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HOMBOY AREA AND SMALLHOLDER BANANA CULTIVATION IN THE LOWER JUBA VALLEY AND ASSESSMENT OF AGRICULTURAL BENEFITS

This report comprises the following volumes:

Main Report

Annex 1 - Homboy Feasibility Study

Annex 2 - Smallholder Banana Development

Annex 3 - Assessment of Agricultural and Flood Control Benefits

Album of Drawings

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SECTION A

INTRODUCTION

CHAPTER 1

THE PROJECT AREA

1.1 Location

The project area is shown in Figure 1.1 and is located in the Lower Juba valley in southern Somalia, about 400 km from the capital Mogadishu. It extends over a gross area of about 14 200 ha from Kamsuuma to the Jilib-Mogadishu surfaced road, a distance of some 30 km. The soils of the project area are predominantly fine textured Shebelle alluvium deposited by flooding from the old Shebelle river channel which runs through the area. This strip of land is relatively narrow (maximum 7 km) and is bounded on either side by very fine textured and saline marine plain soils. These are considered unsuitable for either irrigated or rainfed agriculture and thus development has been restricted to the strip of alluvium plus small areas of beach remnant and channel soils.

The area is subject to a flooding hazard from the catchments to the north of the project flowing along the old Shebelle channel. Since no flood protection is currently available, settlement within the area is restricted to the elevated beach remnant soils. In late 1986 there was an estimated permanent population of 12 000 in the project area, mainly in Homboy and its adjacent village Aminow, with the balance being mostly in the Burgaan area to the south.

Access to the northern and southern ends of the study area is provided by the surfaced Jilib-Mogadishu and Jilib-Kismayo roads respectively. In addition there is a track from Homboy to Jilib and there are also tracks linking Homboy to the surfaced roads. All the tracks are frequently impassable during the rainy seasons.

1.2 Climate

The climate of the project area is classified as tropical semi-arid. Rainfall is bimodally distributed with maxima occurring in the gu (April to May) and der (October to December) seasons respectively. The jilaal season (January to March) is generally hot and dry, but showery weather is common in the xagaa season (June to September). The average annual rainfall at Jilib is just under 600 mm with about 250 mm of this falling in the gu and 180 mm in the der. The most significant feature of the rainfall is the localised nature of falls and the wide variation within small distances. Average monthly temperatures range between 26°C in July and 29°C in March. The hours of sunshine per day vary from a low of about 7 hours in June/July to 10 hours per day in March.

1.3 Topography

A typical cross-section of the Shebelle floodplain (i.e. across the project area) as shown on Figure 1.2 demonstrates a distinct topographic sequence typical of an aggrading river, with a central channel surrounded by elevated levees sloping onto flat areas of cover floodplain and with backswamp depressions along the floodplain perimeters.

A topographic survey was carried out for the 1980 study and final maps were plotted at 1 : 10 000 scale with a contour interval of 0.25 m. This indicated that topographically the project area is generally well suited to surface irrigation. Slopes on the dominant cover floodplain are in the range of 0.1% to 0.3%, although slopes of up to 2% are observed on the levees. The overall slope is from north to south, although localised irregularities and depressions, including old river channels or 'fartas', are common. There is one large depression of about 200 ha in the southern part of the project area known as Far Sitay lake. Ground levels in the project area range from about 18 m in the north to 12 m in the south.

Gilgai microrelief formed by expansion and contraction of clay rich soils on wetting and drying is present, to a greater or lesser extent over most of the project area except for areas of lighter soils such as the levees and meander complex. The gilgai consists of rounded micro-depressions and mounds separated by flat shelf areas. 'Sink-holes' commonly occur in the micro-depressions. The average 'amplitude' of the gilgai, usually taken as the difference in elevation between the bottom of the micro-depression and the overall land surace is about 20 cm on the cover floodplain and shallower depressions but sometimes exceeds 50 cm in some moderately deep depressions in the south-west of the area.

The formation of surface cracks is another feature associated with soil contraction on drying. In some of the heavier clay soils of the depressional areas a polygonal cracking pattern has developed but cracks are more usually discontinuous and concentrated in sink-holes and micro-depressions. The surface cracks are commonly obscured by a surface mulch about 2 cm thick.

1.4 Natural Vegetation

Natural vegetation within the study area is primarily dependent on the duration of flooding under the current hydrological reigme. As flood duration is primarily dependent on elevation, vegetation associations are strongly related mainly to the landform units. The existing vegetation pattern has been affected by cultivation in some areas and this has resulted in changes in species distribution.

In the predominantly flooded deeper depression areas, swamp grasses and sedges predominate with relatively few emergent trees. The shallower depressions are characterised by dense growth of Acacia nilotica while the cover floodplains support a mixed Acacia and non-thorny shrubland in which species such as A. nilotica, A. zanzibarica, A. bussei, Dobera glabra and Thespesia dariis are well represented. On the higher levee areas, non-thorny species tend to dominate and often give rise to a more open cover. In the previously cleared areas that have been fallow for some time, regrowth is dominated by such species as Ficus populifolia, Dalbergia spp and Therpesia dariis.

1.5 Present Land Use

A considerable amount of rainfed agriculture is currently carried out, mainly around Homboy. In 1979 some 25% of the gross project area had been cleared for cultivation, but by late 1986 this had increased to over 30%. The area is also important as grazing for livestock.

Fishing is currently practised in the periodically flooded deeper depressions in the project area, particularly in the Far Sitay lake, which rarely dries out completely. Fish is sold either fresh or fried and forms an addition to the

Figure 1.1

The Study Area

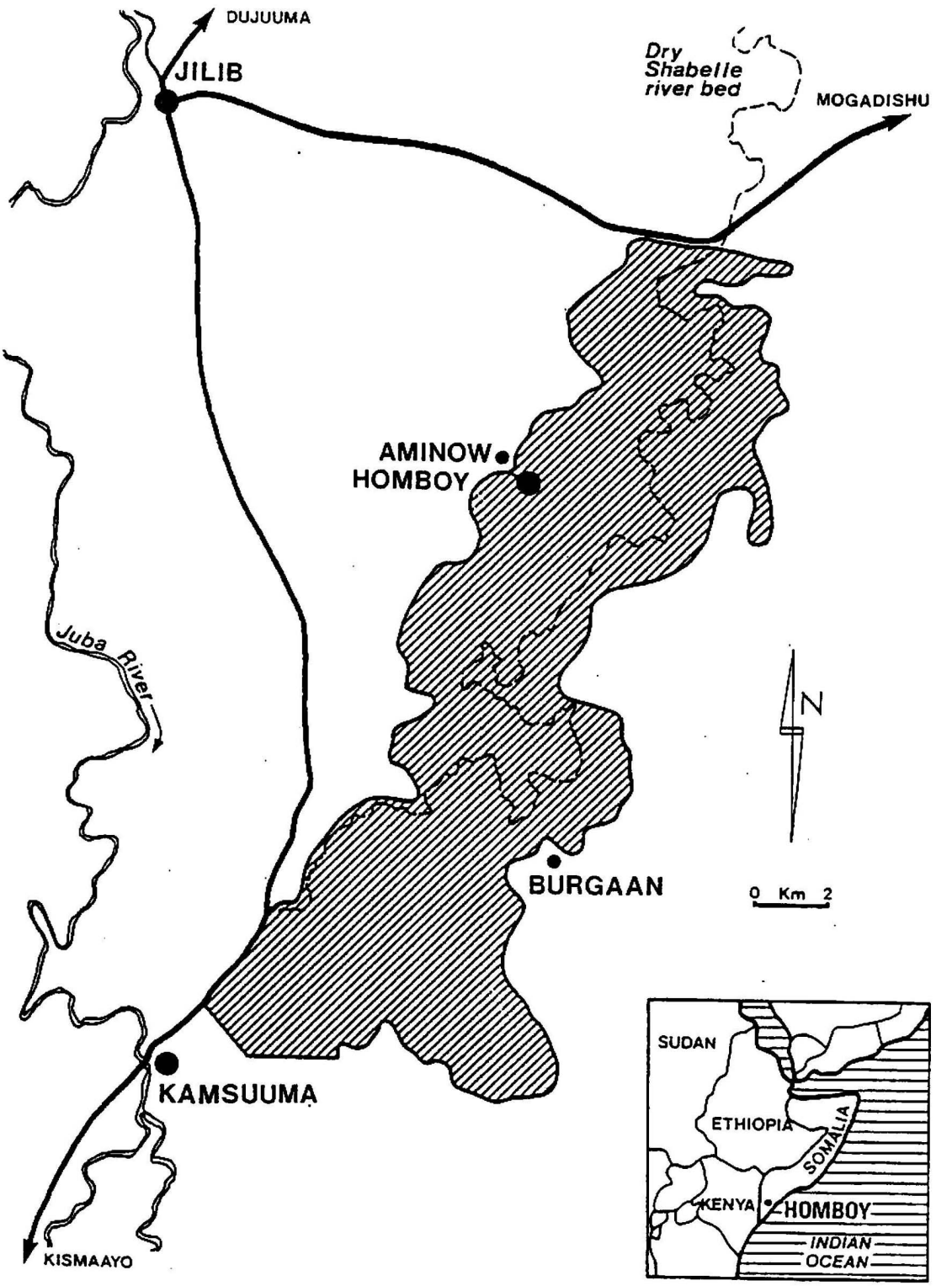


Figure 1. 2

Lower Shebelle Floodplain

Landform	Marine Plain	Depression		Cover Floodplain		Levee	Channel	Levee	Cover Floodplain		Depress-ion Sideslope	Depression	Marine Plain
Soil Mapping Unit*	SMP	Sd2	Sd1	Sb2	Sb1	Si2	Si	Si2	Sb1	Sb2	Sd1	Sd3	MP
Natural Vegetation	Acacia/non-thorny shrubland	Dominated by dense *Acacia nilotica* thicket		Mixed shrubland, including *Acacia nilotica* *Acacia zanzibarica* *Dobera glabra* *Thespesia danis*		Mixed shrubland More non-thorny species	Dense shrubland	Mixed shrubland More non-thorny species	Mixed shrubland, including *Acacia nilotica* *Acacia zanzibarica* *Dobera glabra* *Thespesia danis* and others		Dense *Acacia nilotica* thicket	Mainly swamp grasses and sedges. Few small *Acacia nilotica* and 'Eerib'	[1]Mixed *Acacia*/ non-thorny shrubland
Current Land Use	Uncultivated			Cropped with Sorghum (Der season)			Sesame	Uncultivated	Sorghum Plot	Fallow, with remnant trees (mainly *Dobera glabra*) and low regrowth dominated by *Thespesia danis* and *Dalbergia spp.*	Uncultivated	Sesame, Maize, Sorghum, grown on receding flood water	Uncultivated

protein content of the local diet. The deeper depressions will not be utilised for cropping under the proposed irrigation system, although they will tend to dry up since their catchment area is greatly reduced by the canal and drain network.

The remaining woodland and shrubland in the project area is used as a source of timber for building poles and firewood although most of this resource will disappear on project implementation.

1.6 Wildlife

The Lower Juba region harbours a rich and varied assemblage of wildlife such as elephant, hippopotamus, greater kudu, gerenuk, waterbuck, wart hog, caracal, civet, dik-dik and baboons, along with numerous bird species. Under present circumstances these compete for food and water with the resident farming population and with domestic livestock. We recognise that wild game will inevitably be excluded from the proposed irrigation area but efforts should be made to ensure minimum disturbance of surrounding areas such as the Shebelle swamps upstream of the Jilib-Mogadishu road.

CHAPTER 2

THE STUDY

2.1 Background

The Homboy project has a relatively long history, dating back to the late 1970s. A brief review of the background to the present study is given below.

The severe drought affecting the Sahel region of Africa in 1973 and 1974 had a particularly serious impact on northern Somalia. Livestock and crop losses were heavy and an estimated 600 000 to one million people were affected. The Somali Government took appropriate emergency measures and established relief camps where 245 000 people were housed and fed.

Recognising the need for a more permanent solution to the problem, a decision was taken in early 1975 by the Settlement Development Agency (SDA) to relocate up to 120 000 dispossessed nomads on a voluntary basis in three agricultural settlements in the south of the country. Settlements were established at Sablaalle and Kurtun Waarey in the Shebelle valley and at Dujuuma in the Juba valley.

In 1977 a study of the Juba/Shebelle inter-riverine area carried out by Hunting Technical Services Ltd. (HTS, 1977) raised serious doubts about the ability of the soils at Dujuuma to sustain irrigated or rainfed agriculture. Subsequently in July 1978 the SDA commissioned HTS to carry out a Phase 1 Reconnaissance Study (HTS, 1978) for the identification of land suitable for agricultural development in the Fanoole area where the Dujuuma settlers could be relocated. The report concluded that priority be given to the development of the Homboy area, which with a gross area of 14 200 ha could yield about 8 850 ha net of irrigable land.

In 1979 HTS, in association with Sir M. MacDonald & Partners (MMP), was asked to carry out a detailed study of the Homboy area and produce detailed design and tender documents for the engineering works. These were completed and submitted to the SDA in early 1980 (MMP, 1980 and HTS, 1980), although none of the development works have been carried out. This has been due to several factors, notably the rapidly declining population at the Dujuuma settlement and concern about water availability in the Juba during the low flow period.

2.2 The 1980 Study

The project, as proposed in the 1980 study by HTS/MMP, comprised 8 850 ha net of irrigated land supplemented by 2 675 ha of rainfed land at full development. The rainfed areas were not considered suitable for surface irrigation due primarily to topographic limitations. The scheme was designed to form the basis of the resettlement of nomads temporarily located at Dujuuma with a holding size of 1 ha per family. Overall management of the project would be by the SDA.

Mixed cropping, comprising maize, upland rice, cotton, sesame, groundnuts and vegetables was planned for the majority of the irrigated area, except for certain areas of low-lying Shebelle alluvium exhibiting poor drainage characteristics. These areas are predominantly in the south of the project area and would be used to grow double cropped paddy rice. The overall cropping intensity was 160%. It was assumed that the scheme would be implemented before

the construction of Bardheere Dam and thus full double cropping or perennial cropping would not be possible due to the possible water shortages in the Juba during the January-April low flow period.

The irrigation system was based on a 12 hour maximum working day for the farmers. The basic watercourse unit was 25 ha net using border strip and furrow irrigation of the mixed crops with level basins for the paddy rice areas. Land levelling to achieve optimum land slopes would be required throughout. Each watercourse unit would be served by a watercourse which was in turn supplied from the distributary canals through gated pipes. The watercourses and distributary canals would operate for a maximum of 12 hours each day. At the head of each distributary canal was a night storage reservoir supplied from the main or branch canals. These canals would flow continuously with the night time flow stored in the night storage reservoirs. Water to the main canal was to be provided by an offtake from the Fanoole Main Canal just north of Jilib. The estimated peak requirement was 11.6 m^3/s.

A system of shallow surface drains was provided within the irrigated area to remove excess water from rainfall and irrigation. The drainage water would discharge into the Juba river under gravity when the levels were suitable, although four relatively high areas within the project were provided with drainage pump stations.

Flood protection was an essential component of the project as there is insufficient natural drainage in the area to remove flood waters flowing along the old Shebelle channel. The proposed system comprised the construction of two large reservoirs and outlet structures to the north and east of the project area, capable of accommodating a 1-in-1 000 year flood, which would eventually discharge by gravity into the Juba river.

The project included the establishment of a project headquarters and nine new project villages plus an expansion of Homboy. Each village was provided with settler housing, project buildings, management housing and basic infrastructure.

A network of crushed coral surfaced roads was proposed, comprising a spine road along the western edge of the project and feeder roads connecting the spine road to the ten project villages.

2.3 The Present Study

The objective of the present study is to update the 1980 feasibility study in the light of the changed conditions in the Juba valley - primarily it is to be assumed that water regulation in the river is achieved by Bardheere Dam and the farming system is to be based on smallholders rather than settlers.

Particular emphasis is placed by the Terms of Reference on the following aspects:

- cropping pattern, particularly in view of the perennial supplies afforded by Bardheere Dam;
- farm budgets including livestock;
- irrigation efficiencies, water management and water users' associations;
- smallholder farmers;

- agricultural services, credit and extension;

- labour availability;

- review of flood protection and drainage facilities based on return periods of 50 years for the flood protection works and 10 years for the internal drainage;

- review of detailed designs with particular emphasis on cost savings, including:

    (a) farm size
    (b) canal and drain earthworks
    (c) roads and hydraulic structures
    (d) farmer housing

- reducing capital and recurrent costs for engineering works and farm inputs;

- economic and financial analyses of the project;

- institutional and operation and maintenance considerations;

- training;

- environmental problems;

- implementation schedule based on a phased development of about 5 000 ha in Phase I and 4 000 ha in Phase II.

CHAPTER 3

CLIMATE

3.1 General

The climate of the project area is classsified as tropical semi-arid. Rainfall is predominantly distributed in two seasons, with maxima occuring in the gu (April to May) and der (October to December) seasons respectively. The jilaal season (January to March) is generally hot and dry, but showery weather is common in the xagaa season (June to September).

3.2 Rainfall

The apparent movement of the sun's zenith is followed by the inter-tropical convergence zone (ITCZ) in which the surface winds of the northern and southern hemispheres meet and then rise in a zone of low pressure and considerable atmospheric instability. This instability is the cause of nearly all the rainfall in the area. Within the two post-equinoctial rainfall seasons, the distribution is quite irregular, being generally associated with isolated storm cells. Rainfall intensities in excess of 75 mm per hour have been recorded throughout the area. Within 50-100 km of the coast moist onshore winds produce the xagaa rains in May to July, which effectively extend the gu season to June or July.

The existing raingauge network does not yield much reliable data but there are adequate records from a sufficient number of previously operative gauges to provide a reasonable base of rainfall data. Apart from the coast, there are few physiographic features to influence rainfall distribution although local effects appear to be important in producing higher rainfall near Baidoa and Dinsor; atmospheric instability appears to have similar effects over irrigated swampy areas near Jilib-Avai and Afgoi-Jowhar.

Away from the coast and outside the xagaa rainbelt the two rainy seasons are of similar duration, the gu normally being 35-45 days, and the der 40-50 days. In each season rainfall averages 150-175 mm, rising to 225-250 mm near Baidoa and Dinsor; in the east the gu season tends to be more reliable than the der.

Near the coast the xagaa rains boost the rainfall to 300-350 mm in the period April/July. The der rains vary considerably according to locality, ranging from 100 mm to 200 mm.

The mean annual rainfalls for stations in the Lower Juba valley are given in Table 3.1.

TABLE 3.1

Rainfall Statistics of Stations Relevant to Study

	Mean annual rainfall (mm)	Number of complete years of record
Kismayo	350	34
Jamaame	604	3
Mareere (Juba Sugar Project)	744	7
Alessandra (Jilib)	586	23
Bardheere	398	39

Source: HTS, 1977

Most of the annual rainfall is distributed, often unequally, between two post-equinoctial rainy seasons. The timing and duration of these seasons in southern Somalia was studied for the Inter-Riverine Agricultural Study (HTS, 1977). The start and end of each season was arbitrarily delineated by the first and last daily falls of 10 mm or more. Isolated raindays separated by more than 10-15 days from other raindays were excluded from the main season. It was found that, although elswhere unreliable, the xagaa (June onwards) rains effectively double the duration of the gu season near the coast and as far inland as the Homboy Project area. The rainy season periods for Jilib are presented in Table 3.2.

TABLE 3.2

Rainy Season Periods at Jilib

Gu Season		
(a) Start	1 year in 4	by 9th April
	Average	14th April
	3 years in 4	by 18th April
(b) Duration	1 year in 4	95 days
	Average	77 days
	3 years in 4	59 days
Der Season		
(a) Start	1 year in 4	by 17th October
	Average	26th October
	3 years in 4	by 3rd November
(b) Duration	1 year in 4	50 days
	Average	49 days
	3 years in 4	40 days

Source : HTS, 1977

3.3 Meteorological Data

The meteorological station at Alessandra Research Station near Jilib is only a few kilometres from the edge of the Project area. Long term reliable records are available between 1922 and 1963 and have been used to prepare the meteorological data used in this study. These are presented in Table 3.3.

TABLE 3.3

Climatic Data for Jilib (Alessandra)

Month	Temperature (°C)	Humidity (%)	Wind run (km/d)	Sunshine (h/d)	Penman Eo (mm/d)	ETo (mm/d)	Rainfall (mm)
January	28.7	69	150	9.19	7.1	5.6	2.2
February	28.9	68	170	8.96	7.5	5.9	1.4
March	29.0	67	160	10.00	7.9	6.2	8.0
April	28.3	73	78	7.62	6.4	5.0	138.5
May	28.0	78	35	7.62	5.8	4.5	111.2
June	26.5	79	52	6.87	5.2	4.0	54.0
July	25.8	77	52	6.98	5.2	4.0	52.5
August	26.1	75	60	7.93	5.8	4.5	18.0
September	26.6	73	86	8.51	6.4	5.0	17.7
October	27.3	73	95	7.47	6.3	4.9	74.6
November	28.0	76	78	6.72	5.9	4.6	59.7
December	28.1	74	95	8.21	6.3	4.9	48.3
Year	27.6	74	93	8.01	6.3	4.9	585.9

Note: Figures given are monthly averages.

Source: HTS, 1980

CHAPTER 4

SOILS

4.1 Introduction

A semi-detailed soil survey of the project area was carried out for the 1980 feasibility study. Since then further work in the Juba valley has been undertaken by a team of soil scientists from the United States Bureau of Reclamation (USBR), who are working with the MJVD on a land classification for the whole of the valley below Bardheere. However, due to the large area to be covered, sampling is at a much lower density than the 1980 study and no significant additional information about the soils of the Homboy area has been obtained.

The results of the 1980 survey will therefore be used for the present study, and reference is made to Volume 1 of the report (HTS, 1980). The relevant details are summarised in subsequent sections of this chapter.

4.2 The 1980 Survey

The survey covered an area of some 15 100 ha, comprising the entire lower Shebelle floodplain between the Jilib-Mogadishu road in the north and the village of Burgaan in the south. Soil survey traverses were carried out on trace lines at 1 km intervals and a total of 596 auger borings and soil profile pits were examined, giving a density of observation of one site per 25 ha. The soil pits and auger bores were excavated to 2 m, with 22 of the auger bores extended to 5 m to study subsoil drainage characteristics.

Field tests were carried out to measure surface infiltration and soil permeability at selected representative sites, and laboratory analyses of physical and chemical properties were carried out on selected samples. Soils and land suitability maps were prepared at 1 : 20 000 scale, based on the data from soil investigations and utilising the 1 : 10 000 scale topographic maps as a base.

4.3 Soil Classification and Land Suitability

The soils are mainly fine textured and clay content increases from the levees of the old Shebelle channel through the flat cover floodplains, to the depressional areas. Soils on the lower cover floodplain and in the depressions typically have a prismatic structure in the root zone and a massive/wedge structure in the subsoil. Levee soils are better structured, but appear more susceptible to erosion. Permeabilities are low in the subsoils of cover floodplain and depression soils, except where coarser layers occur. Salinities are generally low and increase with depth but chemical differences between soil units are not significant.

Variations in the soils of the lower Shebelle floodplain are not the only factors influencing land suitability or choice of cropping pattern. Most of the deeper depressions in the proposed project are excluded on the basis of flood hazard, and the levee soils are downgraded on the basis of their topography and irregular shape.The high clay content and poor soil structure in the depressions, however, makes them more suited to rice cultivation. Table 4.1 summarises the soil mapping units in the project area together with the irrigation land suitability classes based on the USBR classification.

TABLE 4.1

Soil Classification and Land Suitability

Soil unit	Class	Suitability	Area (ha)	Area (%)
Cover floodplain	II	Suitable	6 456	42.8
Levee	III	Moderately suitable	1 773	11.7
Shallow depression	III	Moderately suitable	2 774	18.4
Floodplain complex	III	Moderately suitable	641	4.2
Lower terrace	III	Moderately suitable	514	3.4
Farta	IV	Marginal	259	1.7
Meander complex	IV	Marginal	417	2.8
Alluvium over marine clays	IV	Marginal	100	0.7
Other moderate and deep depressions, etc.	VI	Unsuitable	2 151	14.3
TOTAL			15 085	100.0

Source: HTS, 1980.

The table shows that a total of 12 158 ha (Classes II and III) in the project area is suitable for development, although not all of this area could be commanded by a surface irrigation scheme. A further 1 000 ha of the depression soils classified as unsuitable due to permeability and drainage limitations could be utilised for paddy rice monoculture. These areas are located primarily in the south of the project.

The levee soils and the higher soils of the cover floodplain, totalling some 3 000 ha, are designated as suitable for banana cultivation. The lower areas of cover floodplain will support mixed arable crops.

4.4 Surface Infiltration

A total of 13 infiltration tests were carried out at representative sites in the project area and the results are summarised in Table 4.2.

TABLE 4.2

Infiltration Rates

Soil type	Initial rate (mm/h)	Final rate[1] (mm/h)
Levee	125	17
Cover floodplain	127	13
Depression	79	10

Note: (1) After 1 to 2 days.

Source: HTS, 1980

All the soils show acceptable final infiltration rates for surface irrigation. Levee soils, with their relatively lighter textured surface horizons, tend to have higher final infiltration rates, whist the lowest rates were recorded in the clay soils of the depressions.

The infiltration tests were commenced when the soils were in a dry state and under irrigated conditions the soil will not dry out completely between irrigations. Taking the final infiltration rate as an indication of the poorest condition, the maximum time required to infiltrate a typical irrigation application of 80 mm varies from 4.7 hours in levee soils to 8 hours in depression soils. These figures are acceptable in a surface irrigation system and the latter figures may be considerably decreased if the soil has dried sufficiently for surface cracks to develop between irrigation applications.

4.5 Available Water Content

Undisturbed core samples were analysed to determine:

(a) The available water capacity (AWC), defined as the proportion of soil water held between 0.1 and 15.0 bars suction.

(b) The readily available water capacity (RAWC), defined as the soil water that can easily be extracted by the plant roots and held between 0.1 and 1.0 bars suction.

The results of the analyses are summarised in Table 4.3.

TABLE 4.3

Available Water Content

Soil type	AWC (mm/m)	RAWC (mm/m)	RAWC/AWC (%)
Levee	170	110	65
Cover floodplain	170	80	47
Depression	175	40	23

Source: HTS, 1980.

The table shows that the AWC figures are fair, with a decrease in RAWC with increasing clay content. The RAWC for the depression soils is particularly low, although this is not of great significance if paddy rice is grown.

4.6 Subsoil Permeability

Tests to determine the horizontal permeability of the top 2 m of soil were carried out at 22 representative sites in the project area using the 'pour-in' auger hole method. The results are summarised in Table 4.4 and show that permeabilities are generally low, although there is considerable variation among test sites. Predictably the highest permeabilities occur in the lighter

textured horizons of the levee soils, with the lowest values in the clay subsoils of the depressions. In horizons of similar texture, permeability tends to decrease with depth.

TABLE 4.4

Subsoil Permeabilities

Soil type	Depth range (cm)	Nr of tests	Textural range[1]	Hydraulic conductivity (mm/d) Range	Mean
Levee	0-50	1	C	-	37.0
	50-100	4	SiC(l)-C	20-98	46.0
	100-150	3	SiC(l)-C	9-71	34.0
	150-200	3	SiC-C	4-24	13.0
Cover floodplain	50-100	8	C(l)-C	3-12.5	8.0
	100-150	1	SiC	-	14.0
	150-200	7	C	3-9	5.6
	150-200	1	SiCL(l)[2]	-	220.0
Depression (shallow)	50-100	2	C	3-4	3.2
	100-150	1	C	-	4.3
	150-200	3	C	0.6-3.2	1.6
Depressions (Moderate to deep)	50-100	4	C	3-17	6.9
	100-150	0	-	-	-
	150-200	4	C	0-2.9	1.9

Notes: (1) SiCL = Silty clay loam
SiC = Silty clay
C = Clay
(l) = light

(2) Sand lens encountered at 2.0 m depth

Source: HTS, 1980.

Under irrigated conditions the low permeabilities could lead to excessive waterlogging, particularly after heavy rainfall. A surface drainage system will therefore be essential. In the shallow depressions where permeabilities are particularly low and runoff accumulates due to topographic position, paddy rice is the most suitable crop.

In order to assess the drainage characteristics of the deeper subsoil layers a total of 22 borings were extended to 5 m depth at representative profile pit sizes. Most (64%) of the deep bores consisted either wholly or dominantly of clay to 5 m depth. However, given the negligible deep percolation requirement for leaching (see Section C, Chapter 5), there should be no major constraint to irrigated cropping, provided surface drainage is adequate.

No watertables were encountered during the deep boring and previous work indicates a sandy aquifer at a depth of approximately 20 m, confirmed by observation of existing wells in the area. The increase in percolating water under an irrigated system could eventually lead to a rise in groundwater, possibly accompanied by harmful salts. This is a potential problem which may develop in the long term and groundwater levels should be monitored closely during project implementation.

4.7 Chemical Properties

4.7.1 Soil pH

The soils of the project area are all alkali with a median pH value of between 8.1 and 8.5 as shown in Table 4.5. No consistent relationship between pH and soil depth was observed.

TABLE 4.5

pH Values of Main Soil Types

Soil type	Percentage of samples in pH range				
	7.1 - 7.5	7.6 - 8.0	8.1 - 8.5	8.6 - 9.0	9.0
Levees	0	9	59	31	1
Cover floodplain	0	7	60	32	1
Depressions	0.5	3.5	57	38	1
Terraces	0	0	47	53	0
Farta	0	20	80	0	0
Meander complex	0	10	35	45	0
Beach remnant	0	17	75	8	0
Marine plain	0	0	52	48	0

Source: HTS, 1980.

4.7.2 Salinity

Salinity values for samples analysed for the 1980 study are summarised in Table 4.6. Salinities were found to increase with depth and the values given are averages for the top 1 m of soil.

TABLE 4.6

Soil Salinity

Salinity class (after FAO)		Maximum ECe value (mmho/cm)	Area (%)
I	Negligible	2.4	60
II	Low	4.9	25
III	Moderate	7.4	9
IV	High	9.9	4
V	Very high	>9.9	2

The table shows that soil salinity values are generally low and average values do not exceed 4.0 mmho/cm which is accepted as a critical level affecting crop germination and growth (FAO, 1985).

Sulphates are normally the dominant anions, although chlorides are also present in significant amounts.

4.7.3 Alkalinity

The alkalinity of a soil is most commonly expressed in terms of exchangeable sodium percentage (ESP) which is the percentage of the cation exchange capacity that is occupied by sodium. High values of ESP result in the dispersion of the clay, making the soil difficult to work and reducing infiltration and permeability. A soil is considered alkali when the ESP exceeds 15, which is also generally accepted as the limit beyond which deterioration in the soils physical properties will excessively affect crop yields.

Table 4.7 summarises the ESP values obtained from the samples. Most of the values (97%) fall below 15% and most of the upper horizons have values of less than 5%. The only soil with significantly high ESP value is the unirrigated marine plain.

TABLE 4.7

Summary of ESP Values (%)

Soil type	Percentage of samples within ESP range					
	5	5 - 10	10 - 15	15 - 20	20 - 25	>25
Levees	79	12	7	2	0	0
Cover floodplain	83	13	3	1	0	0
Depressions	86	12	1	1	0	0
Terraces	85	5	0	0	5	5
Farta	100	0	0	0	0	0
Meander complex	70	25	0	5	0	0
Beach remnant	100	0	0	0	0	0
Marine plain	31	17	19	7	14	12
All soils	77	16	4	1	1	1

SECTION B

AGRICULTURE

GLOSSARY

MIP	Mogambo Irrigation Project
CARS	Central Agricultural Research Station
MoA	Ministry of Agriculture
IITA	International Institute of Tropical Agriculture
ARI	Agricultural Research Institute
TPI	Tropical Products Institute
ULVA	Ultra low volume application
USA	United States of America
FRS	Fanoole Rice Scheme
IRRI	International Rice Research Institute
HYV	High yielding variety
TSP	Triple superphosphate
KCl	Potassium chloride
US$	United States dollar
NCA	Net cultivated area
ToR	Terms of Reference
SRS	Southern Rangelands Survey
TDN	Total digestible nutrients
DP	Digestible protein
Fe	Iron
Zn	Zinc
Cu	Copper
Mn	Manganese
N	Nitrogen
P_2O_5	Phosphate
m	metre
cm	centimetre
mm	millimetre
ha	hectare
t	metric tonne
kg	kilogram
g	gram
l	litre
md	man day
wd	work day
LU	livestock unit
DM	dry matter

CHAPTER 1

INTRODUCTION

1.1 General

A previous study for Homboy was carried out by the Consultants in 1979/80 when there was an apparent requirement to resettle a considerable number of people from Dujuuma. At that time a basic irrigation layout was recommended with a view to developing a large number of resettlement holdings of 1 ha each, on a relatively simple and standard cropping pattern aimed, to a major degree, at producing basic food for the settlers family with some cash cropping for supplementary income.

1.2 The Agricultural Inputs

The Agriculturist made two visits to Somalia, one of 4 weeks in November/December, 1986, and one of 8 weeks in January/February, 1987. Some 3 weeks were spent in the study area, during which time extensive discussions were held with the staff of the Mogambo Irrigation Project, the Juba Sugar Project and the Fanoole Project. Smallholder farmers living within the study area, who are likely to become scheme farmers, as well as smallholders in the general locality were interviewed on a group basis to assist in determining the current agricultural situation. Discussions were also held with local Party Officials, the District Administration and commercial banana farmers in the Lower Juba valley.

The Livestock Specialist, who has a wide knowledge of the livestock sector in Somalia, visited the project in November, 1986. Most of his input was in Mogadishu but a short visit was also made to the study area.

In Mogadishu, discussions were held with all organisations and government departments involved in the agricultural and livestock sectors. These discussions helped to widen the database by including all relevant material which could be of use when assessing the current situation and the development potential of the study area.

1.3 The Study Area

The study area totals about 15 100 ha and is located between 0°15' to 0°30' N and 42°45' to 43°30' E. The climate is tropical semi-arid with a bi-modal rainfall. The gu or main wet season (April/July) receives about 350 mm compared with about 180 mm in the der (October/December). The average annual precipitation is about 600 mm. The mean figures for other climatic parameters are temperature - 28°C, humidity - 74%, windrun - 90 km/d, sunshine - 8 h/d and evaporation (Penman Eo) - 6.3 mm/d.

The soils of the area were described in detail by HTS (1979), when some 12 200 ha were categorised as Class II or III and recommended as suitable for irrigated agriculture. Some of the depression soils which were put in Class VI for annual crops because of profile drainage characteristics, were reclassed as II to VI for paddy rice. Salinity levels in the upper layers were acceptable, but they were identified as being generally high in the lower horizons (50 to 100 cm). The soil permeability levels should allow adequate leaching consequently salinity was not considered to be a constraint on crop production.

There are several villages located within or on the periphery of the area. The main population centres are Homboy (including Aminow) and Burgaan. Other villages are small and often seasonal. The current population is estimated to be 2 100 families which, with an average of 5.5 people per family, gives a total population of about 12 000 head.

Livestock is an important part of the agricultural scene. It is estimated that the livestock population of the project area is 3 120 cattle, 1 120 sheep, 3 380 goats and 920 camels. During the dry season there is a large influx of nomadic owned stock and numbers are estimated to increase to 8 300 cattle, 2 230 sheep, 6 820 goats and 1 010 camels.

