they would not have a significant effect on the cost of the irrigation works and need not delay implementation[3/]. Events proved differently.

1/ The associated firms were Hunting Technical Services Ltd. of UK, and East African Engineering Consultants, of Kenya. References in this chapter to Sir M. MacDonald refer to the consortium.

2/ (a) Design criteria, Irrigation and Drainage Works, March, 1979
(b) River Diversion Works, Interim Design report, January, 1979

3/ Report on Review of designs for the Bura West Irrigation Sytem, Sir M. MacDonald & Partners, March 1979, and River Diversion Works, Interim Design Report;
Sir M. MacDonald & Partners, January 1979.

not called upon after submission of PPR!

2.03 During the preparation of the final design and the tender documents in late 1978, major design modifications occurred: a barrage instead of the original weir, increased capacity of the main canal on the west bank requiring a 44 percent increase in the volume of earth to be moved, and inverted siphons replacing the raised canal structures which originally were to carry canal water over the principal lagas traversing the project area. These and other physical changes escalated costs. Hydraulic structures costs, for example, increased by 177 percent in the interval between the issue of the appraisal report (May 1977) and September 1979. Other examples of cost increases brought about largely by design modifications are shown in Table 2.1.

Table 2.1 Engineering Cost Changes (Selected Items) 1977 - 1979

	Costs including Physical and Price Contingencies (KSh '000,000)	
	Appraisal Report May 1977	First Progress Report March 1979
Temporary river water pumps	6.28	15.96
Supply Canal Structures	10.68	29.16
Main Canal Structure	4.78	22.45
Irrigation Network	42.71	117.43
Drinking Ponds	-	3.74
Total	64.45	188.74

Source: Kenya: Bura Irrigation Project Appraisal Report, IBRD, 1977; First Six Months Progress Report, NIB, September 1979.

2.04 Before publication of the contract tenders in March 1979, the World Bank was informed of the likely increases in engineering costs. Their supervision mission in April 1979 was given further details of design and cost changes. The October 1979 World Bank supervision mission included an irrigation engineer, which allowed full discussions of the new designs with MacDonald's representatives in both Cambridge, England, and Bura. That both ILACO and MacDonald designs were based on sound engineering principles was not in doubt; if anything, the former design was too light while the latter was too heavy. Rejection of the new designs by the World Bank would have resulted in further delay whereas acceptance would expedite the project and would offer the advantage of

r maintenance costs when completed. The World Bank accepted the new gns. By late 1979, the total base cost of the project as a whole luding the physical and price contingencies) had increased by 59 ent in real terms over the costs described in the appraisal report e Appendix 2). The sensitivity analysis in that report showed that if rall costs rose by 10 percent, the economic rate of return would line by 1 1/2 percentage points. By the end of 1979 therefore, the nomic rate of return had probably fallen by about 9 percentage points ing it no more than about 4 percent.

5 The economic viability of the project at this stage had thus ost disappeared. Donor concern about the situation resulted in a ter to the Kenya government asking if they were still interested in tinuing the project. The Kenya government confirmed that they were. World Bank itself had recognized in July 1979 that the project was bably no longer economically or financially viable[1/]. As well as very low economic rate of return promised by the project, the thdrawal of one of the original donors (contribution KSh 71 m) meant at the gap between total project investment and external finance became o large for the Kenyan budget. The government rejected the World nk's proposal to abandon the project in July 1979, but attempted to duce project costs by postponing the river diversion works, reducing e forestry component to 600 ha (from 3,900 ha net) and reducing the antity of staff houses and scheme roads.

06 In retrospect, it is unfortunate that the donors did not pursue is further. By mid-1979, contracts for river and irrigation works as ll as infrastructural works were still in the process of being let or re in the early stages of construction. Reducing quantity and quality houses and roads as a means of reducing costs was probably correct, t to postpone (and later to delete from phase I) the river diversion rks was to undermine the foundation on which the project was built. ther less essential infrastructural works, if possible, should have been educed or postponed, such as the large-scale water purification plant, tton collection centers and the water-borne sewage system. By

1/ Letter to Permanent Secretary, Ministry of Finance, from World Bank, July 1979.

postponing the river diversion works, too much reliance was placed on the temporary pumping station for too long a time. The MacDonald-designed barrage was undoubtedly expensive, but it appears that cheaper alternative solutions such as a direct river offtake structure serving only the west bank were not reconsidered at this stage. The government's determination to continue the project despite the adverse financial and economic circumstances is understandable, given the very strong political motivation to help the landless and unemployed. Closure would have meant claims by contractors for cancelled contracts. Enduring government confidence in the project, and firmness not to close it down, might itself attract new donors, which is precisely what happened. In July 1982, an agreement was signed between the Kuwait Fund for Arab Economic Development and the Kenya government for KSh 239 m for the construction of river diversion works. Commodity aid from Japan was also requested for agricultural equipment.

2.07 Although engineering design modifications contributed greatly to the increasing costs of the project, inflation too added to the growing burden. In the two years between compiling the estimated costs of the appraisal and planning reports and contracts being let, an average cost increase of about 27 percent was attributable to inflation.

B. Towards Financial Crisis

2.08 Project construction began in mid 1979, delayed by about two years from the original appraisal plan. About two years later, 200 ha were prepared for the first crop of maize. By 1982, the project was about three years behind schedule. During construction, costs continued to escalate. Local inflation rates climbed from 13 percent during 1980 and 1981 to 22 percent in 1982, corresponding to a steady fall in the value of the Kenyan Shilling in foreign exchange markets. The September 1982 project progress report showed that the total base cost of the project (before adding contingencies) was 87 percent greater than the appraisal report estimates. Including contingencies, the total cost to completion, at 1979 prices, was estimated to be KSh 2,210 m (see Appendix 2). Investment per ha would eventually be nearly KSh 330,000--more than double the estimate of the Project Planning Report of 1977.

2.09 Additional costs attributable to engineering design modification were all to be financed by the Kenya government. Also, the withdrawn donor contribution of KSh 71 m was never replaced by a new donor. For these reasons, the Kenya govenment's share of the total investment required by the project rose from the original 21 percent to over 50 percent by 1981 and just under 50 percent in 1982. Alarmed at the project's increasing costs, and at the prospects of the government having to meet a very large proportion of those costs, an Inter-Ministerial Committee was formed in 1982 to look into the questions of cost control and cost reduction. Their first report issued in December 1982 recommended a range of options postponing certain activities if sufficient goverment funds could not be found. Their second report, issued in June 1983, opted for a planned project area of 3,900 ha. By recommending this option, cost savings could be made by cancelling the barrage, the cotton ginnery and the 132 KV transmission line, all of which were part of the original 6,700 ha settlement scheme. The committee also recommended that negotiations with donors be undertaken to seek further funds. When these recommendations were approved, their immediate effect was to reduce the government's overall share of the project investment costs to below 40 percent. In cancelling the barrage however, the government would no longer have the KSh 239 m of Kuwait Fund money to call on, as its availability was specifically linked to river works construction. By limiting development to 3,900 ha, total project costs fell to about KSh 1,200 m or KSh 308,000 per ha.[1/] Of this unit area cost, KSh 127,000 per ha was attributable to infrastructure. It is more than apparent from these figures that the Bura scheme was now severely unbalanced by investment in infrastructure which had been originally designed for a population of 65,000 and would in time serve only a half of that.

C. Irrigation Achievements and Limitations

2.10 Despite the delayed start to the main civil engineering works, execution was prompt, allowing the first agricultural activities to begin in 1981, with a small crop of maize. One project component omitted in

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1/ Estimated by the mid-term evaluation mission, 1984

implementation was the feasibility study for east bank development. For barrage construction to go ahead in July 1979, the east bank pre-feasibility study should have been completed in late 1978 but funds for the study had not been allocated. MacDonald's proposals for the pre-feasibility study were rejected by the Kenya government. The Tana and Athi River Development Authority (TARDA) then requested the Kenya Soil Survey (KSS) to carry out a reconnaissance soil survey on 80,000 ha selected on the east bank of the Tana. The survey was carried out in 1979 and led to the selection of 36,000 ha which were considered moderately to marginally suitable for irrigated agriculture[1/]. In 1980, a semi-detailed soil survey (scale 1:20,000) was carried out on these 36,000 ha by KSS[2/]. The major limitations for irrigated agriculture were soil deficiencies and drainage. Soil drainage was a major limitation due to a rather unstable subsoil. The results of this survey were extremely disappointing and in TARDA's view, further investigations were not justified. KSS was of the same opinion and felt that more detailed studies could only follow an engineering solution to the drainage problem.[3/] The NIB however was less pessimistic and proceeded to draw up terms of reference for additional studies. The worsening financial situation of the Bura project however soon relegated these studies to a very low priority. It is the evaluation mission's recommendation that there is no justification for large-scale irrigation development on the east bank of the lower Tana at this time.

2.11 Completion of the river pumping works, main canal and irrigation networks on some of the commands by early 1982 allowed small crops of maize and cotton to be planted in that year. The planted area has since expanded, reaching about 2,200 ha of cotton in 1984/85. However, a number of difficulties have been experienced in the operation of the irrigation system over the first three years. In summary, the problems stem from the unreliable and insufficient water supply, difficulties with

1/ Soils of the Proposed Bura East Irrigation Settlement Scheme, KSS, Reconnaisance Soil Survey Report No. RPa 1981;

2/ Semi-detailed Survey of the Proposed Bura East Settlement Scheme, KSS, Report No. 55, 1981. Their land suitability classification for cotton was: moderately suitable (S2) - 7930 ha, moderately to marginally suitable (S2-S3) - 770 ha, marginally suitable (S3) - 16960 ha, unsuitable (NS2) - 10340 ha.

3/ Personal communication, head of KSS, November, 1984.

water application and lack of operation and maintenance in general. These irrigation difficulties may have contributed to an extension of the cotton planting season, from the recommended two months to an undesirable four months.

D. The "Temporary" Pumping Station

2.12 Situated over 40 km north of Bura at Nanigi, the pumping station consists of four diesel-engined pumps, two of which have a capacity of 2.15m^3/sec, and two of which have a capacity of 1.1m^3/sec. These inclined pumps have a lift of up to 6 meters. Since they were commissioned, there has been growing doubt about the performance of the pumps because of their cooling system and incline (a possible design flaw), and there has been continuing difficulty in maintaining and fueling the engines. Lack of trained operators and mechanics, lack of spare parts and generally poor maintenance have caused frequent operational breakdowns resulting in water supply failures[1/]. Water shortages caused the loss of 100 ha of maize in December 1983, and will contribute to yield reductions of cotton during 1984 and the probable loss of 400 ha of maize. After less than three years of use, the diesel engines and pumps urgently require a complete overhaul before there can be any assurance of sufficient water at Bura. The mission recommends this overhaul along with a medium term operation and maintenance contract with a local engineering firm for the pump station and an inventory of spare parts for pumps and engines to be held at Bura. In addition a report from independent mechanical engineers on the condition of the pumps and engines is needed.

2.13 The station was originally designed to operate for two to three years pending the completion of river offtake works. When it was agreed in June 1983 to reduce the overall scale of the project, donors and NIB accepted an indefinite life for the pumping station. A realistic estimate of the output of the pumping station places it at only 55 - 60 percent of the installed capacity while the overall project irrigation efficiency is no more than 40 percent. The present installed pumping

1/ During the 1984 cotton season, the installed pump units operated on average only 25% of the time available.

capacity therefore will only be sufficient to secure water supplies for 2,500 ha. At the same pump and irrigation efficiencies, an additional 4.3 m^3/sec needs to be installed to enable 3,900 ha to be irrigated with any degree of reliability.

2.14 Pumping costs for fuel alone in 1984 prices have been between KSh 50 and KSh 55 per 1,000 m^3 at the pump station. If the full irrigation requirements are met therefore, fuel costs alone are about KSh 1,500 per ha. It is apparent however, that the full water requirements were not supplied during the first three cropping years.

E Water Application

2.15 Little is known about the water application rates during the cropping years 1982/83 and 1983/84, when the cropped area was about 740 ha in each case. During 1984 however (crop year 1984/85), the cotton crop water application took place only once per month instead of the planned two week intervals. Breakdowns of pumps and engines were the cause of the water shortage.

2.16 An equally serious problem in water application is the fact that furrow slopes in the field are often too steep in relation to the infiltration characteristics of the soils. Consequently, many tenants are forced to construct bunds across the furrows at 30 - 40 meter intervals along the standard 285 meter furrow. The irrigation method is thus changed from strictly furrow irrigation to a kind of furrow/basin method. The furrow irrigation method at Bura was introduced on the basis of experience gained at Hola. The long furrows and poor soil characteristics however have prevented the system from working as expected at field irrigation efficiencies of 70 percent; a reduction to 55 percent field irrigation efficiency therefore seems appropriate.

2.17 Furrow irrigation is not only proving to be a problem on much of the land already irrigated; there is an additional uncultivated area of about 1410 ha (see Agriculture Annex) which poses considerable difficulties because slopes are too steep, too shallow or even reversed, and in some cases the land surface undulates. In view of the shallowness

of the soils on this area, land levelling will be both risky and costly. Basin irrigation is recommended as an alternative to furrow irrigation, if this land is to be brought under cultivation.

2.18 Generally speaking, monitoring of water supply and irrigation practices is either absent altogether or inadequate. Reduction of water losses in the field could result in very large cost savings for the project; the first step to achieving those savings is water supply and water-use monitoring, followed by possible changes in irrigation design and training of water guards in better water management.

F. Irrigation Operation and Maintenance

2.19 Since irrigation activities commenced in 1981, operation and maintenance input to the system has been minimal or even nonexistent mainly because of lack of equipment, funds and trained personnel. The settlement basin at the pumping station, the supply and main canals, branch canals, block feeders and all drains have been generally neglected. Regular maintenance work is limited to the unit feeders which is done by the tenants themselves. The dredger in the settlement basin has never been used except for two weeks shortly after its arrival in early 1983, and two weeks in May 1984. In early 1984, the settlement basin and the water intake area silted up, causing serious problems. A dragline borrowed from Hola was finally mobilised to desilt these vital structures. Silting and deterioration of the main and other canals arise because the low flow of water is frequently below the minimum design flow. Another source of silting is the serious erosion of canal banks which has occurred on many stretches of the main supply canals. In July 1984 Japanese hydraulic excavators were delivered to Bura; provided experienced plant operators become available, these excavators could improve future maintenance. The only operation and maintenance work conducted on a regular basis has been greasing of gate structures on the canals and the night storage reservoirs. Better overall management and availability of funds should improve this situation.

G. Agricultural Operations and Settler Incomes

(See also Agriculture and Farm Budget Annexes)

2.20 By its nature, the Bura Irrigation Settlement project relies upon tenant labor for certain agricultural activities such as sowing, weeding, irrigating and harvesting. Agricultural operations had to be coordinated with tenant arrivals. Tenant settlement could proceed only as fast as land preparation, house construction and the completion of other basic infrastructural needs. Depending on their time of arrival, tenants sowed either maize or cotton as their first crop.

2.21 The first settlers were brought to Bura in August 1981, approximately two years behind schedule. Two hundred hectares altogether of maize were sown that year on tenant plots of 0.625 ha. In subsequent years, additional area planted corresponds approximately to tenant arrivals (see Table 2.2).

Table 2.2 Area Planted and Tenant Arrivals At Bura 1981 - 1984

	1981	1982	1983	1984
Estimated Tenant Arrivals (after desertions)	320	214	826	440
Cumulative	320	534	1,360	1,800
Estimated Area Sown:				
Maize (ha)	200	560	800	1,100
Cotton (ha)	-	740	739	2,200

Note: Of the area sown, losses of crops occured in some years which reduced the area harvested to below area sown.

Source: Annexes on Agriculture and Health in this report.

2.22 Although the build up of settlers is less than half the rate proposed in the 1977 appraisal report, most settlers have been allocated their 1.25 ha for field crops according to plan. To some extent, the planned cropping patterns have also been achieved, with seed cotton forming the dominant crop on a tenant's full hectarage, and maize occupying 0.625 ha after cotton. With garden crops of 0.05 ha, cropping intensity is about 148 percent[1/]. Intercropping cowpeas with maize, as

1/ As all tenants had not been allocated field crop and garden plots, this figure is slightly overstated.

proposed in the appraisal report, has not been successfully introduced to the Bura tenants, and groundnuts have not been adopted at a commercial level. Average cotton and maize yields have been below appraisal expectation, at 2.5 t/ha and about 2t/ha respectively. The appraisal report anticipated yields of 2.7 t/ha (cotton) and 2.8t/ha (maize) by the third year of production.

2.23 Not all available land has yet been brought under irrigation command or is ready for agricultural use. By 1984, 2,200 ha were settled and cropped in three of the five commands. To meet the 3,900 ha objective of NIB, irrigation water must be increased in volume. To go beyond 3,900 ha, the main canal must be completed to the Masabubu command. This command contain some of the best soils in the whole of the Bura project. From all commands, there is a total of 1,410 ha of land which requires further improvement before it can be used for furrow irrigated agriculture. Alternatively, different irrigation methods, such as basin irrigation, could be considered for this land. Table 2.3 summarises the project's land use position.

Table 2.3 Land Use by Irrigation Command - 1984

	Total ha	Bura ha	Chewele ha	Pumwani North ha	Pumwani South ha	Masabubu ha
Total land	6,450	1,740	750	1,420	1,100	1,440
of which:						
Cropped 1984	2,200	1,390	600	210	-	-
Proposed, if enough water available	1,700	80	130	790	700	-
Land requiring further improvement	1,410	270	20	420	400	300
Lands available after completion of irrigation network	1,140	-	-	-	-	1,140

Source: Agricultural Annex in this report

2.24 The intended cropping scheme for the project is as follows. Tenants have two plots each of 0.625 ha. Early planted cotton is harvested in time to allow the sowing of a maize crop. All cotton is planted by mid-April, and late planted cotton is be followed by a period of fallow. In 1984, the year of the first substantial cotton crop,

almost half of the area was planted after mid-April, extending in some cases to June. Delays in land preparation and irrigation water shortages were the principal reasons for very late planting. This will result in depressed yields from all cotton planted after mid-April.

2.25 Of the factors affecting maize yields, variety, adequacy of irrigation water and soil quality all contributed to the apparently disappointing results. With improved water management and better cultural practices, yields may increase. However, as no yield monitoring of maize was carried out in 1982 and 1983, yield statistics are a matter of conjecture. Seed cotton yields were, in all probability, influenced by irrigation regime and variety. The variety used is BPA 75, originally developed in Uganda as a reliable peasant-type cultivar which produces a crop even though inputs may be neglected. Acala varieties are being examined for possible introduction at Bura; yields of lint are likely to be higher than BPA 75 given good water management and good husbandry. However the quality of BPA 75 is usually considered to be superior and it is less sensitive to lower management and husbandry standards. Large scale trials under field conditions are recommended before any introduction is made (see Agriculture Annex).

2.26 Mechanical cultivation has been carried out uniformly over the cropped area. Three operations are involved: disc plowing, disc harrowing and ridging. On many soils, this amount of cultivation could result in deteriorating structure; this suggests that three operations are excessive. The Hola Research Station confirms this view. Their trials have shown that where weed infestation is not serious and where eradiction of the preceding crop is good, two operations--disc plow and ridge, or chisel plow and ridge--instead of three, do not significantly affect yield. Probably as much as 50 percent of the cropping area can be limited to two operations which would have the effect of reducing tractor and implement needs. If contract land preparation is used, costs would also be reduced by specifying two operations only on 50 percent of the land.

2.27 Family labor is used for planting, weeding, irrigating, fertilizer application, dusting (in the case of maize), harvesting, crop residue eradication and cleaning of field irrigation channels. Harvesting rates of seed cotton are better than anticipated in the appraisal report. Despite higher average rates however, about 75 percent of tenants hire labor at peak harvest time. Where family size is below the equivalent of four adult labor units therefore, they may face a labor constraint on the standard plot of 1.25 ha. Labor is one of the items for which NIB make advances during the season. Other inputs too are supplied on credit, resulting in an increasing level of indebtedness per farmer if cotton returns are low. Low yields caused from water shortage, late planting etc., have meant that debts have not been cleared at the end of the season and are carried forward. In effect, the tenant pays for inefficiencies in input supply over which he or she has no control.

2.28 To date, pest management has not become a serious problem at Bura. The main cotton pests have been American bollworm (Heliothis armigera) and cotton stainers (Dysdercus spp) both of which have been controlled by aerial spraying after a 5 percent infestation has been revealed by scouting. Local outbreaks have been treated by knapsack spraying. Thiodan and Decis are the main pesticides which have been used. So far, about eight aerial applications a season have been applied, although the Hola Research Station is testing the effect of reducing the number of sprays by raising the pest infestation threshold. Perhaps the most serious development for future pest control is the very late planting of cotton, which means that the close season almost disappears, and a real danger of pest carry-over from one season to the next exists. It is recommended that all cotton planting be completed by mid-April.

2.29 As well as the project's serious problems with water supply during the first three years of crop production, the irrigation

efficiency gives cause for concern. The field layout provides for water to be drawn from unit feeder channels by syphon into irrigation furrows 285 m in length. In theory, the fields have been graded and smoothed to achieve a uniform slope along the furrow. Although furrow slopes at Hola, on which Bura's system was based, range from 50 to 150 cm per km, Bura's slopes range from 50 to 300 cm per km. Widespread problems occur when furrow slopes exceed 100 cm/km. Because of the low infiltration rate of the soils, the designed furrow stream of 1.3 liters/sec takes between two and three hours to reach the end of the 285 m furrow, instead of the expected five to six hours. The dense subsoils below the 20 cm or so of topsoil absorb little water which means that water uptake at the crest of the furrow is inadequate. Hence, actual field irrigation efficiency is below the appraisal report's 70 percent. Although precise figures are not available, the present field irrigation efficiency is probably no more than 55 percent.

2.30 Irrigation and agricultural operations have had a significant effect on reducing farmer incomes below the anticipated incomes in the appraisal report. Not only have lower than anticipated yields contributed to diminished farmer incomes but so have reduced real producer prices for cotton and increased real production costs (see Table 2.4).

2.31 Production costs shown in Table 2.4 do not include the costs of mechanical cultivation and water, both of which are the subject of a separate charge by the NIB. In 1984, NIB's land and water charge was KSh 3,000 per tenant. By charging only KSh 3,000, the NIB has not kept their real cost recovery in line with the appraisal report. To some degree, that compensates tenants for the increase in other costs which they face. After charges for land and water and other miscellaneous charges, and after taking account of the shortfall in allocation of garden plots average income for tenants with full field crop area in 1984 will probably be between KSh 5,000 and KSh 6,000 before counting the value of crops consumed. In real terms, this is about 55 percent below the projected cash income of the appraisal report. In some cases, tenant

Table 2.4 Cotton and Maize Producer Prices and Costs 1984

	Seed Cotton	Maize
Producer Price - KSh/kg (1984 prices)		
Appraisal report	6.17	1.71
1984 Season	4.75	2.00
Producer Costs - KSh/kg (1984 prices)		
Appraisal Report	1.75	0.93
1984 Season	1.86	1.07
Production/tenant (average estimate)	3,130 kg	1,250 kg
Subsistence needs/family (average)	-	900 kg

Source: Farm Budgets Annex

incomes on the Bura project are less than the reported incomes they achieved before they migrated to Bura[1/]. For many settlers, therefore, Bura must be a disappointment if not a disillusionment, given the adverse conditions they have had to bear.

2.32 Settler incomes could be increased if a higher producer price was received for seed cotton. Marketed through the Cotton Lint and Seed Marketing Board (CLSMB) for ginning at Hola, Bura seed cotton is of a high quality and is available to the Board in an organized bulk flow. Although the Board applies its standard national pricing formula to Bura seed cotton, it readily admits that it incurs lower costs in buying, handling and ginning Bura seed cotton than it does with other seed cotton. Although international prospects for cotton lint are not good, and although no lint from Bura is actually exported, Bura seed cotton is probably undervalued at 1984 prices. If a 20 percent increase in seed cotton prices could be attained without a commensurate increase in production costs, then tenant incomes could increase by about 40 to 50 percent above their 1984 average levels.

1/ Bura Socioeconomic Study, 1984.

H. Forestry and Environment Impact (see Annexes)

Forestry

2.33 The appraisal report plan to establish a 3,900 ha (net) forestry plantation for the supply of fuelwood and building poles for Bura settlers has fallen victim to the general financial malaise of the project. In all, only 30 ha of mesquite (Prosopis chilensis)[1/] were established from seed in 1983. A further 2 ha trial of Eucalyptus seedlings is being conducted. Cleared brushwood from the project site was distributed free to tenants but this supply lasted only one year. Gazettement of three blocks of riverine forest was not done because it would have entailed resettling the Pokomo/Malekote people who lived there. The fuelwood needs of the Bura settlers now pose a threat to the integrity of much of the riverine forest. Necessary urgent action to prevent forest destruction appears to be constrained by financial resources and the issue of responsibility. NIB lacks funds to implement any forestry program; the Ministry of Environment and Natural Resources claims that Bura is not their responsibility and that all of their funds are committed. Meanwhile, settlers steadily denude their environment of all woody plants in the quest for fuel, and building poles are trucked into Bura from mangrove forests on the coast. It is recommended that the responsibilities of the agencies involved in the forestry component be more clearly defined.

2.34 Recognising the urgent need to conserve fuel in Bura settlement, recommendations are being made for the introduction of "jikos"--fuel-efficient wood burning stoves. A recommedation has also been made for the controlled exploitation of a small part of riverine forest which would meet short-term needs pending the establishment and implementation of a realistic policy on fuelwood plantations.

1/ Formerly P. Juliflora

Environmental Impact

2.35 The Bura project is faced with serious and deteriorating environmental problems. While these problems were largely avoidable, they emerged because insufficient attention had been given to them during project design and especially during implementation. The project has substantially increased pressures for cutting the biologically unique riverine forest that occurs in a relatively narrow strip along both banks of the Tana River. The most significant threat to the forest's continued existence comes from the demand of Bura tenants and spontaneous settlers for fuelwood. This problem has arisen primarily because the project's fuelwood plantation component has yet to be implemented, resulting in a "fuelwood gap" of roughly 5 years (assuming that fuelwood tree planting is undertaken immediately). Since (under the best of circumstances) significant ecological modification of the Bura area riverine forest is inevitable, it is strongly recommended that support be provided for strengthening the on-the-ground management of the 16,807 ha Tana River Primate Reserve near Wenje (details in Environment Annex).

2.36 The dry bush country in the project area naturally supports a rich diversity of wildlife. Since the area of dry bush cleared for Phase I of the Bura project is a relatively small proportion of this rather extensive ecosystem, the effect on the total populations of most of the wildlife species present is relatively slight. Nonetheless, the Bura project is negatively affecting wildlife populations much more than need be the case. One reason for this is the premature clearing of all 6,700 ha of dry bush, even though only 3,900 ha are now scheduled for cultivation. Besides unnecessarily eliminating a substantial amount of wildlife habitat, this unnecessary clearing has exposed the soil to severe wind erosion thereby resulting in frequent dust storms, clogging of culverts and small channels, and reducing the land's long-term productivity. Another negative factor for wildlife is the 46 km supply canal, which is impeding wildlife migration to and from the Tana River.

2.37 To enable some wild animals to cross the supply canal, four inverted siphons were constructed along the canal, each one where a laga (natural drainage channel) crosses the canal. Furthermore, 10 drinking ponds were constructed along the west side of the supply canal. These ponds were intended to provide suitable watering areas for both wildlife and Orma livestock, thereby reducing their tendency to trample and erode the banks of the supply canal. Unfortunately, most of these ponds are still dry and none have reached their desired water level. This problem can be attributed to poor maintenance and possibly in some cases to improper construction. Also, the pond design chosen appears to be considerably more expensive and less reliable than some alternative design options. To the extent that large numbers of wild or domestic animals continue to trample the banks of the supply canal, it is recommended that additional drinking areas be provided as needed. These areas can be flattened (20 m wide portions of canal bank) or ponds connected to the supply canal by small surface branch canals; either alternative would be cheaper and more reliable than the present pond design.

2.38 The biocides used at Bura to control cotton pests may present serious short and long-term environmental problems. Evidence (of an anecdotal nature) presently suggests that biocides at Bura may pose significant risks to the settlers' health, water supplies, and local fish populations. It is recommended that NIB, in conjunction with National Agricultural Laboratories, undertake a biocide monitoring program immediately at Bura, to determine to what extent any serious problems actually exist. Items to be monitored should include acute and chronic effects on settlers' health; populations of beneficial insects, fish, and birds around the scheme; poisoning of wildlife, livestock, and Orma or other people from drainage canal water; and residues in Tana River water and fish. If monitoring detects serious problems, a variety of contingency measures (discussed in Environment Annex) could be taken.

2.39 The environmental and health risks associated with biocide use at Bura are increased by the practice of aerial spraying. While quick and easy to administer, aerial spraying has significant drawbacks which

do not appear to have been seriously considered during project preparation and appraisal. A seemingly preferable alternative would be a tractor-mounted boom spray rig, which would substantially reduce spray drift (and hence the amounts of biocide used). It would also allow trees to be planted as windbreaks to reduce the high rate of wind erosion found at Bura. It is recommended that NIB specify a strong preference for some combination of tractor and hand spraying (rather than aerial spraying) in its annual request for spraying contract bids.

2.40 The principal longer-term risk associated with biocide use is the emergence of resistant pest varieties. After only about a decade of operation, Sudan's Gezira irrigated cotton project seems to face a crisis of escalating costs and declining yields due to such induced pest resistance. To protect Bura from the risk of a similar fate, NIB should immediately undertake a research program in integrated pest management (IPM). IPM relies on a combination of different pest control techniques which simultaneously exert a number of different selection pressures upon each pest species, thereby inhibiting the development of resistant strains. Because the pest species of cotton vary by region, a successful IPM package for a particular site must be locally tested and often locally developed. It is recommended that money for this relatively low cost endeavor (IPM) (to be carried out at Bura or Hola) come from NIB's research budget or by technical assistance from the Kenya Agricultural Research Institute (KARI) and FAO.

I. Settlement Issues

2.41 Settlement was planned to start in early 1980 with an eventual 5,150 families to be settled in stages over 3-1/2 years. The arrival of settlers depended upon successful timely implementation of many complex components including irrigation works, land preparation, housing, drinking water and health services. The first group of 320 settlers arrived almost two years later than planned, between August and December 1981, because of delays in preparation of water and land. Settlement has continued and there are now about 1840 tenants at site (October 1984); villages one to ten are occupied.

2.42 The tenant selection process has not always been ideal in terms of the selection and timing of arrival of tenants. Tenants should arrive before February if they are to plant early cotton or by August/September if their first crop is to be maize. In 1984 the last group of tenants arrived on April 30. In some cases sick or crippled individuals who were unable to work, or people who were not landless were selected for Bura. The settlement officer returned such people. Some tenants reported that they were given misleading information about what to expect at Bura. Life at Bura has been difficult and those those who were disappointed by what they found usually deserted the scheme fairly quickly.

2.43 Desertion rates at Bura were about 25% through 1983 but less in 1984 (Socioeconomic Report, 1984, p 113). Relative to other settlement schemes around the world, these rates are low and indicate that the majority of those selected are either better off at Bura or expect to eventually be better off at Bura than in their place of origin. Estimates are that more than one half of those deserting originate from Central Province. These tenants are less adapted to the climate and diseases found at Bura. If health services had been provided during 1981 to mid-1983 these desertion rates would have been reduced.

2.44 NIB provides housing, transport, food, tools and subsistance advances for the incoming tenants. Cash advances of KSh 300/month are given until the first cash crop is harvested. The length of this advance period depends upon when the tenants arrive in the crop cycle. It is repaid over three years without interest. The World Food Program supplements the cash advances by supplying maize, vegetable oil and beans. The maize ration stops when the first maize crop is harvested; beans and vegetable oil continue until the tenants are paid for their first cotton crop. For many families, it appears that the WFP food allotments are insufficient. NIB should consider increasing the food allotment for large families and providing dried milk if possible for young children. Vegetable plots are an important source of nutrition in the diet and a source of cash in some cases and should be allocated to the tenants as soon as possible. Tenants arriving on the scheme were allocated their 0.05 ha vegetable plot only after a long lag. Many

tenants have reported the desire for a larger plot and have sufficient labor to work it. It is recommended that NIB provide larger vegetable plots to families who both desire a larger plot and have sufficient labor to work on it.

Tenant Incomes and Indebtedness

2.45 A contributing cause of desertion is indebtedness to NIB. All new tenants incur debts automatically to NIB for their relief advances and seed cotton picking advances. But on top of this some tenants incur additional debts because the proceeds from the sale of their cotton crop are not sufficient to clear their NIB input charges. In 1983 the median net income from cotton for tenants with a cotton crop was KSh 4,000 to KSh 5,000[1/]. But considerable disparity in income occurs. For example 18% of these tenants received less than KSh 1,000 from their cotton -- certainly not enough cash to cover basic school fees, food, fuelwood, clothing, and transport needs. About 13% of tenants received nothing from their cotton crop.

2.46 In addition to cotton, the maize crop and vegetable plots can be sources of cash income after meeting subsistence needs. In 1983/84 tenants lost 100 ha of 800 ha planted to maize due to irrigation water shortages. This situation has been repeated in 1984/85 with a water shortage in October resulting to the virtual loss of 300-400 ha of maize.

2.47 Incomes should improve with better NIB management and greater water reliability. At the end of 1983, 65% of the tenants who arrived in 1982 were in debt and 68% of the tenants from 1982 were in debt[2/]. The size of some of these debts was not insignificant.

2.48 Unless incomes improve through better improved NIB management and greater water reliability, tenant welfare is jeopardized and desertion rates may increase. Low tenant incomes also determine the degree to which NIB can successfully recover its costs (housing, crop inputs, subsistence advances, etc.).

1/ Cotton revenue minus deductions for farm services.
Source: Bura project records

2/ Above and beyond what would normally be owned from the relief advance.

2.49 Tenants are paid for cotton in January, and do not, in theory, receive any other cash from NIB until cotton picking advances are paid several months later. Tenants report great difficulty in purchasing necessities during this period. It is recommended that measures be taken to improve tenant incomes, such as more timely supply of agricultural inputs and/or a higher real cotton price. It is also recommended that a system of crop advances be institutionalised.

Tenant Relations With NIB

2.50 Successful settlement projects in other areas of the world are characterized by minimal government involvement and a great degree of settler initiative[1/]. NIB has a large involvement in Bura operations. Given the structure of the irrigation system, NIB provides all crop inputs but weeding, harvesting and field irrigation, which are provided by tenants. Tenants tend to see themselves as laborers rather than settlers, since they do not receive land titles and are dependent upon year to year leases. They must plant cotton and maize as directed by the NIB. They receive housing and other services from NIB, and their livelihood, because of the great role of NIB in the productive system, is very vulnerable to the scheme management (see also para 1.29).

J. Social Infrastructure

2.51 NIB has provided housing, schools, drinking water, roads, and a health center at Bura. Because of Bura's remote location and the previous lack of development in the area, no local authorities existed to provide these services. NIB has experienced great difficulties in reaching agreement to turnover the operation and maintenance of roads and the airfield, the generators, and the drinking water and sewage to the relevant ministries. Without this transfer of responsibility, NIB has had to run services for which it is not well-equipped, both financially and technically, to run. It is recommended that all these services be taken over by the appropriate ministries as soon as possible.