CHAPTER 2

CURRENT AGRICULTURE

2.1 Introduction

The local people have been practising traditional agriculture since the main Homboy village was established around 1925. By 1986, it was estimated (MMP 1986) that some 4 500 ha of the study area had been cleared and that the farming population consisted of about 2 000 households.

Most of the agriculture is rainfed, although historically the farmers also used flood water from the Shebelle or local catchments. The last time the Shebelle floods reached Homboy was reported to be 1981. About one-fifth of the farmers own deshek land (old river channels or depressions) in addition to their rainfed land, but it is only used when rainfall is insufficient for crop production. Possible reasons for not using the deshek land include: distance from the homestead, one farmer group said the distance to their deshek was 20 km; the risk of losing a crop, particularly one which is half grown, by flooding; the increased labour requirement to control bush and weed growth; and the unsuitability of the soil, due to waterlogging, for the staple maize crop.

The rainfed farming follows a low input/low output shifting system with land being cropped up to 5 years before it is rested for 5 to 10 years. The farmers recognise variations in land quality which require that some land needs fallowing more frequently or for longer. They also recognise that certain crops are better suited to certain land types; this applies particularly in desheks.

Some holdings are fragmented with quite long distances, up to one hour's walk, between the plots, while others are all contained within a zariba (barricade of cut thorn bushes). As well as marking the plot boundary, the zariba also prevents wild or domestic animals entering the holding and damaging the crops.

Farm inputs such as seed, fertiliser and pesticides, are not normally available (Conze 1986). ONAT has a machinery centre at Gelib with 30 tractors of which 14 are in working condition; it also runs a small shop in Jamaame which stocks a limited range of pesticides. The DoA sometimes has pesticides such as carbaryl available for sale to smallholders, while Somaltex provides a range of service and inputs to farmers growing cotton.

2.2 Crops Grown

It was quite evident from the group interviewers that the gu season is the main period of crop production. Rainfall in the der season is much less reliable; no farmer groups could estimate the freqency of der cropping, but all agreed that the rainfall is usually inadequate. Indeed, one group claimed it was more than 5 years since they last grew a der season crop.

Maize, being the staple grain, is the most important gu season crop. Sesame, which produces the preferred vegetable oil, is grown for home consumption and for sale and is a significant gu season crop, although it is grown mainly in the der season. Cotton, is the main cash crop and is grown in the gu season. Most farmers also grow cowpeas and vegetables, mainly onions and tomatoes.

The uncertainty of the der rainfall is illustrated by the cropping. Sorghum is the most extensively grown crop because of its tolerance of water stress and drought; the only other major crop is sesame. Vegetables, particularly onions, sweet potatoes and tomatoes are also popular in this season.

2.3 Land Preparation

Once the land has been cleared there is no land preparation to aerate the soil and to bury weeds, or to prepare ridges. Any new weed/bush growth is removed after which the land is considered to be ready for planting.

Some farmers at Homboy main village hire tractors from ONAT but this appears to be the exception rather than the rule. ONAT does not charge for travelling time if it is less than 10 km to the work site; if over 10 km there is a surcharge equivalent to three hours hire. ONAT has persuaded the Homboy farmers to form groups to minimise excess charges and unproductive travelling time. The farmers must go to Gelib and pay in advance before ONAT will agree to send a tractor to Homboy. Many farmers in Homboy and the other villages said they did not use ONAT tractors because they could not afford the hire charge of about SoSh 425 per ha.

Somaltex provides a tractor ploughing hire-service for land which is to be planted with cotton. Somaltex has a representative, who is also a farmer, at village level; before the season starts he prepares a list of all the people who plan to grow cotton and the area to be ploughed. This list, together with those from other villages, is used by Somaltex to plan a land preparation campaign which minimises travelling and down time. The rate per hectare charged by Somaltex is always slightly below the ONAT rate.

Although oxen are extensively used for transportation, they are not used for land preparation or other cultivation operations. The farmers say that this is because they have no experience of using oxen for cultivation operations, and because no ox-drawn implements are available in the LJV.

2.4 Seed

Farmers usually retain their seed from the preceding crop, a standard practice in most subsistence/cash smallholder farming systems. This technique results in the gradual selection of varieties which are well adapted to local conditions, because farmers usually select seed from the larger more productive and healthier plants.

Cotton is the only currently grown crop requiring new seed each year. This is the usual practice in most cotton producing countries, to ensure true to type plants producing lint of the standard quality required by the nation's spinning and weaving industries. Although Somaltex claims to be issuing seed for each crop, it comes straight from the Balcad ginnery; it is unselected and not dressed with a fungicide. This means that the current variety Acala 4-42 is gradually regressing as a result of cross pollination.

The Faculty of Agriculture at Afgoi is multiplying seed of an improved Acala 44. At the same time, Somaltex has applied to FAO for funds to establish its own seed multiplication centre (see Section 3.4.2).

There is no significant production of improved seed of field crops. FAO supports a seed multiplication centre at Afgoi, producing improved maize varieties but this seed is not being used by, nor is it available to, the Homboy farmers.

The University of Wyoming is supervising a variety testing programme at Bonka, near Baidoa in the inter-riverine area, which is specifically directed at the rainfed farming sector. Releases to date have been limited to one improved variety of mung beans, but there are four promising sorghum lines on which the programme is now concentrating. Variety testing programmes on cowpeas and sesame have been under way for a long time but no varieties have been identified which are consistently superior to the local Somali varieties.

2.5 Crop Production

2.5.1 Introduction

All crop production relies on rainfall or occasional flooding. The gu season with its more reliable rainfall, (average 356 mm) is the most important cropping season when the staple grain, maize; the preferred oil seed, sesame and the main cash crop, cotton, are grown. Minor crops grown in this season include cowpeas, onions, tomatoes and other vegetables.

Rainfall in the der season is far less reliable (average 183 mm) consequently cropping is limited to sorghum and some sesame plus a few vegetables.

If farmers use their deshek land, the crops, usually planted on a falling flood, include sesame, vegetables, water melon and occasionally maize.

As most of the crop production is based on mixed cropping, this section of the report will be sub-divided on the basis of inputs and operations rather than by crops.

2.5.2 Soils

The soils of the cropped areas are vertisolic, cracking clays, which the smallholders recognise as being the most fertile. When asked about the large expanse of marine plain, lying to the north-west and south-east of the study area, they said that it was unsuitable for crop production. This view has been supported by several studies (HTS/MMP 1977, HTS 1979) which showed that the marine plain contains saline and alkaline soils.

2.5.3 Varieties

Improved maize varieties such as Afgoi composite and Somtux are not grown. Of the other crops, only cotton is not a local variety, though the custom of using fuzzy seed produced at the Balcad ginnery could mean that cotton seed issued to Homboy farmers was also grown by them. Even the rationale behind new supplies of cotton seed for each crop is unlikely to apply as the lack of a proper cotton seed selection, rogueing and multiplication programme must have resulted in some segregation into different genetic strains.

2.5.4 Planting and Thinning

Most of the area is under mixed cropping, though some farmers said they occasionally plant pure stands. Maize is planted first in late March or early April, with cotton, sesame and cowpeas being planted about one month later. Chemical seed dressings are not used.

All the crops are planted in rows about 1.5 m apart; within row spacing is also 1.0 to 1.5 m. This enables the later crops to be interplanted in the inter-row area. Three seeds of maize, or a pinch of sesame or fuzzy cotton seed is planted at each point.

Although both the farmers and Somaltex said that cotton is interplanted with either maize, or sesame, or both, there was no evidence of maize stools, stubble or crop residues in the cotton fields visited during November 1986.

Because of the wide spacing to enable intercropping, and the variable size and shape of cropped areas, the farmers were unable to make any meaningful estimate of the seed rate per hectare. AHT (1986) estimated seed rates in Gelib district of maize 12 kg, sesame 9 kg and cotton 15 kg. The maize spacing quoted by AHT, 0.8 m x 0.8 m, gives 15 600 points per hectare which, at three seeds per point, and 2 500 seeds per kilogram requires 19 kg per hectare; broadly equivalent to the MMP/HTS (1978) figures of 20 to 25 kg. Similarly, using the AHT spacing for sesame and assuming a pinch of seed is 0.5 g, gives a seed rate of 10 kg/ha, which is the upper level of 5 to 10 kg quoted by MMP/HTS (1978). As each farmer growing cotton receives free seed equivalent to 20 kg/ha, it is reasonable to assume that this is the seed rate.

In the absence of any firm data, and assuming that smallholders will tend to use a high seed rate to compensate for insect damaged seed, low germination percentage and possible insect damage after planting, the following rates are believed to be indicative of the levels currently being used in the study area:

Maize	25 kg/ha*	Onion	6 kg/ha
Sesame	10 kg/ha	Sorghum	10 kg/ha
Cowpea	35 kg/ha	Cotton	20 kg/ha

Note: *This is somewhat above rainfed maize seed rates in other areas.

2.5.5 Fertilisers and Pesticides

No fertilisers are being used on rainfed crops in the study area. Pest control chemicals are used only on cotton and, possibly, onions.

If the farmers believe that they have a cotton pest problem, they inform the local Somaltex representative who makes a visual inspection of the crop and decides whether or not it should be sprayed. No systematic scouting is done when assessing the pest population or degree of damage. If it is decided that control measures are needed, Somaltex arranges a programme using DDT, carbaryl or monocrotophos. The number of sprays seldom, if ever, exceeds two.

Some farmers are said to use insecticides to control thrips on onions, but no confirmation could be obtained on this point.

As no meaningful figures on pesticide rates were obtained, it was assumed that cotton receives two sprays of 2.5 of monocrotophos, and that onions receive two sprays of phosphamidon 50 EC.

2.5.6 Weeding

This operation may be done by the smallholders themselves, or by hired labour. According to AHT (1986) most farmers (75%) weed maize and sesame three times using 38 man days (md) per hectare, while 25% weed only twice and use 30 md. Cotton was said to be weeded four times and to need 48 man days. The weeding operations were reported to be done 10, 21, 42 and 110 days after planting.

It is to be expected that more weeding is done on cotton because Somaltex provides a cash advance to meet part of the cost of such operations, but it is difficult to believe that the input is as high as 48 md. MMP/HTS (1978) undertook some detailed labour studies on irrigated maize and sesame in the MSV, and found that, assuming an md is six hours, the input was 26 days on maize and 10 days on sesame.

The inputs which have been assumed for the without project situation of Hombòy are:

Maize	20 md	Cotton	25 md	Onions	15 md
Sesame	10 md	Cowpea	10 md	Sorghum	20 md

2.5.7 Harvest and Post-Harvest

All crops are harvested by hand. Maize, sesame and cowpeas are harvested after about 90 days. The farmers and Somaltex both said that cotton could be harvested at 120 days, but while a few bolls may be mature at that stage, the crop will need 2 to 3 pickings with the first one at around 130 days after planting. The farmers do not grade the seed cotton as Somaltex uses only one grade when buying the crop. There are 17 buying posts in the Lower Juba valley (LJV); they remain open for 3 months (November to February). The seed cotton is weighed, recorded, paid for then transported by road to Balcad as the Jamaame ginnery is not operational.

Maize for home consumption is usually stored, unhusked and unshelled, in pits though some farmers store the actual grains in 200 l oil drums. Maize cobs that will be used for seed are left on the plant because the farmers believe the seed continues to develop until the stem is dry. The plants are tied in a bundle and stored in a tree until just before the next planting season.

To minimise seed loss through shattering, sesame is cut as the lowest pods are about to open. It is then bundled and stooked until fully dry, after which the bundles are inverted and shaken to extract the seed. The seed is winnowed and stored or sold.

Some cowpeas are picked green to use as a fresh vegetable. The others are left to mature, picked and heaped, threshed by beating with a stick, winnowed, and finally stored for home consumption or sold.

Sorghum is harvested by cutting off the heads which are threshed by beating with a stick. Onions dry in situ in the field after which they are pulled and stored at the homestead or sold.

2.5.8 Yield

The smallholders have no concept of yields in kilograms per hectare. They usually quote yields in sacks per dharab, but for maize and sorghum the sack is full of unhusked cobs or heads of grain. Another problem is the size of a dharab, dimensions given by farmers in group interviews gave areas ranging from 0.1 to 0.5 ha per dharab; the average number of dharabs per hectare appears to be about four. This uncertainty of production or area made it difficult to achieve meaningful estimates of current crop yields.

It was necessary, therefore, to review yields quoted in relevant publications as well as estimates based on information obtained during group interviews. For the latter it was assumed that a 100 kg sack of unhusked maize cobs contained 42 kg grain (60 kg cobs with 70% grain : cob ratio). The yields from these various sources are detailed in Table 2.1.

TABLE 2.1

Estimated Yields from Sundry Sources

Source	Yield (kg per ha)				
	Maize	Sesame	Cotton	Pulses	Sorghum
Somali Agricultural Sector Survey (1986)	700	-	-	-	400
MMP/HTS (1978) Genale Bulo Marerta	600	350	400	300	-
MMP/HTS (1979) Mogambo	800	300	700	-	400
HTS/MMP (1980) Homboy	200	150	-	200	-
Sogreah (1982) National	-	-	300	-	-
AHT (1986) JV desheks	970	500	-	-	-
AHT (1986) Gelib, rainfed[1]	1 200	600	400	500	500
MoA (1986) 1 and 2 MSV[2]	1 070	-	-	400	-
Conze (1986) Historical	-	-	320	-	-
HTS/MMP (1978) Fanoole	400	200	-	-	400
Group interviews - Homboy	820	250	370	60	900
Overall average	750	330	410	290	520

Source: Various references and field studies.

Notes: (1) The sorghum yield is for Saakow and Bu'aale districts.
(2) Research station and on-farm trial yields.

The assumed current situation yield levels for the study area are; apart from cotton, very close to the average of all the sources shown in Table 2.1. They are:

Gu season:

Maize	800 kg/ha	Cotton	250 kg/ha	Onions	2 500 kg/ha
Sesame	300 kg/ha	Cowpea	250 kg/ha		

Der season:

Sesame	200 kg/ha	Sorghum	600 kg/ha
Cowpea	175 kg/ha	Onions	1 750 kg/ha

The decision to use a low seed cotton yield was based on field observations. The spacing was about 1.5 m x 1.5 m giving 4 400 planting points per hectare, with five to ten plants at each point. This resulted in small, less than 0.5 m tall, plants with a few, small bolls. Assuming seven plants per point with an average of three bolls per plant, and a boll weight of 2.5 g, gives a yield of 230 kg/ha. It has been assumed, therefore, that the current yield of seed cotton at Homboy is 250 kg/ha.

No onions were seen in the field and the farmers were unable to provide any indication of the yield per hectare. The estimate of 2 500 kg/ha was based on experience of smallholder onion yields in other countries.

The rainfall is so unreliable that there is a high probability it will be insufficient or poorly distributed and that yields will be reduced; HTS/MMP (1980) gave the duration of the gu plus xagaa rains as 95 days for 1 year in 4, 77 days in the average year and only 59 days for 3 years in 4. The crop yields (gu and der) have been discounted by assuming that the der rains fail for 3 years in 4; in other words, only 25% of the cropped area produces in an average year (see Section 2.9).

2.6 Mechanisation

This is covered in Section 2.3 as the only mechanised operation is land preparation for which tractors and implements are provided for hire by ONAT or on credit, to cotton farmers, by Somaltex.

The only other agricultural equipment, besides the hand tools, used in the study are sprayers which are operated by Somaltex (see Section 2.4.5). There is no charge for this service, but the cost is reflected in the seed cotton price.

Ox carts of a simple flat-bed construction are used throughout the LJV to transport agricultural produce and other goods. Oxen are not used for other purposes such as ploughing.

Most cultural operations are done with the 'yambo', a short, or occasionally long handled, locally made mattock or hoe.

2.7 Crop Labour Requirements

The data on crop labour requirements are very limited. AHT (1986) prepared some estimates based on farmer interviews in the Juba Valley, but the data for Jilib district is believed to be too high. In this context the weeding requirement is discussed in Section 2.5.6. MMP/HTS (1978) did a quite detailed survey on the labour requirement for maize and sesame grown in the MSV. In addition to using a questionnaire, this survey also recorded the actual time farmers spent on each operation. Although the MMP/HTS data are for irrigated crops, they are believed to be more applicable to the Homboy situation than are the AHT data. Data from both sources, plus estimates made for the current study are included in Table 2.2.

The only other recorded data were included in the Sogreah (1982) report and gave 71 work days for 1 ha of a mixed crop of maize, cotton and sesame. The fact that it was a mixed crop obviously inflated the requirement which included 30 md (42%) for weeding, 19 md (27%) for harvesting and 10 md (14%) for post-harvest operations.

TABLE 2.2

Estimated Current Crop Labour Requirements (Work Days)

		Maize			Sesame			Cotton		Cowpea	Onion	Sorghum
		AHT (1986)	MMP/HTS (1978)	Homboy (esti-mate)	AHT (1986)	MMP/HTS (1978)	Homboy (esti-mate)	AHT (1986)	Homboy (esti-mate)	Homboy (esti-mate)	Homboy (esti-mate)	Homboy (esti-mate)
Land preparation	Gu	8	11	5	8	9	5	-	3	5	10	-
	Der	-	-	-	-	-	-	-	-	-	6	-
Planting		8	4	6	8	7	7	7	7	5	-	6
Nursery		-	-	-	-	-	-	-	-	-	10	-
Transplanting		-	-	-	-	-	-	-	-	-	15	-
Weeding		38	9	20	38	9	10	48	25	10	15	20
Pest Control		-	-	-	-	-	-	-	2	-	2	-
Harvesting	Gu	6	14	9	10	15	12	28	15	10	11	-
	Der	-	-	-	-	-	10	-	-	8	8	9
Post harvest		2	-	5	2	8	4	2	2	3	5	-
		-	-	-	-	-	4	-	-	3	4	5
Irrigating		-	1	-	-	1	-	-	-	-	-	-
Miscellaneous		-	5	-	-	5	-	-	-	-	-	-
Total	Gu	62	44	45	66	54	38	85	54	33	68	-
	Der	-	-	-	-	-	31	-	-	26	60	40

Source: AHT (1986); MMP/HTS (1978); Consultants' estimates.

The estimates for the current labour inputs at Homboy are believed to be realistic and are in broad agreement with labour inputs in similar situations in other countries. The estimated number of work days per crop is:

Maize	45	Cotton	54	Onion	58/53
Sesame	38/31	Cowpea	33/26	Sorghum	40

Where two figures are given they are for the gu/der seasons.

2.8 Holding Size

Few data exist on either the total holding size or the area which is actually cultivated per household, for the current population of the project area. The time and financial allocations did not permit a survey to be undertaken, however, the question of holding size and cultivated area was included in all group discussions conducted during field visits. The answers provided by the farmers were too varied to enable any meaningful estimate of cultivated area per household. It was necessary, therefore, to consider other methods and data sources which would provide information on this important topic.

The Southern Rangelands Survey (RMR, 1985) which used aerial survey techniques with ground checking, gave a range of 0.35 to 1.72 ha, (average 1.37 ha) in the Middle Juba and 0.31 to 0.86 ha, (average 0.55 ha) in the Lower Juba.

AHT (1986) obtained figures for registered farmers in the Middle Juba (25 farmers) and the Lower Juba (1 400 farmers) of 9.36 ha and 2.43 ha respectively. The large average size for the Middle Juba was caused by one farmer having more than 50 ha and only 12 farmers having less than 5 ha.

The Interim Report (MMP 1986) estimated that in late 1986 about 4 500 ha of the project area had been cleared by local farmers. If one assumes a 4.2% (2.7% population plus 1.5% new arrivals) population growth rate, there would have been 2 090 households in 1986 giving a cleared area of 2.15 ha per household.

During group interviews at Homboy and related villages, the village authorities said that the land tax collected in 1986 and excluding arrears, was SoSh 40 000. This figure does not include land tax for villages in the south of the project area. At SoSh 5 per dharab and with four dharabs per hectare this is equivalent to 2 000 ha of cultivated land. The number of households in this area was said to be 1 200 in November 1986, this gives a cultivated area of 1.67 ha per household.

Using the above figures and in the absence of any more accurate data, it has been assumed that each household in the project area has 2.0 ha of land under cultivation.

2.9 Rotations and Cropping Pattern

The Homboy farmers do not follow a crop rotation. The decision to plant a particular crop on a particular piece of land is not based on agronomic principles, rather it depends on the weather conditions, the needs of the household and the expected returns.

Maize occupies the greatest area in the gu season, sesame and cotton are also important, while most farmers will have some cowpeas and vegetables. In the der season, sorghum is the most important with sesame much less so; once again a small area of vegetables is usually grown.

It was not possible to get any meaningful estimate of the proportions of each crop in each season. It was decided, therefore, to use the following cropping patterns for analysis purposes. While these patterns may not be strictly accurate, they are based on information received when interviewing groups of farmers and it is believed that they give an acceptable representation of the current cropping pattern on the cultivated land.

Gu season:	maize	50%
	sesame	20%
	cotton	20%
	cowpea/vegetables	10%
Der season:	sorghum	80%
	sesame	15%
	vegetables	5%

The areas planted with each crop in year '0' or 1994 were estimated by using the following assumptions:

- there will be 3 000 households in the project area as detailed in the Interim Report (MMP 1986);
- each household will have 2.0 ha of cultivated land (Section 2.8) all of which is cropped in the gu season;
- the rainfall constraint in the der season limits cropping to 1 year in 4, or 25% per year;
- the cropping pattern will be as described above.

TABLE 2.3

Estimated Crop Areas (ha) in 1994

	Area per farmer		Overall scheme area	
Crop	Gu	Der	Gu	Der
Maize	1.0	-	3 000	-
Sesame	0.4	0.075	1 200	225
Cotton	0.4	-	1 200	-
Cowpea/vegetables	0.2	0.025	600	75
Sorghum	-	0.400	-	1 200
Total	2.0	0.500	6 000	1 500

Source: Consultants estimates.

CHAPTER 3

AGRICULTURAL DEVELOPMENT

3.1 Introduction

This chapter sets out the agricultural development proposals and the expected benefits. It explains the rationale behind the crop selection process, and the husbandry of each proposed development crop. It details the levels of each input that would be required to achieve the projected yields.

It is assumed that water will not be a constraint on crop yields. The cropping pattern and calendar have been designed to prevent labour availability being a constraint, by ensuring that the crop labour requirement in any one month does not exceed the maximum which a family can supply from its own sources.

3.2 Crop Selection

3.2.1 Introduction

Crops which are grown successfully at similar latitudes to those of the study area (0°15' to 0°30'N) and below 250 m include:

Perennials	-	banana, citrus fruit, coffee, dates, coconut, sugar and cashew;
Annuals:		
Grains	-	rice, maize, sorghum, wheat, finger millet, bulrush millet;
Oilseeds	-	sesame, groundnut, soya, safflower, sunflower, castor;
Legumes	-	gram, dwarf bean, mung bean, chick pea, cowpea;
Fibres	-	kenaf, cotton, jute;
Vegetables and fruit	-	tomato, onion, spinach, okra, water melon, sweet melon;
Sundry	-	tobacco

The above list is not exhaustive, but does include the main cash and subsistence crops which could be grown on a smallholder scheme in the Lower Juba valley.

3.2.2 Crop Suitability

A range of parameters (Table 3.1) were applied to the crops listed in Section 3.2.1 to identify those which would be more suitable for growing, under irrigation, at Homboy.

In addition to detailing the crop selection parameters, Table 3.1 also identifies the parameters that would be a constraint on production. As the Homboy scheme would not be developed until after Bardheere dam has been constructed, water supplies are not considered to be a constraint on crop selection. The information contained in Table 3.1 can be summarised as follows:

TABLE 3.1

Crop Selection Parameters

	A	B	C	D	E	F	G	H	I	J	K	L
Perennial												
Banana									y		y	
Grapefruit			y			y			y		x	
Orange	x		y			y		x	y		x	
Lemon			y						y		x	
Lime			y						y		x	
Mango			x	x				x	y		x	
Papaya			x	x				y			y	
Guava			x	x				x			x	
Cashew			x	x					y		x	
Coconut	y			x					y		x	
Coffee	x			x				x	y		y	
Date	x							x	y		x	
Sugar			x	x					y		y	
Grain												
Rice						y	y					
Maize					y					y		
Sorghum			.		x	x				x		
Wheat	x					x	x		x			
Finger millet			x		x	x		x	x	x		
Bulrush millet			x		x	x		x	x	x		

	A	B	C	D	E	F	G	H	I	J	K	L
Oilseeds												
Sesame					y			y		x		
Groundnut			y							x		
Soya	y		y				x	y	x			
Sunflower						y		y	x	x		
Safflower			y				x	y	x			
Castor			x					y	x	x		
Legumes												
Dwarf bean						y		x				
Mung bean						y		x		x		
Gram						y		x		x		
Cow pea						x		y		x		
Chick pea						x		x	x			
Fibres												
Cotton				y		x				x		
Kenaf	x			x					x			
Jute	x			x					x			

	A	B	C	D	E	F	G	H	I	J	K	L
Vegetable/ Fruit												
Tomato			x									
Onion			y									
Spinach			x									
Water melon			x									
Sweet melon			x									
Sundry												
Tobacco			x	x	x				x		x	

Source: Consultant's estimates

Notes:
- A - climate
- B - soils
- C - market
- D - processing
- E - policy
- F - pests, diseases, birds
- G - mechanisation
- H - yield, variety
- I - experience
- J - rainfed crop
- K - establishment period
- L - other
- x - major constraint
- y - minor constraint

Bananas: the only constraint would be the smallholders' lack of experience of growing bananas for export. In this respect it is assumed that the 500 ha banana smallholder pilot project would identify the management, training and extension requirements necessary for developing a smallholder banana sector. It must be pointed out that bananas are popular, profitable and extensively grown in the Lower Juba valley.

Citrus: the sweet orange is excluded because of high temperatures, but grapefruit, lime and lemon could be grown. Although the international market would be better for grapefruit than for limes and lemons, the current Somali grapefruit would not meet the strict quality requirements of the European market. It must also be pointed out, that the world market for citrus fruits is currently over supplied.

Important constraints are the long establishment period and the smallholders' lack of experience. The former could be alleviated by intercropping for up to three years and by a phased development of the smallholding; the latter would require a well trained and sympathetic extension service. The current grapefruit areas, particularly on the Shebelle, have problems with pests and diseases but these could be overcome by following a controlled pest control and crop hygiene programme.

Fruit: the local mangoes are variable in quality with most being far too fibrous for export and, like papaya and guava, they are very susceptible to damage in transit. Mango and guava have long establishment periods but this could be offset in the same way as with grapefruit. The development of a canned fruit industry is possible, but this would require a major investment in the factory, together with a widespead campaign to ensure that sufficient fruit of an acceptable type and quality was available at the right time. At this stage it is considered that while there may be scope for some expansion in fruit crops to meet internal market demand, these crops cannot be considered as a major component in any development programme.

Cashew and Coconut: both these crops have some potential but cashew is not grown currently and requires specialised processing equipment, whilst the coconuts seen during field work were not growing well. Both crops have a long establishment period, with full production not being reached for ten or more years.

Coffee and Dates: these are both regarded as unsuitable for the climatic regime of the Lower Juba. The temperature is too high for coffee and the rainfall is too high and at the wrong time for dates.

Sugar: this has been shown to grow well on the Juba Sugar Project (JSP) but, even if there were spare capacity, and access across the Juba river was provided by a bridge near Jilib, the cost of transporting the cane would make it uneconomic for the Homboy smallholders to grow this crop. Estate production of sugar is capable of meeting the majority of current internal demand, also there are detailed plans available for expanding the JSP should this be necessary or desirable. Thus, sugar cane is not considered to be a potential development crop for Homboy.

Grain Crops: finger millet and bulrush millet are excluded on the grounds that they are not popular food grains and that they are normally grown under rainfed conditions, while wheat, which is currently being tested in the Juba valley, is excluded mainly because of the climatic conditions and susceptibility to bird damage. Sorghum is a staple grain in many parts of Somalia, but this is not so in the Lower Juba where the people prefer maize. Also, it is Government policy

that as sorghum can be grown under rainfed conditions elsewhere, the limited irrigation resources should not be used to grow this crop. Maize is also very suitable for growing in some of the rainfed areas, however, considering that, first, it is the staple grain in the Lower Juba valley, second it grows well and has a high yield potential, and third, it is not susceptible to bird damage, it cannot be excluded as a development crop. Modern varieties of paddy rice grown under irrigation have a high yield potential, consquently it is regarded as most suitable, particularly on those areas with heavy soils and liability to waterlogging.

Oilseeds: sesame is the preferred vegetable oil and, although once again it is a very successful rainfed crop, the smallholders are certain to want to include it in their cropping programme. Groundnut oil is not widely used but the nuts are a popular foodstuff in certain areas thus, while they cannot be considered as a major component of any future cropping pattern, groundnuts could be grown as part of a legume break. Sunflower oil is very popular in Europe and America because of its low saturated fatty acid content. Other advantages are the high (more than 40%) protein meal remaining after oil extraction, which can be used as either human or animal feedstuff, and the use of dried stalks as fuel. At this stage, however, it has not been included in the cropping pattern because of the relatively low yields and its susceptibility to bird damage. Soya and safflower are possible alternative edible oil crops, while castor could be grown to produce an industrial or medicinal oil. As neither soya or safflower oil is widely used, and as castor is primarily a rainfed crop, they are not regarded as having a high development potential.

Legumes: grain legumes, particularly cowpeas and mung beans, are a popular component of the local diet but yields are usually very low. Most legumes are susceptible to soil salinity, fungus diseases and storage pests. It is likely, however, that smallholders would want to grow some form of grain legume and consequently allowance has been made for this in the cropping pattern.

Fibres: cotton is grown extensively in the Homboy area under rainfed conditions, but yields are unlikely to exceed 300 kg per ha because of spacing (1.5 m x 1.5 m) and lack of thinning (5 to 10 plants per point). The ginnery at Jamaame is not operational consequently the seed cotton is taken by road to Balcad, some 450 km north of Homboy. Providing the inputs are available on time, and the extension service teaches smallholders to plant at the correct spacing, then cotton has a good development potential. Its main drawbacks are the susceptibility to pest damage, the high labour requirement and the long growing period. Pre-planting and post-planting operations result in a total period of 6 to 7 months which is a constraint when aiming for a 200% cropping intensity. Jute and kenaf are excluded as development crops because of the large volumes of water needed for retting, that is stripping the bark from the stem and separating the fibre from the bark.

Vegetables: the main markets for vegetables are the urban areas and it is likely that most, if not all, the demand is already being met by local producers. Thus, while there may be some scope for supplying these markets, it would be insufficient to support a major commercial vegetable component in the cropping pattern. It has been assumed, however, that each smallholder would have 0.1 ha of vegetables, primarily for home consumption although there would be some surplus production for sale.

Tobacco: local tobacco is grown in the Lower Juba valley and sold in small bales or coils. As with vegetables, however, supply and demand for this type of tobacco is usually in balance. Production of flue and fire cured tobacco would be difficult because of the fuel requirement, also, the nitrogen content of the

soils is likely to be too high for flue-cured virginia tobacco. In addition, the world market for aromatic and burley tobacco is already adequately supplied by the traditional producers. Thus tobacco is not considered to be suitable for inclusion in the Homboy cropping pattern.

3.3 Land Preparation

It is proposed that this operation should be done by tractor drawn implements because, first, there is no tradition for using draft animals in the Juba valley and second, the time available is severely constrained by the 200% target cropping intensity, consequently land preparation by hand would not be possible.

Most mechanical land preparation in Somalia is done with a disc plough but occasionally mould-board ploughs are used. In previous studies both methods have been recommended on the criteria that disc ploughs have a lower draft requirement while mould board ploughs leave a more level surface and give better weed control. Neither of these implements is being recommended for Homboy, where it is proposed that land preparation should be by chisel plough and disc harrow.

The land should be broken by making two passes, at right angles to each other with a chisel plough, followed by two passes, also at right angles, with a disc harrow.

The chisel plough would fracture the soil body in both the vertical and horizontal planes. This would greatly improve aeration and the initial infiltration before the soil's swelling characteristics closed all the cracks. The disc harrow should have two offset gangs of cut-away or scalloped discs. Athough most crop residues should have been removed prior to land preparation, it is likely that some will remain, using cut-away discs should ensure that the residues are chopped into small pieces and either fully or partially buried.

Using a chisel plough should minimise the soil disturbance which will have two beneficial effects, first, it will reduce any adverse effect on the level surface of the field and, second, it will reduce the loss of soil moisture by evaporation from newly exposed soil surfaces. The two disc harrow operations should produce a satisfactory tilth for planting crops such as maize, sesame, cowpeas and rice. Use of chisel rather than disc ploughing should also result in somewhat lower tractor hours per hectare than with disc ploughing.

It is also proposed that land to be planted with cotton should be ridged, as is the common practice on irrigated vertisols in the Sudan. Ridging has the following advatanges:

- it ensures the correct between row spacing (0.9 m) thus helping to get the correct plant population;
- it makes thinning and weeding much easier;
- it reduces the risk of waterlogging;
- it increases the soil surface area thus aiding infiltration; and
- on sloping land, correctly aligned ridges reduce the erosion hazard.

The increased soil surface area does mean increased evaporation losses when the soil is wet, but as soon as the top few centimetres are dry, moisture loss by evaporation virtually ceases.

All land preparation operations have some effect on the results of previous land levelling operations. The chisel ploughing and harrowing will have minimum effect compared to ridging which will destroy the results of land levelling. In the Genale Bulo Marerta Project Report (MMP/HTS, 1978) it was recommended that land levelling would be necessary after every two to three crop seasons. At Homboy, however, it is proposed that the land should be levelled after the cotton crop, that is once every two years or after four cropping seasons.

3.4 Crop Production

3.4.1 Maize

(a) Introduction

This is the staple grain in the Lower Juba valley and, indeed, throughout much of the Southern Region. It has a high yield potential when irrigated and grown under good management. Large quantities of maize are imported each year, the amount depending on the availability of locally produced grains. The peak import was 325 000 t in 1983; more than 150 000 t were imported in three other years between 1977 and 1984.

As maize is so popular and as it is likely that recurring drought conditions will make it necessary to supplement local, rainfed, grain production by imports or increased production from the irrigated sector, it was decided to include maize as a major component of the Homboy cropping programme.

(b) Soil Requirement

Maize grows well on most soils, but it prefers a well-structured, permeable soil with, if possible, a high organic matter content. The soil should be well aerated and free draining as maize has a low tolerance to waterlogging. The deepest roots can reach down to 2.0 m but 80% of the water and nutrient uptake is in the top 1.0 m of the soil profile. During the growing season, the minimum depth to ground water should be 0.8 m. The optimum pH is 5.5 to 7.0, but maize will continue to produce satisfactorily within a pH range of 5.0 to 8.0. Maize has only medium tolerance to salinity; an ECe of 5 mmho/cm will reduce the yield by 10%, while 7 mmho/cm will reduce it by 50%.

(c) Variety and Seed

Although the local preference is said to be for white maize, most farmers grow mixed grain colour, varieties which produce well under local environmental conditions.

The current MoA recommended variety is the composite Somtux which includes the previously popular Afgoi composite and a Mexican variety in its parentage. Somtux has proved very successful in a long series of trials at Central Agricultural Research Station (CARS), but it is likely that it will have been superseded by the time the Homboy scheme starts. Whichever variety is available, advance arrangements should be made with the Agricultural Research Institute (ARI), and, if it is working, the proposed seed multiplication centre at Afgoi, to supply certified seed to Homboy for bulking by selected farmers.