Schools

2.52 The turnover of schools to the Ministry of Education has gone smoothly.

1/ World Bank, The Settlement of Agricultural Lands: An Issues Paper, June 1977.

There are three NIB constructed primary schools in Village 2, 3 and 9 and another at Huruma market built on a Harambee (i.e. self-help) basis. All villages also have nursery schools built on a Harambee basis, and a secondary school is planned for the rural center.

Drinking Water and Sewage

2.53 The Bura scheme has two water treatment works at present: a temporaryone, constructed in 1979 at the rural center to supply water to the project during the construction phase, and a permanent larger one, completed in June 1983 at almost six times the cost of the temporary treatment works [1/]. Today the temporary treatment works is still serving the needs of the Bura population; NIB has neither the funds nor the expertise to operate the very technical and expensive new works, and the Ministry of Water Development has not taken over its operation. This plant has not been operated except for initial testing since it was completed in 1983.

2.54 When the new water purification plant was constructed the Bura project was envisioned at 6,700 ha. By the time the Government decided to limit the scope of the project to 3,900 ha, construction contracts for water supply and sewerage had been awarded and most of the works completed. Given the reduction in project scope to 3,900 ha, the water plant's large capacity is now unnecessary. Even based on the 6,700 ha size however, the per capita water consumption figures planned in the project design were unnecessarily high by rural standards [2/]. Cost reductions could have been found by reducing the projected per capita demand or by designing a simpler plant (for example, with steel storage tanks instead reinforced concrete reservoirs).

2.55 The water distribution system was over-ambitious. In the initial project design villagers were to share water taps (12 houses per tap) and share showers and clothes washing facilities. In implementation, this design was replaced with very expensive taps at each individual house, with no showers and clothes-washing slabs. This ambitious distribution now lies idle because the new larger capacity water works have never been operated.

1/ The construction of the new plant and distribution system was accompanied by a tripling of costs in real terms over estimated costs.

2/ 100 liters per capita per day in villages and 150 liters per capit a per day in the rural center (Project Planning Report).

2.56 The capacity of the temporary water treatment works is limited to approximately 1200m^3 of treated water per day. Output does not reach this level, because pumps have been operated on a limited basis due to lack of standby pumps. With current output, water to the villages and rural center is rationed. Only one of the village tanks (that for village 1 and 2) is in use; the temporary water treatment works does not supply sufficient water pressure to fill the tanks serving the other other villages. Instead every two villages share standpipes with a continuous flow of water for part of the day.

2.57 The supply in the villages is further aggravated by lack of pressure in the few communal water points and this results in long queues for water. Any large increase in settlement (new tenants) or extension of water distribution (to the Manyatta (spontaneous settlement near the rural center) and to individual houses) is constrained by the the current output of the temporary water treatment works.

2.58 Up until May 1983, the contractor handled the operation and maintenance of the temporary treatment works. Since then, NIB has taken over this function. The operation has been hampered by financial and accounting problems. For a period of five months from March to September 1984 the standby pumps for the raw water pump and treated water pump were in Nairobi awaiting repairs. Repairs were held up because of accounting problems (non-payment of bills). This was a potentially critical situation because there were no standby pumps in case of serious pump breakdowns. Fortunately, no serious breakdowns occurred during this period. Other problems occurred with shortages of chemicals. The NIB engineer has stated that if the temporary treatment works is rehabilitated it would become more reliable and meet the minimal needs of the present scheme population.

2.59 No consideration was given in design and implementation to the recovery of operational costs of the water treatment works. At the moment (late 1984) NIB is operating and maintaining the temporary works at an annual cost of about KSh 600,000 but it is not collecting any revenue from consumers. The cost of running the water supply is not included under the land and water charges that NIB recovers from tenants, while NIB staff at the rural center also receive water free of charge.

This is therefore imposing a burden for which NIB has no bugetary provision or a cost recovery mechanism.

2.60 The operating cost of the permanent works is estimated to be much higher at approximately KSh 2 million to KSh 2.4 million per annum, assuming it operates at half capacity serving the population in the rural center and tenant population of approximately 3,100 households (project size of 3,900 ha). Reducing the volume of treated water output would reduce costs somewhat, by lowering the chemical and fuel input requirements. However most of the costs associated with the works are fixed operating costs.

2.61 Until the permanent works are operated on a continuous, basis consideration should be made to making a cross connection between raw water tanks and temporary works so that raw water pumps for permanent works could occasionally be operated to provide raw water for the temporary treatment works. There should be reliable stand-by pumping capacity for the temporary works to ensure that Bura community is given water on a continuous basis until the permanent water supply is in operation. The present population does not justify operating the expensive purification system. The mission recommends that the temporary system be maintained and if necessary supplemented by pumps or storage tanks from the permanent system. Expert advice should be sought to ensure that the permanent plant does not deteriorate while it is not in use.

Tenant Housing and Latrines

2.62 The original intention in project design was to have settlers construct their own houses and schools. This plan relied heavily on careful timing of settlers' arrivals (so that they could construct their houses before their agricultural tasks started) and on the availability of building materials and supervision. However, the NIB decided in 1979 to construct houses independently using the "Bura Building Force"[1/] (BBF).

1/ A construction crew under NIB.

2.63 The BBF had no experience in building low-cost houses in large numbers. Planning the demand for tenant housing was complicated by continued delays in the availability of prepared land and irrigation water. To compensate for new targets after long delays the BBF rushed to build houses with overtime labor and materials purchased outside formal contracts. There was little or no cost control in BBF procurement of building materials. Standards of workmanship were low because of poor supervision, management and organization.

2.64 The first groups of BBF tenant houses were built at a unit cost of Ksh 22,000. Eventually, the BBF built 1428 houses at an average cost of Ksh 30,600. The total cost of BBF houses which eventually needed rehabilitation was an average of Ksh 44,000 (this rehabilitation occurred in early 1984) [1]. Because of both the high cost and poor quality of the BBF houses, NIB decided in 1982 to disband the BBF and have the balance of tenant housing and schools built by a private contractor. The contractor built another 762 houses at KSh 26,700 each including the cost of the pit latrine. These houses appear, in general, to be better quality than those constructed by the BBF. The contractor-built houses used a slightly modified design, with plastered outside walls. The BBF houses have been plagued with problems such as roofs blowing off in the wind, walls collapsing and roofs leaking. As of September 1984, about 20 houses had already completely collapsed, and another 49 were "in a state of falling".[2]

2.65 Pit latrines, which serve a very important role in environmental health, have also had their share of problems, with many having blown over, collapsed, or caved in. Most of the problems appear to be due to the difficult expansive soils at Bura. Consideration should be given to digging shallower pits and lining them and then providing the

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1/ 455 houses required rehabilitation.
2/ Report to Project Manager, Bura, 1984.

superstructure with ventilation pipes to control flies and remove odors.[1/]

2.66 Since houses were anticipated to be low cost in the design stage (KSh 4000 per house in the appraisal report) it was planned that tenants would repay the house costs over a 10 or 15 period without interest. The annual repayment would be a small proportion of tenants' income. Until now the tenants have not been told what repayment charges NIB will make for the houses. NIB has graded the existing houses and set tentative charges which are a significant share of net income.[2/] If these charges are actually recovered from the tenants, the subsidy provided by NIB will be well over 70% of the cost of the house. Thus tenant houses have been a very costly exercise for the NIB.

2.67 About half of the tenants report that they are not very satisfied with their house design (Socioeconomic Report, 1984) and believe the costs are high given the quality of the houses. In general tenants have not maintained their homes. This is evidence of either their lack of commitment to the scheme, their dependency on NIB, or their uncertainty arising from NIB's failure to state what the housing policy will be.

2.68 For the remaining settler housing, NIB once again reconsidered in June 1984 the option of settler-constructed housing with assistance in the form of building materials. NIB outlined several options for this to about 150 tenants but they responded that they were not prepared to build their own houses or share in the cost of putting up the homes. This may be evidence, again, of their lack of commitment to the scheme.

1/ Suggestion made by the NIB Engineer.

2/ Houses of Class "A" (1194) at Ksh 10,000; houses of Class "B" (449) at Ksh 9,000; houses of Class "C" at Kshs 8,000. Tenants would pay approximately Ksh 1,200 per year for 20 years for the houses costing Ksh 10,000 and less for the class "B" and "C" houses.

2.69 The remaining number of houses needed will be determined by the ultimate settlement area and size of the standard tenant plot (if the plot size is increased to 1.5 ha the total number of settlers will be reduced although additional housing may still be needed because of the location of existing housing). These houses should be built by a professional contractor skilled in management, organization and procurement. It remains to be seen whether the NIB will be able to recover part of the cost of tenant housing. Settler incomes must first increase before this would be feasible. Settlers are not eager to purchase the houses. A remaining important problem is the legal issue of whether the tenant can (or would be advised) to purchase a house on land that they do not own (tenants lease NIB land on an annual basis only).

2.70 In hindsight it is clear that the design proposal of tenant-built houses relied on close coordination of the timing of tenant arrival, availability of skilled manpower to assist and supervise construction, and the availability of building materials. This close coordination could not be achieved. The initial tenants arrived late in the agricultural cycle and moved into BBF houses. Again in hindsight it is clear that NIB did not have the organizational abilities to produce large quantities of quality low-cost houses, and that this task should have been given to a professional contractor from the start. Tenant housing has suffered a major cost escalation, and it appears that NIB will recover little from this component. For the tenants, the quality of housing is poor and housing policy is uncertain. The lack of maintenance of the houses is evidence of the tenants' lack of commitment to the scheme. A policy in regard to tenant housing is urgently required and it is <u>recommended</u> that this question and questions regarding tenants legal status under the Irrigation Act (1966) be referred to the government legal advisers.

K. <u>Health</u> (See Health Annex for full discussion)

2.71 The provision of preventive and curative health services was regarded as an essential pre-condition to settlement of the Bura project. Certain health problems were anticipated due to the introduction of irrigation (and therefore water-borne diseases) in

a dry and arid region combined with poorly nourished incoming settlers, without acquired immunities to these diseases. Schistosomiasis and malaria were the most severe diseases anticipated at project design.

2.72 The planned health center was finished in 1981 but not opened until mid-1983 due to delays in the arrival of equipment and financial constraints in the Ministry of Health. The first settlers arrived between August and December 1981. As a result of the basic lack of health services for the first 18 months of settlement mortality and morbidity rates were very high. In 1982 in particular malaria produced a sharp increase in mortality, especially in young children. The crude death rate in the project area can be estimated at several times the national average during that period. Thus settlement preceded health services by over a year and a half. The only service available during this period was a dispensary operated by the National Youth Service[1/] primarily for construction staff. A non-governmental group of Catholic sisters, including a doctor and two nurses, also arrived at Bura in 1982 to address some of the critical health needs of the population.

2.73 Village health posts and two health sub-centers were dropped from the project design for financial reasons. The existing health center in the rural center is far from some of the villages. As a result, tenant families make less use of the health center than the rural center and Manyatta population.[2/] There is no health outreach in the villages due to lack of transport. The Catholic sisters however play an important role in the health needs of settlers and see roughly 500 to 1000 people a month. Transport to the health center and the nearest hospital at Hola is a problem in the case of medical emergencies or when the patient is unable to walk. Many patients arrive at the health center transported by wheelbarrow in these cases.

2.74 Malaria[3/] is probably the most important cause of morbidity and mortality, and will continue to be an important medical problem, especially as new settlers arrive. Drug resistance to medical

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1/ A major contractor on the scheme.
2/ Spontaneous private settlement.
3/ The predominant species is P. falciparum.

treatment of malaria is appearing. The mosquito vector appears to breed in drainage canals and in pools of water after rainfall. The existing health care infrastructure is not equipped to deal with future malaria outbreaks. It is recommended in the Health Annex that the Ministry of Health take four steps to control malaria: (1) screen and treat villagers to reduce the infected population; (2) treat malaria outbreaks at the village level with a full course of treament; (3) give chemoprophylaxis to all new settlers, or at least the most vulnerable (children and pregnant women); and (4) control the vector population with larvicide in stagnant water. Unless these steps are taken malaria will continue to be severe. The consequences of continued high levels of malaria are significant to settler welfare and to the success of the Bura project; those consequences are increased mortality, deterioration in nutritional status, losses in productivity, and high settler desertion rates.

2.75 The second major health problem at Bura is malnutrition. Nutritional levels at Bura seem to be below the standards of rural Kenya. Both severe kwashiorkor and Marasmus occur frequently in young children. Families arrived in poor nutritional status and were particularly vulnerable before their first maize crop. Vegetable plots were only given to tenants after a long lag because the scheme management felt that if vegetable plots were given out sooner, they might divert tenants' attention from other agricultural activities. The scheme provided (through WFP) households with maize, beans and vegetable oil for the first 18 months of settlement but the amount was inadequate in many cases, especially for large families. Even after the proceeds of the first cash crop were received, tenant income was often insufficient to provide the household with a satisfactory diet. It is recommended that NIB should increase the size of vegetable plots, and increase WFP foodstuffs to needy families. Any steps in improving the management and efficiency of the scheme should also improve tenant income, and therefore allow an improvement in diet and nutritional status. Food supplementation programs (for nutritional rehabilitation and for vunerable groups) have been erratic but should be increased.

2.76 Diarrheal disease is common at Bura but probably no worse than in other areas of rural Kenya. Adequate drinking water supplies have been important in minimizing the incidence of diarrheal disease. One area where it is very severe in young children is in the Manyatta, where treated drinking water is not available. It is recommended that NIB make every effort to extend water supply to this informal settlement.

2.77 Schistosomiasis infection (urinary) is present in about 10% of the settlers at Bura (mainly the Orma, Malekote and Pokomo). The snail vector is not yet in the canals. The disease is endemic however at Hola with a 100% infection rate in early childhood. Steps taken now can reduce an eventual more serious schistosomiasis problem at Bura. Settlers should be screened and treated on a regular basis. When the snail vector is established in the canals at Bura, molluscicding is needed. Finally, the scheme must give the surrounding population (including the informal settlement) enough drinking water so that the population does not need to resort to canal water for clothes washing, bathing or drinking. Mass chemotherapy to control schistosomiasis is expensive; health education and environmental sanitation (clean water and washing areas) are more cost effective ways to control the disease. It is recommended that a schistosomiasis control program be introduced as soon as possible.

2.78 Health services suffered in the implementation process of the Bura Irrigation and Settlement project, although they had a prominent place in the project design. Implementation of health services was impeded by financial problems of both NIB (cutbacks in components) and the Ministry of Health (long delays in providing services) and by poor interministerial coordination.

2.79 The health conditions were alarming during the first 18 months of settlement and were an important reason for high desertion rates. Malaria and malnutrition continue to be very important causes of morbidity and mortality. In time, schistosomiasis will be added to the list; the present health care system is not strong enough to cope with a schistosomiasis vector control program and health outreach activities. It is recommended that all aspects of health care be strengthened.

L. Social Impact of Project

2.80 Important non-quantifiable benefits were anticipated from the Bura Project from the relief of landless poverty, employment creation, and the strategic presence of a population base in eastern Kenya. Actual settlement to date has been far lower than planned but employment creation has resulted both from the informal sector and the tenant population. Tenant incomes have been low by and large. The surrounding population has benefitted from the social infrastructure (schools and health services) at Bura and from employment creation. The indigenous population has been displaced from the project area per se, but their access to water has increased.

M. The Situation of Women and Children at Bura

2.81 A fair amount of consideration was given in project planning to the special problems women settlers would face at Bura. It was recognized that major changes in the control of household incomes would occur with resettlement. Traditionally in many parts of Kenya women control the cash from surplus food crops and use it to supplement the diet of their families. Studies of the Mwea irrigated rice scheme have concluded that the diminished control by women in such schemes over cash crops has contributed to high rates of malnutrition. To reduce this financial dependency of the wife upon her spouse, with the possible negative effects in family welfare from the misallocation of family income, the loan agreement stated that "to ensure proper nourishment of the family a portion of the cotton proceeds should be paid directly to the wife to cover basic needs such as feeding and clothing the family. The PPR suggested not only that regular payments be made to wives, but that "women be registered as the legal tenants of the vegetable crops, that payments to the men be made against the cotton crop over the year and that local banking facilities be made available".

2.82 The social implications of this agreement to make regular payments to wives was never studied fully, and it is an open question how it would have worked in practice. The financial payments to wives were

never carried out--payments are made to the person in whose name the plot is registered. As of September 1984 about 5 percent of registered tenants were women. Women can be registered for the plot in two ways. First, a small proportion of female headed households have been resettled at Bura. Second, a woman can gain access to the plot if her tenant husband dies[1/].

2.83 The workload of women at Bura is heavy and may be heavier than in their place of origin. Women's labor includes participating in most agricultural activities except for irrigation. In particular women cultivate the vegetable plot, haul water, collect firewood, cook and wash clothes. The fuelwood gap hits women the hardest since they are traditionally in charge of gathering or purchasing the fuel. The Socioeconomic Report (1984) of Bura found that, depending upon the village, almost half of the women had to travel over 3 km to collect fuelwood; about 10% had to travel 7 to 10 km. Fuel-conserving jikos are used by a very small group of women at Bura. The introduction of jikos on a large scale is strongly recommended in order to reduce fuelwood requirements. This introduction must include extension and training in their use directed at women. This will form part of the FINNIDA financed forestry program.

2.84 Several women's groups have been established at Bura with the purpose of sharing income generating activities or helping sick members. As recommended in the Socioeconomic Report (1984), NIB should support these groups and perhaps allocate communal vegetable plots for them.

1/ The latter procedure is not automatic. First a letter is sent to the wife's district commissioner to confirm that she is the next of kin to take over the plot. If the husband deserts and the wife remains at Bura, then she cannot, according to NIB rules, work the land and receive payments as it is still registered in his name.

2.85 Women and children are clearly a vulnerable group at Bura, because of their heavy workloads, poor nutritional and health conditions, and lack of access to cash. These problems were recognized at project appraisal, but not addressed in implementation. NIB should make particular efforts to improve the living conditions and reduce the workload of women and children. Measures to introduce fuel-conserving jikos, irrigated forestry, more mills for grinding maize, transport and improved health outreach services could greatly benefit the situation of women at Bura. The irrigated forestry component should not make further demands on women's labor above the time currently used to collect fuelwood.

N. Bura Project Management

2.86 The 1977 appraisal report of the Bura project noted that NIB's "experience and implementation capacity are limited" and that its "overall performance since its inception had been uneven in quality". Annex I of the appraisal report goes on to state "the management and technical problems which hamper its operations raise serious questions as to whether the Board has the capacity without external assistance to undertake responsibility for another irrigation scheme". Proposals were therefore made in the appraisal report for the employment of additional staff including a Bura Project Coordinator and consultants to complete the design of the project, supervise construction and assist the project coordinator in coordinating implementation of the project. In addition, an experienced agricultural management firm or organization (at the time, expected to be the Commonwealth Development Corporation) was to be employed to manage the agricultural production phase for a period of not less than six years. No specific recommendations or proposals appear to have been made to strengthen the main departments of NIB, namely agriculture, engineering and accounts. Also the main training element included in the proposals was related to the agricultural management of the project and it is unclear whether headquarters departmental staff would also be involved.

2.88 In 1981, after discussions between the NIB and the Directorate of Personnel Management the Directorate undertook a management review. Its report was published in February 1982[1/]. The report drew attention to the over-centralisation of NIB's operations giving a variety of reasons for this situation including the lack of experience and ineffectiveness of some departments and the lack of delegation which resulted in the overburdening of the general manager. It recommended that senior management be strengthened by the appointment of two assistant general managers, one to have responsibility for NIB's finance and administration, the second to coordinate all technical functions with responsibility for NIB's two technical departments and the irrigation schemes. Serious weaknesses within the accounts department were also identified, for example, the 1979/80 accounts were long overdue. The proposals emanating from the management review gave rise to further investigation, but it was not until September 1984 that the ongoing management audit[2/] commenced. Also in 1984 Messrs Coopers and Lybrand were appointed to correct the shortcomings in the accounting system and to assist with the completion of the 1981/82 and 1982/83 accounts audits which were long overdue. Thus, some seven years after the signing of the Bura project's legal documents, NIB's organizational structure has remained largely unchanged, with many of the same weaknesses identified at appraisal.

2.89 The appraisal report stated that an agricultural management team must manage the first six years of agricultural production. This management was supposed to take effect by 31st December 1978[3/]. Such a team was not appointed until late 1982, after the arrival of the first settlers and after the first cropping season. The consultants appointed

1/ National Irrigation Board Reorganisation Study by Directorate of Personnel Management (Management Consultancy Services Division) February 1982.

2/ Being conducted on the direction of the Parastatal Advisory Committee by the Inspectorate of Statutory Boards.

3/ Development Credit Agreement Section 3.02.

were NEDECO from the Netherlands. Their team included a project manager, an agricultural manager, an irrigation engineer, a project engineer, a workshop superintendent and an accountant. Unfortunately, their stay was limited to some six months for reasons which are not entirely clear. Before mid-1983 therefore, the project was once again without its consultant team. By early 1984, a new proposal to finance consultants was submitted to the EDF, based on the recommendations[1/] made by NEDECO before their 1983 departure. The new team is likely to start in early 1985, and will consist of five specialists, compared to the six in the first team. The agricultural manager and the project engineer would be dropped from the new team and an agricultural economist would be included, to join the project manager, the accountant, the workshop superintendent and the irrigation engineer. Meanwhile, a Kenyan agricultural manager (who is also the assistant project manager) and a Kenyan project engineer have been appointed as well as counterpart staff for all posts except the agricultural economist.

2.90 NEDECO's report of 1983[2/], issued on their departure, discussed the relationship between the Bura project management and NIB. Because of the complexity and remoteness of Bura, they felt a high degree of autonomy for the project was justified, not only during the construction phase but also during subsequent operations. NEDECO recommended that the Bura management be given full control of the day-to-day operations, particularly the authority to procure and pay directly for supplies such as fuel, spare parts and other maintenance materials, minor agricultural supplies and casual labor. NIB's views on the role of the local Bura management are at variance with this. In a recent memorandum[3/], NIB stated that the team "was to provide technical asistance in managing the scheme, but not to be sole managers of the scheme". In the mid-term evaluation mission's view, this was not the intention of the appraisal report and later documents. The mission

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1/ Bura Irrigation Project: Organization and Managemewnt Structure etc.

2/ NEDECO June 1983

3/ Minutes of a meeting held at NIB HQ October 4, 1984.

believes and recommends however that the agricultural management team comprise both consultant staff and local Kenyan staff and that localisation of posts in the management team proceed as soon as suitably qualified and experienced staff are identified.

2.91 One further point deserves comment and this is the serious financial difficulties currently experienced by NIB. The orderly development of Bura depends on the timely release of funds to NIB from the Treasury. Funds that are over three months in arrears are now being released. The Bura project has a serious cash flow problem and the project only operates by delaying payments to creditors, using funds earmarked for other more viable schemes[1/] and by the use of bank overdraft. Under these circumstances delegation of financial responsibility to Bura management is not possible--nor is orderly development. It is recommended most strongly that funds be released by the Treasury in advance of their commitment.

2.92 Not all aspects of development at Bura are discouraging. The project has succeeded in settling 1,800 tenant families, although not without complaints about such aspects as quality of housing, income levels, shortages of irrigation water, and scarcity of fuelwood. The 1984 cotton crop appears to be producing satisfactory yields which already has improved farmer confidence in the scheme. It would be unrealistic to press for decentralisation of responsibilities to Bura until the many management weaknesses there have been rectified. At that time, extensive delegation of NIB's powers to the Bura project manager and his staff is essential.

1/ Practise commented on unfavorably in the Internministerial Committee Report No. 3.

III. PRINCIPAL LESSONS FROM THE PROJECT

A. Technical Lessons

Need for Suitable Soils

3.01 The last thirty years of investigations into the possibility of large-scale irrigation schemes in the lower Tana basin have shown that good quality irrigable soils are the exception rather than the rule. Soils of doubtful quality can, with good management, produce satisfactory crops under irrigation. However, when the quality of management is eroded by remoteness, communication difficulties, delays in input supplies and other imperfections, then the possibility that there will be factors which will compensate for poor quality soils is much reduced. Thus timely and adequate water supplies become critically necessary conditions at Bura to compensate for poor quality soils. Conditions at Bura are such, however, as to make timely and adequate water supplies dependent on many variables. Adverse changes in any one of these variables jeopardises the water supplies upon which the project depends.

3.02 There was about the Bura scheme, during project conception and implementation, a momentum which resisted all attempts to halt or slow down the scheme despite clear signals which indicated trouble. By the time the appraisal report was written, there were sufficient doubts about the availability of good soils on the west bank of the Tana River, where most survey work had been done, to at least indicate caution when proposals were made to expand the scale of the project to include hoped-for better soils on the east bank. Economies of scale anticipated at the planning stage readily became diseconomies of scale at implementation when the "better" east bank soils failed to materialize.

3.03 Since the time of appraisal and the later decision to restrict the project to the west bank of the Tana River no additional soil studies within the project area have been carried out. From an agronomic point of view there is the experience of only three years of production of

cotton and maize. Cotton yields if not as high as estimated at appraisal are encouraging enough to assume an average yield of 2.5t/ha. No more than 2t/ha however can be assumed for maize. With the limited experience of agricultural production at Bura, the premise made at appraisal that Bura soils can produce satisfactorily with good management and sound irrigation practises has not yet been proved or disproved. In evaluating the "future development options" detailed in Chapter IV the mission has taken this into account as well as the fact that the best soils in Bura lie within the yet undeveloped portion of the project area --parts of Pumwani and Masabubu Commands. The unknown will be the result of cropping over a prolonged period. Continuous monitoring of soil conditions and yields is essential and strongly recommended.

Research - The Lesson

3.04 In hindsight the donors' decision at appraisal neither to cancel nor postpone the project until new feasibility studies were completed was unwise. Further research or a pilot project was desirable to test soil/water relationships and crop production from those soils. Either course would have delayed investment in an open-ended 6,700 ha scheme and one or the other would have confirmed that only low yields of maize[1/] were likely, and that crops such as groundnuts and cowpeas would give difficulties. Research or a pilot project would also have pointed to the need for a very high standard of management of all crops if satisfactory yields were to be achieved. The question of whether a settlement scheme or a large-scale plantation (with lower infrastructural costs) was the appropriate mode of production for the lower Tana basin might then have been faced. Further agricultural research would have expedited the selection of suitable varieties of maize and legumes for production at Bura and would have clarified the issue of appropriate cotton varieties.

Secure Water Supply

3.05 Experience at Hola, and now at Bura, underlines the unreliability of mechanical equipment when it is located in remote places without adequate management, stocks of spare parts, finance or

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1/ Crop yield projections at appraisal and in the Project Preparation Report were generally optimistic as was much of the data on which the project was founded.

transportation, and where only poorly trained operators and mechanics are responsible for its operation and maintenance. This is particularly trueof water pumps, without which the Bura project cannot function. Abstraction of irrigation water from the Tana River is at the heart of the Bura project. The first priority of project implementation was to secure the water supply under fail-safe conditions, that is whatever the state of spare parts, finance or trained mechanics, some water would still be available. Pumps alone can never satisfy this condition; an appropriate gravity feed system (i.e. weir, barrage or direct canal access), when necessary combined with pumps, can. It follows that a decision to rely entirely on pumps for water supply necessitates considerable standby capacity if the system is to be reliable. It is recommended: (1) all engines and pumps be overhauled (in progress) and a report on their condition be obtained from an independent mechanical engineer; (2) in view of the shortage of qualified operators and mechanics an operation and maintenance contract be entered into with a local engineering firm; and (3) stocks of spare parts be held at Bura.

Agreed. 2 done only.

Agreed

Integrated Pest Management (IPM)

3.06 A significant omission in the design and implementation of agricultural operations was the failure to appreciate the risks that large-scale use of biocides might have on the ecology of Bura. Experience elsewhere in Africa where chemical sprays have been used points to ever-increasing numbers of biocide applications having reduced effect. Integrated pest management (IPM) offers a way out of the vicious circle of more sprays breeding more resistant pests. This lesson has been learned in other African countries and should be applied to Bura. Furthermore, farming operations have not been undertaken in a timely manner resulting in cotton production over nearly a full 12 month period. If this continues a serious pest outbreak is inevitable. It is recommended that a system of IPM be introduced for the Bura project.

B. Management Lessons

Need for Scheme Autonomy

3.07 Overcentralization of project management has delayed supplies

of essential materials and prevented prompt reactions to crises by managers in the field. The result has been detrimental to project efficiency. When the full agricultural management team is installed at Bura, autonomy, including financial autonomy, is vital if the project is to continue. It is recommended that a large measure of autonomy be granted to the Bura management.

Failure to Strengthen Management - The Lesson

3.08 Bura is a very complex project with many facets. The appraisal report requirement that an experienced agricultural management firm should be in command for the first six years was both a recognition of its complexity and a method of dealing with it. It is unclear why no action was taken by the Kenya government or donors to ensure that a suitably qualified team was appointed as agreed at appraisal. The long delayed appointment of NEDECO for only six months in 1982/83 and its scheduled return in 1985 is too little and far too late. This failure to strengthen project management was a breach of the management convenants contained in the loan agreements made between the World Bank and the Kenya government. The management weaknesses became more apparent when services were handed over by the contractors to Bura management (water purification plant, electricity, etc.) and funds became scarce. Many subsidiary but vital facets of implementation were neglected such as forestry and fuel conservation and wildlife watering pools in addition to neglect of the maintenance of project irrigation and other facilities.

Effective Interministerial Cooperation

3.09 Cooperation between ministries and agencies concerned with implementation and operation of the Bura scheme has been ineffective. Responsibility for taking over completed parts of the infrastructure byappropriate ministries has been avoided except for the health center and schools. Implementation of secondary but crucial aspects of the scheme, such as forestry, has been delayed in part because responsibility for this development still remains unclear. For such complex schemes as Bura, bureaucratic delays must be avoided and interministerial cooperation is essential. The Interministerial Committee has been a constructive force in the past in analyzing Bura's financial problems and

there is place for this in the future. It is recommended that a steering committee be established to oversee development and to include representatives of all the ministries concerned in the Bura project, chaired by the Office of the President.

C. Financial and Economic Lessons

Marginal Economic Rate of Return - The Lesson

3.10 Construction and other costs in Bura's remote location were generally understated in the appraisal and planning reports. Physical changes in the project also contributed to cost increases compared to these reports. Their combined effects were not offset by increases in project revenue, which tended to decline in real terms owing to lower crop yields than anticipated and lower real prices for the main cash crops. The economic viability of the project at the outset was only marginal and was based on optimistic assumptions about project costs, the implementation period and project benefits; cost escalations due in part to changes in design after appraisal very quickly eroded this viability. A settlement project such as Bura necessitated considerable expenditure on physical infrastructure. It was clear, even at the design stage that this infrastructure would impose a large financial burden on the project and therefore increase the overall financial, if not economic, risk. To compensate for this risk, genuinely higher financial and economic rates of return on the project after allowing for appropriate contingencies should have been sought. Where management capacity for the project suggested a longer rather than a shorter period of implementation, caution was needed before reducing the time of implementation to create a satisfactory rate of return.

High Development Costs - The Lesson

3.11 By national and international standards, the investment per hectare at Bura, both at the outset (US$ 13,000/ha in 1976 prices) and during implementation (more than US$30,000/ha in 1979 prices) was very high, and needed special justification; no special case in favor of the project was made in the appraisal and planning reports. The high costs of the project have resulted in the project absorbing 23% of the Ministry

of Agriculture and Livestock development budget. Project funds from the Treasury are being severely delayed; project implementation has depended on the use of overdraft facilities, delays in settlement of accounts and use of funds earmarked for other NIB irrigation schemes. It is recommended that project funds be released at least six months in advance by the Treasury.

D. Alternative to Settlement Schemes - The Lesson

3.12 One of the overriding causes of the excessive investment in the Bura project has been the costs involved in settlement including infrastructure. Large-scale irrigation schemes as a means to promote settlement are costly and questionable. If the project had been designed as a large scale commercial plantation (precluding all parastatal participation), relying mainly on mechanized agriculture with little reliance on labor, very little settlement would have been entailed. Under these conditions, capital investment per hectare would have been lower, implementation would have been quicker and profitability would have been better. This argument is not a general case in favor of large-scale agriculture over small-scale farming because the tenant style of agriculture at Bura is not small-scale farming in the sense that the farmer has access and control over all his inputs (including land), his cropping pattern and the use of his family labor.

E. Project Not Replicable - The Lesson

3.13 Judged purely in economic and financial terms, the Bura project should not be replicated in other semi-arid areas of Kenya. If there are political and strategic reasons why such schemes should be developed, then the political will necessary to launch the schemes must also find the large subvention payments which will be necessary to sustain them.

F. Conclusion

3.14 Development projects which lack a sound technical base cannot be properly appraised. Where the technical base is lacking, further research or a pilot project are courses which can be safely recommended.

3.15 Complex projects require good management on site, with a high degree of autonomy to promote efficiency and prompt reaction to events. Failure to strengthen management in breach of convenants made in loan agreements, should be treated very seriously by both donors and borrowers if the project is not to falter. Sound management with autonomy is essential and is recommended.

3.16 The acceptance and implementation of projects such as Bura, displaces other, possibly better projects, at a cost to the nation. There is every indication that any large-scale irrigated settlement project in the lower Tana basin will prove to be as difficult and as marginal as Bura. Future irrigated settlement schemes which rely on the Tana River should be restricted either to the upper Tana basin or to the Tana delta. The Bura scheme should not be replicated. Development of the lower Tana basin may be better suited to large-scale irrigated schemes run by non-parastatal commercial organizations (as proposed by the Tana and Athi River Development Authority).

3.17 The Bura project, despite its initial difficulties, is launched and underway. If all past costs are taken into account, the project's economic rate of return is zero. Past costs, however, are sunk costs. Closure of the project would merely recognize past losses and prevent possible future gains. There are however, several possible options for development of the Bura project which if past costs are ignored, will yield positive economic rates of return. These options are explored in the next chapter of this report. As will be seen, the options are all dependent on government or donors finding appropriate resources for their initial funding as well as their necessary annual subsidies.

IV. FUTURE DEVELOPMENT OPTIONS

A. INTRODUCTION

4.01 With a considerable amount of investment already sunk in the infrastructure and land and water development of Bura, the financial and economic consequences of extending the project beyond its present (1984) size of 2,200 ha will be better than halting the project or abandoning it altogether. To abandon the project and close it down, with little chance of salvaging any of the investment, is to accept the loss of all investment to date and to rule out any possibility of future gains, no matter how small. To explore future options is also to pursue possible future net gains, provided those gains are realistically construed and have a real chance of being achieved.

4.02 The development options discussed include provisions for an improved and adequate water supply. One option keeps the project at roughly its present scale, but all others increase the scale of operations and attempt to reduce overhead costs in some cases by temporarily introducing commerical farming. Two options propose a change from pump-fed to gravity irrigation. Gravity involves a more appropriate technology for Bura, both for agriculture and for fuelwood production.

4.03 In view of the limited financial resources available from either donors or the government of Kenya, additional investment funds for the various options will have to be generated as far as possible from a reallocation of available resources. Consideration of these options will not result in a financially viable (or bankable) project; the exercise is meant to optimize the use of the investments already made and to minimize future subsidies required.