(d) Land Preparation

This will be done with a chisel plough and offset disc harrow as described in Section 3.3. At this stage it is not proposed that the land should be ridged, as suggested by MMP/HTS (1978) and HTS/MMP (1980), both of which recommended furrow irrigation. The permeability of the sub-soil at Homboy should minimise the waterlogging hazard, thus obviating the need for ridging and thereby reducing the cost of land preparation. If the soil conditions are such that ridging becomes necessary, the requirement for 60 to 80 hp tractors will rise from 68 to 96 and for ridgers from 19 to 27.

(e) Planting and Thinning

Between 1967 and 1985, the ARI undertook 27 trials at CARS to try to determine the optimum population or spacing for maize. When these trials were reviewed in 1986, it was concluded that factors such as inadequate recording of results, poor research technique, and invalid results because of bird or pest damage, made it impossible to make a definite recommendation on the optimum population or spacing for maize.

It is necessary, therefore, to consider recommendations from other sources which could be adopted for use at Homboy. Acland (1971) describes work done in East Africa where it has been shown that low plant populations are one of the main reasons for low average yields. In Kenya, 0.9 m x 0.25 m (45 000 plants per hectare) has been shown to be best for high yielding, hybrid varieties providing there is no risk of moisture stress. The popular Katumani composite, which is a small plant, yields best at a population of 100 000 plants per hectare. Ilaco (1981) recommends 40 000 to 60 000 plant per hectare for irrigated maize while FAO (1979), quotes 20 000 to 30 000 and 50 000 to 80 000 plants per hectare for large and small varieties respectively. MMP/HTS (1978) recommended 40 000 to 50 000 for the Genale Bulo Marerta area while HTS/MMP (1980) proposed 50 000 for the Homboy project.

Considering all the above, together with data from other sources, it is proposed that the smallholders at Homboy should use 20 kg of seed per hectare; it should be dressed with Fernasan D or its equivalent, at the rate of 0.3 kg per 100 kg of seed. This seed rate should be adequate for a target population of 45 000 to 50 000 plants per hectare. This could be achieved by the following spacings: 1.0 m x 0.2 m (50 000); 0.9 x 0.2 m (55 000); 0.9 m x 0.25 m (45 000) or 0.8 m x 0.25 m (50 000).

It is proposed, however, that the within row spacing is doubled to 0.4 m or 0.5 m. To obtain the same population it would be necessary to plant 3 to 4 seeds per hill and thin to two, instead of 2 to 3 seeds thinned to one seedling at the closer within-row spacing. The seed should be planted between 1st and 28th April so that the crop can make maximum use of the gu rainfall.

(f) Fertilisers

The research programme at CARS from 1965 to 1984 included 32 trials which tested fertiliser treatments on maize. ARI (1986-3) has reviewed this programme and considers the trial results inconclusive, however the following summary suggests that the response to nitrogenous fertilisers cannot be disregarded.

	Significant	Not significant	Unknown	Invalid
N only trials	9	6	-	1
P only trials	-	5	-	-
N and P trials	1	2	3	-
N, P and K trials	-	-	2	1
DAP trials	-	2	-	-

The CARS data cannot be used to identify the source of N (it could be urea, ammonium sulphate or ammonium nitrate) or the application rate which varied from 46 to 150 kg N per hectare.

In Tanzania, the recommendations range from 0 to 80 kg N and 0 to 50 kg P_2O_5 per hectare whereas in Kenya it can be as high as 190 kg N and 120 kg P_2O_5 per hectare. MMP/HTS (1978) and HTS/MMP (1980) both recommended 79 kg N and 25 kg P_2O_5 per hectare.

The recommendation for Homboy is 40 kg DAP after the first disc harrowing operation and 110 kg urea to coincide with the onset of rapid shoot growth some 20-25 days after planting. These rates will supply a total of 60 kg N and 20 kg P_2O_5 per hectare, which is equivalent to about 70% of the N and P_2O_5 removed by the assumed yield.

(g) Weeding

If the plant is checked by weeds during the seedling stage, subsequent growth will continue to be adversely affected irrespective of the efficiency of later weeding operations. Trials in Kenya showed that three weedings, when the crop was 75, 450 and 950 mm high, gave 1 200 kg more grain per hectare than one weeding at 450 mm.

Weeding should commence soon after emergence, when the seedlings are 50 to 70 mm high. Two subsequent weedings, at 20 to 25 and 40 to 45 days after planting will probably be required, after which the crop should be tall enough to shade out weed growth.

Herbicides such as Primextra 500 FW applied by a ULV sprayer such as the Birky would give good control. This method of weed control, however, is not recommended because first, the Homboy farmers should have ample family labour to meet the weeding requirement and second, herbicides containing atrazine can have adverse residual effects on a following crop unless they are used correctly.

(h) Pests and Dieseases

Although maize is attacked by many insect pests, the most serious one is likely to be stalk borer (Chilo sp). This can be controlled by putting a pinch of diazinon 10 G granules into the funnel made by the top leaf at 13 days after planting. It may be necessary to repeat this operation some 35 to 40 days after planting. Each treatment would require about 5 kg of diazinon giving a total requirement of 10 kg/ha.

A second method of control is to apply 15 kg of carbofuran 10 G granules at planting time. This is equivalent to 0.6 g per planting hole at the wide spacing. The carbofuran could be applied by using a small plastic measure similar to those provided by the agro-chemical industry to tobacco farmers in

East and Central Africa. Trials in 1984 (ARI-1986) indicated that 0.75 kg of active ingredient (ai), which could be supplied by 15 kg of carbofuran 5 G, may be as effective as 3 kg of ai. If this is confirmed in subsequent trials at CARS, the lower, and therefore cheaper rate, should be used at Homboy.

Carbofuran is a systemic pesticide that should protect the plant against all leaf eating, boring and sucking pests for a period of 60 days. It is also a nematocide so will give protection against eelworms.

The third method of control would be to spray with Polytrin C 440 EC or Curacron 250 EC/ULV using a Birky sprayer that has been fitted with an insecticide head. Each chemical would have to be applied twice, Polytrin at 1.25 l and Cuvacron at 2.5 l/ha at about 14 and 30 to 40 days after planting. The labour requirement would be 0.5 man days per application. The choice of which method to use will depend on the relative costs and labour requirements.

Maize is susceptible to a range of fungus diseases, but these are seldom of economic importance and consequently no control measures are proposed.

(i) Harvesting

The crop should be harvested by hand as picking the cobs is not very labour demanding. This method is preferred to cutting and stooking as it reduces the time required for the cobs to dry out. After the cobs have been harvested the stalks should be cut and removed from the field.

(j) Post-harvest Operations

Maize required for home consumption, or for sale, would be shelled by traditional methods and sold, or stored unhusked in a covered pit. Pit storage is widely practiced in Somalia and storage pests are not considered to be a major problem. If the incidence of such pests increases, the grain should be treated with an insecticidal dust, such as malathion 1%, (0.1 kg per 100 kg of seed) or pirimiphos methyl dust.

(k) Yield

Average maize yields in Kenya and Tanzania are about 1 200 kg and 600 kg/ha respectively. These relatively low levels are a result of a low standard of husbandry, and much of the maize being rainfed and in a mixed stand. Unimproved varieties grown under good management in Kenya have produced 2 000 kg/ha, while hybrid varieties grown under similar conditions have produced as much as 8 000 kg/ha (Acland 1971). Average yields of irrigated maize in the USA are about 6 000 kg/ha (Ilaco 1981).

Yields obtained on research plots at CARS have ranged from less than 500 kg to more than 5 000 kg/ha. MMP/HTS (1978) estimated smallholder yields at Genale Bulo Marerta would reach 2 500 kg/ha after 8 years. HTS/MMP (1980) estimated 4 000 kg in the gu and 3 500 kg in the der after 10 years.

Smallholders' maize receiving up to four irrigations in the Lower Shebelle (LSV) and Middle Shebelle (MSV) in 1986 produced average grain yields of 2 000 to 2 500 kg/ha in 1986; in 1984 and 1985 the yield range was 2 300 to 3 300 kg/ha (AFMET 1985). As the LJV resembles the LSV more than the MSV, one would expect to get similar yield levels to those recorded by AFMET in crop cutting trials. With an optimum range of inputs and regular irrigation, the yields should be even higher.

The estimated average yield at Homboy is 3 000 kg/ha, although the better farmers can be expected to obtain 3 000 to 4 000 kg/ha in most years.

3.4.2 Cotton

(a) Introduction

Cotton has been an important crop in Somalia with an area exceeding 20 000 ha and producing about 5 200 t of seed cotton. The highest average yield was said to be 700 kg/ha in 1974; from 1970 to 1985 the annual average was 340 kg/ha.

Somaltex estimated that 12 000 ha were planted in 1985; the 1986 estimate was 20 000 ha but low rainfall reduced the area harvested to 10 000 to 12 000 ha.

(b) Soil Requirements

Cotton prefers a well drained moisture-retaining soil, preferably with a fine to medium texture; in practice it is grown on a wide range of soils including heavy, cracking clays. A free draining characteristic is preferable as cotton has low to medium tolerance of short periods of waterlogging; it is very intolerant to waterlogging in the seedling stages.

Although cotton has a strong taproot, 70% to 80% of the rooting system is concentrated in the top 0.9 m of the profile; the preferred minimum depth to groundwater is 1.0 m.

The optimum pH is 5.2 to 6.0, but it grows well in soils with a pH ranging from 4.8 to 7.5. An ECe of 10.0 mmho/cm reduces the yield by only 10%; 16 mmho/cm would reduce the yield by 50%.

(c) Variety and Seed

Somaltex intends to replace the current variety (Acala 4-42) with Acala 44, for which seed is being multiplied at Afgoi by the Agricultural Research Department of the University. A proposal has been submitted to FAO for financial assistance to establish a cotton seed multiplication centre, which would also be used for training and research programmes.

Considering the above, the only recommendation that can be made at this time is that the proposed seed multiplication centre should be established as soon as possible. The distribution of new improved and true to type seed is so important that any delay in establishing the multiplication centre should be offset by selecting good farmers to produce certified seed.

As hand planting is the recommended method, mechanically delinted, fuzzy seed will be quite satisfactory. Seed dressing machines should be installed at each operational ginnery; dressing with 0.35 kg of 12% bronopol dust per 100 kg seed is recommended to control seed borne fungal diseases. Other possible seed dressings are benodanil at 0.25 kg, thiabendazole at 0.3 l or quintozene at 0.4 kg per 100 kg of seed.

(d) Land Preparation

This is discussed in Section 3.3. The land would be chisel ploughed, disc harrowed and ridged by the project's Agricultural Machinery Unit.

(e) Planting and Thinning

The recommended seed rate is 25 kg/ha. This would be hand planted, 25 mm deep, on ridges 0.9 m apart and with 0.25 m between planting points. The use of fuzzy seed will give a variable number of plants per point and necessitate thinning. This operation should be done about three weeks after germination when the plants have their second true leaf; the number of plants per point should be reduced to the two strongest. This will give a theoretical plant population of 88 000 per hectare but in practice it is likely to be lower because not all plants will survive to maturity. This population is recommended for the Sudan and falls within the frequently quoted range of 40 000 to 100 000 plants per hectare (ILACO 1981).

To ensure that the crop matures in the dry period before the gu rainy season; the seed must be planted in August. An average planting date of 15th August means that picking can start in early January and be completed by mid-February.

(f) Fertilisers

As far as could be determined, only one fertiliser trial on cotton has been undertaken by CARS. Rates of 0, 50, 100 and 150 kg N per hectare and 0, 50 and 100 kg P per hectare were tested, and the results showed a positive correlation between application rates and yield, although there was no interaction between N and P. As it would be misleading to draw any definite conclusion and make recommendations on the results from one trial at Afgoi, it has been assumed that fertiliser requirements at Homboy will be 115 kg of urea and 40 kg of diammonium phosphate (DAP) per hectare. These rates will give 54 kg N and 20 kg P_2O_5 per hectare which approximates to the quantities removed by a crop yielding 1 500 kg of seed cotton per hectare (HTS/MMP 1980). The DAP should be broadcast just before ridging, whilst the urea should be applied 40 to 50 days after germination. The application of urea should be timed so that it follows a weeding operation, to reduce the amount of fertiliser that is taken up by the weeds.

(g) Weeding

Cotton seedlings are very susceptible to competition from weeds. If the weeds are not removed early, the growth of the cotton will be retarded to such a degree that it cannot recover, and the yield will be seriously reduced. Weeding should begin in the first week after planting to minimise competition with the young cotton plants. The Homboy Report (HTS/MMP 1980) recommended four hand weedings, but it would be preferable if the weeding operation could be continuous until the crop canopy is sufficiently dense to shade out any further weed growth. This should occur 65 to 75 days after germination.

Weed control could be done with herbicides but using such chemicals demands a high degree of skill; also herbicides are expensive and have to be imported, consequently hand weeding is the preferred and recommended method.

(h) Pests and Diseases

Cotton has more insect pests than any other crop. In some countries, for example, Sudan and Thailand, more than ten sprays are usually required to prevent major damage by insects. Fortunately cotton pests have not been a

serious problem in Somalia though the American (Heliothis sp) and Spiny (Erias sp) bollworms have caused damage to cotton at Afgoi and Balcad. Most of the other common pests of cotton (aphids, stainers, jassids) are also present, but to date they have only done minor damage.

It is to be expected that the introduction of intensively grown cotton on 1 900 ha will lead to increased populations of insect pests. It was decided, therefore, to include the spray regime proposed by the Ciba-Geigy extension staff, namely six sprays of Polytrin C 440 EC at fortnightly intervals, starting 35 days after germination. The Polytrin should be applied at the rate of 1.0 l/ha using the Birky ULV sprayer with an insecticide head.

Polytrin C 440 EC is a mixture of two insecticides, profenofos, an organophosphate, and cypermethrin, a synthetic pyrethroid. This combination makes it effective against a wide range of pests including bollworms, sucking pests, leaf eaters and spider mites.

It must be emphasised that Polytrin, like most other modern pesticides, is toxic and care must be used when spraying the cotton. To ensure that the spraying is done correctly, the extension staff must be well trained so that they can demonstrate the correct procedures to the smallholders.

(i) Harvesting

It is proposed that the cotton should be harvested by hand. There are two International cotton harvesters at Balcad, which Somaltex says it may rehabilitate for use in an emergency such as shortage of harvesting labour. This is believed to be impracticable because mechanised cotton picking requires:

- growing varieties which mature evenly and have plants of equal height and size;
- high husbandry standards, particularly spacing, fertiliser treatment and pest control;
- efficient and timely defoliation;
- installation of additional seed cotton cleaning machinery at the ginnery;
- a transporting system which can move bulk cotton from the field to the ginnery;
- and large fields to prevent downtime when manoeuvering the picker in the field or moving between fields.

Growing medium staple cotton means that it can be harvested in three picks. The top pickers in Zimbabwe can harvest up to 60 kg of seed cotton per day, but the average there and in most other cotton producing countries is 20 to 30 kg per day. It has been assumed that the smallholders at Homboy will be able to pick 25 kg per day giving a labour requirement for harvesting of 60 work days.

The current practice of having only one grade should change to the more common three grades. Some countries have only two grades with a large price differential, but this system often results in the lower grade being left on the plants. Having three grades with a lower price differential between each grade, encourages the farmers to harvest all their cotton. The extension service should teach the farmers to grade as they pick; this method reduces the need for regrading and the likelihood of the cotton being rejected at the buying post because it consists of mixed grades.

(j) Uprooting and Burning

Most cotton producing countries have a statutory close season, but not all of them enforce it. The rationale behind a close season is that, by uprooting and destroying all the cotton plants, the risk of a carry-over of pests and diseases is greatly reduced.

It is recommended that, if Somaltex is serious about expanding cotton production to meet the needs of the local textile industry, then cotton uprooting legislation should be drawn up and enacted as soon as possible. Even if such legislation is not approved, it is proposed that a cotton close season from 1st April to 30th June should be adopted at Homboy. It is further proposed that agreement to accept such a close season should be a conditional clause in each tenancy agreement.

When calculating the time available for land preparation for maize, which follows cotton in the proposed crop rotation, a period of four weeks (mid-February to mid-March) was left free for uprooting and burning of the cotton stalks.

Uprooting of the cotton stalks could be made much easier by partial mechanisation, as is done in countries such as Sudan. The roots are cut 5 to 10 cm below the soil surface by a blade which is attached to a tractor drawn toolbar. Tractor availability at this period would be adequate, but using them would increase the production cost for cotton. It is proposed, therefore, that this operation should only be considered, if and when, it is shown that the smallholders' labour resources are inadequate to meet the needs for uprooting the cotton stalks.

(k) Yield

The best treatment in the one fertiliser trial at Afgoi produced 3 450 kg of seed cotton per hectare. On the Bura Irrigation Scheme in north Kenya and at Tenterhoe in Ethiopia, smallholders get yields of 2 500 to 3 000 kg/ha. Yields of irrigated medium staple cotton in Sudan are much lower at about 1 400 kg/ha. The Genale Bulo Marerta Project (MMP/HTS 1978) estimated smallholder cotton yields of 1 500 kg/ha after 8 years while the Homboy project (HTS/MMP 1980) estimated 2 500 kg/ha after 10 years.

While it is likely that some Homboy smallholders will get yields in excess of 2 000 or even 2 500 kg/ha, it is just as likely that others will get much lower yields. This could be because they planted the cotton late, the weeding operations were inadequate or untimely, they missed one or two insecticide sprays, or they were unable to complete the harvesting.

It was assumed, therefore, that the overall scheme average yield would be 1 500 kg of seed cotton per hectare giving a total production of 2 850 t equivalent to about 1 850 t of lint.

3.4.3 Sesame

(a) Introduction

Sesame is an important oilseed crop which is extensively grown under rainfed and wild-flooding irrigation in the Southern Region of Somalia. It is the most popular vegetable oil, although this fact has been masked by the high level of

imports in recent years. Local production of vegetable oils, of which sesame accounts for some 90%, has been running at about 47% of total demand, the shortfall in supply has been met by importing large quantities of soya and sunflower oil.

The relative popularity of sesame oil is demonstrated by the fact that in the study area, and elsewhere, its retail price is more than twice that of any imported substitute. Several other oilseeds were considered for inclusion in the Hombay cropping pattern (see Section 3.2), but the popularity and good market prospects for sesame oil, coupled with the shortfall in supply, led to the selection of sesame as a development crop.

(b) Soil Requirements

Sesame prefers a medium to coarse textured, freely draining soil, but as with many crops, it is grown in soils ranging from sands to vertisolic clays. It has low to medium tolerance of short periods of waterlogging; during the growing season the minium groundwater depth should be 1.0 m. The plant has a distinct taproot about 0.9 m long and a dense surface mat of feeding roots. The range of pH tolerance for satisfactory yields is 5.5 to 7.0. Some varieties have been known to tolerate as much as 10 000 ppm total soluble salts, but salt tolerance differs greatly among varieties.

(c) Variety and Seed

A lot of work has been done in several countries to try to develop an indehiscent variety and thereby reduce harvesting losses, but no commercially successful varieties have been identified. Several reputedly improved varieties, such as Morada and the Venezuela 50's series, have been tested in East Africa and Somalia. In 1974 over 20 introduced varieties were tested at CARS (MMP/HTS, 1978) but none of these has proved to be consistently superior to the local varieties. These have been selected, albeit unwittingly, by the local farmers over a long period of time, as the highest yielding and best adapted to the local climatic conditions.

It is assumed that the scheme farmers will continue to select their seed from the previous crop. If, by the time the scheme starts, an improved variety is available, then arrangements should be made to obtain sufficient seed for all the farmers, or sufficient for a bulking exercise in the early years of the scheme.

(d) Land Preparation

This would be by chisel plough and disc harrow as described in Section 3.3.

(e) Planting and Thinning

Planting would be by hand, on the flat. A 1984 der season trial at CARS (MoA, 1980-2) attempted to compare four plant populations but there was no significant difference between any of the treatments (250 000, 375 000, 500 000 and 625 000 plants per hectare). In rotation experiments with maize, the ARI uses a spacing of 0.8 m x 0.25 m which, with two plants per hill, gives a population of 100 000 per hectare.

HTS/MMP (1980) recommended a seed rate of 8 to 10 kg/ha and a spacing of 0.75 m by 0.3 m. Tribe (1967) quoted 6 to 9 kg/ha. MMP/HTS (1978) stated that sesame is able to compensate for quite a wide variation in population and recommended 8 kg of seed per hectare.

In many countries where smallholders grow sesame, the area per holding is relatively small, often less than 1.0 ha and the seed is broadcast; this is followed by thinning to about 10 cm between plants when it is grown either in a pure stand or in association with other crops (such as cotton, beans, maize). As the farmers at Homboy will have 1.0 ha of sesame, and as double cropping will make great demands on the farmers' labour resources, it is recommended that the crop should be in rows, 0.7 to 0.8 m apart, with a pinch of seed being planted every 0.25 to 0.30 m. This method of planting will make the subsequent weeding operations much easier.

The seed should be dressed with Fernasan D, or its equivalent, at 0.3 kg per 100 kg of seed. The recommended seed rate is 8 kg/ha. At the first weeding, the seedlings should be thinned to 2 to 3 plants per hill; this would give a population of 100 000 to 150 000 plants per hectare.

It has been clearly demonstrated at CARS (MoA, 1986), that sesame should not be planted in the gu season because of its susceptibility to fungus diseases, particularly Cercospora spp and Alternaria spp. In the Homboy cropping pattern (see Section 3.7), sesame is included as a der crop to be planted between 15th October and 15th November.

(f) Fertilisers

Although it is reported that sesame does not respond well to fertilisers (Acland, 1971, MMP/HTS, 1978), it is well known that the crop grows best on fertile soils. Two trials at Afgoi did give significant yield increases but only with high application rates, (up to 150 kg N and 300 kg P_2O_5 per hectare).

MMP/HTS (1978) and HTS/MMP (1980) both recommended 23 kg N and 13 kg P_2O_5 per hectare. In the absence of any evidence to the contrary, the same rates (40 kg of urea and 25 kg DAP) are proposed for Homboy as they provide all the N and half the P_2O_5 removed by a crop yielding 600 kg of seed per hectare (Ilaco 1981). The fertilisers should be broadcast by hand after the first disc harrowing operation.

(g) Weeding

Sesame has a very slow growth rate in the early stages consequently it is intolerant of weed competition. The first weeding operation should start 5 to 7 days after germination; if the weeds are not removed at this stage the entire growth cycle will be adversely affected and yields will be reduced. The second weeding should begin 15 to 20 days later.

Hand weeding will be made much easier by row planting. If the seed was to be broadcast, the labour requirement for weeding would increase considerably.

(h) Pests and Diseases

It was noted in Section 3.4.3(e) that the first pest control measure is to grow sesame only in the der season. This avoids the high humidities which prevail from April to September, and which provide an ideal environment for the spread of fungus diseases.

The sesame webworm (Antigastra spp.) can cause damage in the der season, but the main pest is likely to be cutworms (Agrotis spp) which kill the newly emerged seedlings. As severe outbreaks are irregular, no control measures against pests or diseases have been included on a regular basis.

(i) Harvesting

Being dehiscent and very prone to shattering, the crop has to be harvested by hand. The current practices (Section 2.5) should be followed. The HTS/MMP (1980) proposal of standing the stooks on plastic sheets may reduce the seed loss, but it is doubtful if the saving would be sufficient to cover the cost of the sheets.

(j) Post-harvest Operations

Threshing would be done by carefully shaking upturned bundles of stalks. The seed would need to be winnowed to remove plant debris prior to sale or storage.

Stored sesame seeds are seldom damaged by stored product pests unless the storage period is more than 9 months (Tribe 1967, El Baradi, 1972).

(k) Yield

Smallholder, rainfed sesame yields in East Africa are 200 to 350 kg/ha, however, if improved practices are followed they can rise to 450 to 550 kg/ha (Acland, 1971). Tribe (1967) quotes yields up to 1 000 kg in Sudan, (this must have been in exceptionally favourable conditions as 300 to 400 kg is a more usual level), and 1 000 to 2 000 kg/ha under research conditions in the USA. Ilaco (1981) estimates a range of 200 to 700 kg/ha in the main producing countries, while MMP/HTS (1978) and HTS/MMP (1980) both estimated a smallholder yield which reached 800 kg/ha after 10 years. The ARI at CARS has seldom exceeded 650 kg/ha even under research conditions.

If the crop always has adequate water available so that it never suffers moisture stress, and if all the proposed husbandry practices are carried out correctly, then it should be possible to obtain up to 1 000 kg of seed per hectare at Homboy. It is unlikely, however, that this level could be achieved by all the farmers on the scheme; consequently an average yield of 600 kg/ha has been assumed.

3.4.4 Pulses

(a) Introduction

Protein is one of the major components of the human diet. In developing countries, the production of vegetable protein is important because of the high costs of refrigeration/drying/processing requirements of animal protein. Grain legumes or pulses, such as cowpea, are a major source of vegetable protein.

Another important advantage of pulses is their ability to fix atmospheric nitrogen, providing the appropriate rhizobium strain is present in the soil. This reduces the requirement for high cost nitrogenous fertiliser and reduces the depletion of soil fertility.

These two points were the main factors behind the decision to include a grain legume crop in the proposed cropping pattern. There is a wide choice of grain legumes, several of which are listed in Section 3.2, which could be grown at Homboy. Cowpeas were selected on the basis that they are a popular food in Somalia, the leaves and pods can be eaten as green vegetables or the crop can be left to produce dry grain.

The 1986 cropping programme on MIP has indicated that high humidity in the gu season may result in a high incidence of fungal diseases on irrigated cowpeas, although at Homboy where rainfed cowpeas are extensively grown in the gu, the farmers did not consider that diseases were a serious problem. If, however, diseases prove to be a major yield constraint of irrigated cowpeas at Mogambo and, therefore, a potential problem on the Homboy scheme; the scheme farmers could plant mung bean which has been less susceptible to fungal diseases when grown at MIP. The costs and benefits of mung bean would be very similar to cowpeas, the growing periods are the same and both are legumes, thus changing from one to the other would not affect the returns to the farmers or the project.

(b) Soil Requirements

Cowpeas can grow on a range of well drained soils, thriving best in a loamy clay. In Sudan they are grown on soils ranging from coarse sand to cracking clay. They have low to medium tolerance to short periods of waterlogging, and prefer a minimum groundwater depth of 0.4 m during the growing period. The range of soil reaction over which cowpeas will give a satisfactory yield is pH 5.5 to 7.5, they tolerate poor acid soils and have a better tolerance of salinity compared with other grain legumes. An ECe of 2.0 mmho/cm will reduce the yield by 10%, while 5.0 mmho/cm will reduce it by 50%.

(c) Variety and Seed

Research programmes at the CARS, Afgoi have tested a range of improved varieties, provided mainly by the International Institute of Tropical Agriculture (IITA) (MoA, 1986 Nr 1 and 2). Three promising varieties, namely TVX 4659-13C 1K, TVX 199-012 F and IT 82E-32 were selected for further testing. In the 1984 der season and with a population of 67 000 plants per hectare, they significantly outyielded the local control variety. The yield increase was about 70%. Even at a lower population of 33 000 per hectare, the variety TVX 4659-13C1K significantly outyielded the local variety.

The ARI intends to undertake further varietal testing at CARS before selecting a variety for general release. The availability of adequate supplies of improved seed should present no problem as the Homboy project is not scheduled to start until well into the 1990s. By that time the varietal programme should have finished and a seed multiplication programme should be well advanced.

The MIP has introduced determinate varieties; that is, they produce most of the flowers and seeds within a short period, because the crop is harvested mechanically. Either determinate or indeterminate varieties could be grown at Homboy because first, the cowpeas will be harvested by hand and second, a growing period of 90 days, plus 14 days to complete harvesting and remove crop residues, has been included in the cropping calendar.

(d) Land Preparation

This would be done with a chisel plough and offset disc harrow as described in Section 3.3.

(e) Planting and Thinning

The cowpeas would be planted by hand and on the flat. Few plant population trials have been done at CARS and to date there are no statistically proven recommendations on spacing. The general trend has been that higher populations give higher yields. In the der 1984 variety trial the highest yielding variety was not significantly better at the higher population, whereas two other improved varieties gave significantly (5% level) higher yields at the higher population level.

In rotation experiments, CARS uses a population of 100 000 plants per hectare. Kay (1979) quotes populations ranging from 40 000 to 100 000; El Baradi (1975) quotes 40 000 to 180 000, while Acland (1971) quotes 56 000 for cowpeas in East Africa.

If the finally selected variety has an upright habit, the populations should be high (say 125 000 to 150 000) but a spreading, indeterminate type would need a lower population of around 75 000. These levels could be obtained by the same spacing, say 0.6 m x 0.2 m, which gives 83 000 planting points per hectare, thus thinning at the first weeding to one or two plants per hill would give the requisite populations. It may be that future work at CARS will identify an optimum population and spacing; if this happens, the farmers at Homboy should adopt the CARS recommendation.

A seed rate of 30 kg/ha should be adequate to achieve the proposed plant populations. The seed should be dressed with a fungicidal dressing such as Fernasan D at the rate of 0.3 kg per 100 kg of seed.

(f) Fertilisers

Being a legume, cowpeas should not require much nitrogenous fertiliser, but it has been observed in Sudan and elsewhere (El Baradi, 1975), that a small application of nitrogen at planting seems to stimulate the nitrogen fixing process as well as seedling growth. It is proposed, therefore, that 50 kg of DAP per hectare should be applied by hand between the first and second harrowing operations. This will provide 9 kg of N and 25 kg of P_2O_5 per hectare.

A series of trials was carried out at CARS in the 1984 der season to investigate the effect of rhizobium innoculation together with the applications of various major and minor nutrients (P, Cu, Zn, Mn, Fe). The overall results were inconclusive. Rhizobium alone, or in combination with one of the nutrient elements, produced a significant increase in grain yield in only two out of six trials.

In several of the trials, one or more of the rhizobium treatments gave a significant increase in the number of flowers/pods, the fresh weight of nodules or the oven dry weight of plants, but the increases were not carried through to grain yields. To save time and space, a series of pot experiments could be used to determine those aspects which merit further investigation at field level.

(g) Weeding

Cowpea seedlings are very sensitive to competition by weeds, thus early weeding is essential. It is proposed that this should be done by hand. Weeding could be done mechanically using a tractor mounted implement but this would be costly. It could also be done with herbicides but the sensitivity of cowpeas to this type of agro-chemical (Kay, 1979), and the risk of damage to the crop, are too high to consider recommending chemical weed control.

(h) Pests and Diseases

Insect pests are one of the main constraints affecting cowpeas; all parts of the plant are attacked but it is the pests feeding on flowers and pods which do most damage. Where pest control measures are undertaken, the usual regime is three to four sprays, at weekly intervals beginning 28 days after germination, with an organo-phosphorus pesticide. The proposed regime at Homboy is two or three sprays at 28, 38 and 48 days after germination of 1.0 to 1.5 l/ha of profenofos/cypermethrin pesticide cocktail. This would be applied using a hand held ULVA sprayer and the average requirement would be 2.5 l/ha. This chemical mixture should not be applied within 14 days of harvest and consumption, so the third spray should only be applied to cowpeas that will not be harvested as a green vegetable.

Both fungal and bacterial diseases can cause losses. It is recommended, however, that chemical control measures should be undertaken only when it is apparent that the disease outbreak will lead to a major reduction in yield. If spraying is necessary, then a proprietary chemical such as Benomyl or Perenox should give adequate control.

Stored product pests can do serious damage to dry grain. It is recommended that grain to be stored is mixed with Malathion dust, or similar pesticide, and that sacks in which the grain is stored are dusted with malathion every four weeks. The total requirement of pesticide will be 2.0 kg per year on each holding.

It was reported by El Baradi (1975) that cowpeas treated with groundnut or coconut oil were fully protected against insect infestation for a storage period of up to six months. Although seeds treated in this way lose their viability, they are still quite suitable for human consumption. It is suggested that this method of reducing storage losses should be tested at Homboy first, to see if it works and second, to see if the oil-protected grain is still considered to be palatable.

(i) Harvesting

Pods can be harvested before the seeds are fully developed and used as a fresh vegetable. Alternatively they can be left to mature and produce grain. In the latter case, time of harvesting is critical as the dry pods shatter easily. Harvesting for grain should be done several times to reduce losses caused by shattering; if a determinate variety is grown, it should be harvested when about two-thirds of the pods are dry.

(j) Post-harvest Operations

The crop could be threshed by using a stationary combine or a small, engine-powered threshing machine. To reduce costs, it is proposed that the crop should be threshed by heaping the pods and beating them with a stick; clean grain can be obtained by winnowing by hand.

It is to be expected that the smallholders will sell some grain and retain some for home consumption. That which is retained should be treated with a pesticide as described in Section 3.4.4 (h) and stored in sacks which are regularly dusted with Malathion or similar stored products pesticide.

(k) Yield

Cowpea yields are notoriously variable ranging from less than 100 kg to more than 3 000 kg/ha. One reason for the low yields is that cowpeas are often grown as an inter-crop when production seldom exceeds 200 to 300 kg/ha (El Baradi, 1975, Kay, 1979). Pure stands under good management and receiving a full range of inputs can produce very high yields; Kay (1979) quotes 3 100 kg of dry grain per hectare at IITA in Nigeria. Acland (1971) estimates that under East African conditions, and with good husbandry, yields of 650 to 900 kg/ha should be possible. The trials programme at CARS, which one assumes was under good management produced yields up to 1 250 kg/ha. The MIP management estimates that a fully mechanised and expertly managed crop should be capable of producing up to 1 500 kg/ha. Currently up to 1 000 kg/ha is being obtained at Mogambo, but it is hoped this will increase as the staff become more familiar with cowpea husbandry under local conditions.

Considering the inherent constraints of a smallholder farming system (see Section 3.4.2(k)), it is assumed that, whilst some farmers will get yields of 1 000 kg/ha, or more, the overall scheme average will be 750 kg/ha of dry grain.

3.4.5 Rice

(a) Introduction

Rice is the most suitable crop for the heavy, slow draining soils which cover some 950 ha of the study area. It is also a very popular food as is shown by imports which exceeded 70 000 t per year from 1977 to 1984. During the same period local production was about 8 000 t per year, but this situation was skewed because private individuals imported rice which affected the market for the local product.

There is no doubt that good yields of high quality rice can be grown in Somalia, thus reducing the reliance on imported rice grain. Upland rice has been recommended in the past, but it was irrigated, not rainfed, with an irrigation interval of four to ten days. In effect, the only difference from paddy rice was that no water layer was to be established. The rice recommended for Homboy is paddy rice, which is already being grown in the Lower Juba valley on the MIP and at Fanoole.

(b) Soil Requirements

Paddy rice requires a fine textured soil which will retain a water layer on the surface for much of the crop's growth period. This is why rice can only be recommended for 950 ha of the Homboy scheme. Rice is not adversely affected by waterlogging but it has a very low tolerance to drought and water shortage. The optimum pH is 5.0 to 6.5, but the yield is satisfactory within the range of 4.0 to 8.0. Rice is moderately tolerant of salinity an ECe of 5.0 mmho/cm reduces the yield by 10%, while 8.0 mmho/cm reduces it by 50%.