B. Limits of Available Land for Development Options

4.04 The major reason for limiting the development of the west bank to 6,700 ha during phase I was serious doubts about the suitability of soils in the project area. Given the many constraints at Bura, it will take at least another ten years before expansion of the project beyond phase I can be proposed and justified. So far, there has been no justification for extending the project to the east bank of the Tana. The Tana and Athi River Development Authority (TARDA) has switched its development priorities to the Tana delta. In the absence of an explicit official long term irrigation development policy, the development options considered here limit themselves to the boundaries of phase I. The land available in phase I and beyond is shown in Table 4.1.

Table 4.1: Land Available for Development Options, 1984 Onwards

		Commands					
				Pumwani			
	Total ha	Bura ha	Chewele ha	North ha	South ha	Masabubu ha	Others ha
Present objective of NIB	3,900	1,470	730	1,000	700	-	-
Available for use on completion of main canal	1,410	-	-	-	-	1,140	-
Area requiring improvement before it can be used	1,140	270	20	420	400	300	-
Reserved as prison farm	250	-	-	-		-	250
Phase I area	6,700	1,740	750	1,420	1,100	1,440	300

Source: Agricultural Annex of this report and mission assessment.

4.05 For practical purposes, the area used in evaluating the development options consists of that shown in the first two lines of the table, totalling 5,040 ha. The balance of Phase I requires further land development[1/]. Before land in the Masabubu command can be used, the main canal must be extended by 8 km to allow irrigation to proceed. (For all options, the mission strongly recommends completion of the main canal in substitution for the proposed flood

1/ Land development for the balance of 1,960 ha is at an estimated cost of KSh 5,000/ha.

protection bund.) About 600 ha in Pumwani South and 1,100 ha in Masabubu are yet to be harrowed and land planed.

C. Criteria for Selecting Development Options

4.06 Five basic development options in Table 4.2 were chosen by the mid-term evaluation mission according to the five following considerations. First, given three years production experience and the existing conditions at Bura in late 1984, a realistic view of future possibilities was necessary. Second, the physical availability of land and the area under command, for either settlement or commercial farming, constrains the scale of the development options. Third, the type of water supply at the head of the conveyance system and its operational costs largely determine the magnitude of investment needed to irrigate the area of land chosen. Fourth, the need to limit the recurrent expenditure required by the project while at the same time establishing a minimum income for tenants sufficient to prevent their desertion from the scheme, was considered as fundamental to the success of all development options. Fifth, the expansion beyond the 3,900 ha into the Masabubu Command would bring the highest class soils of the Bura scheme into cultivation. The basic physical parameters of the options chosen are summarised in Table 4.2.

Table 4.2: Summary of Physical Parameters of Development Options

Option	Type of water supply	Total Area under cultivation (ha)	Total Area under Settlement (ha)	Commer-cial (ha)	Period of Major Investment (Years)
1	4 pumps	2,500	2,500	-	2
2	6 pumps	3,900	3,900	-	2
3	6 pumps	3,900	2,800	1,100	2
4 a	8 pumps	5,040	3,200	1,840	3
b	Gravity intake and 6 pumps as standby	5,040	3,200	1,840	3
c	Gravity intake and 6 pumps as standby	5,040	5,040	-	3
5	Fixed weir, with 6 pumps during its construction	5,040	5,040	-	6

Source: Mid-term Evaluation mission.

4.07 The idea of introducing commercial farming to the Bura scheme was first mooted by the Inter-ministerial Committee in 1983. Proposed here as an intermediate stage in the settlement process, commercial farming would require leases of uniform blocks of land of 1,000 ha or more for a period of at least five years. In order for the Kenya government to have the freedom to introduce settlers on temporary leased land at an appropriate future date, the NIB would act as water undertaker, which means that the commercial farms will not be required to invest capital in land and water development. The commercial farms under options 4a and 4b will be located in Pumwani South and Masabubu commands. Under option 3, 700 ha of Pumwani South command and 400 ha of Pumwani North command will make up the 1,100 ha of commercial farm proposed. A distinct disadvantage about this third option will be the mixing of settler and commercial interests in the same command.

D. Irrigation Efficiency

4.08 An important criterion for determining the maximum pump station capacity is the calculated maximum discharge required at the canal head. The lower the overall irrigation efficiency of the project, the higher is the required pump capacity during peak demand, i.e. during May and June. The overall project irrigation efficiency was estimated by Sir M. MacDonald & Partners (Design Criteria Report 1977) at 49 percent. The mid-term evaluation mission believes that this efficiency is too high for the conditions now prevailing in Bura. Estimating the field efficiency at 55 percent and the conveyance efficiency at 70 percent, the mission believes that the overall efficiency of the project is only 40 percent at the most. As a consequence, the calculated maximum discharge required at the canal head for 3,900 ha will increase from 5.04 m^3/sec (as per MacDonald & Partners) to 6.20 m^3/sec (see Table 4.3).

Table 4.3 Comparision of Gross Monthly Water Requirements for Different Development Options (in m3/sec)

Month	Net Water Requirement for 6,700ha	Efficiency %	Gross Water Requirement 3,900 ha	Gross Water Requirement Based on monthly efficiency of 40% 2,500 ha	3,900 ha	5,040 ha
January	0.38	23	0.98	0.36	0.56	0.72
February	2.58	45	3.36	2.44	3.81	4.92
March	3.55	47	4.38	3.36	5.24	6.77
April	2.13	43	2.85	2.02	3.15	4.07
May	4.20	49	5.04	3.97	6.20	8.01
June	4.14	49	4.98	3.92	6.11	7.90
July	2.92	46	3.72	2.76	4.31	5.57
August	1.19	36	1.91	1.12	1.75	2.26
September	1.73	41	2.46	1.70	2.65	3.42
October	2.00	43	2.75	1.89	2.95	3.81
November	1.54	40	2.27	1.46	2.27	2.93
December	1.06	35	1.78	1.01	1.57	2.03

Note: Domestic water supply ($0.05m^3$/sec) and forestry ($0.65m^3$/sec) requirements are not included in the figures above.

Source: Sir MacDonald & Parterns, Report on Design Criteria for Irrigation and Drainage, March 1979 and mission estimates.

Based on the water requirements given in the last three columns of Table 4.3 the annual volumes of water to be supplied for the areas applicable to the development options are 68.4 million m^3 for 2,500 ha, 107.4 million m^3 for 3,900 ha and 137.8 million m^3 for 5,040 ha.

E. Pump Station Capacity

4.09 In view of past experience and the many problems which have surrounded the pump station, it is self-evident that when pumps are used for water supply, a safety margin of spare pumping capacity is necessary to secure reasonably guaranteed water to the project. The installed capacity of the pumping station in 1984 was 6.45 m^3/sec. Using MacDonald's overall project efficiencies shown in Table 4.3 and the corresponding gross water requirements for 3,900 ha (the NIB's revised project size), the installed pumping capacity would appear to be adequate. However after applying the revised overall project irrigation efficiency of 40 percent it is equally apparent that the peak demands in May and June, at 3,900 ha, can only be met when all four pumps operate continuously for 24 hours a day. Past experience eloquently denies this possibility.

Pump Station Output Criteria

4.10 The mid-term evaluation mission has therefore adopted the following capacity criteria for pump development options at Bura.

a) During peak water demand, a standby pump capacity should be respected as follows:

2,500 ha - one full duty pump (2.15m^3/sec) or 33 percent of total pump station capacity of 6.45 m^3/sec;

3,900 ha - one and a half full duty pumps (3.225 m^3/sec) or 30 percent of the total installed capacity of 10.75 m^3/sec;

5,040 ha - two full duty pumps (4.30 m^3/sec) or 29 percent of the total installed capacity of 15.15 m^3/sec;

b) Due either to ageing of pumps or low river water levels, the output of the pump units will be 95 percent of their design capacity;

c) Those pumps in full operation will need approximately 18 hours per week for daily maintenance etc., reducing their daily output to 90 percent.

4.11 On the basis of these assumptions, the effective outputs as a percentage of rated capacity of the various configurations of pumps are 2,500 ha (4 pumps) - 56 percent; 3,900 ha (6 pumps) - 60 percent and 5,040 ha (8 pumps) - 60 percent. Table 4.4 compares effective outputs of the pump configuration with maximum gross monthly requirements for the three development option areas. There is a greater degree of spare capacity when the option area is 5,040 ha, a necessary precaution when such a large area is dependent on pumped water supply.

Gravity Intake

4.13 The gravity intake proposed for options IVb and IVc will be located 12 km upstream of the present pumping station at site number 1, originally located by Sir MacDonald & Partners[1/]. Site number 1 was once considered as a temporary gravity intake for water pending the construction of permanent river diversion works. This idea was rejected because of its high capital cost and a temporary pumping station was constructed instead. The meandering characteristics of the Tana River mean that a direct offtake structure cannot alone be considered as a completely reliable water source. Siltation, bank erosion and blockage during flooding may cause a temporary stoppage of water. However, when the direct offtake structure is used in conjuction with pumps, the reliability of supply will be much improved.

4.14 On the basis of river water levels recorded at the site during MacDonald's 1978 survey, the supply canal can be commanded by gravity, provided upstream reservoirs regulate river flow to a minimum discharge of $35 m^3/sec.$[2/]. Three critical events may reduce water availability from the gravity offtake. They are:

a) very low river flows. On the basis of a brief review of the TARDA simulated river flows for the Tana River (Sir M. MacDonald & Parters, 1984), low water levels are estimated to cause an intake reduction of less than 5 percent in any year.

b) Closure of the intake during floods, which is likely to occur during May, November and December. There is a probability that the intake would be closed by floods during these months for one year in three, causing an average annual reduction in flow of about 10 percent. Such closures would affect the Bura project in May when the irrigation of cotton is at its peak.

1/ Interim Design Report on River Diversion, Sir M. MacDonald & Partners, 1979.

2/ Ibid.

c) flood damage. Overspill, however, will tend to occur on the east bank of the river, because it is lower than the west bank.

4.15 It is estimated that the gravity intake will be capable of providing 80 percent of the Bura project's annual water requirements. In addition, when it is used, the pump station silting basin can be drained and cleaned by mechanical excavators. If the gravity intake and other earthworks are undertaken, the mission recommends that they are made the subjects of an open tender, which will avoid the delay which might arise if the project's already assigned earthworks contractor is used.

River Diversion Structure

4.16 The range of development options would not be complete if construction of a weir as the principal source of water had not been included as option 5. Several sites suggest themselves for this fixed weir, all of which would need review[1/]. However, pending such a review, for the purposes of illustration of a representative site, the mid-term evaluation mission has chosen for this option the same site which featured in the ILACO designed weir of early 1977. It is situated at Nanigi, just north of the present pumping station, and will require a 7 km earthwork canal to connect it to the existing supply canal. If the Nanigi weir is physically viable, then no studies and designs additional to the ILACO studies would be necessary, thus keeping extra costs to a minimum and speeding up implementation.

Required Studies Before Investment

4.17 None of the river water offtake methods discussed above can be undertaken without further enquiries. It is recommended than an independent consultant makes an assessment of of the technical viability

1/ In general, a fixed weir and a barrage are identical in meaning. However, because a barrage may also include a moveable gate, the term fixed weir has been used here.

of the inclined pumps of the existing pump station, with particular regard to the water-lubricated rubber bearings. Under the gravity options (4b and 4c), these pumps would be used only occasionally, which might cause deterioration of the rubber bearings. Before the present temporary pumping station can be declared a permanent option, it requires a similar independent consultant's assessment. Terms of reference need to be drawn up for this study. Similarly, terms of reference would be needed for studies of the gravity fed options (i.e. direct river offtake and fixed weir). The mission recommends that, until these studies are completed, the Bura project be consolidated at 2,500 ha, which would allow time to adjust and improve its organizational and managerial structure.

G. The Forestry Component

4.18 For illustration purposes only a forestry component of 900 ha gross (775 ha net, after allowing for roads, firebreaks etc.) has been included in all options. This area can be increased or decreased depending on the needs and type of water supply. A forestry block of 600 ha (gross) just north of the Bura command has already been prepared for planting. The balance of 300 ha (gross) should be so located as to make use of waste water from drains or spillway where supply is pumped. Alternatively, land which is unsuitable for agricultural production in any of the existing commands can be used.

4.19 When the option relies on pumped water, the supply to the forestry plantation will be limited to the seven month off-season, when no water is required for cotton crops. Under these conditions of irregular irrigation, annual production of fuelwood is expected to be 15 m^3/ha[1/]. Where gravity-fed water allows more regular irrigation, yields are expected to rise to 25 m^3 of fuelwood per ha per year. Harvesting will take place at five year intervals with four coppice rotations and one final felling, necessitating replanting after 25 years. Establishment costs therefore are spread over this period. The

1/ The project's forestry consultants (funded by FINNIDA).

rate of establishment is 155 ha/year. Under the gravity options (i.e. 4b, 4c and 5) production from the forestry plantation will be 125 percent of needs for the maximum number of settlers. Option 2's forestry component will supply only 63 percent, options 3 and 4a, only 75 percent, and option 1, 90 percent of maximum fuelwood needs[1/]. The varying fuelwood gaps in Options 1, 2, 3 and 4a will have to be met from other sources, such as controlled riverine forest cutting or "imports" from other areas of Kenya.

4.20 The species of tree proposed for the fuelwood plantations is Prosopis chilensis[1/]. It will be established by direct sowing plantations. A nursery capable of producting 20,000 seedlings a year for amenity tree planting will also be established.

H. Costs and Benefits of Options

General Derivation of Costs

4.21 Time did not permit a detailed costing of all options based on suppliers' and contractors' quotations. Many costs were obtained from recent tenders available at NIB. Some irrigation recurrent costs were obtained from the Third Inter-Ministerial Committee report of November 1983. Major irrigation and river works costs were obtained from previous studies or reports (updated for contingencies and inflation or from recent contract rates which applied at Bura), such as the appraisal and project planning reports (for option 5) and Sir M. MacDonald & Partner (option 4 gravity feeds). Further details of river water extraction costs are given in Appendix 3.

Mechanical Cultivation and Ginnery Requirements

4.22 Wherever possible, capital and operational costs have been reduced from the levels suggested at appraisal or incurred in 1984. For example, contract mechanical cultivation rates offer advantages over the costs of supplying and maintaining a fleet of tractors and implements, especially when reduced operations on 50 percent of the project area

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1/ Also known as Proposis juliflora

are taken into account (see Agricultural and Farm Budget Annexes). The mission recommends that every effort to reduce operating costs be explored including land preparation by contract. A further example of cost reduction is the elimination of a cotton ginnery for Bura. In 1984, the Hola ginnery was undergoing a rehabilitation program designed to increase its ginning capacity to 18,000 lint bales a season. Two hundred kilometers south of Hola, at Malindi, a private sector ginnery consisting of 35 single roller gins had, in 1984, a capacity with two working shifts of about 8,000 lint bales a season. This capacity could be doubled through a combination of three working shifts and an extended ginning season, or by installing double roller gins in place of single roller gins. At full development, Bura would produce seed cotton from 5,040 ha, while Hola will produce from 850 ha. At yields of 2.5/ha, total production from Bura and Hola combined will be 14,700 tonnes of seed cotton, which is equivalent to 4,800 tonnes of lint or 26,000 bales. Once the Hola ginnery is working at maximum capacity (i.e. 18,000 bales), the Malindi ginnery should be able to absorb the excess. If the private owners of the Malindi ginnery see Bura and Hola as reliable sources of seed cotton, they will be encouraged to increase their capacity in line with increased seed cotton supply. The investment for this increased capacity would be entirely within the private sector and would not need government participation.

Benefits

4.23 The field crops grown under all the options are cotton and maize. Yields are assumed to be static over time at 2.5 t/ha and 2 t/ha respectively. Producer prices for these crops are those prevailing in late 1984, namely KSh 4.75/kg for seed cotton and KS 2/kg for maize. Yields and prices of garden produce are assumed at 14 t/ha and KSh 2/kg respectively.

4.24 For economic analysis of the project options a slightly different price is used for seed cotton, reflecting the economic value of this crop to the national economy. A seed cotton price based on export parity and an efficient Cotton Lint and Seed Marketing Board (CLSMB) is used (see Table 4.5). In October 1984, the export price of BPA 75 lint was estimated at US$0.84 per lb. No actual export prices were available,

as BPA 75 had not recently been exported. On the contrary, 8,000 bales of Tanzanian lint were imported in early 1984 at a CIF price of US$0.96 per lb. In 1984 therefore, the import parity price was considerably greater than the export parity price. For the purposes of the economic analysis therefore, the more conservative export parity price was chosen.

Table 4.5 Derivation of Economic and Financial Price of Seed Cotton 1984

(In KSh per kg of lint)	Economic Price Hola	Economic Price Malindi	Financial Price Hola	Financial Price Malindi
Export price FOB Mombasa BPA lint US$.84/lb	27.70	27.70		
Domestic price for lint fixed by government			25.30	25.30
Deduct: Export costs	0.34	0.34	-	-
Lint Transport & Storage	0.46	0.19	0.46	0.19
Ginning costs	3.25	3.25	3.25	3.25
	23.65	23.92	21.59	21.86
Add: Cotton seed sales	2.32	2.32	2.32	2.32
Price at ginnery	25.97	26.24	23.91	24.18
Less: Transport & Storage of seed cotton	1.06	1.98	1.06	1.98
Normal CLSMB costs (buying commission, cotton services, interest)	5.88	5.88	5.88	5.88
Estimated Other Losses and Overheads of CLSMB	-	-	2.42	1.77
Equivalent lint price at farmgate	19.03	18.38	14.55	14.55
Seed cotton price (33%)	6.28	6.07	4.8	4.8

Source: Cotton Lint and Seed Marketing Board.

4.25 In the economic price calculation in Table 4.5, the estimated other losses and overheads of the CLSMB are not deducted on the grounds that an efficient organisation would not incur these expenses. By taking the average economic seed cotton price at Hola and Malindi ginneries, an economic farmgate price of KSh 6.2/kg is estimated (export-parity based).