(c) Variety and Seed

The traditional varieties, Kendo and Shendo, originated in China. Both the Fanoole Rice Scheme (FRS) and MIP are currently growing IR24. This variety was bred at the International Rice Research Institute (IRRI), especially for its

sticky or gelatinous appearance after cooking. This characteristic, which is popular throughout much of South East Asia, is not liked in Somalia. The variety testing programme at MIP has already screened over 320 varieties while trying to find a replacement for IR24. Unfortunately, the early maturing and popular variety IR36, together with varieties developed from IR36, do not grow well under Mogambo conditions. Two parental lines, however (namely, IR/9129/202/222/1 and IR/9129/201/222) and their offspring, appear to be well adapted to the Lower Juba valley. The MIP staff are optimistic that their testing programme will produce an acceptable replacement for IR24.

Such a replacement should be ready long before the Homboy scheme is developed. It is recommended that as soon as construction of Homboy starts, an adequate supply of seed should be ordered from MIP.

As rice is mainly self-pollinated, farmers do not need to be issued with fresh seed every year. The small amount of cross pollination, however, does result in some regression, consequently it is proposed that new seed should be provided (at cost) every fifth growing season. New seed would be required for 240 ha each season; at 90 kg/ha this would total 22 t which could be produced on 8 ha. This area assumes 20% of the production is unsuitable for use as seed. The seasonal requirements for new seed could be purchased from Mogambo, or it could be produced on the Homboy scheme itself by approved or certified smallholders.

(d) Land Preparation

This would be done with a tractor mounted chisel plough and offset disc harrow as discussed in Section 3.3.

(e) Planting and Thinning

In the wet tropics, where paddy rice is usually the most important cereal crop, it is normal to produce seedlings in a nursery and to transplant them by hand. This task has such a high labour requirement that it was considered unsuitable for Homboy. Mechanical planting, using a tractor-drawn, combine drill is proposed as the most appropriate alternative. This method, which is also used at MIP and FRS, has the added advantage that no subsequent thinning operation is required.

The distance between rows should be 0.15 to 0.25 m. This should provide a plant population of about 600 000 per hectare, broadly equivalent to rice transplanted at 0.15 to 0.25 m with two to three plants per hill.

A population of 600 000 plants per hectare is high, but dense planting of modern, short-term varieties helps to overcome the constraint on tiller production that is imposed by the short, vegetative, growth period. As the number of tillers is positively correlated with yield, close planting of modern varieties can have a beneficial effect on yield (de Datta, 1981); another advantage of close planting is that the rice competes better with weeds.

Prior to planting the seed should be dressed with Fernasan D, or its equivalent, at 0.3 kg per 100 kg of seed.

(f) Fertilisers

Modern, short strawed, high yielding varieties (HYV) have a strong, positive response to fertilisers, particularly nitrogen. This response is made possible by their resistance to lodging.

Large amounts of N are required at the early and mid tillering stages to maximise the number of panicles; phosphorus is an essential constituent of all the plants biochemical processes; although potassium is less important, it is still essential, and any deficiency will affect adversely both plant growth and yield.

According to Acland (1971), the usual practice on irrigation schemes in Kenya was to apply 30 kg N and 56 kg P_2O_5 per ha; this must have been primarily for local improved varieties. Ilaco (1981), does not quantify application rates, but observes that large doses of N are justified for responsive HYVs. MMP/HTS (1978) recommended 140 kg urea and 50 kg DAP for Genale-Bulo Marerta area, as did HTS/MMP (1980) for Homboy.

Trials at CARS showed that the most significant response was to 50 to 100 kg of N per hectare, but only if applied during the first month of growth. Optimum applications of P_2O_5 appeared to be 25 to 50 kg per hectare, but only if N was applied as well. There was no response to K_2O.

At FRS they are applying 140 kg N and 25 kg P_2O_5 per hectare, the rates used at MIP are 150 kg N and 50 kg P_2O_5 per hectare.

The nutrients removed by a crop producing 4.0 t of grain per hectare would be about 76 kg N and 28 kg P_2O_5. Some 86 kg of K_2O would be removed also, but these should be adequately supplied from a clay soil.

The proposed application rates for rice at Homboy, 150 kg of urea and 60 kg DAP per hectare, should provide all the N and P_2O_5 required by the growing crop.

As the crop is to be drilled, it is proposed that the DAP should be applied with the combine drill at the same time as seeding. The urea should be broadcast by hand. Half should be applied at commencement of maximum tillering, 35 to 40 days after drilling, and half at panicle initiation, about 15 days later. The first application should increase the number of tillers and panicles, while the second should increase the number of filled spikelets per panicle (de Datta, 1981).

(g) Weeding.

Experience at MIP has shown that 5 l of piperophos per hectare, at 14 days after sowing, gave good control providing the soil was saturated. It had no herbicidal effect when the soil was dry. MIP intends to apply this chemical by herbigation, that is mixing it with the irrigation water just before it enters the field. Even with a successful chemical operation immediately after seeding, MIP has found it necessary to have follow-up sprays of 15 l propanil and 4 l MCPA per hectare.

As herbigation would be difficult on a smallholder scheme where it is likely there would be a range of planting dates and as the Fanoole Irrigation Project is getting satisfactory weed control with 15 l of propanil per hectare, the following regime is proposed for Homboy. There should be a first spray of 5 l propanil at the three-leaf stage, about ten days after planting, followed in some years by a second spray of 10 l propanil about 35 to 40 days later.

Some hand weeding will also be necessary and this has been allowed for in the crop labour requirements. It is suggested that some simple, hand-operated, rotary weeders, which can be seen throughout South East Asia, should be imported for testing. Details of possible suppliers of such machines, or blue-prints from which they could be made, could be obtained from IRRI.

Another aid to weed control is the water layer, but this is not effective unless a mimimum depth of 0.05 m is maintained.

(h) Pests and Diseases

Insect pests are not a major problem, but the stemborer, Chilo partellus, is likely to cause some damage in most years.

While the indiscriminate use of pesticides as a preventative measure cannot be recommended, it has been assumed, for analysis purposes, that one of the following control measures is used at the most susceptible growth stages. These are at tillering and at heading.

Spraying with profenofos and cypermethrin at 1 to 1.5 l/ha for each application; or a first spray of 2.5 l of dicrotophos per hectare followed by 2.5 l of carbaryl; or 5 kg diazinon 10 G granules in the leaf funnels at early tillering.

The main pest of rice is undoubtedly the weaverbird, (Quelea quelea), although other grain-eating birds also cause damage. The Quelea birds migrate into southern Somalia about mid-July and remain until February or March. Their main, and preferred food, is small grass seeds, but if these are in short supply the birds will ravage a rice crop to such an extent that there is little grain left to harvest. The risk of damage by birds is so great that 70 child days, that is two children for about 35 days, have been included for bird scaring in the labour requirements.

Roosts and breeding colonies can be destroyed by explosives or by aerially spraying with fenthion; these methods have been extensively used in East Africa but, although many birds are killed, the effect in the overall population is very slight. Other control measures include spraying the crop with a bird repellent, or using automatic bird scarers, however, these methods are not capable of providing protection against Quelea spp.

Bird scaring by children plus rapid harvesting by combine harvester are the most efficient methods of minimising damage by birds. Growing rice in large blocks also helps as this reduces the number of people required for bird scaring.

FRS mentioned rats and game animals as causing some, but not major, damage. It is possible that growing a large area of rice will result in increasing damage by rats, which are a major pest in the rice producing areas of South East Asia. if this occurs, it will be necessary to introduce rodenticides such as Racumin or zinc phosphide.

Rice diseases are not a problem. Blast (Pyricularia oryzae) has been identified on the FRS, but the infection was too slight to cause any yield loss. The only measure proposed for protecting the crop against diseases, is to dress the seed with a fungicide.

(i) Harvesting

It is proposed that this operation should be done by a self-propelled, tanker combine. Rapid mechanised harvesting will:

- help to minimise bird damage;
- avoid the very high labour requirement needed for hand harvesting and threshing;
- minimise the harvesting duration thus enabling double cropping with paddy rice.

As each farmers' plot cannot be combined separately, the scheme management and extension staff will have to explain to the farmers just how the harvesting operation will be done. Providing such discussions take place well in advance, and the benefits to be derived from combining are explained in detail, it is believed that this harvesting method will be acceptable to the smallholders at Homboy.

(j) Post-harvest Operations

The grain will be transported from the field to the village in a high-sided, tractor-drawn trailer. The trailer will have a bagging shute so that, if required, some grain can be bagged off for the farmers whose fields have just been harvested. The balance will be taken by lorry to the rice mill at Fanoole, or will be stored on the scheme for milling at a later stage.

(k) Yield

There are 111 rice growing countries in the world. Japan and Spain have had the highest average yield of 6 000 kg/ha. Some 70% of the countries produce under 3 000 kg/ha, while 52% produce under 2 000 kg/ha (de Datta, 1981).

The yield is a function of:

- the number of panicles;
- the number of spikelets per panicle;
- the percentage of filled spikelets;
- the grain weight.

If any of these are adversely affected by factors such as moisture stress, nutrient deficiency or pest damage, the yield will be reduced.

If the conditions for growth are good, rice can produce very high yields, for example IR8 gave 10 300 kg per ha in a replicated experiment at IRRI (de Datta, 1981). Smallholder rice yields on the Mwea Irrigation Scheme in Kenya average about 5 500 kg/ha, with the more successful farmers getting up to 9 300 kg/ha (Acland, 1917). Ilaco (1981) quotes an average of 3 000 to 5 000 kg/ha for HYVs with high input levels and complete water control.

MMP/HTS (1978) estimated yields at Genale Bulo Marerta would reach 3 500 kg/ha after 4 years and 4 500 kg/ha after 10 years. HTS/MMP (1980) estimated 3 500 kg/ha after 10 years. The Jowhar experimental farm has produced as much as 7 000 kg/ha but this required very heavy applications of N (115 kg/ha) and P_2O_5 (64 kg/ha). The average yield at Jowhar was about 5 000 kg/ha. On the Haaway Rice Scheme, yields ranged from 3 000 to 5 000 kg/ha, the higher levels required 69 kg of N per hectare. Average yields at Haaway were 3 000 kg/ha.

FRS has been growing irrigated rice since 1982. The highest yields obtained have been around 7 000 kg/ha, but the overall average is 4 200 kg/ha. At MIP yields have varied from 2 000 to 7 500 kg/ha.

A crop cutting survey of IR24 on 42 smallholdings in the MSV in 1985 gave an average yield of 4 500 kg/ha. The fertiliser use was 92 kg N and 45 kg P_2O_5 per hectare; the seedlings were transplanted by hand at a 0.2 m by 0.2 m spacing. Although these fertiliser rates are high and transplanting gives the ideal plant population distribution, the production level gives a good indication that, providing conditions are favourable and the input requirements are met, paddy rice in Somalia has a very high yield potential.

Taking account of the potential of HYV, the proposed input levels and yields obtained in similar situations in Somalia and elsewhere, the estimated yield level of smallholder irrigated rice at Homboy is 4 000 kg/ha.

3.4.6 Other Crops

(a) Introduction

The World Bank's comments on the Interim Report proposed that in addition to the recommended 950 ha of paddy rice and 3 000 ha of bananas the following crop enterprises might be included in the Homboy cropping patterns: water melons, grapefruit, tree fruits, and vegetables. The relative proportions suggested in the Bank's comments for each of these enterprises is given in Table 3.2.

TABLE 3.2

Proportions of Possible Alternative Crops

Crop	Ha	Percent(3)
Water melons	500	10
Grapefruit	500	10
Other tree fruits	200	4
Vegetables(1)	350	7
Arable crops(2)	3 350	69
Total	4 900	100

Notes: (1) The Aide Memoire did not specify an area of vegetables; 350 ha is based on 0.1 ha per family.

(2) This is the balance of the arable area and would be under a maize, sesame, cowpea, cotton rotation.

(3) Percentage of total area of 4 900 ha.

Source: World Bank Aide Memoire of 24/1/1987.

Although it is agreed that crop diversification is generally to be recommended, and that crops such as water melons and citrus can be very profitable, it is believed that it would be unwise to develop a cropping pattern along these lines. The following sections discuss each component of the proposed pattern, and the conclusions regarding the production of alternative crops to those listed in Sections 3.4.1 to 3.4.4.

(b) Water Melons

This crop is grown in both the Northern and Southern Regions. The main production area is the MSV where more water melons are being grown to meet the local demand and to supply the modest export trade which has been developed by Somalfruit. This export trade, however, is not on a regular or sustained basis, rather, it has been developed to utilise spare capacity in ships loading bananas and other cargo at Kismayo. It is possible that a steady export trade may have developed by the time the Homboy Scheme is developed, but at this time it would be unwise to base what would be a major development, on a doubtful market.

Somalfruit has studied potential markets in the Middle East and Europe. Export to Europe is limited to a short season (December to March), because the Mediterranean countries are able to meet the demand for the remainder of the year. In 1986, Somalfruit exported 1 010 t to the Middle East and 340 t to Italy, worth a total of US$ 371 000. The company has sought additional export outlets in these and other areas, but without success. Although it has no plans to increase the exports of water melons, it intends to continue to monitor those world markets which could be supplied from Somalia.

From an agronomic viewpoint, the suitability of the LJV for water melons has not been proved, although small areas are being grown, particularly between Yontoy and Kismayo. This crop prefers a fertile sandy, or sandy-loam soil, which is free draining and has a pH of 5.8 to 7.2. The Homboy soils which are heavy cracking clays have none of these characteristics. According to FAO (1979), heavy textured soils result in slower crop development and cracked fruits, if the latter point were to apply at Homboy, the melons would be unsuitable for either the internal or external market.

Water melons like a hot (30°C day, 22°C night temperature) and dry climate and, while they tolerate a wide range of rainfall regimes, high humidity is almost certain to result in severe problems with fungal diseases. Another advantage of hot and dry conditions is that the fruit has a higher sugar content.

The crop responds well to fertilisers, indeed to obtain high yields it is necessary to use levels such as 80 to 100 kg N, 60 to 140 kg P_2O_5 and 40 to 100 kg K_2O which are equivalent to 170 to 200 kg urea, 130 to 310 kg TSP and 80 to 200 kg KCl per hectare (Ilaco 1981). HTS quotes applications of 25 to 40 t organic manure plus 550 to 700 kg/ha of a 4 : 16 : 4 compound.

Pests include melon flies, cucumber beetles and nematodes, but it is the fungal diseases (downy and powdery mildew, anthracnose, alternaria and water melon mosaic virus) which are likely to be the main problem.

The yield of water melons is very variable. FAO (1979) quotes 25 to 35 t while HTS mentions 7.5 to 10 t with up to 30 t in the USA.

Bearing in mind that:

- the conditions at Homboy would not provide the ideal agronomic requirements;
- the current development has been in the Shebelle valley even though there is a distinct transport advantage for possible producers in the Lower Juba valley;
- the uncertainty of the market potential, particularly when the 900 ha of water melons, proposed by TAMS-FINTEC for the Faraxaane project on the Shebelle, would be in production well before Homboy;
- the farmers are going to have to learn about a new crop (paddy rice), a new type of agriculture (irrigation), and a very intensive work programme (double cropping). Consequently it would be rather optimistic to expect them to grow a new, perishable and disease prone fruit crop that would have to meet export market quality standards.

It is believed that water melons should not be considered as a major new development crop.

(c) Grapefruit

These are a popular crop in Somalia. They are grown in both the Shebelle and Juba valleys, but those seen in the LJV during fieldwork were very poor and had many trees missing. It would need a specialist input to determine the reasons for the poor condition of the trees, but the most likely causes are soil salinity and temporary water logging, irregular irrigation and nutrient deficiencies, particularly N, K and possibly Zn.

Citrus tree roots have a high oxygen requirement so they prefer a well aerated soil with a medium to coarse texture. The optimum pH range is 5.5 to 6.5, but they can tolerate 5.0 to 8.0 and still give a reasonable yield. The depth to the watertable should be at least 1.3 m as the tree has a strong taproot; the main nutrient uptake is in the 1.0 to 1.5 m zone. These requirements suggest that the soils at Homboy would not be ideal for grapefruit.

For any new development, particularly in an area where citrus is not being grown extensively, it would be advisable to import disease-free seed of Rangpur lime to be used as the rootstock. This variety is preferable to the sour orange and rough lemon rootstocks as used currently. Similarly, disease-free bud wood of Thompson's seedless and Marsh seedless varieties should be imported. Field planting would be 7.0 m by 7.0 m triangular, giving 235 trees which, assuming a 20% supply requirement, would need 280 seedlings per hectare. To produce this number of seedlings in a polybag nursery would require about 600 seeds, (0.25 kg of seed), as it is likely that pests, diseases, deformation and death will result in 50% of the seedlings being discarded.

Field operations would include clean weeding a circle (1.0 m radius) around each tree. The rest of the area could be intercropped, preferably with a legume, for 3 to 4 years, after which it should be left to grass over. This grassed area should be slashed regularly.

The most likely pests are mites, mealy bugs, scale insects, leaf miners, rhinoceros beetles and nematodes. Diseases include gummosis, Diplodia, Tristeza and Penicillium; the latter could be quite serious as it is most prevalent in areas with high temperatures. Possible control measures are:

Mites - up to five sprays of 1.5 l Neoron 500 EC/ha

Scale and aphids - 20 l/ha of Malathion 10 EC

Scale - two sprays of 3 l Ultracide 40 EC/ha

Ants - sprinkle 10 g of diazinon 2% dust at the base of each tree

Fungus diseases - Maneb or Zineb at 1.0 kg/ha

To get acceptable yields it would be necessary to ensure regular and fairly heavy applications of fertiliser (Table 3.3). The trees are almost certain to be affected by low trace-element availability, particularly zinc which is known to be deficient in MIP, and possibly manganese and copper. These can all be applied as fungicides but it is believed that zinc should be applied directly as $ZnSO_4$ (Table 3.3).

TABLE 3.3

Fertiliser Regime for Citrus
(kg/ha per year)

Year	N	P_2O_5	K_2O	$ZnSO_4$(1)
In the planting holes	-	60	-	-
1 - 3	15	12	-	10
4 - 6	20	15	5	10
7 - 8	30	18	15	10
9 - 10	50	21	40	10
11 - 12	70	24	80	-
13 - 20	90	27	110	10

Notes: (1) 10 kg every 3 years.

Source: Consultants' estimates.

Under normal circumstances grapefruit trees would be expected to have a productive life of about 30 years. At Homboy, however, it is likely that heat, nutrition, pest and management stresses, will reduce this to 20 years. ILACO (1981) quotes yields ranging from 10 to 50 t/ha, while Acland (1971) gives an average of 13 t/ha in East Africa, with up to 26 t/ha from intensively managed plots.

A yield of 20 t is believed to be the maximum achievable level at Homboy, with a build-up as follows:

Year	kg/ha per year
4 - 6	1 000
7 - 8	3 000
9 - 10	7 000
11 - 12	14 000
13 - 16	20 000
17 - 20	15 000

The flowering and therefore the fruiting season can be controlled by imposing water stress to induce flowering. This would be done to ensure that fruiting coincided with the optimum export period.

Somalfruit has tried to locate an export market in Italy, but the demand for grapefruit is small, and it is already supplied from other Mediterranean citrus producing countries. Similar investigations in the Arabian countries have shown that there is even less demand than in Italy. If Somalfruit (which is well established, has good contacts in the international fruit trade and has the capability and organisation to purchase, process and package an export quality commodity) is unable to identify an export market, then it would be unwise to develop a large area of grapefruit at Homboy.

It could be argued that a grapefruit development component at Homboy would be able to supply the internal market. It is likely, however, that the local demand will be fully met from the on-going EDF Shebelle Citrus Project. This is already in the early stages of development and when completed the area of grapefruit should be about 1 400 ha.

(d) Other Fruit

The most widely grown fruit, after bananas, in the LJV are mangoes, but papaya, guava, other members of the citrus family and custard apples are also grown. The mangoes are marketed in other parts of Somalia, particularly Mogadishu, while the others are mainly used to supply the local markets.

Somalfruit has already tried to develop export markets for mangoes and papayas. It has exported several consignments of 50 cartons of papayas, but none of these ventures has led to a follow-up order from the importing country. It would be unwise, therefore, to develop any large areas of tree or other fruit crops until a market has been identified and an export organisation developed.

At this stage, it is proposed that there should be an area of about 10 ha, near to the project headquarters of which part, say 5 to 8 ha, would be used for testing possible alternative or new crops (e.g. cashew) and/or new varieties (e.g. less fibrous mangoes). The balance of the area would be used for a small adaptive research programme (see Section 3.8).

(e) Vegetables

There are many vegetables which can be or are being grown in the LJV, but all the main urban markets are supplied from local growers who have very little or zero transport costs. A production unit at Homboy to supply even the Jilib or Kamsuuma markets would have difficulty in competing with producers living on the outskirts of these towns.

As it is likely that the smallholders will produce vegetables for their own consumption, it has been assumed that each Homboy farmer would grow 0.1 ha. This would give a total of about 375 ha of vegetables for the whole scheme. The farmers would probably grow tomatoes, egg plants, leaf vegetables, cucurbits and, possibly root vegetables such as radishes, but the choice and area of each vegetable is likely to vary from farm to farm.

As it is unlikely that there will be any large variation between the costs and benefits of growing different vegetables, onions have been taken as an indicator crop to provide data for the financial and economic analysis. Onions are a popular crop with the farmers, there is a good demand in the urban centres and they store well.

Onions are grown on many soil types though they prefer a freely draining, medium-textured soil with a pH of 6.0 to 7.0. They have a low tolerance of waterlogging, the depth to the watertable should be at least 0.5 m. The maximum rooting depth in 0.5 m through most of the water and nutrient uptake is in the upper soil horizons (0.0 to 0.3 m).

The optimum temperature is 15°C to 35°C. Bulb formation is faster at high temperatures, whereas bolting is more likely if it falls below 10°C. The best yields are obtained if the early growth stages occur in cool weather, followed by higher temperatures in the later bulb formation stage.

Both cream and red fleshed varieties are being grown in Somalia, but it is noticeable that the white fleshed ones do not store as well as the others. Cream fleshed varieties such as Sphinx and Bon Accord, which are popular in Zimbabwe, have excellent keeping qualities. Red varieties such as Bombay Red, California Red, Burgundy and Ruby are likely to continue to be popular.

Direct planting requires 6 to 10 kg of seed per hectare, planted with 0.3 m between rows in which the seedlings are thinned to one every 0.075 m. It is more usual, however, to plant the seed in a nursery: 5.0 kg will provide sufficient seedlings for 1.0 ha. When the seedlings are about as thick as a pencil, 30 to 60 days, they should be transplanted in rows 0.25 to 0.3 m apart with an in-the-row spacing of 0.05 to 0.075 m.

Fertiliser is essential for high yields. Most literature sources (FAO, 1981; El Baradi, 1971) quote rates of about 80 kg N, P_2O_5 and K_2O. El Baradi (1971) emphasises the need for good early vegetative growth to provide the basis for subsequent bulb formation; also, he points out that too much N results in soft spongy onions with poor keeping qualities. It is proposed, therefore, that 75 kg of DAP should be applied before transplanting, followed by 50 kg urea at 5 weeks after transplanting. These rates would provide 37 kg of N and P_2O_5 per hectare.

The most common pests are thrips. If necessary, these can be controlled by applying 0.5 kg Malathion 25% WP at 14-day intervals. Downy mildew, neck rot and black mould are the most common diseases. Two or three sprays of 0.3 kg Ridomil MZ 63.5% WP or 2.0 kg Dithane M45 per hectare early in the growing season should give good protection. It is emphasised, however, that insecticides and fungicides should not be used unless absolutely necessary.

Early and continuous weeding is important because of the shallow rooting habit, however, care must be taken to avoid damaging the root system.

A softening of the neck and subsequent drooping of leaves shows that the crop is mature, even if the leaves are still green. The plants should be harvested individually and left for a few days to dry in the sun. Once the bulbs are dry the tops should be cut off to leave a short neck. If the bulbs are to be stored for sale or use at a later stage they will require further drying. This can be done by making small heaps of onions, through which air can circulate freely.

Yields per hectare are said to range from 7 to 20 t (El Baradi, 1971), 7.5 to 30 t (HTS), 25 to 35 t under irrigation (DoA, Zimbabwe, 1982), and up to 45 t (irrigated) (FAO, 1979). To achieve high yields, it is necessary to irrigate the crop every 3 to 4 days; this is demonstrated by the fact that the rate of water uptake starts to reduce when the depletion of total available soil water reaches about 25%, whereas for cotton it does not start to reduce until the depletion is 65%. As it is proposed that water will be always available in the canals, there should be no yield reduction caused by water stress. It is likely, however, that some farmers will be unable to adhere to a strict irrigation schedule, or will fail to adopt the optimal husbandry practices, consequently yields can be expected to range from 5 to 15 t/ha. To allow for this range, it has been assumed that the average yield for the whole scheme will be 7.0 t/ha.

3.5 Mechanisation

Mechanisation with tractors is an expensive operation requiring the expenditure of large amounts of hard currency on the tractors, implements, spare parts and fuel. The decision to recommend the use of tractors for certain operations was only reached after giving serious thought to the benefits that would accrue, and the difficulties that would occur if different methods were adopted.

If it had been possible, the use of draft animals would have been recommended, but there is no tradition for this in the Lower Juba valley consequently it was not considered to be a feasible option.

The primary objectives in recommending the use of tractors were to overcome the massive labour peak that would occur with manual land preparation, and to ensure the rapid completion of this operation, without which it would be impossible to achieve a 200% cropping intensity. Mechanised land preparation has the added benefits of improved soil aeration and initial infiltration.

To minimise the disturbance to previous levelling operations, it is proposed that land preparation should consist of chisel ploughing in two directions followed by two passes with a semi-mounted offset disc harrow. Both gangs would have cut-away discs to improve the break up and burying of any remaining crop residues. This method of land preparation would have the advantage of minimising the loss of soil moisture by evaporation. The only other mechanised land preparation would be to ridge the area to be planted with cotton.

The production of paddy rice would be fully mechanised. A post emergence herbicide would be applied with a tractor-mounted sprayer, sowing would be done with a combine drill, and harvesting would be by self-propelled combine harvester. The grain would be transported from field to village in a tractor drawn trailer.

Although current experience on the MIP is that large 120 hp tractors are required for land preparation operations, this is not the case elsewhere in Africa. Mechanised land preparation is widely practiced in the Sudan, on large irrigation schemes such as the Gezira, Managil and Rahad as well as in the rainfed areas of South Kordofan and South Darfur. The soils of central Sudan are heavy, cracking and self mulching clays or vertisols which are virtually the same as the soils of the Juba valley; in Western Sudan (S. Darfur), the nag'aa soils are heavy non-cracking clays requiring a similar power input for cultivation operations to that used on the vertisols.

Land preparation in these areas of Sudan is done quite satisfactorily using 75 to 85 hp tractors providing that the implements are set correctly and are matched with the tractor, and the correct gear and speed are used.

There is no reason why smaller tractors should not be suitable for most operations at Homboy, particularly if the scheme is managed by skilled and specialised staff during the establishment period.

Using smaller tractors means smaller implements and a correspondingly slower rate of work. This, in turn, necessitates more tractors to complete the land preparation in the time available. While the increased requirement could offset any cost saving; a greater number of tractors provides greater flexibility and reduces the adverse effect which occurs when a tractor is in the workshop.

It is proposed that large 110 to 120 hp tractors should be used for disc harrowing. This would allow the use of heavy, semi-mounted, offset discs which would be much more effective in producing an acceptable seed bed.

The operations to be mechanised and the estimated performance for each operation are given in Table 3.4. These data were used as the basis for calculating the number of tractors and the implements required for the arable and rice areas.

TABLE 3.4

Mechanised Operations and Performance

Operation	Working width (m)	Operating speed (km)	Efficiency	Output (h/ha)
Chisel ploughing(1)	1.5	5.0	0.7	1.6
Disc harrowing(2)	2.2	6.5	0.7	1.0
Ridging(3)	1.8	5.0	0.7	1.6
Drilling	2.4	5.0	0.7	1.2
Combining(4)	4.2	4.5	0.6	0.9
Lifting(5)	2.0	5.0	0.7	1.4
Herbicide spraying(6)	5.0	5.0	0.7	0.6

Notes: (1) Five tines.

(2) Semi-mounted, offset twin gang; cut-away discs in front.

(3) Three ridging bodies at 0.9 m intervals mounted on tool bar.

(4) Self-propelled bagger combine.

(5) Blade to lift groundnuts. It could also be used for uprooting cotton. Blade is mounted on a tool bar.

(6) Boom sprayer.

Source: Consultants' estimates.

Nothing has been included for transport of crops, other than paddy rice, from field to house, or from house to central buying point. The scheme layout of five village areas means the longest distance a farmer would have to walk to his holding would be 4 to 5 km; carrying produce from the field to the house should present no problems.

When calculating the number of tractors required, it was assumed that in any 14-day period, a tractor would work for 12 days with 2 days being allowed for maintenance and repair. It was further assumed that a day would consist of 8 working hours. In practice an even longer day would probably be worked in the peak month; with 8 hours or less per day being worked in other months. In addition to working hours there would be additional daily requirements for routine maintenance and travelling to, between and from the smallholdings. This gives an operating time of 96 hours in each 14-day period.

To calculate the time available for land preparation, it was assumed in the case of maize, cowpeas, sesame and paddy rice, that the first 14-day period after the previous crop was lost, because of delays by the smallholders in completing the harvest operation and removing crop residues. The need to uproot and burn the cotton stalks was the basis of the assumption that two 14-day periods are lost after the cotton harvesting is complete. These assumptions mean that the number of 14-day periods available for land preparation are:

Arable cropping pattern		Rice cropping pattern	
Maize	2	Rice	2
Sesame	5	Maize	4
Cowpea	2	Sesame	5
Cotton	2		

Using the data given in Table 3.4, the peak 14-day period requirements are, for the 65 to 85 hp tractors, 6 460 hours in the second half of March when chisel ploughing the land for maize, cowpeas and rice; and for 110 to 120 hp tractors 3 780 hours, also in the second half of March when harrowing the maize, cowpea and paddy rice land. At 96 hours per 14 days, this gives a requirement of 68 tractors of 75 to 85 hp and 40 tractors of 110 to 120 hp.

A total fleet of 108 tractors gives an annual usage of 650 hours per tractor and, on the basis of 200% cropping intensity, 110 ha per year per tractor. Both these figures are considered to be acceptable for a mechanised scheme such as that proposed for Homboy.

The numbers of implements required assuming the performance detailed in Table 3.4 and 96 hours per 14-day period, are:

Chisel ploughs	63	Sprayers	3
Ridgers	17	Disc harrows	40
Combine drills	6	Trailers (10 t)	5
Combine harvesters	5		

If ridging of maize land becomes necessary because of an increasing waterlogging hazard, the requirement for 75 to 85 hp tractors will increase by 28 units. This increase is disproportionate to the increase in area to be ridged because of the time constraint affecting the maize component in the arable rotation. Four more ridgers would also be required.

3.6 Labour Requirements

The crop labour requirement date for several studies, (MMP/HTS 1978, HTS/MMP 1980, MMP/HTS 1984, Sogreah 1982, MMP/HTS 1986) were reviewed. The data were considered to be acceptable for the proposed Homboy scheme with a few minor adjustments made necessary by differences in husbandry practices or yield levels. The estimate requirements by operation and by crop are detailed in Table 3.5.

TABLE 3.5

Estimated Crop Labour Requirements (man-days per ha)

Operation	Maize	Cotton	Sesame	Cowpea	Paddy rice	Onion
Land preparation	1	1	1	1	1	12
Basal fertiliser	1	1	1	1	-	1
Nursery	-	-	-	-	-	30
Transplanting	-	-	-	-	-	24
Planting	5	10	3	5	1	-
Herbicide application	-	-	-	-	2	-
Pest control	2	6	-	2	2	1
Weeding and thinning	25	45	15	20	12	24
Top dressing	1	2	-	-	2	1
Bird scaring	-	-	-	-	70	-
Harvesting	14	60	13	18	1	30
Post harvest	10	12	8	6	2	15
Irrigating	14	19	12	10	12	16
Total	73	156	53	63	105	154
MMP/HTS (1978)	72	157	62	-	176	-
HTS/MMP (1980)	72	159	62	-	135	-
MMP/HTS (1984)	66	148	56	-	81	-
Sogreah (1982)	-	156	-	-	-	-
AHT (1984)	61	44	65	-	-	-
HTS (1977)	85	137	56	-	164	-

Source: Consultants' estimates and sundry references.

There are several apparent anomalies in Table 3.5 which require explanation. A working day is assumed to be 6 hours; any operation requiring less than one day is assumed to require a complete day.

No data were seen detailing the requirement for cowpeas and onions in Somalia. Some of the MMP/HTS (1978) data for tomatoes were applicable for certain operations, but it was necessary to draw on data from the Sudan (MMP/HTS 1979 and HTS 1986) as a basis for calculating the labour requirements.

The land preparation input of one man-day assumes that the smallholder will be present when his land is being ploughed. The large requirement for onions is for making small basins to minimise the effect of inadequate levelling.

There is no allowance for a basal application of fertiliser to rice; this will be applied mechanically at the same time as drilling the seed.

Two man-days are allowed for pest control on cowpeas even though this operation is unlikely to be necessary.

The requirement for cotton harvesting assumes a picking rate of 25 kg seed cotton per day, an average rate for smallholders. The figure assumed by AHT (1984) of 60 kg/day must be an error, as it equals the top rate of Zimbabwean pickers in a crop of 3 000 plus kilograms per hectare.

The wide variation in the total requirement for rice results from the number of children used for bird scaring and the harvesting method - mechanised or manual. As Homboy would have large blocks of paddy rice, it was assumed that two children per hectare would be able to scare the birds away.

The reason for the sesame requirement being nine days less than the MMP/HTS (1978) and HTS/MMP (1980) estimates, is the lower proposed yield of 600 kg/ha compared with 800 kg/ha.

The monthly labour requirements of each crop, cropping pattern and farming system are presented in Section F of this Annex. The family labour pool, which can provide a maximum of 61 md, though not for prolonged periods, can meet the peak monthly labour requirement of 53, 51 and 56 md in the banana, paddy rice/arable, and arable farming systems respectively.

3.7 Cropping Patterns

3.7.1 Introduction

There are several factors which influence the composition of the cropping pattern - crop suitability, the availability of labour and water, the target cropping intensity, which is itself a function of the water availability, and the duration of each potential crop.

An analysis of population data indicates that the average family has the equivalent of 2.4 adult labour units, 0.3 units of which would be required in most cases, for the family's livestock enterprises. The balance available for meeting crop labour requirements would provide 55 work days per month, although at times of peak requirements this could rise to 61 work days per month. As the peak requirement would be less than 61 days, labour availability would not normally be a constraint on the cropping pattern.

The Homboy scheme is not scheduled for development until after the Bardheere dam has been built. This means that water availability should not be a constraint on crop selection or cropping intensity.

The Terms of Reference require that, if possible, the cropping intensity should be 200% compared with the 160% proposed in the 1980 study. This figure has been used as the target intensity when drawing up the proposed cropping patterns.

3.7.2 Perennial Crops

Bananas are the main recommended perennial crop for Homboy. They have good market prospects and are well suited to the 2 km wide strip of lighter soils adjacent to the old Shebelle channel running through the middle of the project. This area will comprise about 3 000 ha net.

As bananas are fallowed for 12 months after each 4 years' cropping cycle, it is proposed that two annual crops are grown in the fallow period to increase the cropping intensity to 200%. These could be maize and sesame, with possibly some vegetables. The development requirements for the farming system based on bananas are discussed in Annex 2.

3.7.3 Annual Crops

The land not used for bananas will be developed under farming systems based on double cropped paddy rice or double cropped dry-foot annual crops, depending on soil type. These two systems are described below:

(a) Rice

Double cropped paddy rice is recommended for the heavier soils, most of which are situated at the southern end of the project area. These total some 950 ha net. They usually overlie a coarser textured sub-soil consequently drainage should not be a problem. The watertable is currently some 20 m below ground level; it is not expected to rise to critical levels within the foreseeable life of the project.

Some of the existing schemes, the Mogambo rice project, for example, have problems with double cropping rice as the low flow period in the Juba can reduce the time available for irrigation to only 9 months. This time constraint, which is aggravated by the problems of land preparation during rainy months, will cease to exist after completion of Bardheere dam.

A single crop of paddy rice with an arable crop is not considered economic. It would require a large capacity distribution system which would be under-utilised when the arable crop was in production.

(b) Arable Crops

The arable crops included in the cropping pattern are maize, sesame, cowpea and cotton; a token area of vegetables is also included. The pulse crop could be mung bean or groundnuts instead of cowpeas, whilst sunflower or safflower are possible oilseed alternatives to sesame.

The recommended cropping pattern will cover about 3 950 ha and comprise areas of maize and cowpea in the gu season followed by sesame and cotton respectively in the der, as shown in Table 3.6. There will be a small area of vegetables in both seasons.

TABLE 3.6

Arable Crop Cropping Pattern and Calendar (median dates)

Crop	Land preparation	Growing period	Irrigation period
Maize	16 Jan - 14 Apr	15 Apr - 15 Aug	15 Apr - 1 Aug
Sesame	1 Oct - 1 Nov	1 Nov - 1 Feb	1 Nov - 1 Feb
Cowpea	1 Mar - 31 Mar	1 Apr - 30 Jun	1 Apr - 30 Jun
Cotton	1 Jul - 14 Aug	15 Aug - 28 Feb	15 Aug - 14 Feb
Vegetables - gu	1 Mar - 30 Apr	1 May - 30 Aug	1 May - 15 Aug
Vegetables - der	1 Sep - 31 Oct	1 Nov - 28 Feb	1 Nov - 14 Feb

The cropping intensity for the recommended cropping pattern is 200%.

Table 3.6 shows that maize, sesame, cowpeas and vegetables have a growing period of 90 to 120 days, whereas cotton needs 180 days plus 15 days for uprooting and burning of stalks and residues. If circumstances should lead to a breakdown in the pattern then the cowpeas should be excluded and the cotton planted in mid-July instead of August. This in turn would allow an extra few weeks for land preparation for maize to recommence the standard cropping pattern.

It is most unlikely that all the farmers would want to follow the standard pattern. Some will doubtless want to plant groundnuts, beans, safflower or sunflower in place of all or part of the sesame or cowpea course. Groundnuts would be the most difficult to accommodate as their growth period is 120 days but, providing any changes are discussed in advance with the extension and water management staff, there should be no reason for refusing a smallholder the right to make minor variations in the cropping pattern.

One relatively major adaption that could be proposed would be to have a smaller area of cotton in an attempt to reduce the large labour requirements in January and February. As such a change would reduce the overall water requirement, even if the cotton was replaced by groundnuts, once again the change should be allowed.

The several constraints affecting time of planting prevent a cropping pattern with a standard interval between successive crops. This in turn necessitates some form of mechanisation to ensure that the land is prepared correctly. As there is no tradition for animal draught in the Lower Juba, it has been assumed that 70 hp and 120 hp tractors will be used.

3.7.4 Cropping Patterns

The cropping patterns for the two proposed farming systems, one based on double cropped paddy rice, the other on double-cropped dry-foot crops, and for the whole scheme, are detailed in Table 3.7.

TABLE 3.7

Cropping Patterns

Crop	Area under crop (ha)				Percentage of NCA(2)			
	Banana system(1)	Rice system	Arable system	Scheme	Banana system(1)	Rice system	Arable system	Scheme
Paddy rice	-	1 900	-	1 900	-	100	-	21.5
Maize	480	855	2 370	3 705	16	45	60	41.9
Sesame	480	855	1 896	3 231	16	45	48	36.5
Cowpeas	-	-	1 422	1 422	-	-	36	16.1
Cotton	-	-	1 896	1 896	-	-	48	21.4
Vege-tables	240	190	316	746	8	10	8	8.4
Bananas(3)	2 400	-	-	2 400	160	-	-	54.2
Total	3 600	3 800	7 900	15 300	200	200	200	200.0
NCA	3 000	1 900	3 950	8 850				

Source: Consultants' estimates.

Notes: (1) Banana System as discussed in Annex 2.
(2) NCA - net cultivated area.
(3) Bananas, being perennial, are assumed to give a 200% cropping intensity.

These patterns achieve the target cropping intensity of 200%, as required in the Terms of Reference.

The overall scheme pattern clearly shows the importance of maize and sesame, both of which, together with cowpeas and vegetables, would be grown primarily to meet the household's food requirement, although any surpluses are expected to find a ready market. Some of the rice will probably be retained for the household's use, but a large proportion, together with all the seed cotton, is expected to be sold.

3.7.5 Crop Rotations

Figure 3.1, which details the cropping calendars, also illustrates the crop rotations which have been used for analysis purposes. These are paddy rice : paddy rice on the heavy soils, and maize : sesame on the dry foot crop area, cultivated by rice farmers. The rotation for farmers growing only dry-foot crops is maize : sesame : cowpeas : cotton.

It must be emphasised that these are notional rotations and that in practice the farmers are likely to introduce a range of variations; for example, groundnuts instead of cotton, mung beans instead of cowpeas; soya, sunflower or safflower instead of sesame.

3.8 Research Requirements

It is believed that all agricultural research should be co-ordinated by the Agricultural Research Institute. Applied research should be done primarily on approved stations with properly qualified staff, but adaptive research can and should be undertaken on projects such as Homboy.

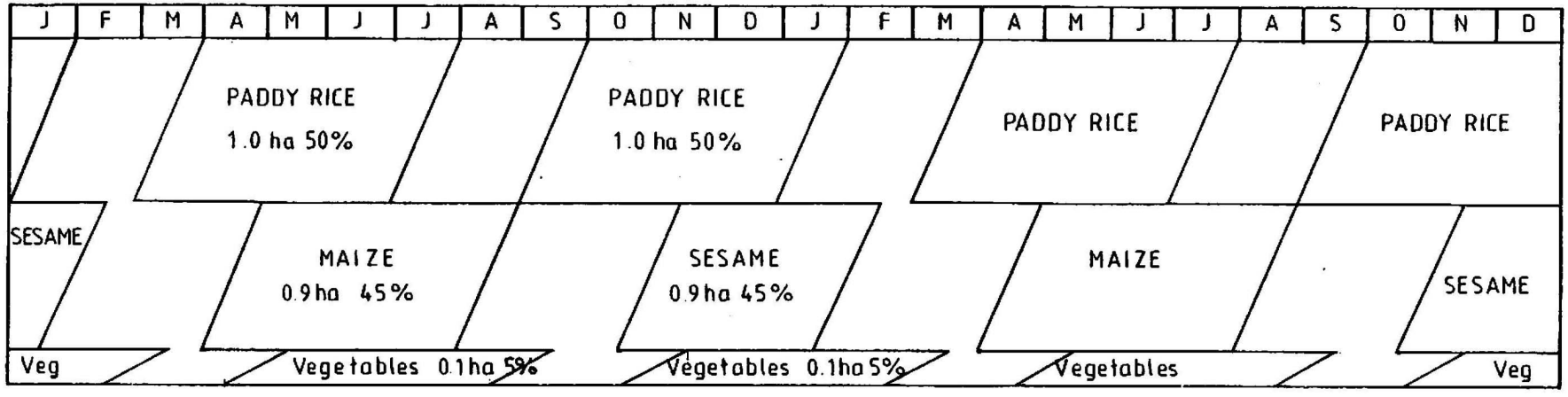
There is a need for investigations into the fertiliser requirements on the Homboy soils, particulary of N, P, and some of the micro-nutrients/trace elements. This kind of programme demands a high degree of precision and research experience. It should only be done at Homboy if firstly there are suitably qualified staff available and, secondly, it can be supervised by the ARI directly or through the Senior Research Officer on the Alessandra Research Station.

There is scope for an adaptive research programme, approved by the ARI, but being undertaken by project agricultural staff. This would consist mainly of on-farm trials, but possibly including some testing of new crops or varieties on the proposed 5 to 8 ha testing area near the project headquarters (see Section 3.4.6(d)). The central area could be used to test and demonstrate new varieties of crops such as citrus, mango and cashew, it could also act as a central nursery proving fruit tree seedlings or budded plants.

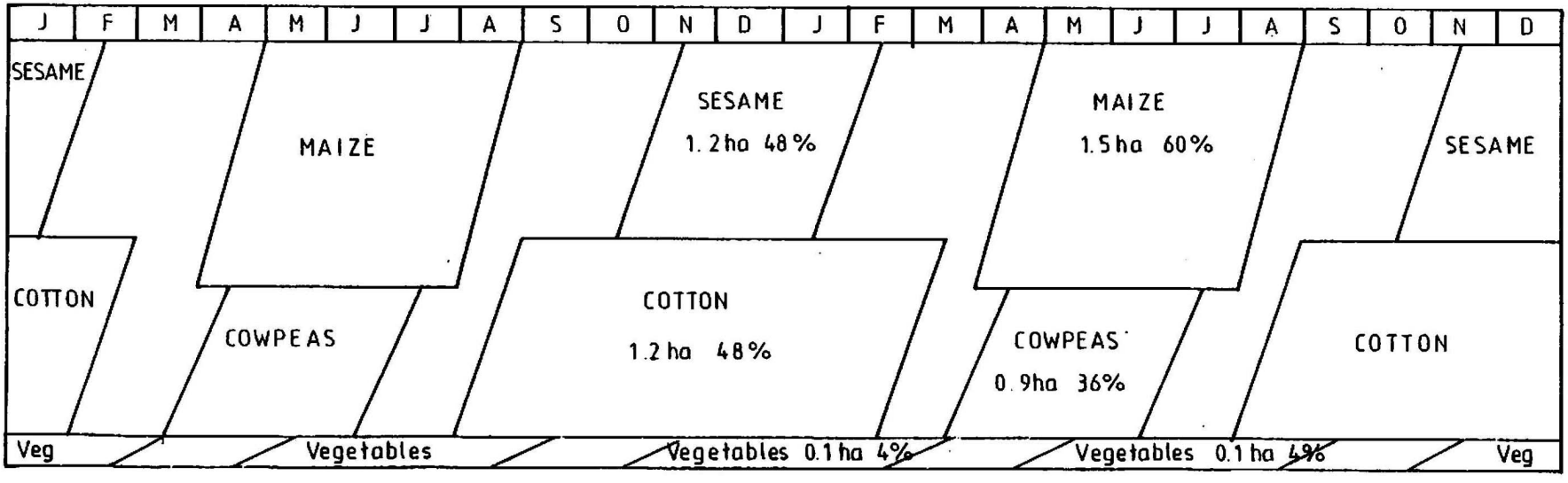
As it will be nearly a decade before the Homboy project starts, it would be unwise to be too detailed about possible adaptive research programmes, as they may already have been undertaken elsewhere. It is believed, however, that there is real scope for improved manual or animal drawn equipment, both of which could reduce the crop labour requirement. Equipment which should be tested in on-farm trials includes:

- animal drawn and hand-operated planters;
- animal drawn inter-row weeders;
- manually operated rotary paddy-rice weeder;
- pedal operated maize sheller;
- manual/engine powered threshing machines for sorghum and cowpeas.

PADDY RICE FARMING SYSTEM (2.0 ha)



GENERAL ARABLE FARMING SYSTEM (2.5 ha)



NOTE : START AND FINISH DATES INDICATE TOTAL GROWING PERIOD.

Figure 3.1
Farming Systems

CHAPTER 4

LIVESTOCK

4.1 Introduction

During the previous study (HTS/MMP, 1980), the livestock sub-sector was not considered in depth as it was apparent that, under the system conceived, there would be a very high proportion of settlers who would not own livestock and that, through a reasonable level of movement control, the existing livestock population could continue to exploit rangeland areas outside the irrigated area and also benefit from the increase in crop residues.

It was also anticipated that sufficient surplus fodder would be generated for the additional nomadic animals using the area during the dry season. It was foreseen that this influx would at least double the livestock population, and that there would be a need for a system of crop residue storage, together with some rationalisation of temporary camp sites with restricted access into the irrigated area during the crop season.

It was concluded that it would be impractical to attempt to exclude livestock from the project but that, under the small settler scheme as then envisaged, the potential for organised livestock enterprises was limited. It was anticipated that livestock numbers would probably increase, and that it would be necessary to develop essential services in order that the livestock industry should thrive and contribute towards the overall productivity of the project.

The following factors, identified by HTS/MMP (1980) as requiring consideration because of their impact on the livestock sector, apply equally to the present study:

(a) the curtailment of livestock access through engineering developments, the expansion and intensification of cropping and the overall increase of the smallholder population.

(b) the loss of animal feed from natural resources and the compensatory effects of crop residues and stubble.

(c) the potential for improved livestock husbandry under the project and the likely attraction for smallholders to increase their stock numbers.

4.2 Present Situation

4.2.1 Introduction

The project lies within the Lower Shebelle floodplain where deeper depressions are liable to flood, and, during the rainy season, the area as a whole tends to be too wet for heavy concentrations of livestock. During the jilaal season, however, the region is of major importance to nomadic stock in search of water and dry season feed.

The settled farmer population in 1979 was estimated at 1 275 families with a further 223 families of nomadic origin, settled and semi-nomadic. It was suggested at that time that the latter would probably be the owners of most of

the resident grazing livestock. During the current study this has been confirmed, and it has been established that the incoming nomads during the dry season are mainly from the same extended families.

4.2.2 Population

In common with the lower reaches of the Shebelle and Juba rivers, the resident farmers of Homboy, many of whom are settled nomads, keep a considerable number of livestock. Cattle predominate; according to current estimates, some 40% of the national cattle population are in the Lower Shebelle and Juba regions.

The project area lies between Jilib and Jamaame where livestock densities in 1979 were estimated at 25 cattle and 11 cattle per km^2, respectively. Since then, a full aerial census of the southern rangelands (RMR, 1985) has been undertaken with overflying during November/December 1983 (wet season) repeated in March 1984 (dry season).

While it is not possible to completely isolate the project area on the maps produced by the survey, it can be identified as falling largely into a single ecological zone. This zone (No 38) totals 3 200 km^3 and covers other areas where the livestock density is similar to that of Homboy. While it is not possible to abstract density figures specific to Homboy, the livestock population estimates shown in Table 4.1 have been calculated from the survey densities given in the census report for Zone 38.

It is suggested that these estimates offer reasonably accurate figures for the numbers of each species resident in the area and for the nomadic influx during the dry season. Further refinement would require a full ground census or a specific aerial count for the project area.

Reference to the census report (RMR, 1985) shows the following densities per square kilometre for ecological Zone 38 for the five relevant domestic species in 1983 and 1984:

Cattle	22	and	58.5
Sheep	7.9	and	15.7
Goats	27	and	48
Donkeys	0.17		
Camels	6.5	and	7.1

It can be seen from Table 4.1 that the livestock population may more than double during the dry season with cattle numbers increasing by more than 150%.

There are slightly more goats amongst the apparent resident population, but in terms of livestock units (LUs), cattle are the most significant with camels totalling about half the LU value of cattle. In terms of range carrying capacity, however, the camels would not be in major competition with the cattle for feed except in drought periods.

The nomadic influx of the dry season appears to be strongly biased towards cattle which represent some 90% of the additional LUs. The relatively small increase in camel numbers may be accounted for by visiting nomads' preference for oxen as pack animals.

TABLE 4.1

Estimated Livestock Population with Conversion to Livestock Units (LU)

	Cattle	Sheep	Goats	Donkeys[2]	Camels[3]	Total (LU)[1]
Nov/Dec 1983 (wet season)	3 120	1 120	3 380	25	920	-
LU[1]	2 250	-	360	15	1 120	3 745
March 1984 (dry season)	8 300	2 230	6 820	25	1 010	-
LU[1]	5 980	-	650	15	1 230	7 875
Percentage gain of LU in dry season	165.8	-	80.5	0	9.8	110.3

Notes: (1) LU values have been calculated by taking the average species weights in the census report to give the biomass in kilograms, divided by 250 kg of live weight ascribed as 1 LU = to average mature Somali cow. The LU is a convenient unit for nutritional calculations. The LU value for sheep is included with that for goats.

(2) Enquiry at Homboy village would suggest that the estimate for donkeys is low as the settled village livestock owners use them for transport and apparently do not keep camels nor use draught oxen.

(3) The natural vegetation at Homboy and much of the surrounding area is well suited to camels and enables a year round market for their milk. These animals are kept by the semi-nomads.

Source: Consultants' estimates and RMR (1985)

4.2.3 Ownership

The division of the present village populations into livestock owners and non-livestock owners appears to be fairly clearcut with the latter referred to locally as 'farmers'.

As discussed in Chapter 3.2 of Section F of this Annex, it is difficult to estimate an accurate total human population for the project area and the proportions of each group, but the current census should provide this information in due course.

The aerial census provides an indication of population densities for ecological Zone 38 from house and hut counts. These are divided into three groups as follows:

rural population (1983/1984)	68.63 per km^2
nomad population (Dec 1983)	6.95 per km^2
nomad population (March 1984)	13.92 per km^2

The population estimates for the sedentary population given in Section F Chapter 3.2 indicate the possibility that the rural population density in the project area may be higher. On the basis of that data, from the original 1980 study and 1986 village headman, the 1983/1984 population would be between 10 600 and 9 850 persons compared with 9 750 persons based on the Southern Rangelands Survey aerial census. The Rangelands Survey did identify in 1983/1984 the following nomad population in the project area:

nomad population (1983)	985 people
nomad population (1984)	1 975 people

Incoming nomads may therefore number about 1 000 people, say 200 families with an average herd size of about 30 head of cattle.

Division of the rural population into livestock owners and farmers can be calculated on a very rough basis from the range of group sizes (cattle) given in the aerial census and from enquiries at Homboy village as to herd sizes and ownership.

Information from these two sources indicated that herd sizes vary from 1 to 70 head with three main groupings of 1 to 20, 21 to 40 and over 40 head. Village enquiries indicated that about 50% of cattle owners keep more than 40 head, 35% between 21 to 40 head with the remainder at less than 21 head.

Allowing for the probable distortions in the information and using the total resident cattle population of 3 120 head, average herd sizes are probably about 35 head. This compares reasonably well with the mean group size of 25 head for ecological Zone 38 in the wet season, as cows-in-milk and their calves are kept separately near to the villages.

Livestock owning families within the project area may therefore number between 90 and 100 representing up to 500 people.

Comparison with the population estimates in the previous study; i.e., 1 275 'farmer' families and 223 nomadic settler and semi-nomad families, indicates that, assuming livestock owners fall into the nomadic settler group with the semi-nomads, a reasonable level of consistency exists with a current level of about 1 500 'farmer' families and about 290 families of nomadic origin. It further offers evidence of a steady growth in population with an increase in nomadic settlement.

4.2.4 Management

It is not proposed to discuss the management aspects of the dry season nomadic animals except to indicate the probable interchanges and interdependence between the settled and incoming nomads.

The main concern of the resident livestock owners is the production of cows' milk and, to a lesser degree, goats' milk. Thus, the resident cattle herd includes a very high proportion of females. The herd is divided into two groups, the first, comprising cows-in-milk and their calves, is kept at the village grazing the nearby range and stubbles, the second, comprising dry cows, young heifers and a few oxen (uncastrated), are herded by relatives or hired labour away from the village but mainly within the project area.

In the dry season both groups may be fed crop residues. The milking cows may receive supplementary feed, e.g. sesame cake, maize bran (from local pounding) and stripped maize cobs, but only if the dry season grazing is very poor.

In order to achieve the high proportion of female animals, especially mature cows, it is understood that exchanges by negotiation and barter with nomadic relations take place during the dry season, with young oxen transferring to the nomadic herds and some productive females joining the resident herd.

Bulls are very rarely castrated except for some pack and draught animals and for obviously poor 'doers'; the operation is carried out at 4 years old. This appears to be the accepted age of maturity as heifers are generally first bred during their fifth year, with a first calf when they are over 5 years old.

Calves are separated from their milking dams at the village, but are required to suckle while the cow is being milked. They are retained at the village until the cow dries up when both join the second grazing group.

The average lactation is said to be 8 months with claims of up to 12 months. The duration may relate to the time when the cow becomes pregnant again but it is influenced mainly by the quality of the cow. On average, the period between calvings is 18 months, suggesting that many cows are not served until they rejoin the second group.

Sheep and goats are herded separately from the cattle and generally forage within the village and nearby. Lambs stay with the ewes, but most goat kids are separated from their dams as the latter are usually milked at least once a day; much of the milk is used for cheese. Otherwise both species are kept mainly for local slaughter and for sale as meat animals outside the community.

4.2.5 Nutrition

A better understanding of the resident livestock population and its distribution has become available in the present study, and it has been possible to convert the estimated population into a standard of LUs which can be related more accurately to the estimated amount of fodder.

The latter, including range grazing, fallow, stubbles and crop residues, was previously estimated to be sufficient for between 2 600 and 3 100 head of mature cattle, i.e. LUs at 250 kg liveweight requiring 2.28 tonnes of dry matter intake per year. This would have been equivalent to about 5 000 mixed cattle, and there was seen to be sufficient flexibility in the calculation to obviate the need to make allowance for other domestic stock.

In the present study, the LU value of the resident population has been estimated to be 3 745 (Table 4.1) including a cattle herd of just over 3 000 head. These total LUs can be justifiably reduced by the 1 120 LUs ascribed to camels, as they will mainly exploit higher level browse not available to other species.

The net estimated LU value for the remainder of the livestock will then be just over 2 600 which lies within the estimate for available fodder. However, as recognised but not quantified in the previous study, the influx of nomadic livestock during the dry season may increase the total LUs, exclusive of camels, by over 150% to about 6 650 LUs. On a short-term basis, therefore, the fodder resources may be severely stretched which could significantly affect the performance of resident animals prior to the gu season rains.

More information has also been gained on livestock ownership patterns, which show that the livestock owners are a very much smaller minority of the resident human population than previously thought.

The significance of this factor in relation to nutrition, lies in the ownership of harvested crop residues, e.g. maize and sorghum stover. The 'farmer' majority will probably gather a considerable quantity of this material after grain harvest, and its availability to the resident livestock owner may depend on his ability to pay for it, against possible competition from outside the area.

Currently prices would appear to be in the range of SoSh 1 000 to SoSh 1 500 per tonne where a tonne is representative of the local standard of 10 bundles.

An additional feed source which was not included in the previous assessment is sesame cake. This is available locally at an oil extraction mill in Homboy village. On-site use is apparently restricted to cows-in-milk at times of severe fodder shortages, thus it does not add significantly to the overall feed resource. Currently it is sold at SoSh 12 per kg, but no information is available on the throughput of the mill nor on the existence of similar equipment elsewhere in the project area.

The fact that it is used, even if only on an occasional basis, may be significant in the future development of irrigation, because livestock owners may have to modify their management and feeding practices as the available range grazing is reduced.

4.2.6 Production

Little information is available on production parameters for any of the resident domestic species but, as shown above, the calving interval for mature cows may be about 18 months with first calving at 5 years. No information could be found on overall mortality rates for any species except for a reported 10% loss in calves at Homboy village.

Milk production from cows at Homboy village is locally estimated at between 1 and 2 l/d beyond calf requirements, with reports of some cows producing up to 4 l/d at peak production. It is unlikely that the average daily production exceeds 1.0 l/d over an 8-month lactation, and a reasonable estimate of total production per cow would be 200 to 250 l per lactation.

Each cattle owner at Homboy village appears to keep up to 10 milking cows at the village at any one time; the number depends on the size of the herd and the rate at which cows come into milk. Using this information and the apparent ownership pattern, it can be estimated that, on average, cattle owners have 5 cows in milk at any one time; i.e. a total of 450 cows. To maintain this number in milk would require up to 1 800 cows in the resident project herd; i.e. between 50% and 60% of the estimated total number of cattle.

The total annual milk production at an average of 1.0 l/d per cow-in-milk for the project area would be perhaps 140 000 to 180 000 l.

Offtake for meat from the resident cattle herd is probably mainly from cull cows with an occasional ox. No information was obtained on the rate of offtake, but the butchery at Homboy village appears quite active and there is evidently a good market supplying the non-livestock owning 'farmers'.

This market will also apply in the cases of sheep and goats and, to a lesser extent, camels. However, because sheep and goats have a higher breeding rate and faster growth, it is likely that many are sold outside of the project area in addition to those being slaughtered for home consumption.

Allowing a 5% offtake from the total biomass, and assuming one LU equals 250 kg liveweight, then a possible 47 t of liveweight may go for slaughter annually yielding a possible 23 t of carcass meat. This figure does not allow for the potential offtake from incoming nomadic livestock in the dry season.

As mentioned above, goats are also milked and it is understood that much of their milk is processed locally into soft white cheese, but there is no information available on the numbers of goats actually milked nor on the proportion of mature females in the flock. A daily production of between 0.5 and 1.0 l beyond offspring requirements was claimed at Homboy village, but agreement on the period of lactation was not forthcoming. The latter is probably a maximum of 4 months and may average less than 3 months, as goats are prolific breeders with a gestation period of only 5 months. Again, in view of their rapid breeding and in spite of the local desire to maximise mature female numbers, the latter possibly make up about 35% of the flock, i.e. between 1 300 and 1 400 head. Of these, 50% may be milked for an average of 2 months each year, which, at 0.5 l/d, would yield about 20 000 l. If converted wholly into cheese this would produce about 3 000 kg.

4.2.7 Marketing

The impression gained from discussions at Homboy village indicated that the livestock owners were able to sell most of their surplus produce locally to the 'farmer' majority.

Cow's milk in early December was selling at SoSh 20 per half litre and goat cheese at SoSh 250 per kg. These are wet season prices, when milk production is high, and could double during the dry season. It is probable that a relatively high proportion of these products are sold, as the livestock owners represent a very small proportion of the project area population.

Prices for slaughter animals at Homboy village were quoted at between SoSh 6 000 and SoSh 7 000 for a 4 year old ox, cull cows up to SoSh 6 000 depending on age and condition, SoSh 2 000 to SoSh 3 000 for goats and SoSh 1 000 to SoSh 1 500 for sheep.

An indication of the premium set on milking cows can be seen in a quoted price of SoSh 20 000, while trained working oxen at 6 to 7 years old may sell at SoSh 15 000.

4.2.8 Health

The Homboy area, in common with most of the riverine areas of Somalia, is prone to tsetse fly infestation and, according to the veterinary assistant, the incidence of trypanosomiasis amongst cattle and camels is quite high. His main task is carrying out inoculations in those areas where the tsetse challenge is strongest. Samorin is the drug commonly used.

The area does not appear to have suffered any significant outbreaks of other diseases prevalent in Somalia recently but, in view of the fact that regular vaccination campaigns are not carried out, it is possible that mortality rates may be high in periods of stress, e.g. towards the end of the dry season, and that many deaths go unreported with the cause not diagnosed.

4.2.9 Services

Since the previous study (HTS/MMP, 1980) there has been a slight improvement in the services provided by the Ministry of Livestock, Forestry and Range in that the veterinary clinic at Jilib is in the charge of a professional veterinarian and a veterinary assistant has been posted to Homboy village.

The Livestock Development Agency has been disbanded and is therefore no longer available to provide the possible services in marketing livestock as suggested in the previous study.

4.3 Livestock Potential and Policy

4.3.1 Introduction

It has already been indicated that the design of the proposed irrigation area will be essentially the same as recommended in the 1979/80 study and, also, that there has been no significant change in the carrying capacity of the rangeland and cropping areas since then.

The reduced carrying capacity calculated for land outside the irrigated area remains the same, i.e. between 600 and 730 LUs exclusive of camels, which, on present estimates of resident population, would leave between 1 800 and 2 000 LUs requiring a new source of nutrition which can only come from within the irrigation development.

Further, during the last study, little information was available on the nomadic livestock influx during the dry season and at that time it was not possible to quantify their impact. This impact, based on estimates made during the present study, is considerably greater than previously thought, with total LUs, exclusive of camels, increasing by over 150%. This will not only put extreme pressure on the reduced range and rainfed crop areas, but could create problems in accommodating the temporary camps for about 1 000 people and in access to traditional watering points. Although it may be possible for the authorities to direct these people to other areas, such action would probably cause considerable aggravation and would be sociologically very disruptive.

The latter aspect is concerned with the relationship of the visiting nomads with the resident livestock owners who are of nomadic origin. There is obviously a high degree of interdependence between the two groups, and the period of the dry season influx is evidently a time when exchanges of livestock and staple food take place, and other family matters are resolved.

As will be shown in the next section, the potential fodder production from the irrigated crops should provide sufficient supplies for the additional animals. However, the question of access into the scheme with its intensive cropping pattern will have to be resolved and, when the time comes for allocation of irrigated holdings, it may be logical to site the livestock-owning residents near to the outer boundaries with access to the surrounding rangelands.

The group that may prove most difficult to accommodate could be the camel owners. They appear to be separate from resident livestock owners, living in temporary housing but maintaining a fairly constant camel population of about 1 000 head. This increases only marginally during the dry season. These animals feed mainly from the upper levels of the Acacia thickets prevalent in the project area. The irrigation development will remove well over half of this nutritional source.

It appears unlikely that many of this group will take up irrigated smallholdings; also, their camels would be difficult to integrate into the scheme with their somewhat specialist feeding habits. This problem is unlikely to become acute until the second phase of Homboy is developed, and may only become critical when other similar and neighbouring schemes, e.g. Fanoole, have been fully developed. In the meantime, they should be able to find adequate fodder within the Jilib and Jamaame areas.

4.3.2 Potential

Regarding livestock, the irrigated area offers the same four sources of animal feed as discussed in the previous study. These are:

- crop residues - e.g. maize stover, rice straw, etc.;
- crop processing by-products, e.g. sesame cake and cotton seed;
- stubble grazing;
- 'opportunity' grazing, e.g. roadsides, canal banks and drains.

In the previous study, where the assumption was made that traditional management would continue and that livestock could be distributed fairly widely throughout the irrigated area, the availability of fodder from the above sources was

considered to be fairly uniform and that access to stubbles could be accommodated. The exception was assumed to be by-products from crop processing on the grounds that such material would involve a financial input which would not necessarily be acceptable to the owners. However, based on current planning for crops and with better information on livestock ownership and the distribution pattern, these assumptions become largely invalid.

The major changes that must be taken into account are as follows:

- the resident livestock population is wholly owned by a relatively small minority of the resident human population;
- the increase in holding size from 1 to 2½ ha creates a move towards commercial cropping with less emphasis on subsistence aspects;
- the objective of 200% cropping severely restricts livestock movement within the cultivated areas;
- the introduction of about 3 000 ha of smallholder bananas excludes livestock almost totally and, under current animal feeding practices in Somalia, does not produce any useful crop residues.

The implications of these changes are extremely significant to the future policy for livestock on the scheme.

The livestock owners will not have sufficient crop residues on their own 2.5 ha holdings to feed their own livestock and certainly no surplus for visiting nomadic animals and, with the intensive level of cropping, their access to stubbles will be very limited.

The non-livestock owning 'farmer' majority, may be reluctant to allow livestock access to stubble and may require payment for crop residues. The latter material could require transport to sites where relatively large groups of animals can be kept.

Under present circumstances, there will be no access into the banana plantations, nor will they provide residues for livestock. Good banana management excludes animals from productive plots, and the practice of feeding pseudostems and other residues is not a common feature in Somali management. The possible contribution from banana residues to livestock nutrition is discussed in Section 4.3.4.

Theoretically, at least, the 'opportunity' grazing element remains as assessed in the previous study. Access to this fodder source will be primarily controlled by the project management which may place restrictions on access to certain parts, restrict access by species; i.e., cattle and camels as too large and destructive to infrastructure, or lay down regulations on maximum group-size and numbers of attendants required.

The larger holding size would require more work by fewer people than would have been the case with the 1 ha holding proposed by HTS/MMP (1980). Thus there may be less people to protect crops against wandering livestock, and farmers could demand restriction on animal movements.

The ownership pattern for livestock will tend to concentrate the animals in fairly large groups and it may prove extremely difficult for them to exploit the 'opportunity' grazing throughout the scheme. In the previous study stubble and 'opportunity' grazing were estimated to have a potential carrying capacity of about 1 600 LUs which, in combination with available outside grazing for 600 to 730 LUs, would be nearly adequate for the currently estimated resident livestock population of 2 600 LUs. Any shortfall would be made up from the potential crop residue element. The previous total potential for the latter being sufficient for 6 500 LUs.

Given that one-third of the area will be under bananas, some 450 LUs must be subtracted from the stubble grazing element and a further 90 LUs from 'opportunity' grazing. This reduces these sources to a value of just over 1 000 LUs which, in view of the other factors discussed, should be further reduced by 50% leaving a potential for only 500 LUs capacity. Under these circumstances, crop residues may be required to make up a shortfall in nutrition for resident livestock in the order of 1 300 to 1 500 LUs, i.e. 3 000 to 3 500 t of dry matter. This may represent up to 6 000 t of residue production allowing for wastage.

4.3.3 Potential Feed Values of Crop Residues and By-products

Table 4.2 shows the nutritional values for crop residues and by-products from crops that may be included in the general cropping pattern on the irrigated holdings but excluding bananas.

It is notable that a cropping intensity of 200% is anticipated and probable that 1 000 ha of suitable land will be used exclusively for paddy rice growing two crops per year.

(a) Residues

Under the traditional management as practiced by the existing resident livestock owners, the materials given in Table 4.2 which are of greatest interest to them, are the crop residues and, for the present, it will be assumed that all may be made available to livestock. Further, in view of their similarity in feed value, only the dry matter and probable availability, as shown in Table 4.2, will be taken into account when asessing the potential in terms of LUs requiring 2.28 t of dry matter per year.

The total irrigated area is 8 850 ha from which 2 400 ha of bananas and 373 ha of vegetables can be subtracted leaving 6 077 ha of other crops. A further 950 ha of monocropped rice can be treated separately leaving 5 127 ha of mixed cropping. The latter would include maize, sesame, cotton and cowpea.

The relative areas of each fodder producing crop in the three proposed farming systems (paddy rice and dry foot arable), are detailed in Table 4.3. This table also identifies the yield, total DM yield and estimated available DM yield. The latter is assumed to be 60% of the total DM.