4.26 By the same token of an efficiently run CLSMB, it also appears that the financial farmgate price of seed cotton is low compared to what it would be if the Board did not incur other losses and overhead of KSh 1.77 to KSh 2.42 per kg of lint. The financial analysis below therefore is conducted at two seed cotton prices: the first being the existing price in 1984, the second being a price 20 percent greater than the 1984 price. The higher price could be justified if CLSMB improved their efficiency and if proper recognition were given to Bura's high quality lint and its relatively low cost of collection at the ginnery.

4.27 Also included in the economic analysis is a value of KSh 400 per cubic meter for fuelwood produced on the project's forestry plantation. This price is based on the delivered price of mangrove poles trucked in from forests at the coast (the cheapest alternative fuelwood source if the irrigation plantations were not established and fuelwood collection was prohibited).

4.28 In those options which include a commercial farm element, (options 3, 4a, 4b), a minimum land and water charge of KSh 3,000 per ha is made on the commercial farm. This is the only income received by the project from commercial farming and features in the financial analysis[1/]. In the economic analysis, the estimated gross crop revenue less costs are treated as the net benefits from commercial farming. A typical farming pattern for a commercial farm has been chosen. It is cotton (2.5 t/ha), maize on 50 percent of the land (3.5 t/ha), and a small area of grass seed as an additional export crop (0.54 t/ha). Unit prices for these crops are KSh 6.2/kg[2/] seed cotton, on the basis that the farming company can market it without going through the CLSMB, KSh 1.76/kg for maize and KSh 45/kg for grass seed. Total employment on a commercial farm is expected to be about 25 persons per 1,000 ha.

1/ As well as the project featuring commercial farming as a means of using the area with low overhead costs, certain management tasks such as running the pumping station could be contracted out to the private sector, with probable cost savings. Such a strategy has only been included in the short run (for three years) in the analysis.

2/ A deliberately conservative figure, based on a 20% increase over our current prices.

I. Financial and Economic Assessment of the Options

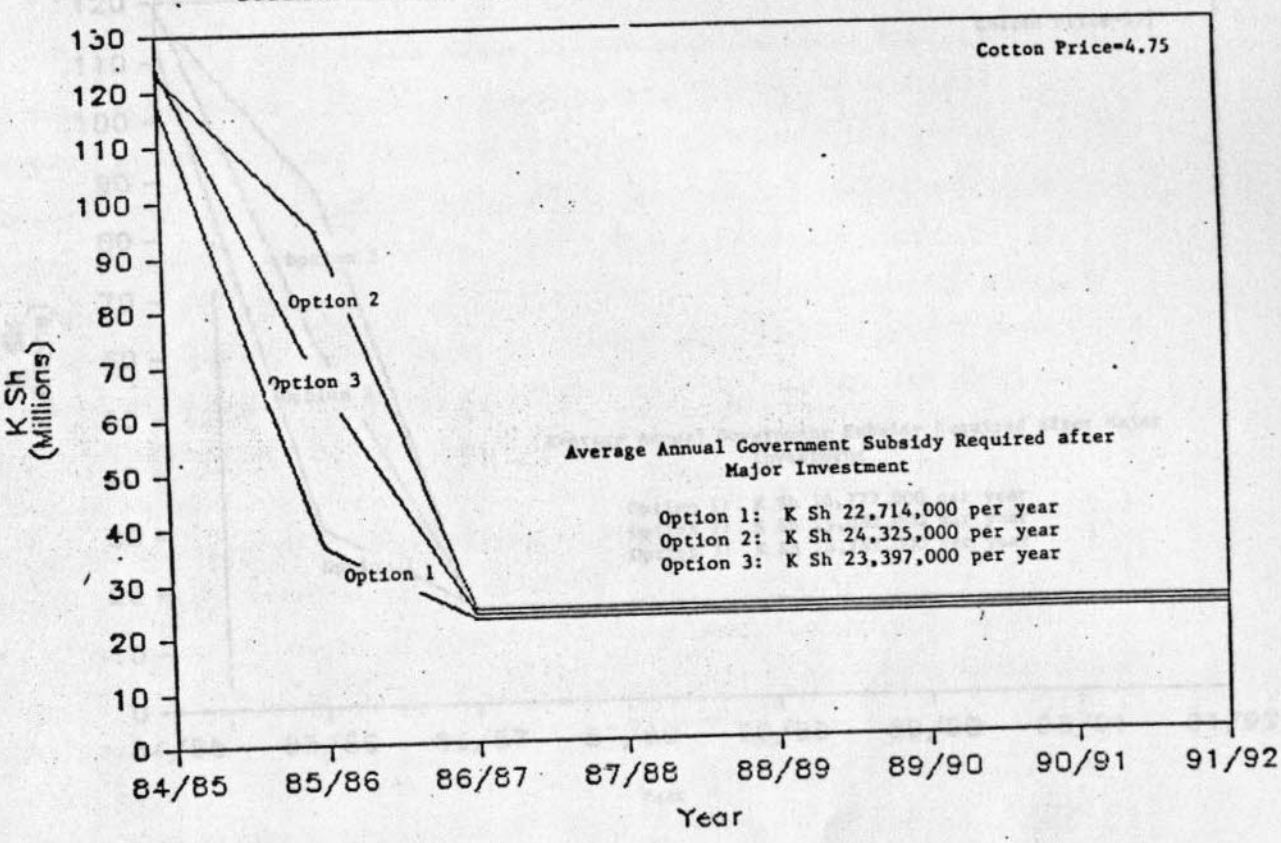
4.29 The statistical annex to this report brings together all costs and revenue assumptions for each option and presents a year by year summary of necessary financial outlay. These summaries, and the resulting tables given below, are tentative estimates only of the option results; they do not represent complete accounting accuracy but they give the order of magnitude of expenditure which each option requires. Benefits for each option were assessed on the basis of two financial seed cotton prices, namely KSh 4.75/kg (current price) and KSh 5.7/kg (20% increase in current price). Consequently, the effect of a higher seed cotton price can be seen on investment needs and future government subsidies.

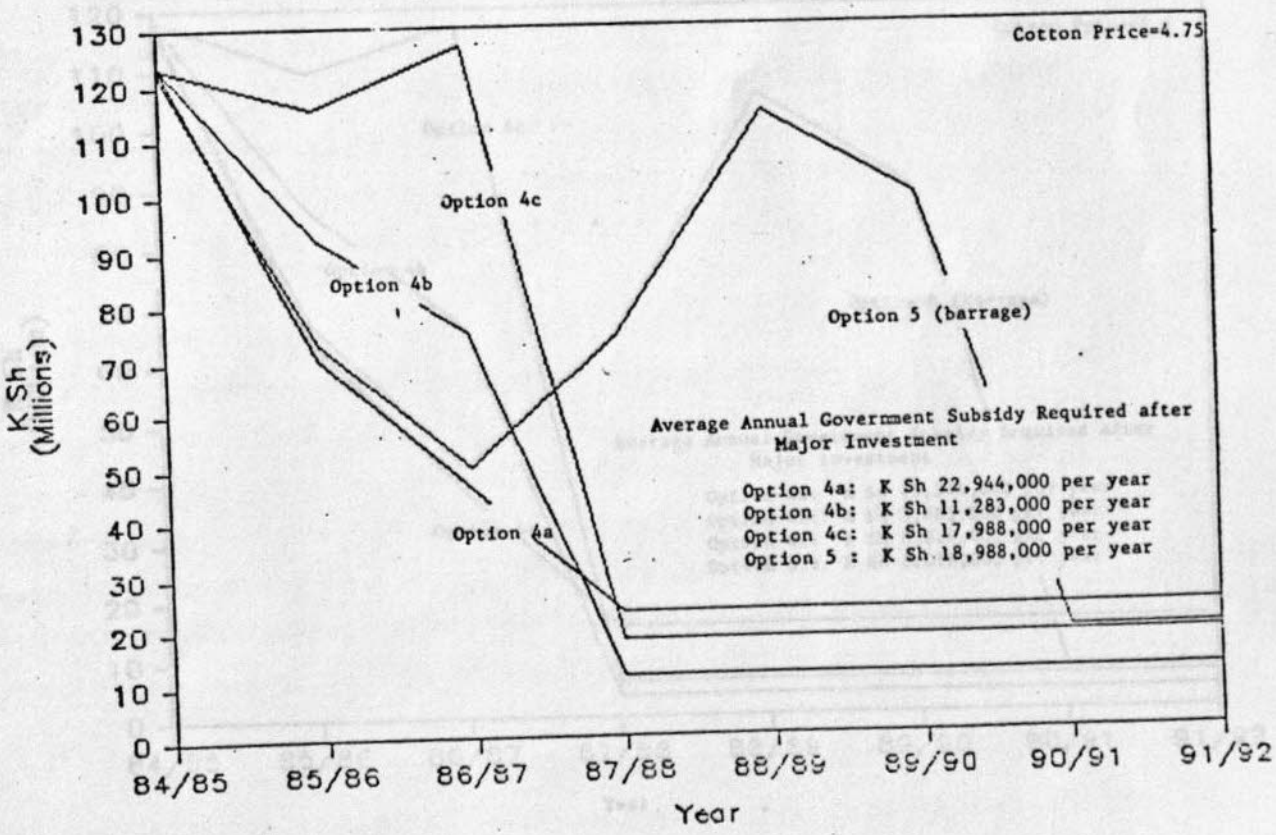
4.30 The government subsidies payable in all options include a target for settler incomes, assessed by the evaluation mission as KSh 10,000 (including value of subsistence crops) per settler on plot sizes of 1.25 ha, and KSh 12,000 on plot sizes of 1.5 ha. When taking an average of these, a gross settler target income of KSh 11,000 has been used in the financial analysis. For economic purposes however, the value net of family labor has been shadow priced at KSh 4,000 per settler per year, based on the average income earned by settler families prior to their coming to Bura.

4.31 All options have a similar pattern of financial outlay. The initial years of development (between two and six years) require high outlays, while subsequent years fall to a fairly regular goverment subsidy. All options consider as a cost both incremental investment expenditure and the investment expenditure already committed but not yet spent, but about which nothing can be done. This committed development expenditure is estimated by the mission at KSh 76 millions. As Figure 4.1 shows, annual expenditure during the period of development varies between KSh 36 million and KSh 127 millions, depending on the option and depending on the development year (assuming the lower seed cotton price). Results are that government subsidies to the project after the initial investment period are lowest in those options which include a gravity intake (i.e. 4b and 4c).

Figure 4.1

Comparison of Annual Government Subsidy Required to Meet Target Settler Income* under Development Options With Current Cotton Producer Price (4.75)



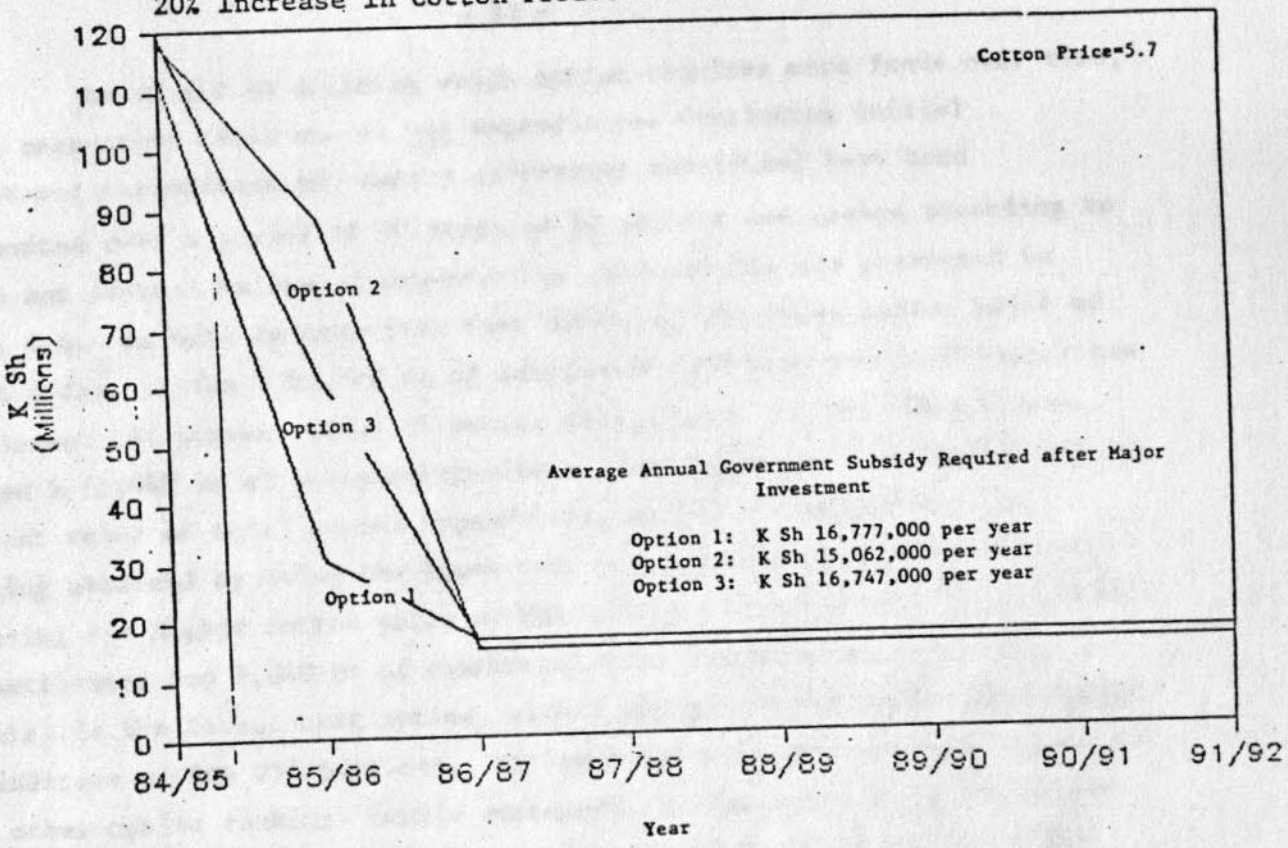


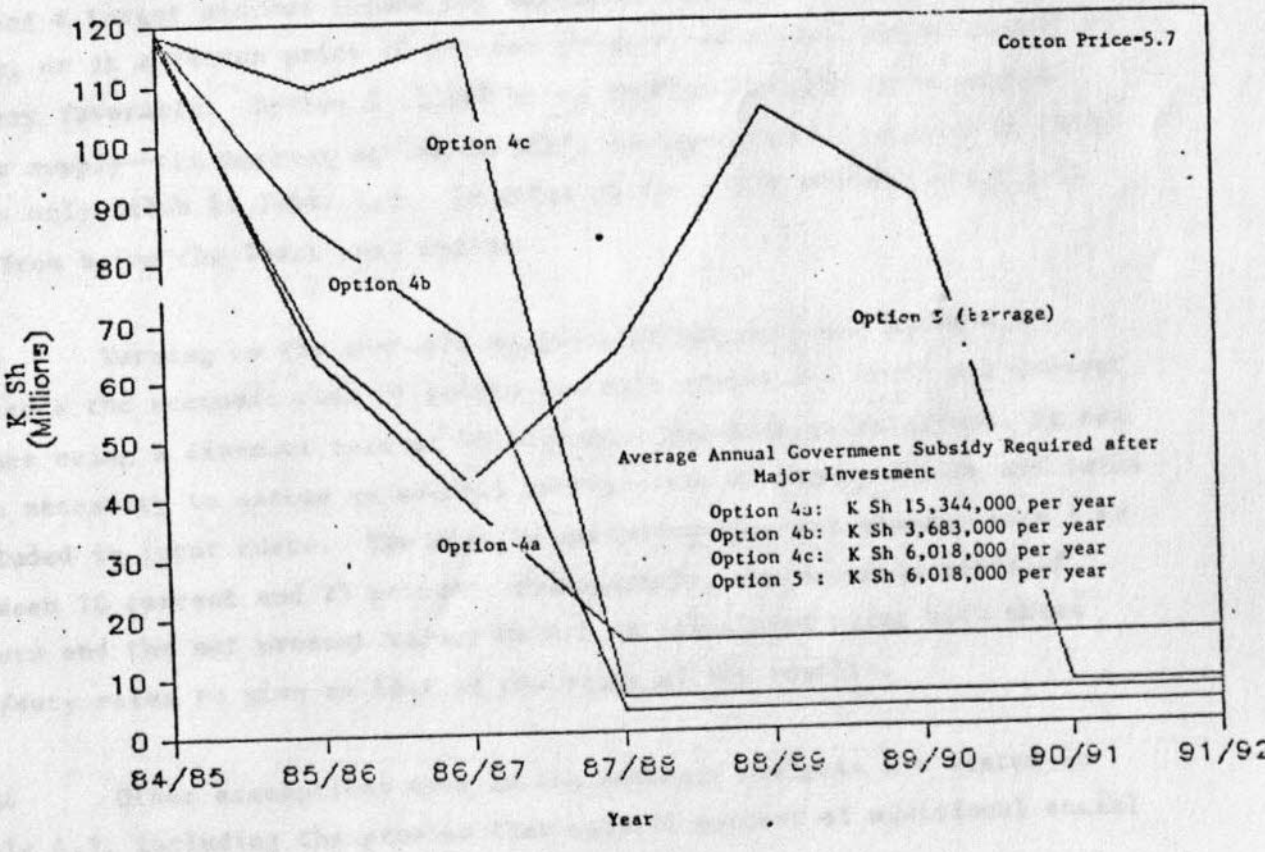
Note: Major investment period is two years for options 1, 2, and 3, three years for options 4a, 4b, 4c, and six years for option 5 (barrage). For further details see financial tables in Statistical Annex.

* See text for explanation.