TABLE 4.2

Nutritional Values of Livestock Feeds, Estimates of Production and Probable Availability to Livestock

Feed	Per cent dry matter DM	Per cent TDN(1)	Per cent DP(1)	Production per cent of	Probable availability per cent of production
Groundnuts					
Tops	90	40	4.7	100 nut yield	50
Hulls	92	19	16	11 nut yield	60
Cake	94	85	42.4	55 nut yield	90
Maize					
Stover	90	50	2.0	100 grain yield	60
Cobs (stripped)	90	46	0.0	20 grain yield	60
Grain	88	69	9.0	100 grain yield	95
Rice					
Straw	93	41	0.6	50 paddy yield	60
Hulls	92	10	0.1	17 paddy yield	50
Bran	91	67	8.4	12 paddy yield	80
Cotton					
Stalks(2)	90	40	-	75 seed cotton	50
Hulls	91	44	0.0	10 seed cotton	60
Oil cake	93	72	34.0	40 seed cotton	95
Sesame					
Stalks(2)	90	40	-	100 seed yield	50
Cake	94	71	39.4	58 seed yield	95
Pulses					
Straw	90	42	3.2	100 seed yield	50

Notes: (1) TDN - Total digestible nutrients, DP - digestible protein; these values are not used in the overall carrying capacity calculations but are significant in considerations of nutritional balance and serve to emphasise the high nutritional values of many by-products.

(2) The values and production levels of cotton and sesame stalks are not well recorded and the figures used in this table are not technically confirmed.

TABLE 4.3

Estimated Production of Dry Matter

Crop	Area (ha)	Yield (kg)	Dry matter (t) Total	Available
Maize	3 705	3 000	12 000	7 200
Sesame	3 232	600	1 750	1 050
Cotton	1 896	1 500	1 920	768
Cowpea	1 422	750	960	580
Rice	1 900	4 000	3 530	2 120
Total	12 154(2)		20 160	11 718

Notes: (1) Includes maize stover and stripped cobs at ratio of 5 : 1.
(2) Actual area 6 077 ha at 200% cropping intensity.

Source: Consultants' estimates.

On the basis of 2.28 t DM per LU, the available DM is sufficient for about 5 100 LUs.

Assuming that all the available DM in crop residues can be fed to livestock, then the surplus beyond resident livestock requirements should be adequate for the nomadic influx of 4 000 LUs.

This assessment represents an ideal situation; it would require considerable logistic support in moving the crop residue material to the livestock or vice versa.

In the current Somali livestock situation, in which the major constraint to progressive development has always and will continue to be a chronic shortage of animal feed, especially during the dry season, the concept of not using the potential feed offtake from an irrigation development would be unacceptable. The movement of fodder to stock; or vice versa, should be left to the private sector, and it is anticipated that market forces and entrepreneurial initiatives will develop a system whereby this can happen.

(b) By-products

The question of the value of crop processing by-products to the local livestock sector is more complex, and depends partly on the proximity of facilities for processing. Sesame oil extraction plants are quite common at village level, and the owner of the seed can receive his resulting oil and seed cake directly from the mill at the standard cost of processing. Seed cotton is sold as a single commodity and the cotton seed produced at the ginnery, which is often far distant, must be repurchased and has lost its intrinsic ownership value.

In the majority of livestock management systems in Somalia, free feed resources are exploited as long as they are available, and feed inputs are purchased only as an emergency measure. The exceptions to this are the urban livestock as found in Mogadishu and other major population centres. Developments such as Homboy offer an opportunity to break this pattern through the introduction of extension advice on improved progressive management.

At Homboy, in particular, where there is already an active milk market amongst the non-livestock owning 'farmers', there would appear to be a strong case for improvements in management and production. Such developments could in due course create a market for crop processing by-products and, if local processing facilities were to become available, the following feedstuffs (Table 4.4) could come from the mixed cropping and rice elements of the irrigated areas.

TABLE 4.4

Potential Feed Value of Crop Processing By-products (t)

By product	Total DM(1)	TDN	DP
Maize bran (2)	1520	1140	190
Cotton seed (3)	1620	1230	480
Oil cotton seed cake (4)	1040	740	360
Sesame cake (5)	530	380	200
Rice bran (6)	830	550	90
Total	5500	4000	1300

Notes: (1) Calculated as - area x yield x % of yield x % DM
(2) 3 750 x 3.0 x 0.15 x 0.90
(3) 1 896 x 1.5 x 0.65 x 0.90
(4) 1 896 x 1.5 x 0.40 x 0.93
(5) 3 231 x 0.6 x 0.58 x 0.94
(6) 1 900 x 4.0 x 0.12 x 0.91

Source: Consultants' estimates.

Other assumptions used in Table 4.4 were that 50 kg of cotton seed is required for use as seed for the following crop, and 50% of the sesame yield is retained by the household with the oil being extracted by pounding. Cotton seed cake is preferable to cotton seed but, while the development of oil expressing is unlikely, there are plans to rehabilitate Jamaame ginnery.

4.3.4 Possible Exploitation of Banana Plantations

In spite of a relatively long experience of banana cultivation in Somalia, there is little evidence of any serious attempt to feed the harvest residues to livestock. One report from Jilib said that banana stems are fed in times of shortage of other feed resources.

The main residues which may become available from the Homboy plantation are:

Pseudostem - which may weigh up to 70 kg

Male stalk - about 1.5 kg in weight

Leaves - up to 2 kg per harvested stem

Other material such as waste fruit, female stalk and rhizome may also be useful if available. All these items, which become available when bunches of bananas are harvested, must be removed from the plantation. Harvesting should take place at about 10 day intervals throughout the year, thus a regular supply of residues should be created.

While there are differences in the make-up (percentage dry matter, nutrients, fibre) of the three main items, only the pseudostem will be considered as it obviously represents the largest proportion.

The immediate disadvantage of the peudostem is its bulk over 90% of which is water. The following analyses shows the average contents:

Dry matter (DM)	7% of whole
Crude protein (CP)	2.3% of DM
Total digestible Nutrients (TDN)	44.5% of DM
Fibre	36.0% of DM

It can be seen that a 70 kg stem may only yield 5 kg of dry matter and that the latter will include a high proportion of more or less indigestible fibre. Fortunately, Somali livestock are well adapted to high fibre diets, so that aspect may not be too significant. The major problem would be that of intake where a 250 kg cow (1 LU) at 2% of body weight DM intake per day; i.e., 5 kg of DM, would be required to eat the whole of a 70 kg stem. This would be well beyond its capacity; it is unlikely that it could exceed one-third of a daily ration, with the rest made up by a dry fodder preferably including a proportion of concentrate; e.g., sesame cake.

Both the leaves and the male flower have a slightly higher dry matter content than the pseudostem, 20% and 13% respectively, with, somewhat lower fibre content and higher TDN and CP values. This would make them better than pseudostems if animals can be persuaded to eat them.

Annual yield per hectaré of pseudostems could exceed 300 t say 20 to 25 t of DM, which would make a significant contribution to the overall animal feed situation. If the total available DM is increased to include 33% banana residues, it becomes 17 800 t, sufficient for 7 800 LUs, an increase of some 20% over the peak dry season population.

A possible method of feeding the material would be to slice the stems and mix them with dry residues like maize stover. Such a mixture may well be suitable for the itinerant nomadic livestock during the dry season, as they will depend largely on residues after the project is fully developed.

4.3.5 Access

This aspect was covered in the previous study in which a network of livestock crossing points over irrigation structures was recommended to allow access in and out of the irrigated area.

As major alterations to the number of irrigation structures are not envisaged these recommendations remain adequate.

4.3.6 Services

As there is a clinic under a veterinarian, at Jilib, and a veterinary assistant at Homboy, the current health services should be sufficient to meet future requirements. The increased bush clearance may reduce the tsetse challenge and consequently reduce the level of treatment required against trypanosomiasis.

In the longer term, as development progresses there may be justification for an animal husbandry extension specialist who should be trained and experienced in milk production management.

4.4 Conclusions

The livestock owning residents, excepting the camel keepers, are expected to take up holdings when Homboy is developed. The resident livestock population would have to be accommodated and be given access to the crop residues.

It has been conservatively estimated, that the potential fodder generation is in excess of the existing resident livestock population requirements and that opportunity exists for increasing overall production levels and improving the level of milk production.

It has been established that the itinerant nomadic influx during the dry season increases the livestock population, exclusive of camels, by 150% for some 3 months, and that the nomads are closely connected with the resident livestock owners. This influx is likely to continue after the scheme has been developed, when the estimated fodder availability should be sufficient to meet their needs. There will need to be some modification of management practices and flexibility in approach to bring animals and the food supply together.

Based on current estimates of the resident human population in the project area, the livestock owners appear to represent less than 10%, and to maintain relatively large herds and flocks. There is no information on this group's relative rate of growth, for humans or livestock, and as the project will not be implemented until 1994/95, it cannot be foreseen whether more livestock owners and their animals will require holdings and make greater demands on the fodder resource. This could be significant if smallholders from outside the project area are brought in as they may also own livestock which would need to be accommodated. The current non-livestock owning residents, who are in the majority, may also invest in animals as their income from irrigated crop production increases.

In the long run, the project may become an attractive proposition for livestock development which could offer a valuable addition to project benefits. It is therefore essential that the concept of livestock integration is planned for from the start of implementation.

CHAPTER 5

ENVIRONMENTAL IMPACT

5.1 Natural Vegetation

Vegetation associations which have developed in the Homboy area are based mainly on elevation and landform as this affects the depth and duration of flooding. In the deeper depressions, which are subject to the most extensive and deepest flooding, swamp grasses and sedges predominate together with a few trees which are able to survive extended periods of waterlogging. Shallower depressions have a dense growth of Acacia nilotica, while the floodplains support a mixed stand of Acacia and non-thorny species in which A. nilotica, A. zanzibarica, A. bussei, Dobera glabra and Thespesia danis predominate. On the higher areas, the vegetation is more open and consists mainly of non-thorny shrubs and trees. Cultivated areas that have been left fallow are quickly colonised by species such as Ficus populifolia, Dalbergia spp and T. danis.

5.2 Wildlife

A number of gazelle and other mammals and a wide range of birdlife were seen during the study. This confirms the 1980 Report's (HTS/MMP 1980) observation that the Lower Juba Region has a rich and varied wildlife population. The number of animals and the lack of fear shown by animals near to the road is a direct result of the Government ban on hunting which was imposed some ten years ago.

The existing wildlife population must compete with the human and livestock populations for food and water. Likewise, some damage to standing crops must result from the warthogs and baboons which abound in the area, but the local farmers made no specific complaints regarding crop damage by wild animals.

5.3 The Impact of the Scheme

Extensive areas have already been cleared by local farmers. In such places the development of an irrigation scheme will have little effect as most animals have already moved out. Scheme development could have a beneficial effect on bird life as year round supplies of water may lead to an increase in both the species and numbers of birds. It could also create problems, as it has done at Mogambo, by attracting large numbers of water birds such as Egyptian geese and ducks which can damage crops in the seedling stage. Similarly, in drought years when the supply of wild grass seeds is limited, grain crops grown under irrigation could be severely damaged by Quelea spp.

It is an unfortunate fact, that in those parts of the study area which are covered with secondary growth or old, established bush/scrubland, which will have to be cleared, the mammalian wildlife will be driven out and will not be able to return. There is, however, plenty of unused land to the north, east and south into which the animals can move as the Scheme is gradually established. Thus, although developing the Homboy Scheme will have an adverse effect on the environment within the 9 000 ha scheme area, it should have minimal effect on wildlife which can continue to thrive, by inhabiting the same vegetation associations and occupying land with similar terrain and soil types outside the Scheme area.

SECTION C

ENGINEERING

CHAPTER 1

BUSH CLEARANCE AND LAND LEVELLING

1.1 Bush Clearance Requirements

A survey carried out for the 1980 study indicated that some 3 500 ha within the gross project area of 14 200 ha had been cleared for rainfed farming. This was predominantly around Homboy, with some small areas in the south near Burgaan. This survey has been updated for the present study, and it has been found that the area already cleared has increased by 1 000 to 4 500 ha, which is 32% of the gross project area. This additional cleared land is also predominantly around Homboy and Burgaan, and is shown on Plate Nr 3 in the Album of Drawings.

The uncleared land is covered with medium to dense mixed small acacia and scrubland, although there are small areas of swamp grasses and sedges with relatively few emergent trees in the deeper depression areas. Tree density in the uncleared areas is estimated at approximately 500 per hectare. Tree heights are typically 2 to 3 m with the trunks 100 to 200 mm in diameter.

1.2 Methods of Bush Clearance

Possible methods of bush clearance are burning in situ, chemical applications and mechanical clearance by bulldozer, chaining, rake or root plough. Of these, the recommended method for Homboy is clearance by a root or multi-application rake with a root plough behind the tractor to bring up the roots in the same operation. This will leave some roots on the ground surface which can be collected by hand. Bush and roots should be heaped into windrows at convenient intervals during raking, and thence transported by lorry to designated points in the villages for use as house building material or domestic firewood. In areas where this is not practicable or for small material the bush and roots should be burnt. Large mature individual trees should be left to provide shade and focal points, provided that they do not interfere with the irrigation and drainage works.

It is estimated that a 200 hp crawler tractor with a rake on the front and a root plough behind could achieve a bush clearance rate of 0.5 ha/d.

1.3 Land Levelling

After construction of the irrigation and drainage systems, land levelling will be necessary to ensure efficient water application and homogeneous moistening of the soil profile.

Land levelling can be an expensive and difficult procedure to carry out effectively, but is essential if the projected irrigation efficiencies are to be achieved. Poor land levelling can lead to considerable yield losses and wastage of water.

1.4 Criteria for Land Levelling

For the proposed crops, the possible methods of irrigation and allowable slopes are discussed in Chapter 4 and summarised in Table 1.1.

TABLE 1.1

Land Levelling Criteria

Crop	Possible method of irrigation	Maximum allowable slopes (%)	
		In direction of irrigation	Across direction of irrigation
Paddy rice	Basin	0.05	Level
Bananas	Furrow	0.30	±0.30
Mixed crops	Furrow or border strip	0.30	±0.30
Vegetables(1)	Small basin	0.30 Level	Level Level

Note: (1) Small areas only.

The minimum area which can be economically levelled to one plane is normally taken as about 1 ha. Smaller planes than this can reduce the earthworks to a limited extent but cause increasing problems with movement of earthmoving machinery. It is recommended therefore that a minimum plane of 1.0 ha is adopted, although this could be reduced to 0.5 ha in areas of difficult topography. Depths of cut should be limited to 0.50 m to avoid possible exposure of sand lenses or saline layers. Depths of fill should also be restricted to avoid excessive settlement which would then require further levelling to be carried out. The maximum depth of fill should be about 0.6 m, deposited in layers of not more than 0.3 m.

1.5 Land Levelling Requirements

In order to assess the land levelling requirements, eight representative sample areas each of 9 ha (300 m x 300 m) were selected for the 1980 study and surveyed on a 30 m x 30 m grid.

Each area was divided into land levelling plots of between 1 and 2 ha, depending on the proposed crop and irrigation method. For the mixed crops to be grown on furrows or border strips of maximum length 300 m, a land levelling plot of 1.8 ha (300 m x 60 m) was adopted. This size was also used for the paddy rice area to be irrigated in basins. The banana areas however will have a maximum furrow length of 150 m, and thus a plot size of 1.35 ha (150 m x 90 m) has been used.

The survey data for each plot were analysed by computer to give the plane of best fit within the allowable slopes shown in Table 1.1, and the earthmoving quantities, assuming balanced cut and fill and a bulking factor of 1.0, were determined. The results are summarised in Table 1.2.

For comparison purposes, some of the sample areas were re-analysed using smaller planes of about 0.5 ha. Generally the saving in earthworks was very small (5% to 10%), except for some of the paddy rice basins where the volumes of material reduced by up to 20%.

Overall, the results indicate typical excavation volumes of 300 to 400 m^3/ha, although individual plots, particularly those in the paddy rice basin areas, could require earthmoving of up to 1 000 m^3/ha.

TABLE 1.2

Land Levelling Requirements

Sample Area 1

Proposed crop - mixed crops

Irrigation method - furrow or border strip

Plot size - 1.8 ha (300 m x 60 m)

Plot Nr	Furrow		Border strip	
	m^3	m^3/ha	m^3	m^3/ha
1	361	201	743	413
2	358	199	450	250
3	273	152	273	152
4	310	172	310	172
5	337	187	340	104
Average	328	182	423	235

Sample Area 2

Proposed crop - mixed crops

Irrigation method - furrow or border strip

Plot size - 1.8 ha (300 m x 60 m)

Plot Nr	Furrow		Border strip	
	m^3	m^3/ha	m^3	m^3/ha
1	925	514	941	523
2	1 095	608	1 100	611
3	463	257	464	258
4	523	291	526	292
5	394	219	399	222
Average	680	378	686	381

Sample Area 3

Proposed crop - bananas

Irrigation method - furrows

Plot size - 1.35 ha (150 m x 90 m)

Plot Nr	Earthworks m^3	m^3/ha
1	308	228
2	299	221
3	283	300
4	251	186
5	351	260
6	301	223
Average	299	221

Sample Area 4

Proposed crop - bananas

Irrigation method - furrows

Plot size - 1.35 ha (150 m x 90 m)

Plot Nr	Earthworks m^3	m^3/ha
1	371	275
2	181	134
3	335	248
4	281	208
5	191	141
6	243	180
Average	267	198

Sample Area 5

Proposed crop - paddy rice

Irrigation method - basins

Plot size - 1.2 ha (200 m x 60 m)

Plot Nr	Earthworks m^3	m^3/ha
1	871	726
2	1 060	883
3	1 166	972
4	722	602
5	352	293
Average	834	695

Sample Area 6

Proposed crop - bananas

Irrigation method - furrows

Plot size - 1.35 ha (150 m x 90 m)

Plot Nr	Earthworks m^3	m^3/ha
1	330	244
2	304	225
3	361	267
4	581	430
5	392	290
6	360	259
Average	386	286

Sample Area 7

Proposed crop - bananas

Irrigation method - furrows

Plot size - 1.35 ha (150 m x 90 m)

Plot Nr	Earthworks m^3	m^3/ha
1	305	229
2	330	248
3	162	122
4	484	363
5	569	427
6	402	302
Average	375	278

Sample Area 8

Proposed crop - bananas

Irrigation method - furrows

Plot size - 1.35 ha (150 m x 90 m)

Plot Nr	Earthworks m^3	m^3/ha
1	217	161
2	234	173
3	300	222
4	439	325
5	286	212
6	350	259
Average	304	225

1.6 Land Levelling Methods

Land levelling will be carried out by cutting high areas of the plot and transporting the material to provide fill in the low areas, so that all earthmoving is within the plot being levelled. The size of the plot to be levelled will normally be 1 ha minimum although this could be reduced to 0.5 ha if necessary. The final plot will depend on topography, field shape and convenience.

Several methods of land levelling are commonly carried out:

(a) Scrapers and graders controlled by profile boards.

(b) Scrapers and graders controlled by lasers.

(c) Drag scrapers controlled by lasers.

Alternative (a) (conventional levelling) is not recommended because of the problems of control and the need for experienced and skilled staff.

Of the other two possibilities alternative (b) is the preferred option. This is primarily due to the fact that the earthmoving plant (scrapers and graders) are more flexible than drag scrapers and could be used for other parts of the works. In addition, the required depths of cut are likely to be greater than the normal operating range of a drag scraper (up to 0.10 m), necessitating more than one pass.

The recommended system is based on a laser emitter generating a reference plane which need not be horizontal but can be adjusted to have a known slope in directions defining an inclined plane. The laser beam is detected by receivers on masts positioned above the blade on the graders and scrapers with an automatic control system which decodes the signals from the receivers and actuates the machine's hydraulics. The operator can override the automatic controls if this is required at any point. The graders are equipped with twin receivers and control to adjust both the height and cross slope of the blade. The scrapers are equipped with only one receiver and pick up the spoil ribbons formed by the graders in the high areas and deposit in low areas which are then finished using the graders. Little ground checking is required in such a system, but can be done using acoustic rods to pick up the laser output. The control system can be fitted to most existing models of earthmoving machinery.

Self-elevating scrapers have proved to be more suitable than box scrapers since the elevating attachment on the scraper enables it to load its bucket full (which an ordinary box scraper generally could not do in land levelling operations without a bulldozer-pusher), and to take shallow cuts as required for both cut and fill and imported fill levelling.

A group of three graders and three elevating scrapers should achieve a land levelling rate of 6 ha/d for an earthmoving requirement of 400 m^3/ha.

1.7 Land Planing

Land planing is carried out so as to reduce the irregularities in the natural micro-topography or any deviation remaining after land levelling. Three passes of a land plane in different directions have been found to be sufficient to smooth out variations within $\pm$0.05 m provided that the surface soil is loose. Prior loosening of the soil is carried out by harrowing, if necessary. The area is to be planed after land levelling and prior to field preparation for the first planting.

Land planing is normally considered an agricultural operation and is not costed as part of the engineering works.

1.8 Termitaria

Termitaria are mounds made up of subsoil which has been brought to the surface by termites during the construction of their nests. Termitaria can be a major problem on some schemes, although fortunately they are relatively infrequent at Homboy.

Prior to land levelling, any termitaria in the irrigated area should be broken up and spread evenly, with the soil under the mound ripped to break the sub-surface voids. The soil in the vicinity of the mound should then be treated with an appropriate insecticide to ensure that the termites do not re-colonise the area.

CHAPTER 2

FLOOD PROTECTION WORKS

2.1 Introduction

Flooding in the project area can either be from external or internal sources. This chapter is concerned with external flooding - primarily from the old Shebelle meander complex which runs from north to south through the area, and to a lesser extent from Juba river flooding and local runoff after rainstorms.

For the 1980 study (HTS, 1980) the flood protection works were designed for a 1-in-1 000 year flood event - severe design criteria for an agricultural development. The Terms of Reference for the present study stipulate that protection should be provided against a 1-in-50 year flood assuming implementation of Bardheere dam on the Juba river, and recently completed and proposed river management works on the middle and upper Shebelle river.

The relaxing of the design criteria to a 1-in-50 year flood would appear to be logical from a cost-benefit point of view. The probability of a flood equal to or exceeding the 1-in-50 year event occurring during the 25 year economic life of the project is, however, 40%. This is appreciable and the agricultural, social and economic implications of this must be borne in mind. From an engineering standpoint, the modified design criteria allow a simplification of the flood protection works with a commensurate reduction in construction costs.

2.2 Origins of Flooding

The Homboy project area is geomorphologically in the Shebelle valley, located 15 to 65 river kilometres upstream of its confluence with the Juba river. This reach of the Shebelle comprises a system of well defined, braided, meandering fartas which carry runoff from the Hara Naga and Kormajirto catchments together with any excess water from the lower Shebelle swamps to the Juba river. This latter component is very small in comparison to the runoff from the Hara Naga and Kormajirto catchments. Although these fartas usually remain dry, they occasionally carry large flood flows which pose the main flood hazard to the Homboy project area.

The south-western tip of the project area can also be flooded by overbank flow from the Juba river as happened in the 1981 gu season (MMP, 1981) and by local runoff as was the case in the 1985 gu season (AHT, 1985).

Finally, heavy rainfall can pond in the Homboy depression. During the 1985 gu season well above average rainfall caused flooding which destroyed approximately 50% of the crops being grown in the Homboy desheks and reduced yields by approximately 50% on a further 20% of the cropped area. Homboy village was isolated for two months (AHT, 1985). Protection of the project against such rainfall flooding is provided by the internal drainage system described in Chapter 5.

2.3 The Shebelle River

The Shebelle river has a theoretical catchment area probably in excess of 300 000 km^2 (Lockwood/FAO, 1968). Most of the runoff is generated in the upper reaches of the river in the Ethiopian highlands. As the river proceeds through Somalia, non-returnable floodplain spillage, infiltration, evaporation and

consumptive use progressively reduce the mean annual flow and flood peaks (Table 2.1). Only a small proportion of the flow volume entering Somalia upstream of Beled Weyn reaches the swamps in the lower Shebelle valley.

TABLE 2.1

Shebelle River - Channel Capacities and 1981 Flood Peaks

	Distance from Juba confluence (km)	Estimated mainstream channel capacity (m^3/s)	1981 flood peak (m^3/s)
Beled Weyn	1 040	n/a	>1 000
Bulo Burti	860	n/a	502
Mahaddey Weyn	670	n/a	167
Jowhar	635	150	n/a
Afgoi	470	96	89
Audegle	410	87	87
Avai	230	50	< 50

Throughout most of the middle reaches, from Dududle downstream to Falkeerow, the water level in the mainstream channel is above the surrounding floodplain during high flows. In the past, peak flows overtopped the river banks and spilled into the floodplain causing the carrying capacity of the mainstream channel to decrease downstream.

In its lower reaches, from just downstream of Kurtun Waarey to just upstream of Homboy, the Shebelle has a low average gradient of approximately 1 in 8 000. This has resulted in the formation of a system of swamps, lakes and multiple channels which cover an area of some 850 km^2 (MMP, 1983). These are referred to collectively as the lower Shebelle swamps.

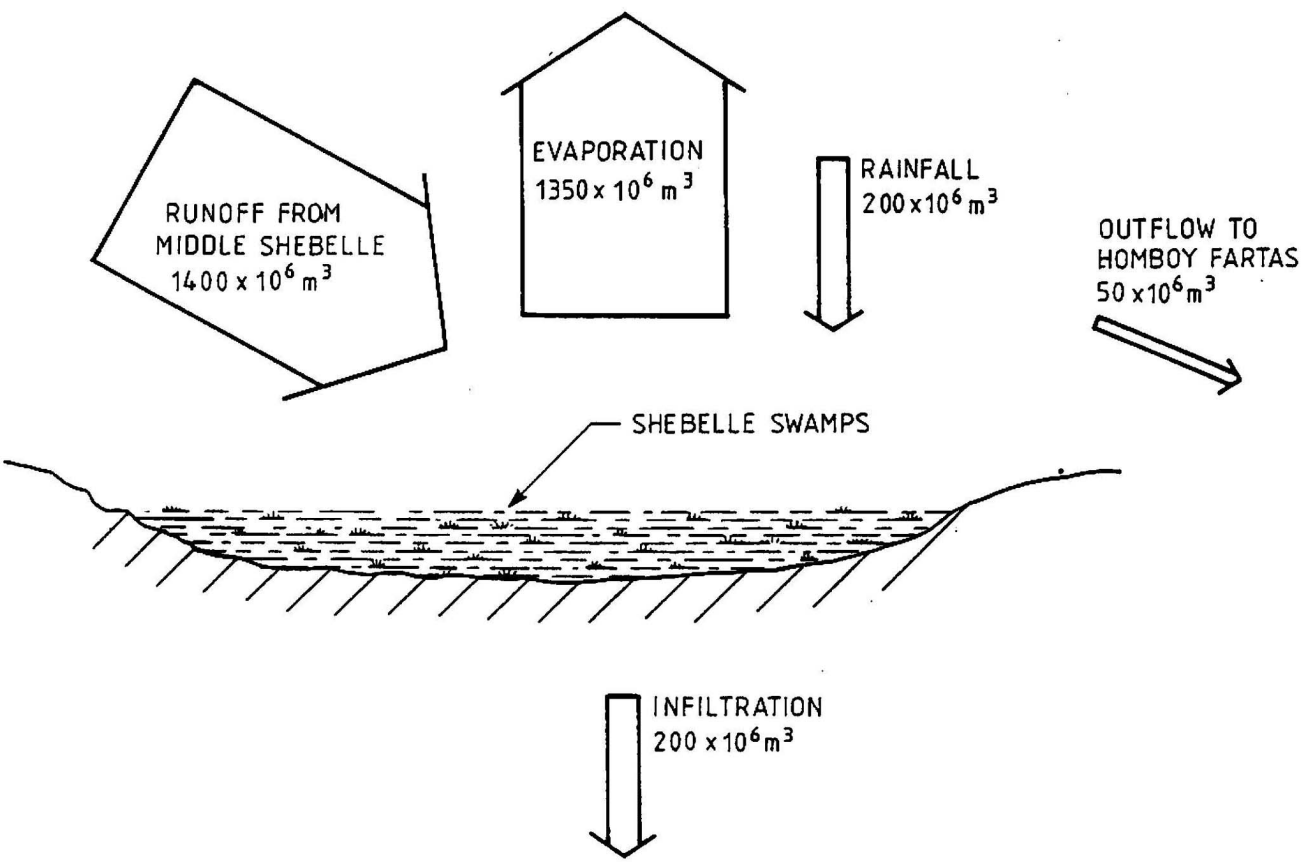
In dry to normal years flows into the swamps are totally absorbed and lost by evaporation and infiltration. Only in very wet years does water leave the swamps via the fartas passing through the Homboy area. It is thought that this runoff results from heavy rainfall onto already high water levels in the lower swamps, rather than from transmission of water entering from the upper Shebelle. An approximate average annual water balance of the swamps is presented in Figure 2.1. This indicates that the average annual outflow from the swamps is 50×10^6 m^3 which would be equivalent to a continuous average flow of 1.5 m^3/s.

2.4 River Management Works

The natural attenuation provided by the middle reaches of the Shebelle is obtained at the expense of damage to agriculture on the inundated floodplains. To reduce this damage and to harness excess river flows for irrigation purposes downstream, a number of river management works have recently been built or are being planned. In 1980 the Jowhar Offstream Storage Reservoir (JOSR) was commissioned with an intake channel capacity of 35 m^3/s and a total storage of 200×10^6 m^3. The 40 m^3/s Dududle Flood Relief Channel was first operated in the 1986 gu season and the possibility of upgrading this scheme to an offstream storage reservoir has been proposed.

Figure 2.1

Shebelle Swamps
Average Annual Water Balance



In that they replace the natural attenuation of the river, such schemes will have little effect on the peak flows entering the lower Shebelle swamps. Table 2.2 gives the annual runoff and peak flows at Afgoi both before and after commissioning of JOSR, and indicates no significant changes in river regime.

TABLE 2.2

Annual Flow Statistics - Afgoi

Year	Runoff ($m^3 \times 10^6$)	Peak Flow (m^3/s)
1963	n/a	97
1964	1 263	92
1965	906	112
1966	1 165	88
1967	1 695	98
1968	2 166	99
1969	1 892	98
1970	1 745	100
1971	1 574	100
1972	1 774	105
1973	n/a	97
1974	1 214	95
1975	1 147	99
1976	n/a	100
1977	n/a	100
1978	n/a	109
1979	1 898	113
1980*	780	90
1981	1 609	90
1982	1 890	96
1983	2 134	97
1984	1 272	90
1985	1 427	90

Note: * JOSR commissioned May 1980.

Theoretically at least, by supporting low flows, offstream storage schemes could increase the total annual runoff entering the swamps. This is, however, unlikely to happen as any increase in low flows will almost certainly be absorbed by abstractions for irrigation.

It can be concluded that river management works in the middle and upper reaches of the Shebelle in Somalia will have only a small effect on the water balance of the lower Shebelle swamps and, consequently, will have a negligible effect on flood flows leaving the swamps above Homboy.

2.5 Flood Estimation Procedure

The lower Shebelle swamps effectively protect the areas downstream from flood flows originating in the upper Shebelle catchment. Flooding in the Homboy area is reported to occur generally after heavy rainfall, indicating that flooding is

largely associated with local run-off rather than flow passing Avai. The tributary catchments downstream of Avai theoretically extend as far north as the Bardheere-Dinsor road, as shown on Figure 2.2. However, the well defined surface drainage of the upper catchment disperses on reaching the coastal plain some 75 to 100 km north of the Shebelle. No evidence has been found to suggest that there is any continuous channel flow across the plain even after heavy rainfall.

The effective cachment area upstream of the Jilib-Mogadishu road is divided into six sub-catchments as shown in Figure 2.2. None of these in fact drain directly into the main Shebelle channel which appears to be raised between wide natural levees. Most of the tributary channels terminate in backswamp depressions. No records exist of the flows in these tributaries or, indeed, in the Shebelle downstream of Avai. The approach adopted in previous studies for the determination of design floods in the Homboy area has been based on the US Soil Conservation Service method which relates the cumulative direct runoff to the cumulative storm rainfall according to an empirical curve selected from a consideration of land use, soil type, vegetation cover and antecedent moisture conditions. This method has been reviewed and revised to give the 1-in-50 year flood, as described in subsequent sections of this chapter.

2.6 Design Rainfall

There are no reliable rainfall stations within the catchment area, and for this analysis an average of the Kismayo, Jilib and Bardheere figures were taken. Long-term records exist for all three stations and they are considered to be reasonably representative of the catchment area.

Annual maxima 1-day and 3-day rainfall events from these stations were fitted to an extreme value type 1 (Gumbel) distribution. The return periods of storms producing the 1-in-20, 1-in-50, 1-in-100 and 1-in-1 000 year floods were determined by the method recommended in the UK Flood Studies Report, (NERC, 1975).

Studies of the effective rainfall produced by 1-, 3- and 5-day storms of the same frequency showed that 72-hour events are the most critical as far as runoff production is concerned. To calculate the 72-hour rainfall the following procedure was carried out for each of the given return periods:

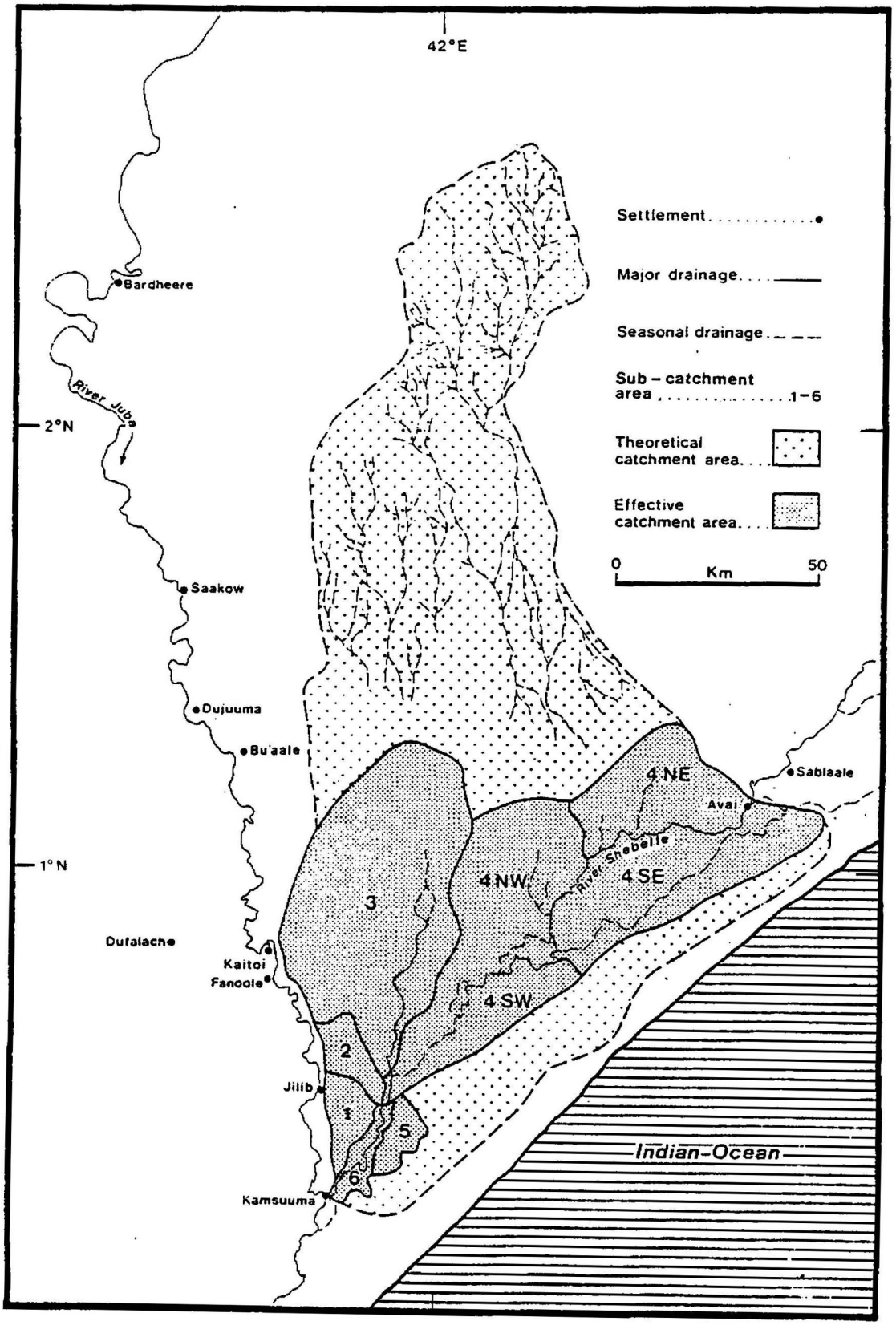
(a) The 1-day design rainfall for the catchment was obtained by averaging the 1-day values for each station obtained from the Gumbel analysis.