Figure 4.2

Comparison of Annual Government Subsidy Required to Meet Target Settler Income* under Development Options With 20% Increase in Cotton Producer Price (5.7)





Note: Major investment period is two years for options 1, 2, and 3, three years for options 4a, 4b, 4c, and six years for option 5 (barrage). For further details see financial tables in Statistical Annex.

* See text for explanation.

4.32 As an aid to deciding which option requires more funds over time, their respective total annual net expenditures (including initial investment expenditure and future government subsidies) have been discounted over a period of 30 years at 10 percent and ranked according to their net present values of expenditure. The results are presented in Table 4.6. As will be seen from that table, at the lower cotton price of KSh 4.75/kg, option 1 (2,500 ha of settlement with pump-supplied water) has the lowest net present value of annual expenditure, at KSh 310 millions. Option 5 (5,040 ha of settelement with a fixed weir) has the highest net present value of total annual expenditure, at KSh 483 millions. The ranking obtained by using the lower cotton price is only slightly altered by using the higher cotton price of KSh 5.7/kg. Then, option 4b (3,200 ha of settlement and 1,840 ha of commercial farm, supplied by a gravity intake) is the lowest cost option, with a net present value of total annual expenditure of KSh 253 millions. Option 1 falls to second place, while all the other option rankings remain unchanged, in the order 3, 4a, 2, 4c and 5. Thus, if government policy is to minimize expenditure on Bura after meeting a target minimum income for settlers, then at the present cotton price, or at a cotton price 20 percent greater, options 1 and 4b appear to be very favorable. Option 2 (3,900 ha of settlement based on a pumped water supply--the nearest option to NIB's revised project decided in 1983) ranks only fifth in Table 4.6. In other words, NIB's revised project is far from being the least cost option.

4.33 Turning to the economic analysis of the options, Table 4.7 presents the economic rate of return for each option and their net present values using a discount rate of 10 percent. For both calculations, it has been necessary to assume an overall average rate of import duties and taxes included in input costs. The mission estimates that the average rate lies between 10 percent and 15 percent; consequently, the economic rates of return and the net present values have been calculated using both these tax/duty rates to give an idea of the range of the results.

4.34 Other assumptions used in the economic analysis are stated in Table 4.7, including the proviso that only 75 percent of additional social

Table 4.6

FINANCIAL AND RISK RANKING OF DEVELOPMENT OPTIONS

Ranking of Options by Total Financial Cost to Government over the next 30 Years (Net Present Value figures (K Sh 000) in parentheses)

Ranking Lowest Cost to Highest	Current Cotton Price (4.75)	Project Risk*	With 20% increase in Cotton Price (5.7)	Project Risk*
(1)	OPTION 1: (-310,037,000) (2500 ha of settlement with pumps)	Medium	OPTION 4B: (-253,000,000) (5040 ha of settlement/ commercial with gravity	Low
(2)	OPTION 4B: (-320,788,000) (5040 ha of settlement/ commercial with gravity intake)	Low	OPTION 1: (-255,036,000) (2500 ha of settlement with pumps)	Medium
(3)	OPTION 3: (-345,208,000) (3900 ha of settlement/ commercial with pumps)	Medium-High	OPTION 3: (-255,036,000) (3900 ha of settlement with pumps)	Medium-High
(4)	OPTION 4A: (-361,005,000) (5040 ha of settlement/ commercial with pumps)	High	OPTION 4A: (-293,218,000) (5040 ha of settlement/ commercial with pumps)	High
(5)	OPTION 2: (-375,502,000) (3900 ha of settlement with pumps)	Medium-High	OPTION 2: (-294,928,000) (3900 ha of settlement with pumps)	Medium-High
(6)	OPTION 4C: (-428,159,000) (5040 ha of settlement with gravity intake)	Low	OPTION 4C: (-328,794,000) (5040 ha of settlement with gravity intake)	Low
(7)	OPTION 5: (-483,029,000) (5040 ha of settlement with barrage)	Very Low	OPTION 5: (-391,189,000) (5040 ha of settlement with barrage)	Very Low

Note: Discount Rate=10%, for detailed financial tables see Statistical Annex.

*Project risk of options was assessed by the evaluation mission's irrigation engineer based on two factors: the risk of the irrigation method and the project size. For example, the pumped water option 4c is judged to be higher risk than the pumped water options 1 to 3 simply because a larger area is exposed to that risk.

Table 4.7
ECONOMIC ANALYSIS OF PROJECT OPTIONS

Option	Eventual Hectares*	Water Source	Economic Rate of Return		Net Present Value** (K sh 000)		Ranking of Options by Net Present Value (High to Low)
			taxes=15%	taxes=10%	taxes=15%	taxes=10%	
1	2500 ha of settlement	Pumps	11%	5%	5400	-17800	Option 4b
							Option 4c
2	3900 ha of settlement	Pumps	18%	14%	60700	29400	Option 4a
							Option 2
3	2800 ha of settlement; 1100 ha of commercial	Pumps	18%	13%	52658	20000	Option 3
							Option 5
							Option 1
4(a)	3200 ha of settlement; 1840 ha of commercial	Pumps	23%	18%	108100	70400	
4(b)	3200 ha of settlement; 1840 ha of commercial	Pumps then Gravity	22%	18%	141500	105000	
4(c)	5040 ha of settlement	Pumps then Gravity	18%	15%	113700	76600	
5	5040 ha of settlement	Pumps then Barrage	12%	9%	27500	-11200	

* Commercial hectares could be replaced with settlement after commercial lease expires
** Discount rate=10%

Note: for detailed tables see Statistical Annex

Assumptions Used in Analysis

1. Foreign exchange is shadow priced at K sh 16.5 = US $ 1.
2. Family labor is valued at K sh 4000 per year
3. Project life is 30 years.
4. Only incremental investment is included (all sunk costs are excluded, including investment already committed in 1984/85). 20% of recurrent costs for 1984/85 are excluded because they are already incurred. Incremental benefits (resulting from incremental investment) exclude the cotton crop from 1984/85 but include other crops in 1984/85 and all crops thereafter. These benefits are truly incremental because they can be achieved only with improved water reliability and additional additional crop inputs.
5. Taxes are assumed to be either 10% or 15% of total project cost.
6. Fuelwood is valued at K sh 400 per cubic meter of solid wood (based on cost of importing fuelwood from the coast)
7. Only 75% of the costs of additional social infrastructure are included (schools and houses).
8. Only 25% of the costs of operation and maintenance of drinking water are included.
9. Cotton is valued at export parity (K sh 6.2 per kilo of lint). See text for explanation of cotton price.

to 3,200 ha and a commercial farm would operate the remaining 1,840 ha. If large scale commercial farming is indeed the correct mode of development for the remote and difficult area of the lower Tana basin, implementation of option 4b will demonstrate that conclusively.

4.38 One option which is not illustrated in Figures 4.1 and 4.2. nor in Tables 4.6 and 4.7 is the close-down option. For a relatively small sum of about KSh 20 millions, the existing settlers on the Bura scheme could be compensated and contractors' claims could be settled, and the project could be abandoned, or leased by NIB to a commercial firm as a potential plantation site. It is very unlikely, however, that the late 1984 condition of the Bura scheme, even if cleared of settlers, would appeal to a commercial venture on a short term lease. After securing adequate water supplies and paying for the operation and maintenance of a very large irrigation system, NIB would need to charge the commercial venture a very high land and water cost, estimated at up to KSh 5,000 per ha. Given the risks involved, and the capital which a commercial venture would have to find, the mission believes that the option of close-down and subsequent short term lease by plantation agriculture is not a real option.

4.39 In that event therefore, and given the difficulties of abandoning the scheme, resort to some development option is imperative. There are no easy choices, and all options considered here require large annual government subsidies (see figures 4.1 and 4.2). All options require substantial improvement in management. Without these improvements the cost of the options are presented underestimated and the benefits overestimated. For technical, financial, and economic reasons we strongly recommmend that options 4b be pursued, if adequate funding can be mobilized. The first step twards option 4b is to have a feasibility study for the river diversion structure. Until this study is completed, we recommend the Bura project should be consolidated at 2,500 ha. We further recommend that if the adopted option includes a commercial operation that serious consideration be given to the commercial company assuming management responsibility for the entire project. Any agreement must include adequate safeguards to fully protect tenant welfare.

APPENDIX 1

SUMMARY OF LESSONS AND RECOMMENDATIONS

(From Main Report Chapters II, III, IV and Annexes I, III, IV and V)

SUMMARY OF LESSSONS AND RECOMMENDATIONS

Chapter II

See Paragraph

2.10 It is the evaluation mission's recommendation that there is no justification for large scale irrigation on the east bank of the lower Tana at this time.

2.17 Recommends that basin irrigation as an alternative to to furrow irrigation should be used in areas with shallow top soils.

2.25 Recommends field trails of Acala varieties be carried out

2.28 Recommends all cotton planting be completed by mid April.

2.33 Recommends responsibilities of agencies involved in the forestry component be more clearly defined.

2.34 Recommends the introduction of wood burning jikos.

2.35 Recommends support for management of the Tana River Primate Reserve.

2.37 Recommends additional drinking areas be provided for animals.

2.38 Recommends a biocide monitoring program be undertaken.

2.40 Recommends an Integrated Pest Research Management (IPM) system be introduced.

2.44 Recommends tenants receive larger vegetable plots.

2.49 Recommends measures be taken to improve tenants incomes: to provide a more timely supply of all inputs, a higher cotton price, and the institutionalization of crop advances.

2.51 Recommends all services be taken over by the appropriate Ministries.

2.61 Recommends the temporary water purification system be maintained; advice be sought to ensure the permanent system does not deteriorate.

2.70 Recommends that questions related to tenants' legal status under Irrigation Act be referred to governments' legal advisers.

2.74 Recommends various steps be taken to control malaria.

2.76 Recommends treated water be extended to the Manyatta.

2.77 Recommends a schistosomiasis control program be introduced.

2.79 Recommends all aspects of health care be strengthened.

2.84 Recommends support for womens' groups including the allocation of communal vegetables plots.

2.90 Recommends the agricultural management team comprise both consultants and local staff.

2.91 Recommends that funds be released by the Treasury in advance of their committment.

Chapter III

See Paragraphs	
3.03	Continuous monitoring of of soil conditions and yields is strongly recommended.
3.04	Further research prior to appraisal would have expedited the selection of suitable crops and varieties.
3.05	Recommends all engines and pumps: (1) should be overhauled and a report from an independent mechanical engineer prepared; (2) there be an operation and maintenance contract for the pump station; (3) stocks of spares should be held at Bura.
3.06	Recommends a system of Integrated Pest Management (IPM) be introduced
3.07	Recommends a large measure of autonomy be given to Bura management.
3.09	Recommends that a steering committee be established and chaired by the Office of the President, to oversee development and and also the Intermisterial Committee continue to function.
3.11	Recommends that project funds be released six months in advance by the Treasury.
3.13	The Bura scheme should not be replicated in other semi-arid areas of Kenya.
3.16	Development of the Lower Tana basin may be better suited to large-scale plantation irrigation than irrigated settlement.

Chapter IV

See Paragraphs	
4.05	Recommends completion of the main canal in substitution for the proposed flood protection bund.
4.17	Recommends that an independent consultant makes an assessment of the technical viability of the inclined pumps.
4.39	Recommends option 4b (with gravity intake) be pursued if adequate funding can be mobilized and that a feasibility study for the river diversion structure be undertaken; and if the option includes a commercial farming component consideration be given to the company assuming management responsibility for the whole project -- with an agreement to safeguard tenants.

Agriculture: Annex I

See Paragraphs:	
1-3,7,9	Land selected for development: in view of the uncertainty over soil quality settlers are exposed to considerable risk. Marginal lands should possibly have been excluded.
4-6, 8,12	Cropping pattern and crop yields: based on the experience at Hola with more favorable soils, yield projections were generally over optimistic.
19	Land cleared of vegetation in advance of development is suffering from wind erosion (Pumwani and Masabubu).
22	Long furrow irrigation adopted by the project requires modification over part of the project area.
28,43,60	All cotton planting should be completed by mid-April otherwise serious pest problems will occur.
29	To increase maize production improved water management, better suited varieties, more effective extension and sound cultural practises are required.
32	Before introducing new cotton varieties further analysis and field trials by small holders are required.
43, 44	Land preparation has taken much longer than planned resulting in an extended cotton season beyond its optimum, increasing pest risks and interfering with the timing of maize planting.
45, 48	A reduction in the number of mechanised land preparation operations is justified.
57	Tenants debts incurred due to pump station failure should be written off by the NIB.
58, 60	More effective pest management techniques are required.
65-67	Improved field water management is required.
73 -75	Appointment of the Bura agricultural management team has been seriously delayed. When appointed in early 1985 it must be given a large measure of autonomy.

77 and 78 A review by the Irrigation Act (1966) is necesssary. Tenant incentives and land tenure arrangements (for land and housing) require examination.

79 The decision by NIB to increase the main plot holding from 1.25 ha to 1.5 ha is endorsed.

80 With additional shifts and an increase in the number of gins, the ginneries at Hola and Malindi can handle the outturn from 3,900 ha. Additional storage is being constructed at Hola by the CLSMB.

Health Sector-Annex III

See Annex summary

1 Malaria a been the most important problem associated with early development of Bura. Further epidemics can be anticipated.

3 and 4 Health services including operation and equipping of the Health Center for schemes like Bura must not be allowed to lag behind other developments.

5 Lack of transport has reduced health service field based activities.

6 Control programs for Schistosomiasis initiated at this stage would facilitate disease control in the longer term.

7 Primary health care programs should be developed at village level.

8 Regular monitoring of the health status of settlement population should be carried out combined with disease control programs and community based treatment for important endemic diseases.

Wildlife and Ecology-Annex IV

See Annex paragraphs	
4-9	Protection and introduction of a forest management plan for parts of the riverine forest on the Tana river between Garissa and Garsen is required.
10	Support for the Tana River Primate Reserve is recommended.
26-27	Maize should be protected from wildlife damage by the installation of an electric fence.
30-36	Aerial spraying of biocides may present serious short and long term environmental problems, health risks and the emergence of resistant pest varieties. A monitoring program and an Integrated Pest Management Research Program (IPM) should be undertaken.
41-42	Establishment of an environmental unit in NIB is recommended.

Forestry-Annex V

See Annex Recommendations

1, 3	Fuelwood should be supplied to the Bura population from irrigated plantations, the Tana riverine forest (controlled by a forest management plan), agricultural residues and brushwood cleared from the project area;
2	Wood burning jikos should be introduced to improve fuelwood utilisation, and control or banning of charcoal production and imports of charcoal should be considered.
4	Exploitation of the Tana riverine forest to be strictly managed and the limited supply available to be argumented by imports from the Lamu mangrove forests until the Bura irrigated plantations provide adequate fuelwood and poles.
5 and 8	A forest management specialist should as a matter of urgency prepare the management plan for the riverine forest.
6, 10 and 11	The irrigated plantations amenity plantings and shelter belt planting program should be implemented in accordance with the forest plan currently being prepared. This plan should include harvesting and transport arrangements.
7	A socioeconomic study will form part of the forest sub-project and will address all aspects of fuelwood production, provision and use.
12	The institutional framework for undertaking this forestry program should be decided as a matter of urgency.
13	Silvicultural research should be extended to cover forest improvement in the Tana riverine forest, species for establishment in semi-arid areas and plantations where limited irrigation is available.

APPENDIX 2

BURA IRRIGATION AND SETTLEMENT PROJECT
TOTAL ESTIMATED PROJECT COST OVER PROJECT IMPLEMENTATION PERIOD
(1979 Prices, K SH 1,000,000)

	May 1977 World Bank Appraisal Report	1977 Project Planning Report	NIB September 1979 Progress Report	NIB September 1980 Progress Report	NIB September 1981 Progress Report	NIB Septeaber 1982 Progress Report	NIB Septeaber 1983 Progress Report	NIB March 1984 Progress Report
	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL	TOTAL
IRRIGATION WORK								
a) River Works			1.11	0.99	0.99	0.99	0.99	0.99
i) Contract 19 Site Investigation						236.80	350.84	169.98
ii) Barrage (incl. Consulting Fees)	103.86	103.86						
b) Irrigation and Drainage Works								
i) Contract 3 Supply Canal	52.50	41.02	43.75	38.35	41.40	40.35	42.10	42.10
ii) Contract 4 Main Canal etc	54.22	54.98	51.07	60.70	62.21	63.02	55.33	55.67
iii) Contract 5 Hydraulic Structure etc	80.20	134.14	204.85	214.95	226.36	236.30	269.60	268.10
iv) NYS Advisors			18.85	18.85	18.85	19.39	41.40	52.52
ROADS AND AIRFIELD								
i) Contract 13 Roads and Airfield	26.45	30.78	49.10	55.45	71.99	61.00	59.30	57.56
ii) Surfacing scheme Roads							19.00	19.00
iii) Diversion Road						7.40	7.40	7.40
INFRASTRUCTURE								
a) Water Supply and Sewerage	65.07							
i) Contract 1 Temporary Water Supply			17.09	18.60	18.60	8.64	18.64	18.64
ii) Contract 8A Water Treatment Works		65.07	64.59	79.88	111.86	110.56	110.75	114.44
iii) Contract 8B Village Water Supply			49.47	43.18	44.41	47.07	39.92	39.46
b) Electricity Supply	11.93	11.93	23.48	29.12	50.89	50.00	47.50	5.00
c) Buildings	141.71							
i) Contract 2 Advance Buildings			20.82	21.01	21.06	20.75	20.68	20.68
ii) Contract 6 NIB Buildings			110.13	127.55	163.54	212.70	210.99	208.16
iii) Contract 7 Government Buildings			79.17	98.29	86.07	113.29	113.56	55.07
iv) Contract 20 Prefab. Houses		142.60	2.06	2.01	2.01	2.01	2.01	2.01
v) Contract 21 Tenants Houses						83.93	38.41	38.91
vi) Contract 22 Schools and Aeenities						50.00	3.89	16.38
vii) Bura Building Force			63.65	70.16	108.46	53.27	54.87	54.87
PUBLIC HEALTH	10.39	11.67	10.64	11.43	1.20	1.17	1.56	1.56
AFFORESTATION AND FORESTRY CANALS (1)	46.70	43.11	12.79	13.91	69.69	124.18	65.00	102.02
VEHICLES AND EQUIPMENT	56.23	46.32	50.69	55.42	137.39	100.51	84.84	84.84
GIKMERY	67.48	46.85	71.37	97.47	136.62	155.94	162.65	79.29
OPERATION AND MAINTENANCE	122.91	198.57	158.05	105.04	101.41	226.00	158.70	156.31
PROJECT LAND SURVEY AND ACQUISITION (2)						2.37	6.40	6.40
FARM INPUTS INCLUDED				48.87	51.04			
CONSULTANTS AND STUDIES	55.06							
a) Bura West	0.00	124.41	91.07	95.99	115.41	111.98	99.94	99.85
b) Bura East	0.00		15.13	15.74	24.38	21.55	0.65	0.66
AGRICULTURAL MANAGEMENT	25.78	38.64	30.09	33.04	25.50	33.00	33.00	24.93
TRAINING	6.87	5.22	8.26	9.02		7.94	4.48	7.05
TOTAL:	927.35	1139.17	1247.28	1385.02	1691.31	2210.24	2122.92	1504.14

(1) includes wildlife
(2) included in consultants and studies

SOURCES: 1977 World Bank Appraisal Report, 1977 Project Planning Report and NIB Six Monthly Progress Reports 1 to 10.