(b) This was converted to a 24-hour design rainfall by applying a correction factor of 1.13.

(c) The 24-hour rainfall was converted to 72-hour rainfall by applying the 3-day to 1-day rainfall ratio also obtained from the Gumbel plot.

Figure 2.2

Lower Shebelle Cachment Areas



The results are summarised in Table 2.3:

TABLE 2.3

Design Rainfall

Flood return period (years)	Storm return period (years)	Kismayo 1-day rainfall (mm)	Jilib 1-day rainfall (mm)	Bardheere 1-day rainfall (mm)	Catchment 1-day rainfall (mm)	Catchment 24-hour rainfall (mm)	Catchment 72-hour rainfall (mm)
20	35	106	130	115	117	132	174
50	73	116	148	127	130	147	194
100	140	128	164	141	144	163	211
1 000	1 000	147	196	166	170	192	263

The 72-hour point rainfalls were reduced to catchment averages using Boyer's equation which reproduces the faster areal decay observed in the inter-tropical convergence zones:

$$p(area) = 2\,m\,b^{-2}\,x^{-2}\,[1 - (1 + bx)^{(-bx)}]$$

where b = 0.0235

m = maximum (central) rainfall depth (inches)

x = radius of area (miles)

$p(area)$ = mean areal rainfall (inches)

2.7 Design Flood

The US Soil Conservation Service method of deriving flood hydrographs from design storms was applied to each of the six contributing catchments. These storms were then lagged according to drainage pattern geometry and summed to produce the 1-in-50 year design flood entering the project area. The results indicate a peak inflow of 412 m^3/s with a total flood volume of 154 x 10^6 m^3.

2.8 The 1980 Flood Protection Scheme

This section gives a brief description of the flood protection scheme proposed in the 1980 study (HTS, 1980).

The scheme was designed for the 1 in 1 000 year flood which was estimated to have a peak inflow of 665 m^3/s with a total flood volume of 248 x 10^6 m^3.

Preliminary calculations showed that routing floods through the project area by constructing a drain based on the existing farta channels was not a viable solution. The design flood peak would require a large and prohibitively expensive drain. Floods would instead be routed round the project area taking advantage of storage available in natural depressions to attenuate peak flows and reduce channel and structure sizes.

Computer models were set up to simulate various schemes and find the most cost-effective solution. This led to the final design which involved upgrading two depressions to regulating reservoirs by bunding and regulating their outflow by outlet structures. The Northern Reservoir to the north of the Jilib-Mogadishu road would provide significant attenuation and storage of arriving floods. A large gated outlet structure, capacity 330 m^3/s, from the Northern Reservoir would allow controlled discharge of the attenuated floods into the Eastern Reservoir via the Upper Outfall Drain.

The Eastern Reservoir was required to provide further flood storage and attenuation. The combined capacity of these two reservoirs was sufficient to store the entire 1-in-1 000 year flood. The Eastern Reservoir outlet structure was designed to allow the accumulated flood waters to be discharged to the Juba river at a maximum flow rate of 10 m^3/s via the Lower Outfall Drain. Runoff from the internal drainage system would also discharge to the same drain.

The low level Lower Outfall Drain would be unable to function when the Juba river was above a level equivalent to a river discharge of 150 m^3/s. A computer model of the flood protection system was therefore used to test the response of the system to consecutive floods and the coincidence of floods and high river stage. Simulations using the available 17 years of concurrent historic rainfall and river flow data demonstrated that, even in the most critical periods, the combined capacity of the two reservoirs was never more than 70% used and that the flood protection system would function satisfactorily.

2.9 Revised Flood Protection Scheme

2.9.1 Introduction

A complete review of the flood protection system has been undertaken in the light of the revised design criteria. Although the design flood return period has been reduced from 1 in 1 000 years to 1 in 50 years, the peak flow of 412 m^3/s is still too large to be routed through the project area, and the approach of routing the flood through storage areas outside the project area still provides the most practical and economic solution. After studying several options it was concluded that a system similar to the original design but without the Northern Reservoir would provide the most cost-effective flood protection. The natural depression upon which the Northern Reservoir was based still attenuates flood peaks to a certain extent but does not provide any controllable storage.

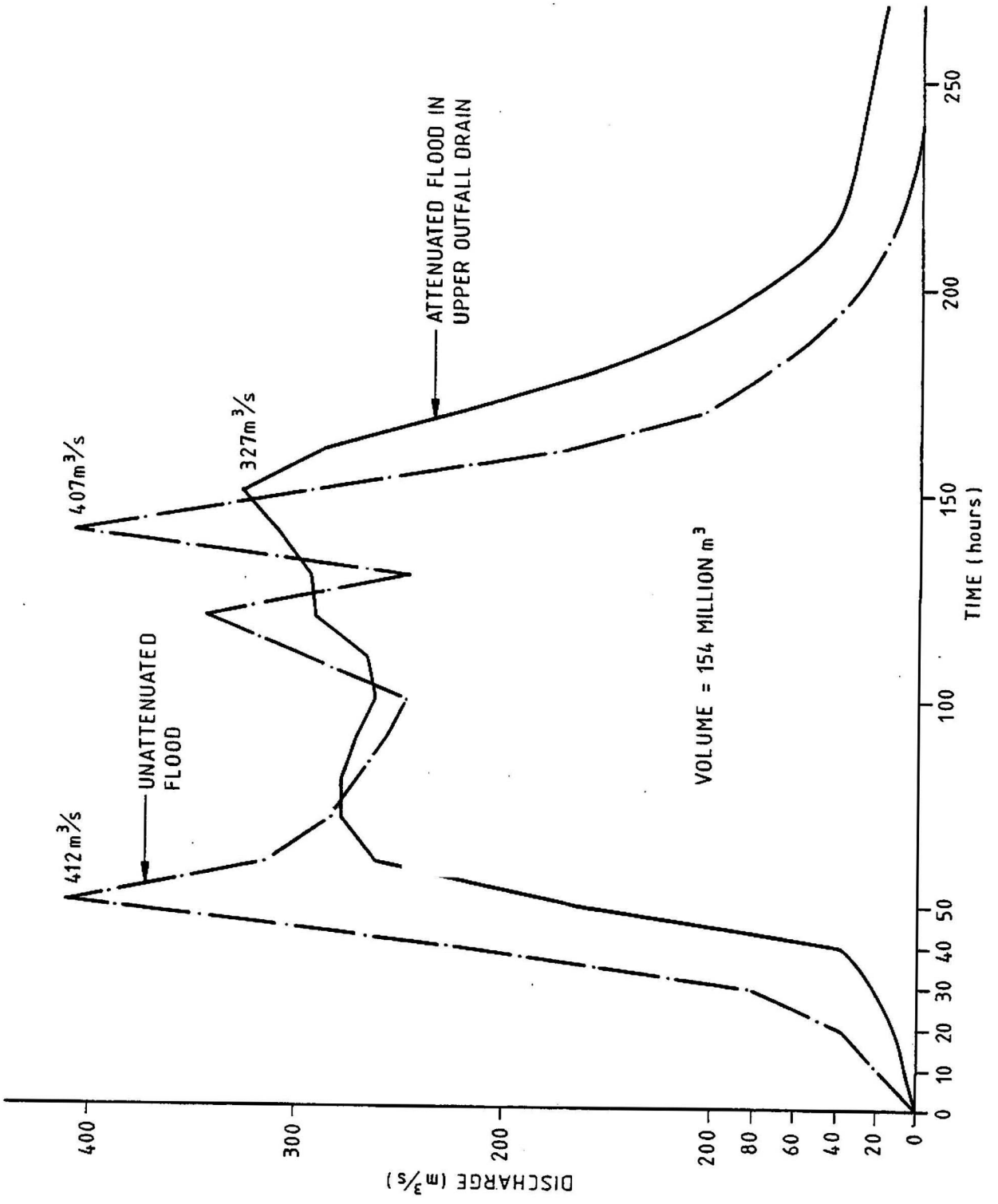
2.9.2 Upper Outfall Drain

The Upper Outfall Drain will convey water from the north of the Jilib-Mogadishu road to the Eastern Reservoir, a distance of about 6.3 km. Although the peak inflow has been calculated as 412 m^3/s, a degree of attenuation will be provided by both the 'Northern Reservoir Depression' and the Upper Outfall Drain itself. This is illustrated in Figure 2.3 and indicates that the attenuated peak flow is 327 m^3/s; the Upper Outfall Drain has therefore been designed for this discharge.

The peak water level in the Eastern Reservoir is 18.95 m (see Section 2.9.3), and adopting a water surface slope of about 25 cm/km gives a level at the head of the Upper Outfall Drain of 20.50 m. The drain is formed by excavating a low flow channel and using the excavated material to form the right hand embankment.

Figure 2.3

1 in 50 Year Design Floods



No embankment is required on the left hand side since the flows will be contained by the high land. The total required area of flow is about 300 m^2 and hence the low flow channel would be excavated to sufficient dimensions to satisfy both the minimum flow area and the embankment fill requirements. The embankment should extend back to join the Main Canal at Km 1 to prevent flood water which has crossed the Jilib-Mogadishu road from entering the project area. Details of the Upper Outfall Drain are shown in Plates 35 and 37.

2.9.3 Eastern Reservoir

The attenuated peak of the 1-in-50 year flood (327 m^3/s) is the critical design criteria for the Upper Outfall Drain, and corresponds to a required storage in the Eastern Reservoir of 154 x 10^6 m^3. However it is possible that a series of smaller floods such as would occur during a very wet year, would require more storage than an isolated 1-in-50 year flood. In this case it is a critical 1-in-50 year combination of consecutive rainy periods and high river levels at Kamsuuma which becomes the design criterion. This can only practically be determined by simulation.

To do this, a computer model was set up to study the variation in storage in the Eastern Reservoir from day-to-day using 17 years of recorded rainfall data and simulated releases from Bardheere Dam taken from Electroconsult's Design Study Report (Electroconsult, 1986). Outlet discharge from the Eastern Reservoir was taken as 10 m^3/s, and the reservoir stage-storage curve used is shown in Figure 2.4. The main components of the model are shown schematically in Figure 2.5.

The low level of the Lower Outfall Drain means that it cannot discharge to the Juba river when levels at the Kamsuma outlet exceed 11.6 m (equivalent to about 150 m^3/s). Flows at Kamsuuma were estimated from the simulated Bardheere dam releases and a relationship between monthly flows at Bardheere and Kamsuuma based on historic data.

A sensitivity analysis of model parameters was carried out. Firstly the river flow at Kamsuuma above which the Lower Outfall Drain would not function was studied. It was found that increasing the value upwards from 150 m^3/s had no effect on maximum levels attained in the Eastern Reservoir. This is because the maximum inflows to the reservoir occur during the violent gu rains and, for the 17 years simulated, these rainy periods did not occur at times when river levels were high. Maximum reservoir levels only start to increase if the critical Juba river flow is below 120 m^3/s.

Varying the design capacity of the Lower Outfall Drain within reasonable limits (5 m^3/s to 20 m^3/s) also has little influence on the maximum water levels attained in the Eastern Reservoir. This is because such maximum water levels result from sudden flood inflows which fill up the reservoir in a matter of a day or two. The rate of outflow via the Lower Outfall Drain is almost insignificant compared with the rate of inflow and thus has little effect on maximum water levels. However, the time taken to empty the reservoir is dependent on the outflow. It is considered that a maximum emptying time of 6 months is desirable - periods greater than this could lead to the onset of a further rainy season before the reservoir is fully emptied. Adopting this criterion then the capacity of the Lower Outfall Drain is taken as 10 m^3/s.

The most sensitive factor is rainfall. Recorded data at Jilib, Bardheere and Kismayo were assumed to be representative of rainfall on the contributing catchments but the installation of raingauges in these areas would allow much more confidence to be put into the results.

A summary output from the model using the design values of all parameters is given in Table 2.4. It is seen that a maximum reservoir storage of 128.1 x 10^6 m^3 is attained both in 1957 and 1964. A plot of the April to June period in 1964 (Figure 2.6) illustrates how the reservoir fills very quickly but empties gradually.

In order to determine the 1-in-50 year event, the 17 annual maximum reservoir volumes obtained from the model were fitted to an extreme value Type 1 (Gumbel) distribution as shown in Figure 2.7. From this it can be seen that the 1-in-50 year storage volume is 157 x 10^6 m^3, which is marginally greater than the figure of 154 x 10^6 m^3 obtained from the 1-in-50 year storm. The reservoir has been designed for the larger of the two volumes, giving a peak water level of 18.95 m from the stage-storage curve.

The Eastern Reservoir is contained by high ground on the north, south and east sides. An embankment is only required on its western side, as shown on Plate 4. The embankment has been designed with a 5 m top width, 1-in-3 inside slopes and outside slopes sufficient to retain a 1-in-5 seepage gradient from peak water level (18.95 m) to adjacent ground level. A freeboard of 0.55 m has been provided giving an embankment top level of 19.50 m.

2.9.4 Eastern Reservoir Outlet

The Eastern Reservoir outlet consists of gated 3 x 1.2 m diameter pipes with reinforced concrete inlet and outlet boxes. The design discharge is 10 m^3/s.

The structure discharges into the Lower Outfall Drain and thence to the Juba river when the levels are suitable.

2.10 Juba River and Local Run-off

The south-western part of the project area can be flooded both by overbank flow from the Juba river and from local runoff. Preliminary examination of simulated releases from Bardheere dam (Electroconsult, 1986) suggest that the regulation of peak flows will substantially reduce the risk of the project area being flooded from the Juba. The extent of this risk is discussed in the studies of the flood control benefits of Bardheere dam (Annex 3).

In 1985 the south-western tip of the project area was flooded by the diversion of local runoff. It is difficult to take this sort of situation into account when designing the flood protection works, however, it is thought prudent to provide a small flood protection bund running from the high ground to the south of new village Nr 4 along the outside of branch drain D2 to its confluence with the Lower Outfall Drain. This bund would have a top level of 15.0 m, similar to the bund protecting the Kamsuuma banana plantations to the south, and would divert any runoff between these two bunds into the unirrigated depression area behind the banana plantations.

Figure 2.4

Eastern Reservoir Stage Storage Curve

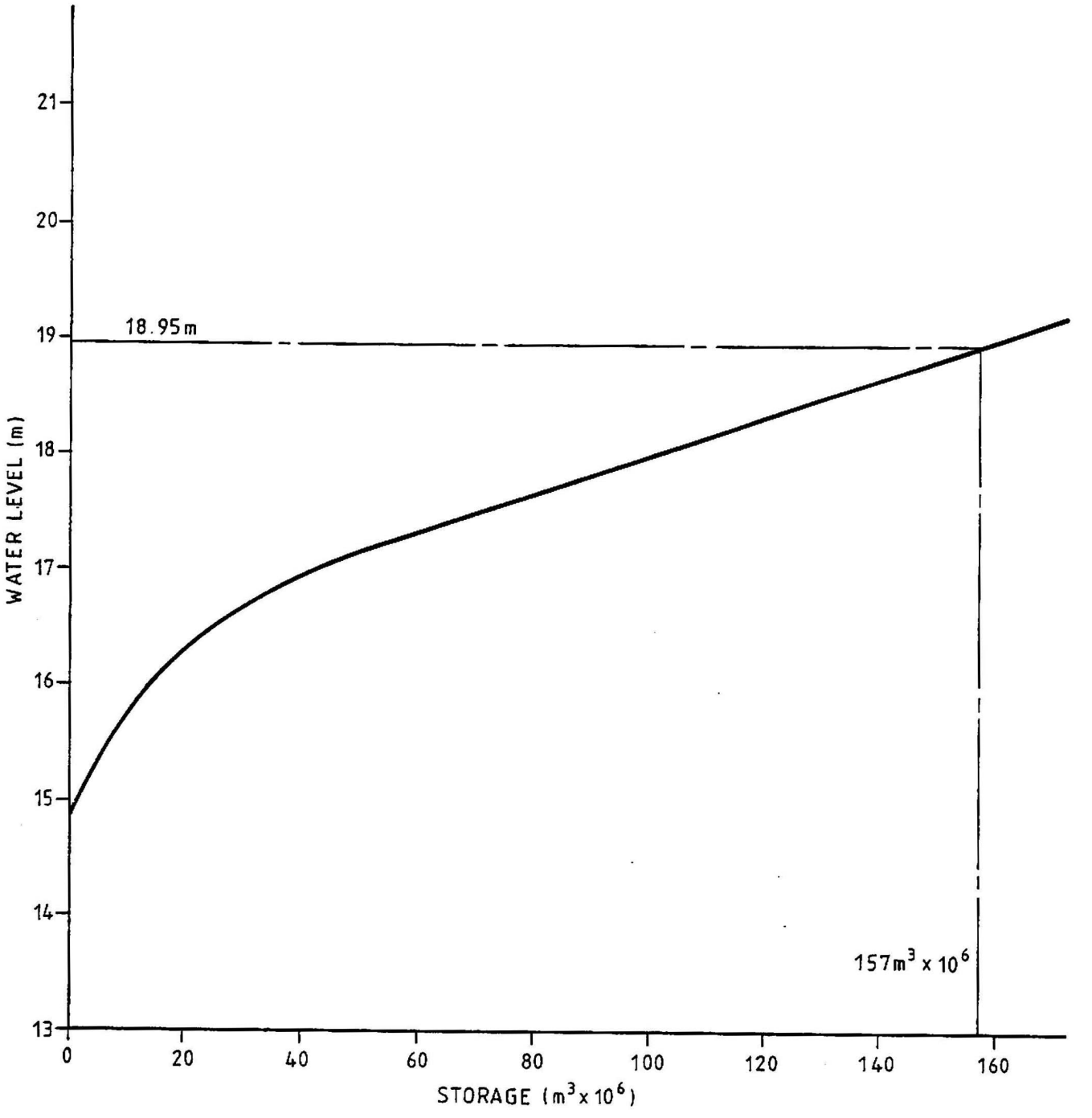
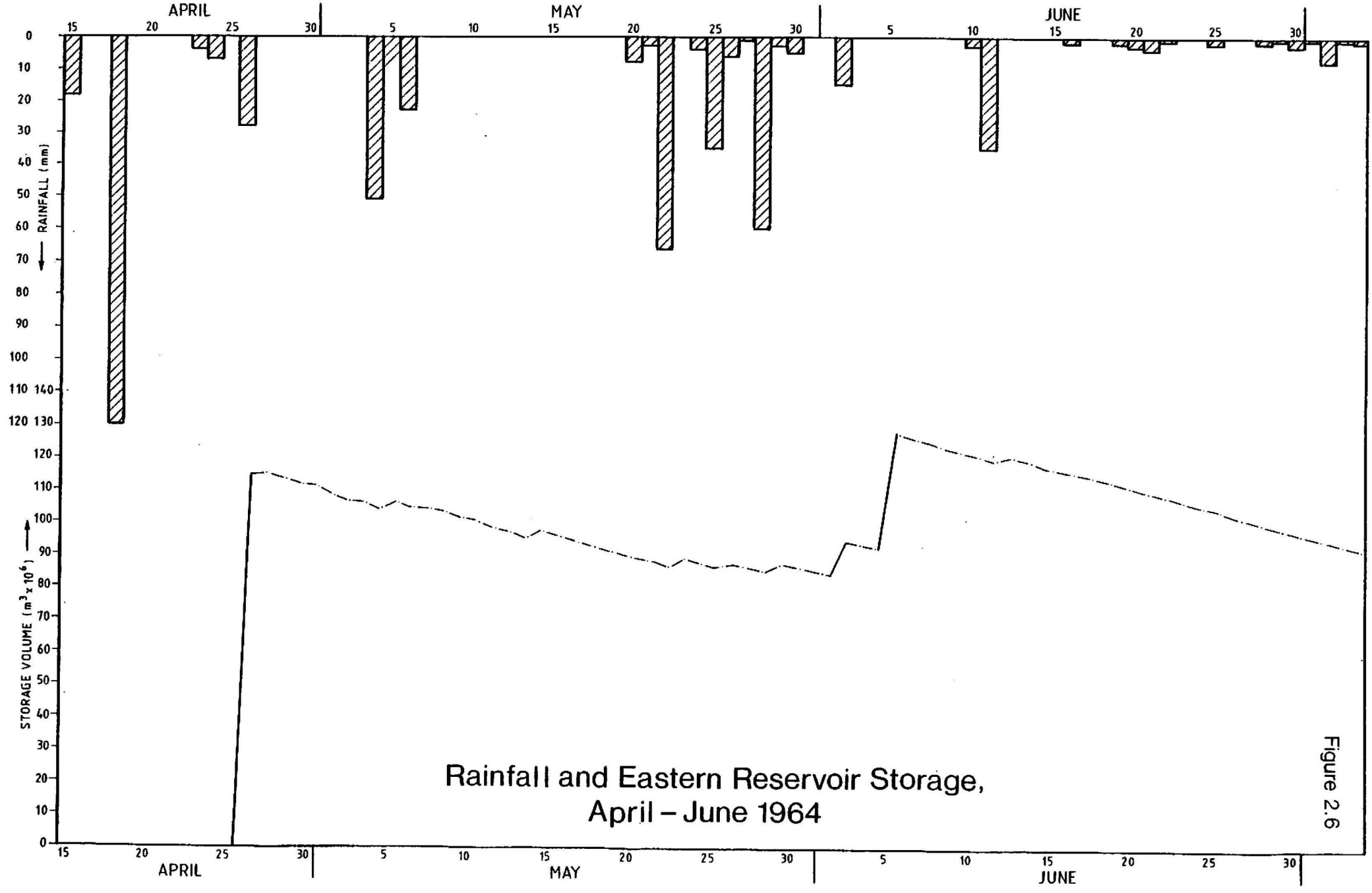


Figure 2.5

Homboy Flood Protection System



Rainfall and Eastern Reservoir Storage,
April – June 1964

Figure 2.6

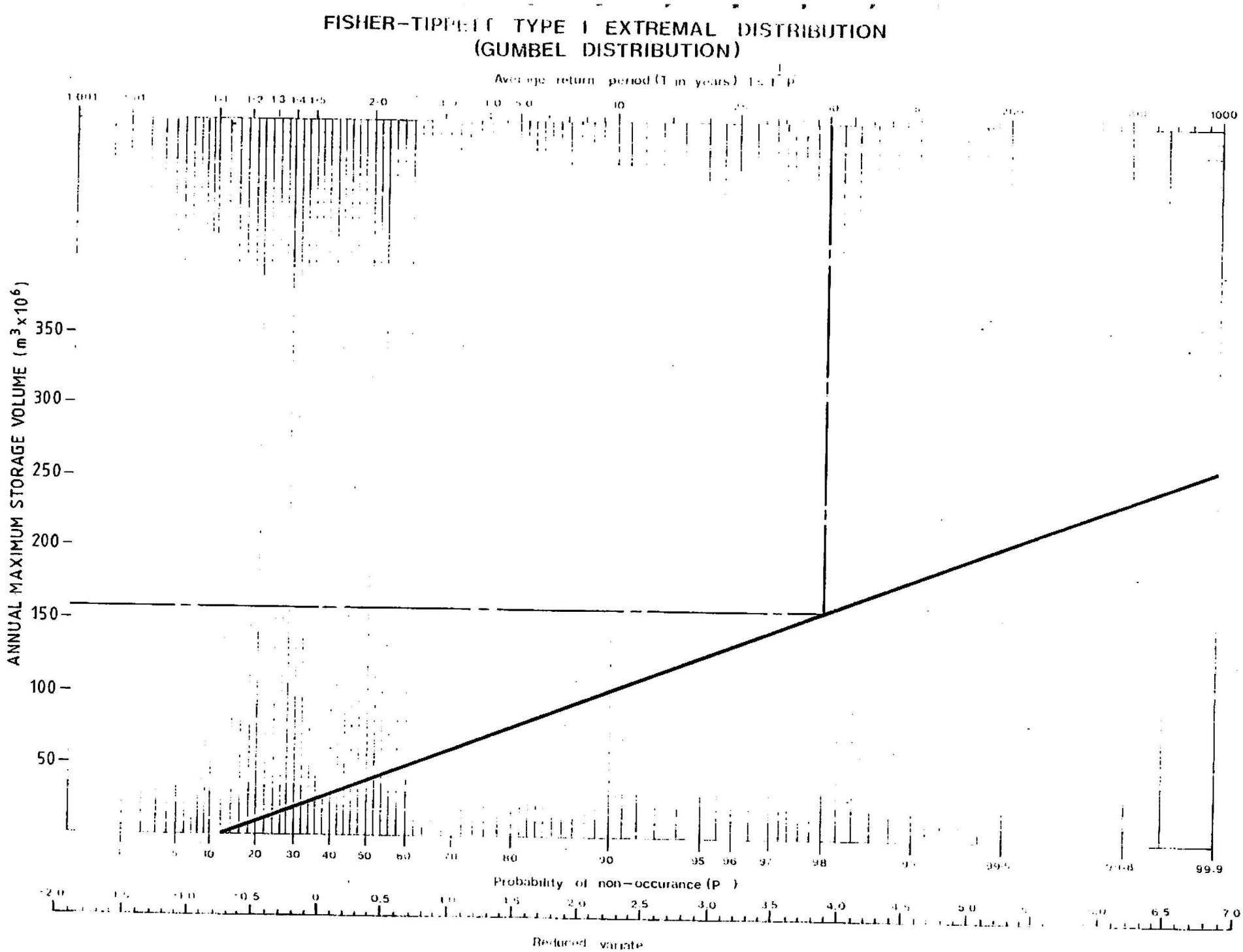


Figure 2.7
Eastern Reservoir Storage Analysis

TABLE 2.4

Homboy flood protection scheme - simulation program output

Bardneere-Kamsuma flows:

QBARD	QKAM
0.0	0.0
50.0	30.0
100.0	75.0
150.0	130.0
200.0	190.0
250.0	250.0
300.0	300.0
350.0	340.0
400.0	360.0
450.0	380.0
500.0	400.0
550.0	410.0
600.0	420.0

Eastern reservoir characteristics:

RESH	RESA	RESV
14.70	0.0	0.0
15.00	3.0	1.5
16.00	19.1	10.5
17.00	50.0	43.5
18.00	65.6	103.5
19.00	80.0	160.0

QDRAIN = 10.0

Catchment characteristics:

CATCH	AREA	ARF	AUF
1	186.0	0.93	0.39
2	2623.0	0.76	0.27
3	758.0	0.86	0.29
4	601.0	0.88	0.31
5	936.0	0.84	0.27
6	522.0	0.84	0.32
7	1270.0	0.83	0.27

LOSSES = 0.0
QMAX = 150.0
EVPMTH = 249.0 239.0 277.0 217.0 203.0 176.0 182.0 203.0 217.0 221.0 200.0 221.0
INFILT = 3.0
RNMULT = 1.0

IYR	NOVIN	NORES	NOLOD	TOTVIN	TOTRN	TOTLOD	TOTEVP	TOTINF	VOLMAX	HTMAX	AMAX
53	4	11	14	10.4	0.2	10.0	0.4	0.2	4.5	15.3	8.3
54	6	4	9	5.4	0.0	5.3	0.1	0.0	1.2	14.9	2.4
55	8	43	46	43.2	1.3	39.0	3.7	1.8	20.8	16.3	26.6
56	9	119	92	107.3	9.5	78.7	26.1	11.9	61.7	17.3	54.7
57	18	198	176	203.1	25.4	151.0	51.4	24.3	128.1	18.4	71.9
58	5	19	23	16.7	0.3	17.6	0.8	0.4	7.7	15.7	14.0
59	8	83	84	95.4	8.8	72.1	21.9	10.2	83.9	17.7	66.5
63	8	93	9	65.0	7.3	8.6	23.3	10.0	41.1	16.9	47.8
64	9	176	160	172.5	27.2	153.2	53.7	25.2	128.1	18.4	71.9
65	4	6	9	6.7	0.1	6.5	0.2	0.1	2.3	15.1	4.3
66	7	4	9	3.8	0.0	3.6	0.1	0.0	1.6	15.0	3.2
77	9	96	43	137.8	10.4	36.0	30.3	13.1	86.7	17.7	61.2
78	13	312	161	130.8	15.0	137.9	50.2	21.8	74.9	17.5	58.2
79	5	77	21	14.2	0.0	15.7	2.1	0.9	7.8	15.7	14.2
80	7	62	66	65.5	7.8	54.1	13.0	6.3	48.2	17.1	51.2
81	12	229	58	69.1	10.8	41.5	26.8	12.4	47.8	17.1	51.1
82	11	69	39	34.3	2.1	31.3	3.5	1.6	11.9	16.8	20.4

IYR = Year
NOVIN = Days of flow into reservoir
NORES = Days of water in reservoir
NOLOD = Days of discharge via Lower Outfall Drain
TOTVIN = Total volume of runoff inflow
TOTRN = Total volume of rainfall on reservoir
TOTLOD = Total volume discharged via Lower Outfall Drain
TOTEVP = Total volume of evaporation losses
TOTINF = Total volume of infiltration losses
VOLMAX = Maximum end-of-day reservoir storage
HTMAX = Maximum end-of-day water level
AMAX = Maximum end-of-day reservoir area

All volumes in million cubic metres

Homboy flood protection
Eastern reservoir volumes

RANK	YEAR	RECORDED MAXIMA	RETURN PERIOD A	RETURN PERIOD B
1	57	128.10	30.57	21.32
2	64	128.10	10.97	21.32
3	77	86.70	6.69	8.62
4	59	83.90	4.81	6.14
5	78	74.90	3.75	4.83
6	58	61.70	3.08	3.44
7	80	48.20	2.61	2.58
8	81	47.80	2.26	2.47
9	63	41.10	2.00	2.13
10	55	20.60	1.79	1.46
11	82	11.90	1.62	1.29
12	79	7.80	1.48	1.23
13	58	7.70	1.36	1.22
14	53	4.50	1.26	1.18
15	65	2.30	1.18	1.16
16	66	1.60	1.10	1.15
17	54	1.20	1.03	1.15

RETURN PERIODS ESTIMATED FROM:

A: GRINGORTEN PLOTTING POSITION
B: FITTED TYPE 1 EXTREMAL DISTRIBUTION

CHAPTER 3

CROP WATER REQUIREMENTS

3.1 Introduction

Crop water requirements are defined as the depth of water required to meet the crop water loss (ETcrop) through evapotranspiration. The effect of climate on crop water requirements is given by the reference crop evapotranspiration (ETo) which is defined as the rate of evapotranspiration from an extensive surface of uniform green grass of height 80 to 150 mm. Crop water requirements are then derived from the relationship:

$$ETcrop = Kc \times ETo$$

where Kc is the crop factor which varies with crop type, growth stage and other conditions. Allowance must be made for effective rainfall, prewatering requirements, irrigation efficiencies and conveyance losses in the estimation of gross requirements.

Calculations of water requirements have followed the methods set out in FAO Irrigation and Drainage Paper Nr 24 (FAO, 1977). The procedure is described in subsequent sections of this chapter and the climatological data used are discussed more fully in Section A of this annex.

3.2 Cropping Patterns

Several crops and cropping patterns have been considered in Section B of this annex. The three major cropping patterns are:

(i)	General arable	-	maize	(60%)
		-	cotton	(48%)
		-	sesame	(48%)
		-	cowpeas	(36%)
		-	vegetables	(8%)
(ii)	Banana	-	banana	(160%)
		-	maize	(20%)
		-	sesame	(20%)
(iii)	Paddy rice (200%)			

The cropping intensity for each of these cropping patterns is 200%, and cropping calendars are shown in Figures 3.1.

The possible introduction of other arable crops or fruit will be on a relatively small scale and will not significantly affect the water requirements. Therefore this chapter only considers the requirements of the three major cropping patterns given above.

3.3 Evapotranspiration

Reference crop evapotranspiration (ETo) has been calculated by the modified Penman method on a monthly basis using climatological data for Alessandra. These values are then adjusted by a factor of 1.13 for design conditions, as described below:

(a) an allowance of 8% is made to allow for year to year variations (FAO, 1977);

(b) an allowance of 5% is made to allow for the variation between day and night wind speeds that exists in the project area (FAO, 1977).

The adopted values for ETo are shown in Table 3.1.

TABLE 3.1

Reference Crop Evapotranspiration (ETo)

Month	ETo (mm/d)	
	Unadjusted	Adjusted
January	5.6	6.3
February	5.9	6.7
March	6.2	7.0
April	5.0	5.7
May	4.5	5.1
June	4.0	4.5
July	4.0	4.5
August	4.5	5.1
September	5.0	5.7
October	4.9	5.5
November	4.6	5.2
December	4.9	5.5

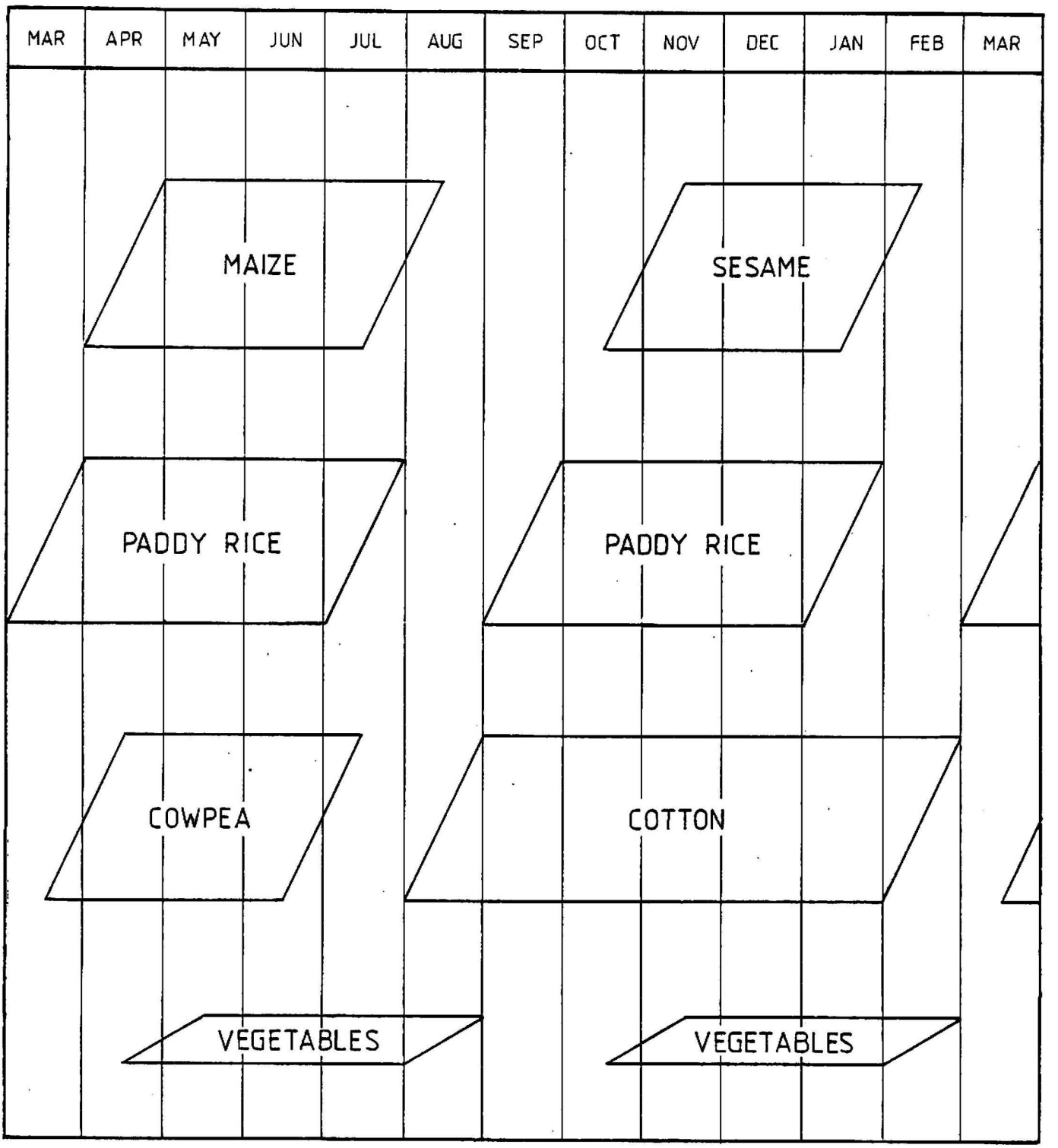
Source : HTS, 1980.