APPENDIX 3

MAIN FEATURES OF CAPITAL AND RECURRENT EXPENDITURE OF DEVELOPMENT OPTIONS

A. General Remarks on Option Costs

1. With regard to irrigation and land development, the major differences in capital and recurrent expenditures are determined by the size of the project area and the type of water abstraction. In Table 1 that follows the current expenditure for staff and equipment required for the various options are given. Costs are based on unit prices in the Third IMC Report (November 1983). The cost of fuel and spares for the pumping station are respectively KSh 54 and KSh 11 per 1,000 m^3 of pumped water. Annual road maintenance is based on the cost of two operation and maintenance graders at a cost of KSh 662,000 per year. Every 5 years the resurfacing of the airfield and rural center will cost KSh 600,000.

2. The costs for the establishment and maintenance of the 900 ha forestry component as well as the current costs of the irrigation system are presented in detailed cost tables in the statistical annex.

B. Option 1 (2,500 ha)

3. After a complete overhaul of the existing pump station an area of 2,500 ha can be irrigated. The capital and some of the recurrent expenditure in this option 1 are obligatory for all other options.

4. Telecommunications to improve communication between Bura (HQ) and the pump station have been allocated KSh 2.7 million.

The Nanigi Compound

5. At Nanigi village (near the pump station) 18 houses and water treatment facilities are included in contract 21, at an estimated cost of KSh 2.9 million. Depending on the size of the pump station an investment of KSh 1.74 m, KSh 2.32 m and KSh 2.90 m respectively has been foreseen for options 1, 2, 3, and 4a.

Flood Protection Bund

6. Since the remaining 8 km main canal to the Masabubu Command is still incomplete, rain drainage water threatens parts of Masabubu and Pumwani South and the Manyatta. The cost for completion of the main canal is estimated at KSh 5.28 m while a flood protection bund has been included in the NYS contract at a cost of KSh 3.74 million (excluding physical contingencies). The completion of the canal is recommended and this eliminates the need for the flood protection bund.

Roads

7. Completion of the works in the rural center is envisaged. The costs of village roads is a function of the number of villages. For 2,500 ha the costs are KSh 11.76 m. This will increase to KSh 14.80 million for 3,900 ha and to KSh 15.0 m when the barrage or gravity intake is constructed. Surfacing of scheme roads (estimated at KSh 19.0 m for 3,900 ha) has not been considered in the options.

Irrigation Equipment

8. Expenditure in 1984/85 of KSh 6,605 m is for maintainance equipment from Japan, including a dragline bulldozer, lowloader, trucks and hydraulic excavators. The replacement of heavy maintainance equipment will start from 1992/93 onwards.

9. Engines and pumps are to be replaced in 7 and 10 years respectively.

10. The complete overhaul of the existing pump units is estimated at KSh 0.5 m while a management and maintenance contract at an annual cost of KSh 150,000 has been included for a period of 3 years.

Consultancy

11. These costs are based on cash flow projections of MMP. The costs for the agricultural management team are based on the contract proposal.

C. Options 2 and 3 (3,900 ha)

12. The main feature is the expansion of the pump station with 2 full duty pumps (2.15 m^3/sec each) The costs per pump unit (including erection) at 1984 prices is composed as follows:

Pumps	KSh 1,378,000
Engines	" 494,000
Duties, Taxes	" 1,084,000
Erection	" 707,000
	KSh 3,663,000

An additional 600 ha in Pumwani South needs harrowing and land planing at a rate of KSh 1,400 per ha.

D. Option 4a (5,040 ha)

13. In this option the station needs to be expanded with another two full duty pumps (costs KSh 7,326 m). Additional civil works at the pump station are necessary (KSh 3.0 m).

14. About 8 km of main canal needs completion for the irrigation of Masabubu at a base cost of KSh 1.54 m, while a total of 1,700 ha requires harrowing and planing.

E. Options 4b and 4c (Gravity) (5,040 ha)

15. While 2 more pumps are installed to complete 3,900 ha, the study, design and implementation of the intake and gravity canal will be initiated and completed in 1986/87 at a total cost of KSh 58.10 m (excluding contingencies).

16. The proposed gravity-intake option will include the following works:

a short intake channel leading to a screened and gated intake structure which will feed a settling basin, of approximately 700 x 20 meters enabling desiltation by a dragline;

a 12 km long supply canal which will be deep cut (5 - 6 m) over the first 6 km and 2 m cut over its remaining length;

four super-passages allowing run-off to pass over the supply canal. The super-passage culvert immediately downstream of the settling basin would be gated to control upstream water-levels. The same would be for the super-passage at Laga Tula to prevent backflow to the intake when the pump station is in operation. It would be possible to use both sources simultaneously provided that levels are carefully controlled through gate operation.

17. When the gravity intake is used it will be possible to drain the silting basin of the pump station and clear it with mechanical means.

18. MMP has provided a preliminary costs estimate on the basis of the rates of contract 5 (1979 price) presented in the table below.

19. It is assumed that the study, design, tendering and construction will take a period of 2 years.

Preliminary Cost Estimate - Gravity Intake (options 4a, b, c)

	Prices in KSh million	
	Phase I	Phase II 1/
Earthworks	14.70	14.70
Intake	3.40	4.00
Super-passages	11.30	14.50
1979 baseline prices	29.40	33.20
Physical Contingency 15%	4.41	4.98
1979 Price	33.81	38.18
Price contingency 60%	20.29	22.91
1984 Price	54.10	61.09
Engineering supervision	4.00	4.00
	58.10	65.09

Source: Sir M. MacDonald & Partners

20. The extension of the main canal and the on-farm development are equal under option 4a and also obligatory for the barrage option 5.

21. The pump station will be used as a stand-by and is estimated to supply 10-20% of the water requirement.

F. Option 5 (Barrage) (5,040 ha)

22. The cost of the river diversion structure is based on the estimates in the appraisal and PPR reports. At 1984 prices the base costs are KSh 138,046 m (see table below). Engineering and supervision is estimated at KSh 7.5 m. Gravity feed water should be available by 1990/91 to enlarge the area from 3,900 ha to 5,040 ha.

G Preliminary Base Cost Estimate - Nanigi Weir

Construction Nanigi Weir (1977 prices)	KSh 59,711 m
Construction Nanigi Weir (1984 prices)	KSh 109,866 m2/
Earthwork canal (7 km) "	KSh 17,560 m3/
Structures "	KSh 10,620 m4/
Total costs (1984 prices excluding contingenices)	KSh 138.046 m

1/ Structures based on 12,000 ha; not recommended by mission.
2/ 1977-1984 increase in foreign prices: 1.39 (55%)
1977-1984 increase in local prices : 2.39 (45%)
Overall weighted increase in prices : 1.84 (100%).
3/ 75% of gravity intake canal in option 4b.
4/ 50% of structures option 4b.

H. The Average Costs of Irrigation

23. The major objective of this evaluation exercise is to assess the financial implications of the various options for the Kenya government in general and for the NIB specifically. The operation and maintenance costs of the pump station and the irrigation system for the various development options is given below.

	Irrigation Costs in KSh per Ha			
	Pump Station			Gravity
	2,500 ha	3,900 ha	5,040 ha	5,040 ha
O&M Pump Station	1,920/-	1,895/-	1,870/-	210/-
O&M Irrigation System	930/-	880/-	775/-	795/-
Total recurrent costs	2,850/-	2,775/-	2,645/-	1,005/-
Depreciation pump units[1/]	640/-	640/-	640/-	100/-
Total Irrigation costs (per ha)	3,490	3,490/-	3,285/-	1.105/-

1/ Depreciation Engines: 5 years.
Depreciation Pumps : 10 years.

TABLE 1

RECURRENT EXPENDITURES FOR OPERATION AND MAINTENANCE

Of the Irrigation and Drainage System and Scheme Roads (Kshs'000)

Operation and Maintenance Irrigation System	Unit Price	Depreciation Years	2500 ha No.	2500 ha Spares	2500 ha Fuel	2500 ha Taxes	3900 ha No.	3900 ha Spares	3900 ha Fuel	3900 ha Taxes	5040 ha No.	5040 ha Spares	5040 ha Fuel	5040 ha Taxes
Dragline	3,200	10	1	50	190	1	1	50	190	1	2	100	328	2
Bulldozer	2,000	5	-	-	-	-	1	70	190	1	2	140	300	2
Dredger	6,750	10	1	50	172	-	1	50	172	-	1	50	172	-
Hydraulic Excavator	1,800	10	2	100	370	1	2	100	370	1	2	100	370	1
Low loader	1,800	10	1	25	92	1	1	25	92	1	1	25	92	1
Water trailers	133	10	1	4	-	-	1	4	-	-	1	4	-	-
Flat trucks	490	5	1	36	93	13	2	72	186	26	2	72	186	26
Tippers	490	5	1	36	93	13	2	72	186	26	3	72	186	26
Tractor	175	5	1	18	70	-	2	36	140	-	2	36	140	-
Fuel trailer	182	10	1	4	-	-	2	8	-	-	2	8	-	-
4 Wheel-drive vehicles	262	5	3	90	109	30	4	120	252	40	4	120	252	40
Motorcycles	48	5	4	28	50	3	6	42	75	5	6	42	75	5
TOTAL				411	1315	62		649	7849	101		769	2189	103
Road graders	1800	10	2	70	550	-		70	550	-		70	550	-
PUMP STATION														
Fuel per 1000 m^3	54/-			68,450	3,696		107,450		5,802		137,800		7,452	
Spares per 1000 m^3	11/-			753				1,183				1,518		

Staff Pump Station	Unit Price	No.	Costs (KShs x 1000)	No.	Costs (KShs x 1000)	No.	Costs (KShs x 1000)
Pump Station Supervisor	48	1	48	1	48	1	48
Assistant Supervisor	40	1	40	1	40	1	40
Operators	31	2	62	3	93	4	124
Watchman	5	2	10	2	10	2	10
			160		190		222
Staff Operation and Maintenance of Irrigation and Drainage System							
Water Management Officer	54	1	54	1	54	1	54
Supervisor	40	2	80	2	80	2	80
Headman	24	2	48	3	72	3	72
Dredger Operator	21	1	21	1	21	1	21
Dredger Attendant	16	2	32	2	32	2	32
Gate Operators	16	2	32	3	48	5	80
Plant Operators	21	4	84	5	105	7	147
Drivers	16	5	80	8	128	8	128
Laborers	5	22	110	35	175	35	175
			541		715		789
Road Maintenance							
Plant operators	21	2	42	2	42	2	42

APPENDIX 4

TERMS OF REFERENCE FOR THE 1984 MID-TERM EVALUATION

1. Aims

1.1 It is proposed to conduct a mid-term evaluation of the project (i) to review and evaluate the impact and effects of the project in relation to initial project design and objectives; (ii) to provide a basis for any necessary redefinition of objectives and/or reorganization of project resources and structure during the remaining project period; (iii) to begin to evaluate the lessons of the project for the development of the Tana River basin beyond the life of the project; and (iv) to make a preliminary assessment of the lessons to be drawn from Bura for the future of irrigation and settlement in Kenya.

2. Timing

2.1 The mid-term evaluation will take place over a three month period commencing August 13, 1984.

3. Specific Objectives

3.1 Evaluate the design of the project. This objective will look back at the indentification, preparation and implementation processes through which the project has passed, to identify points at which critical decisions were taken, to assess those decisions and determine whether alternatives existed. This objective will only be retrospective in methodology: its purpose is to draw out the lessons of the project for the future - for possible further development in the Tana basin: for assessing whether such a project could ever be replicated in Kenya and with what changes to design, etc. The work will review:

-key elements in project design, including irrigation system design (e.g. choice between barrage/weir/pump station, overnight storage reservoirs, long furrow irrigation), management arrangements (e.g. NIB direct scheme management), agricultural package (e.g. cropping pattern and possible alternatives, choice of cotton variety, tractor services, etc.), village planning, including provision for social and utility infrastucture, appropriateness of settlers houses and arrangements for transfer of ownership, settlement arrangements (e.g. settler selection, recruitment and introduction to site, relocation assistance, etc.);

-project cost and reasons for increase;

-the evolution of the implementation schedule;

-institutional and management arrangements - how they evolved? how they performed?

and will assess whether real alternatives existed at each point (e.g. was there a lower cost alternative and at what sacrifice?).

3.2 Evaluate the operational performance and prospects of the project. The purpose of this objective will be twofold: (1) to provide indications of performance leading to recommendations for changes and improvements in arrangements for operations; and (2) to draw lessons for the future of this and other projects. This component would cover:

-project funding, including analysis of the impact of restricted Development Estimates;

-scheme operation finances, can the scheme break even, make a profit? How? If not, how to cover the gap?

-project management arrangements and performance. Review of alternative management responsibilities, leading to a recommendation on future management arrangements;

-project accounting;

irrigation, including adequate water supply;

-agriculture, including production and research (particularly on cotton and maize vaieties);

-construction;

-training;

-cotton ginning and marketing. Is there adequate ginning capacity? If not, how can it be provided?;

-fuelwood supply and afforestation;

-settlement;

-social services;

-housing, water supply, sanitation and electrical supplies;

-creation of a local authority and adoption of services.

3.3 Evaluate the effects and impact of the project on the settler population. In particular, review the results of the baseline agro-economic survey to be conducted in the second quarter of 1984 and evaluate:

(i) factors determining farmer production levels of cotton and maize, including soil and land preparation, irrigation management, input supply, supply of consumer goods, pest control, labor availability, crop varieties, cropping patterns, planting dates, marketing, processing, pricing;

(ii) farmer expenditure and income from on-project farming, analysis of available family labour, distribution of labour requirements and the returns per labour/day;

(iii) the situation of the farmer with respect to income, housing, facilities, etc., vis a vis farmer in rainfed areas;

(iv) distribution of benefits in the farm family;

(v) other sources of income to the farm family including off-farm employment and other farming and livestock production;

(vi) the situation of women; and

vii) health and nutritional situation of the farm family.

3.4 Evaluate the beneficial and adverse effects of the project on the population and environment of the surrounding region.

3.5 Evaluate the economic and financial viability of the project. This component will provide an update on the ERR and examine issues for financial viability including cost recovery.

3.6 Evaluate the project in relation to comparable projects elsewhere (Rahad?) and to other possibilities in Kenya. This component will be done on the basis of 3.1 - 3.5 above. It will isolate specific project parameters for comparison with experience elsewhere in tropical Africa. It will also evaluate Bura with reference to Kenya's potential for undertaking this kind of project, as well as other alternative designs. This component will also review other development possibilities for irrigation in Kenya, including small scale irrigation, ground water pumping, etc. (using available data sources and other comparable experience in Kenya).

3.7 Evaluate the legal framework for large and small scale irrigation in Kenya, particularly the Irrigation Act, to point out where legislative changes are required to accomodate future development of irrigation schemes.

4. Conclusions

4.1 In the light of 3 above, assess and make proposals for responding to (a) the need for adjustments to present project arrangements; (b) the need for further study or analysis; (c) the implications for future developments, in particular the appropriateness of this kind of development for Kenya and the institutional, legal, and policy implications for future programmes, and (d) what steps if any should be taken to prepare further projects in the area or in the sector.

5. The Evaluation Team. The composition of the evaluation team would be as follows:

1. Team leader/coordinator (an independent consultant funded by the World Bank)
2. Agricultural economist (an independent consultant funded by the EDF)
3. Irrigation engineer (an independent engineer funded by the Netherlands)
4. Agriculturalist (seconded by the World Bank)

5. Economist (seconded by the World Bank)
6. Agriculturalist (seconded by MOALD)
7. Economist (seconded by MOALD)

Shorter term consultants will provide inputs on: ecology and wildlife (possibly funded by the World Bank) and legal matters, forestry (funded by Finland), and health (funded by ODA). It is possible that other short term consultancy requirements will be identified; these and their funding will be discussed during implementation. Team members will be seconded to the team for the duration of evaluation. Team members will not have been previously involved in the management or supervision of project. The Bura Project Coordinator will assist the team on a full-time basis to facilitate arrangements, provide access to information, etc. In addition, the new chief engineer of the NIB will be available on a full-time basis to assist the team on engineering matters. The team would be a working group independent of the institutions to which its members belong and would report back to all interested parties. (For Government, the coordinating body would be the Bura Interministerial Committee). The confinanciers will provide administrative support, information and funding as necessary.