3.4 Crop Factors

Crop factors (Kc) depend not only on the crop itself, but also on the variety, its growth stage and the time of year in which it is grown. The method proposed by FAO for annual crops is based on dividing the growth period into four development stages - initial, crop development, mid-season and late season. Crop factors are then assigned as shown in Table 3.2.

Figure 3.1

Cropping Calendar



NOTE : START AND FINISH DATES INDICATE FIRST AND LAST IRRIGATION

TABLE 3.2

Crop Factors - Annual Crops

Crop	Development stages (days)	Crop factors Initial	Mid-season	Late season
Maize	20/30/35/20	0.25	1.05	0.55
Cotton	30/40/65/45	0.25	1.05	0.65
Sesame	25/20/35/10	0.25	1.05	0.25
Cowpea	15/25/35/15	0.30	1.05	0.30
Paddy rice	30/30/30/30	1.10	1.10	1.10
Vegetables	20/30/35/20	0.25	1.05	0.60

Source: FAO, 1977

In order to determine monthly crop factors for each crop, the crop factor curves are plotted for the first and last planting dates and average crop factors determined from the two curves.

The monthly crop factors for both newly planted (in March) and established bananas are shown in Table 3.3. Average monthly values can then be obtained from weighted averages of the newly planted and established banana area, which are assumed to be in the ratio 1 : 3.

TABLE 3.3

Crop Factors - Bananas

Month	Crop factor Newly planted	Established	Weighted average
January	-	1.00	0.75
February	-	0.80	0.60
March	0.65	0.75	0.73
April	0.60	0.70	0.68
May	0.55	0.70	0.66
June	0.60	0.75	0.71
July	0.70	0.90	0.85
August	0.85	1.05	1.00
September	0.95	1.05	1.03
October	1.00	1.05	1.04
November	1.00	1.00	1.00
December	1.00	1.00	1.00

Source: FAO, 1977

3.5 Effective Rainfall

Part of the crop water requirements can be met by rainfall. However as the rainfall will vary from year to year in both magnitude and frequency, a dependable rather than average rainfall should be used. A 1-in-5 dry year (i.e. the rainfall which has an 80% chance of being exceeded) has been selected as a suitable criterion.

Not all the rain that falls is available for crop growth as part will be lost by surface runoff, deep percolation and evaporation. The proportion of rainfall which is classified as effective can be calculated using the USBR factors shown in Table 3.4. The lower the rainfall, the higher the percentage efficiency since less water is lost to runoff and deep percolation.

TABLE 3.4

Effective Rainfall Percentages

Monthly rainfall (mm)	Percentage effective (%)
0-25	90.0
25-50	87.5
50-75	83.3
75-100	75.0
100-125	66.0
125-150	56.7

Source: FAO, 1977

The rainfall records for Alessandra have been used in the calculation of crop water requirements and the 1-in-5 dry year effective rainfall values are given in Table 3.5.

TABLE 3.5

Effective Rainfall

Month	Total average (1922-1960) (mm)	1-in-5 dry year (mm)	1-in-5 dry year effective (mm)
January	2.2	0.0	0.0
February	1.4	0.0	0.0
March	8.0	0.0	0.0
April	138.5	69.0	57.5
May	111.2	56.0	46.6
June	54.0	23.0	20.7
July	52.5	17.0	15.3
August	18.0	5.0	4.5
September	17.7	0.0	0.0
October	74.6	1.0	0.9
November	59.7	20.0	18.0
December	48.3	11.0	9.9
Total	585.9	191.0	173.4

3.6 Prewatering Requirement

Prewatering prior to sowing is desirable for annual crops to facilitate land preparation activities and promote weed growth so that this can be dealt with before drilling takes place. For the general arable rotation at Homboy each crop follows closely after the previous crop and thus a prewatering application will not generally be necessary. There is however sufficient capacity in the system should a prewatering be required. In the case of paddy rice, which requires the soil to be saturated early in the growing cycle, a prewatering of 150 mm has been assumed.

3.7 Rice Flooding

The rice basins should be flooded as soon as the seedlings have reached sufficient height to avoid being drowned. Ultimately a ponded depth of 150 mm is suitable, but it is neither necessary nor desirable for this depth to be achieved in one irrigation application. For the water requirement calculations it is assumed that the ponding depth is increased to the maximum over a period of one month.

3.8 Irrigation Efficiency

In order to derive canal capacities at each level in the system it is necessary to introduce the concept of irrigation efficiency. No irrigation system is able to deliver exactly the quantity of water required to sustain crop growth - inevitably there is wastage. Losses occur throughout the system and are made up of the following components:

Management losses: water which runs to waste as a result of imperfections in the operation of the system.

Seepage losses: water seeping from canals and through bunds surrounding the rice fields.

Evaporation losses: evaporation from free water surfaces in canals and transpiration from plant growth in canals.

Percolation losses: water which, although applied to the field, passes down through the soil profile beyond the root zone and is therefore lost to the crop.

It is convenient to define two efficiency terms to allow for the above losses. These are:

- conveyance efficiency
- field efficiency

Conveyance efficiency takes account of all seepage losses between the Supply Canal head regulator and the head of a watercourse. These seepage losses are calculated from the canal design equations as discussed in Chapter 4. Field efficiency allows for all losses downstream of the watercourse head. Field efficiencies for the general arable/banana areas and the paddy rice areas are discussed below.

(a) General Arable and Banana Areas

The general arable and banana areas will be irrigated by furrows, or possibly in border strips. A field efficiency of 0.50 is adopted, which assumes a reasonable level of management, but should be attainable in practice. Unfortunately, there are virtually no measurements of field efficiencies in Somalia to substantiate the assumptions, although during the Jowhar Sugar Estate Drainage and Reclamation Study (MMP, 1978) and average application efficiency of 67% was recorded over one season.

(b) Paddy Rice Areas

For the rice crop, percolation losses of 5 mm/d are allowed for separately and the field efficiency comprises primarily losses resulting from mismanagement. There will also be some seepage losses from the watercourses, but these will be fairly small since the paddy rice fields are ponded. A field efficiency of 0.80 is considered appropriate.

Taking canal seepage losses into account, then the overall project efficiency, defined as the ratio of the net consumptive use to the Supply Canal head discharge, is 43%.

3.9 Leaching Requirement

Irrigated soils can receive considerable quantities of dissolved salts in the irrigation water. To leach these salts, adequate water must be applied to allow some water to pass through the entire root zone. This is termed the leaching requirement and is calculated from the expression:

$$LR = EC_W/(5EC_e - EC_W)$$

where LR = leaching requirement, expressed as a proportion of the net crop irrigation requirement

EC_W = electrical conductivity of applied irrigation water

EC_e = average electrical conductivity of soil for a given reduction in yield

The Juba river water is generally of good quality, with typical monthly salinity values ranging from 0.15 to 4.0 mmhos/cm. The higher values occur when the river rises following the first rains after the jilaal season due to the washing of salts that have accumulated on the soil surface, and last for only one or two days. Bardheere dam will tend to smooth out electrical conductivities over the year; and using the annual mean value for EC_W of 0.4 mmhos/cm (MMP, 1979), the leaching requirements for each crop with a 10% yield reduction are shown in Table 3.6.

TABLE 3.6

Leaching Requirements

Crop	EC_e for 90% yield potential[1] (mmhos/cm)	Leaching requirements (%)
Maize	2.5	3.2
Cotton	9.6	0.8
Sesame	3.0	2.7
Cowpeas	5.7	1.4
Paddy rice	3.8	2.1
Bananas	2.0	4.0
Vegetables	2.5	3.2

Note: (1) From FAO, Irrigation and Drainage Paper 29 (FAO, 1985)

These leaching requirements are very low and will be easily exceeded by irrigation losses even allowing for a leaching efficiency of about 0.5. Thus no additional water will be necessary for leaching and no significant loss in yield potential is envisaged.

3.10 Monthly Crop Water Requirements

Monthly net crop water requirements are shown in Tables 3.7 to 3.9. The method of calculation is as follows.

The reference crop evapotranspiration (ETo) multiplied by the crop factor gives the consumptive use of the crop in millimetres for the month concerned. The effective rainfall is then deducted to give the monthly net requirements. In the case of paddy rice an additional allowance for prewatering, ponding and percolation has been made.

Gross requirements at the field outlet (i.e. the head of the watercourse) can be obtained by dividing the net requirement by the field efficiency, and the peak daily values upon which the canal designs are based are shown in Table 3.10. These peak requirements occur in the der season.

TABLE 3.10

Summary of Peak Crop Water Requirements

Cropping pattern	Peak water requirements (mm/d)	
	Net	Gross
General arable	5.3	10.6
Banana	5.1	10.2
Paddy rice	13.5	16.8

TABLE 3.7

Crop Water Requirements - General Arable Areas

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evapotranspiration ETo (mm)	195	188	217	171	158	135	140	158	171	171	156	171
Effective rainfall (mm)	-	-	-	58	47	21	15	5	-	1	18	10
Maize:												
Crop factor	-	-	-	0.21	0.56	1.02	0.81	0.08	-	-	-	-
Consumptive use (mm)	-	-	-	36	88	138	113	13	-	-	-	-
Net requirement (mm)	-	-	-	-	41	117	98	8	-	-	-	-
Cotton:												
Crop factor	0.90	0.47	-	-	-	-	-	0.17	0.35	0.84	1.05	1.05
Consumptive use (mm)	176	88	-	-	-	-	-	27	60	144	164	180
Net requirement (mm)	176	88	-	-	-	-	-	22	60	143	146	170
Sesame:												
Crop factor	0.81	0.08	-	-	-	-	-	-	-	0.03	0.26	0.88
Consumptive use (mm)	158	15	-	-	-	-	-	-	-	5	41	150
Net requirement (mm)	158	15	-	-	-	-	-	-	-	4	23	140
Cowpea:												
Crop factor	-	-	0.03	0.60	0.97	0.81	0.06	-	-	-	-	-
Consumptive use (mm)	-	-	7	103	153	109	8	-	-	-	-	-
Net requirement (mm)	-	-	7	45	106	88	-	-	-	-	-	-
Vegetables:												
Crop factor	0.69	0.15	-	0.19	0.51	0.93	0.69	0.15	-	0.19	0.51	0.93
Consumptive use (mm)	135	28	-	32	81	126	97	24	-	32	80	159
Net requirement (mm)	135	28	-	-	34	105	82	19	-	31	62	149
Cropping pattern requirement:												
Maize - 60% (mm)	-	-	-	-	25	70	59	5	-	-	-	-
Cotton - 48% (mm)	84	42	-	-	-	-	-	11	29	69	70	82
Sesame - 48% (mm)	76	7	-	-	-	-	-	-	-	2	11	67
Cowpea - 36% (mm)	-	-	3	16	38	32	-	-	-	-	-	-
Vegetables - 8% (mm)	5	1	-	-	1	4	3	1	-	1	2	6
Total net requirement (mm)	165	50	3	16	64	106	62	17	29	72	83	155

TABLE 3.8

Crop Water Requirements - Banana Areas

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evapotranspiration												
ETo (mm)	195	188	217	171	158	135	140	158	171	171	156	171
Effective rainfall (mm)	-	-	-	58	47	21	15	5	-	1	18	10
Bananas:												
Crop factor	0.75	0.60	0.73	0.68	0.66	0.71	0.85	1.00	1.03	1.04	1.00	1.00
Consumptive use (mm)	146	113	158	116	104	96	119	158	176	178	156	171
Net requirement (mm)	146	113	158	58	57	75	104	153	176	177	138	161
Maize:												
Crop factor	-	-	-	0.21	0.56	1.02	0.81	0.08	-	-	-	-
Consumptive use (mm)	-	-	-	36	88	138	113	13	-	-	-	-
Net requirement (mm)	-	-	-	-	41	117	98	8	-	-	-	-
Sesame:												
Crop factor	0.81	0.08	-	-	-	-	-	-	-	0.03	0.26	0.88
Consumptive use (mm)	158	15	-	-	-	-	-	-	-	5	41	150
Net requirement (mm)	158	15	-	-	-	-	-	-	-	4	23	140
Cropping patterns requirement:												
Banana - 160%(mm)	117	90	126	46	46	60	83	122	141	142	110	129
Maize - 20% (mm)	-	-	-	-	8	23	20	2	-	1	5	28
Sesame - 20% (mm)	32	3	-	-	-	-	-	-	-	-	-	-
Total net requirement (mm)	149	93	126	46	54	83	103	124	141	143	115	157

TABLE 3.9

Crop Water Requirements - Paddy Rice Areas

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evapotranspiration												
ETo (mm)	195	188	217	171	158	135	140	158	171	171	156	171
Effective rainfall (mm)	-	-	-	58	47	21	15	5	-	1	18	10
Paddy rice - gu:												
Crop factor	-	-	0.55	1.10	1.10	1.10	0.55	-	-	-	-	-
Consumptive use (mm)	-	-	119	188	174	149	77	-	-	-	-	-
Prewatering (mm)	-	75	75	-	-	-	-	-	-	-	-	-
Ponding (mm)	-	-	75	75	-	-	-	-	-	-	-	-
Percolation (mm)	-	-	78	150	155	150	78	-	-	-	-	-
Net requirement (mm)	-	75	347	355	282	278	140	-	-	-	-	-
Paddy rice - der:												
Crop factor	0.55	-	-	-	-	-	-	-	0.55	1.10	1.10	1.10
Consumptive use (mm)	107	-	-	-	-	-	-	-	94	188	172	188
Prewatering (mm)	-	-	-	-	-	-	-	75	75	-	-	-
Ponding (mm)	-	-	-	-	-	-	-	-	75	75	-	-
Percolation (mm)(1)	78	-	-	-	-	-	-	-	75	155	150	155
Net requirement (mm)	185	-	-	-	-	-	-	70	319	417	304	333

Note: (1) Based on 5 mm/d over average cropped area.

CHAPTER 4

IRRIGATION SYSTEM

4.1 Introduction

Water will be supplied to the Homboy project from the Fanoole Main Canal just north of Jilib and distributed to the irrigated area by a network of canals and watercourses.

Surface irrigation is proposed, the main methods used being basin irrigation for paddy rice grown under flooded conditions and furrows elsewhere. Border strips could be adopted as an alternative for field crops such as sesame and cowpeas. The small areas of vegetables will be irrigated by small basins. In all cases the success of the irrigation depends to a large extent on accurate land levelling to ensure an even distribution of water across the fields.

In accordance with the aim of this study to keep costs to a minimum, the engineering works for the irrigation system have been reduced to a level sufficient to produce a basic workable system which, given adequate management and smallholder endeavours, can provide satisfactory results.

4.2 Furrow Irrigation

4.2.1 General Arable Crops

For the main general arable crops (maize, sesame, cotton, cowpea) the furrows will be spaced at about 0.8 m. To follow existing topography and minimise land levelling costs, furrow slopes of up to 0.3% are proposed, with a maximum cross slope of 0.3% to prevent the flow breaking out of the furrow. Whenever possible furrows should be aligned down the minor slope of the field as this will also help to minimise land levelling costs.

Furrows should ideally be as long as possible to reduce minor canalisation costs and assist mechanisation. However, if too long a furrow is used, management becomes difficult and excessive water enters the soil at the upper end before the lower end is adequately irrigated. For conditions at Homboy a maximum furrow length of 300 m is proposed.

The maximum non-erosive flow in a furrow can be estimated from:

$$Q = \frac{0.6}{s}$$

where Q = flow in furrow (l/s)

s = furrow slope (%)

Thus for a maximum furrow slope of 0.3%, furrow discharges should be less than 2 l/s.

Water can be introduced into the furrows from the watercourse either by siphon pipes or small header ditches offtaking from and running parallel to the watercourse. Siphon pipes, although potentially offering good water management, are rarely used in Somalia. In addition they are relatively expensive, highly prone to pilfering and farmers can have difficulties with the priming procedure. It is recommended therefore that small header ditches, constructed and maintained by the farmers themselves, are utilised.

The intake of water by soils can be described by:

$$I = aT^b + c$$

where I = cumulative intake (mm)

T = watering time (min)

a,b,c = constants depending on soil type and irrigation method.

From this relationship optimum flow rates and watering times can be determined, and design charts have been formulated to simplify the process (ASAE, 1983).

Assuming a watercourse discharge of 60 l/s and a furrow discharge of 1.5 l/s then 40 furrows can operate at one time. For a furrow length of 300 m and spacing of 0.8 m, then a typical irrigation of 100 mm gross could be applied in:

$$\frac{300 \times 0.8 \times 0.1 \times 1\,000}{1.5 \times 60 \times 60} = 4.4 \text{ h}$$

4.2.2 Bananas

Current practice in the Juba valley is to plant bananas at a spacing of 2.5 m between rows and 2.0 m along the row. Furrows are constructed between the rows at a spacing of 2.5 m. Typical furrow lengths are 100 m, a figure which is below the theoretical maximum but appears to work well and simplifies field irrigation. It was also observed that a considerable amount of dead banana leaves and other debris tend to clog the furrows, and hence the longer the furrow the greater the danger that water will not reach the end of the run. Short furrows, however, will have higher minor canalisation costs than long furrows, and as a suitable compromise, a maximum furrow length of 150 m is proposed. Thus for a furrow discharge of 1.5 l/s, a length of 150 m and spacing of 2.5 m, an irrigation of 100 mm gross could be applied in:

$$\frac{150 \times 2.5 \times 0.1 \times 1\,000}{1.5 \times 60 \times 60} = 6.9 \text{ h}$$

4.2.3 Furrow Trials

Although such variables as stream sizes and times of irrigation can be estimated as indicated in the preceding sections, it is essential that furrow trials are carried out once the scheme has been constructed. The trials should be undertaken on a representative section of slopes, soil types and furrow lengths to determine optimum flow rates and irrigation times to provide the required amount of water to the crops uniformly throughout the furrow length.

4.3 Border Strip Irrigation

Border strip irrigation could be used as an alternative to furrow irrigation for close growing field crops. The land is divided into strips approximately 15 m wide by earth bunds, and water is applied at the head of the strip and allowed to flow down the slope infiltrating the soil as it flows across it. The strip must be levelled to an even slope along its length and zero slope across its width. Efficient irrigation is obtained by choosing the strip width, length and discharge to meet the soil infiltration rate and land slope conditions. Trials are the best way of establishing these criteria, but for the conditions at Homboy the following border strip designs as recommended by FAO (FAO, 1974), should prove suitable:

Slopes:	along strip - 0.1% to 0.3% across strip - flat
Strip dimensions:	length - 300 m width - 15 m
Irrigation depth	100 mm gross
Flow per strip	60 l/s gross

Thus all of the watercourse flow is diverted into one strip at a time by temporarily breaking the watercourse bank and diverting the flow into a header ditch. A 300 m long strip could be irrigated in:

$$\frac{300 \times 15 \times 0.1 \times 1\,000}{60 \times 60 \times 60} = 2.1 \text{ h}$$

4.4 Basin Irrigation

Irrigation of paddy rice will be carried out by basins. The 25 ha net watercourse unit is divided into a number of basins each of which receives the whole watercourse discharge (50 l/s) for a time. Basins are normally specified as flat in both directions, but experience gained from paddy rice cultivation at the Mogambo project has shown that providing a small slope along the basin tends to overcome the inevitable settlement of fill areas following irrigation and allows fields to be drained without ponding in the settled areas. A slope of 0.05% was found to be effective and is proposed for Homboy. The slope across the basins should be zero.

The most efficient irrigation is in theory obtained by using large basins, although except for very flat topography land levelling requirements per hectare will increase with basin size. It is also normal practice to apply water to a basin at a rate of at least 2 to 4 times the times the infiltration rate. Taking a watercourse discharge of 50 l/s and infiltration rate of 10 mm/h, leads to a maximum basin size of about 0.5 ha. The dimensions of the basin will vary with the topography so as to minimise land levelling. Normally, however, the basin length should not exceed 200 m for ease of management. A typical application depth of 170 mm gross could be applied to a 0.5 ha basin in:

$$\frac{0.5 \times 100 \times 100 \times 0.17 \times 1\,000}{50 \times 60 \times 60} = 4.7 \text{ h}$$

4.5 Irrigation Interval

The irrigation interval for the general arable crops and bananas can be calculated by dividing the readily available water content (RAWC) in the root zone by the daily net irrigation requirement for any given month. The smallest interval (i.e. most frequent irrigation) is therefore generally obtained using the maximum daily net requirement, although early growth stages when rooting depths are shallow may also be critical. Assuming an average RAWC for the levee and cover floodplain soils of 95 mm/m then the irrigation intervals for each crop at peak requirements are shown in Table 4.1.

TABLE 4.1

Irrigation Intervals

Crop	Effective rooting depth (m)	RAWC (mm/m)	RAWC in root zone (mm)	Maximum net requirement(1) (mm/d)	Maximum irrigation interval (d)
Maize	1.00	95	95	3.9	24
Cotton	1.00	95	95	5.7	16
Sesame	0.75	95	71	5.1	13
Cowpea	0.75	95	71	3.4	20
Banana	0.75	95	71	5.7	12
Vegetables(2)	0.25	95	24	4.8	5

Note: (1) From Table 3.10.

(2) Onions

The table shows that the interval between irrigation for the general arable crops and bananas in the peak month should not exceed 12 days. For vegetables the irrigation interval should not exceed 5 days.

The maximum irrigation interval for paddy rice is based on the need to maintain ponded conditions in the basin. An assumed loss to deep percolation of 5 mm/d together with a peak approximate evapotranspiration rate of 7 mm/d gives a net usage of 12 mm/d. The ponded depth immediately after an irrigation will be 150 mm which at this usage would reduce to zero after 12.5 days. Therefore the irrigation interval should not exceed this period.

The irrigation intervals described above and shown in Table 4.1 were all calculated from the maximum net irrigation requirements. Consequently the figures represent the minimum expected intervals at any one time during the growing season, which generally applies to the critical stage of flowering and early seed development. At other times the net irrigation requirements are less. Therefore, either the time between irrigations can be extended or the total depth of water applied at each irrigation reduced. This can be seen, for example, for irrigation during crop maturation when a far greater depletion of available moisture can occur without loss of yield.

4.6 Depth of Application

For the general arable and banana crops the depth of application should be sufficient to refill the soil moisture reservoir in the root zone from its depletion level to field capacity. Any additional water would cause the moisture holding capacity of the soil to be exceeded, resulting in surface ponding and runoff. The depth of application should therefore not exceed the RAWC in the root zone. Both cropping patterns have a peak gross monthly requirement of about 300 mm and therefore a suitable irrigation schedule in the peak month would be 35 mm gross applied every 3-4 days for vegetables and 100 mm gross applied every 10 days elsewhere.

For the paddy rice areas a nominal irrigation interval of 10 days is also proposed. The water requirement in the peak month is 408 mm net (510 mm gross with a field efficiency of 0.80) and therefore a suitable irrigation schedule at that time would be 170 mm gross applied every 10 days.

4.7 Watercourse Unit

The irrigable area is divided into fields known as watercourse units. A standard unit size of 25 ha net (approximately 30 ha gross) has been adopted, but due to the irregular topography of the project area it has been impossible to standardise on unit dimensions. It is important that only one cropping pattern is adopted for any one watercourse unit otherwise agricultural operations and irrigation scheduling will become over-complicated.

The watercourse units will be served by small channels or watercourses. Each watercourse can serve one paddy rice unit or two banana/arable crop units. Thus each paddy rice unit will receive water continuously, whereas the other units will be rotated on an equal time 'on/off' basis.

In many of the watercourse units it will be necessary for the watercourse to sub-divide so that maximum furrow, border strip or basin lengths are not exceeded. In these cases the flow is directed into each branch of the watercourse in turn by temporary earth bunds or portable checks.

Typical watercourse unit layouts are shown in Figures 4.1 to 4.4.

4.8 Canal System

The canal system comprises a network of continuously flowing open channels fed by gravity from the Fanoole Main Canal. The canals are defined as below:

Supply Canal	-	The canal offtaking from the Fanoole Main Canal and bringing water to the project area.
Main Canal	-	The canal flowing through the project area feeding branch and distributary canals.
Branch Canal	-	A canal offtaking from the Main Canal and feeding distributary canals.

Distributary Canal - A canal offtaking from the Main or branch canals and feeding several watercourses.

Watercourse - A small channel offtaking from a distributary canal, or in some case from the Main Canal, which supplies water to individual watercourse units.

All canals are numbered consecutively with reference to the canal from which they offtake, as shown on the irrigation layouts (Plates 5 to 12). Even numbered canals offtake on the right and odd numbered canals offtake on the left. Further details are given below:

Branch canals - Two branch canals offtake from the tail of the Main Canal and are numbered HB1 and HB2.

Distributary canals - These are numbered with respect to the regulator group from which they offtake. There are six groups on the Main Canal and one at the tail of each of the two branch canals: e.g. H2/D2 is the first distributary on the right at the second group on the Main Canal, and HB1/D1 is the first distributary on the left at the group on branch canal HB1.

Where a distributary canal sub-divides the larger of the two channels has the same name as the parent canal and the smaller is given a suffix: e.g. H5/D3 sub-divides into H5/D3 and H5/D3.2 which offtakes on the right.

Watercourse units - Each watercourse unit is numbered with a further suffix: e.g. H2/D3/5 is the third watercourse unit on the left offtaking from distributary canal H2/D3.

4.9 Daily Irrigation Period

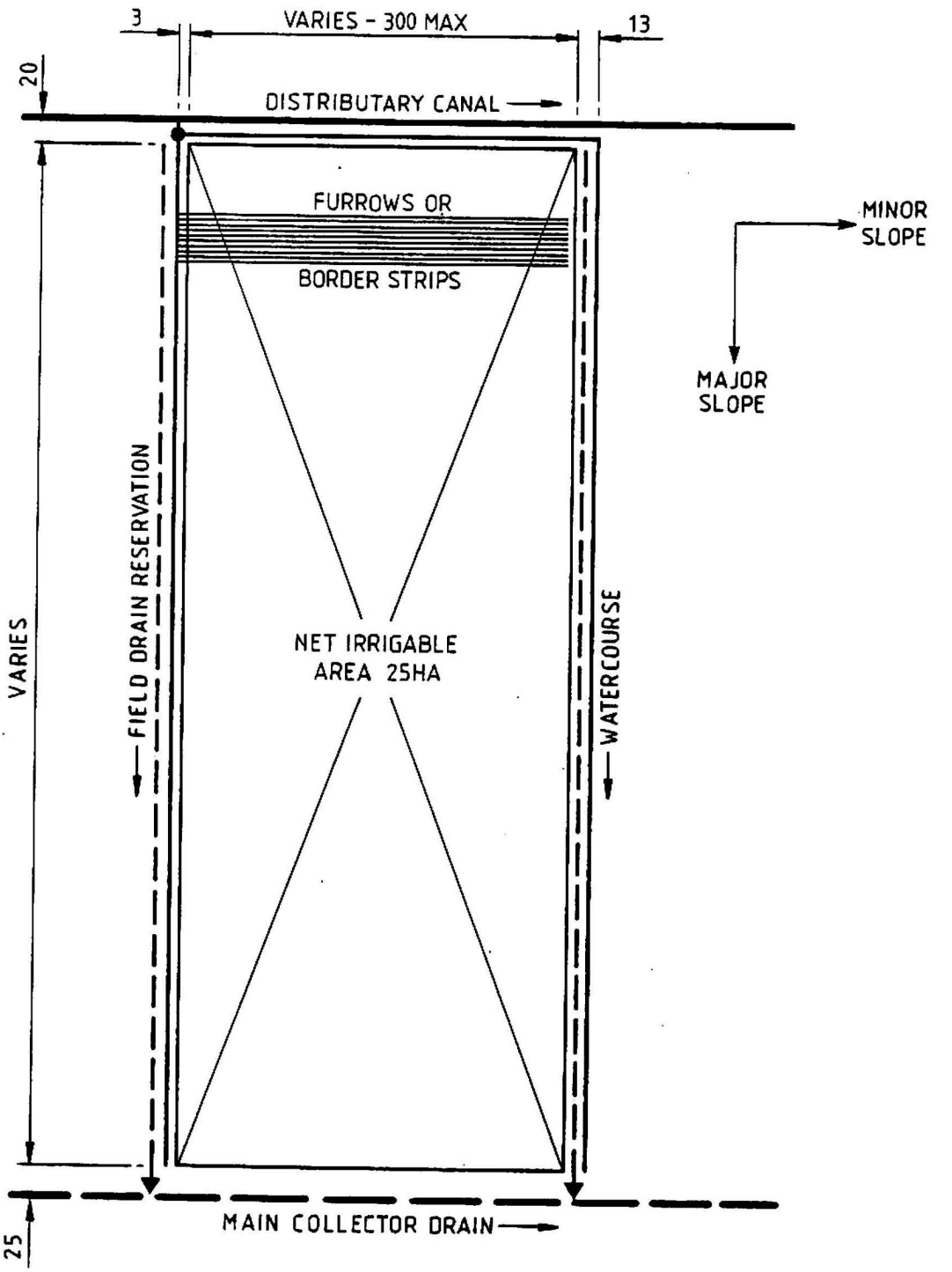
4.9.1 Introduction

When planning an irrigation scheme one of the major decisions to be made is the daily irrigation period, as this affects system design, costs and operational procedures. Generally, the longer the daily irrigation period, the cheaper the scheme, but the greater the potential operating problems at field level because of the amount of night irrigation involved.

Irrigation in the Juba valley is normally limited to the daytime only but night irrigation is reported during the jilaal season between full moon and half moon, and has also been carried out on the Mogambo project. In the banana areas, irrigation is normally limited on average to 10 h/d but with occasional peaks of 14 to 16 hours during jilaal when the river levels are low and crop water requirements high. Night irrigation is also practised in parts of the Genale area on the Shebelle river.

Figure 4.1

Typical Watercourse Unit
General Arable Crops – Type 1

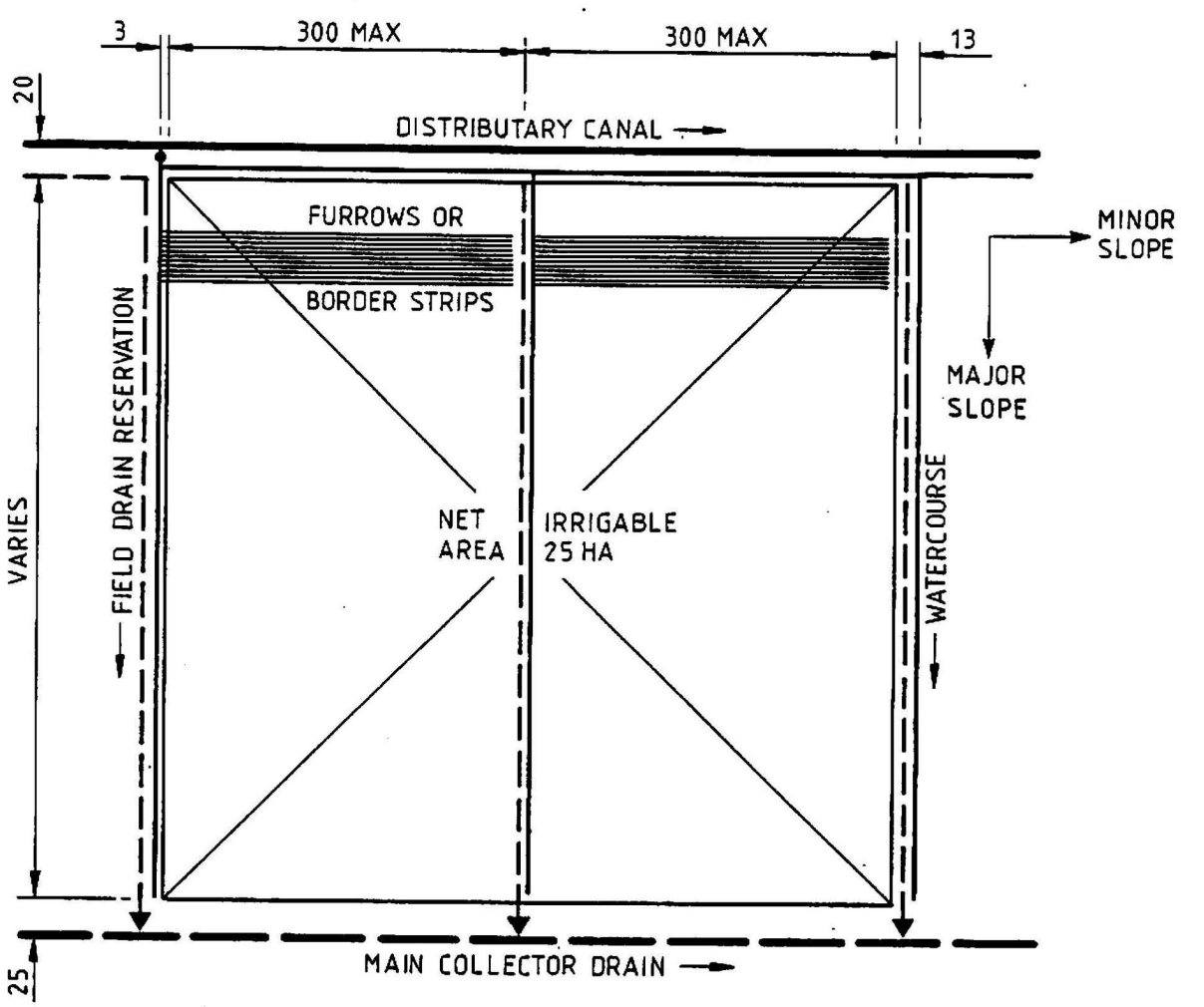


NOTE: ALL DIMENSIONS IN METRES

SCALE
m 0 100 200m

Figure 4.2

Typical Watercourse Unit
General Arable Crops – Type 2

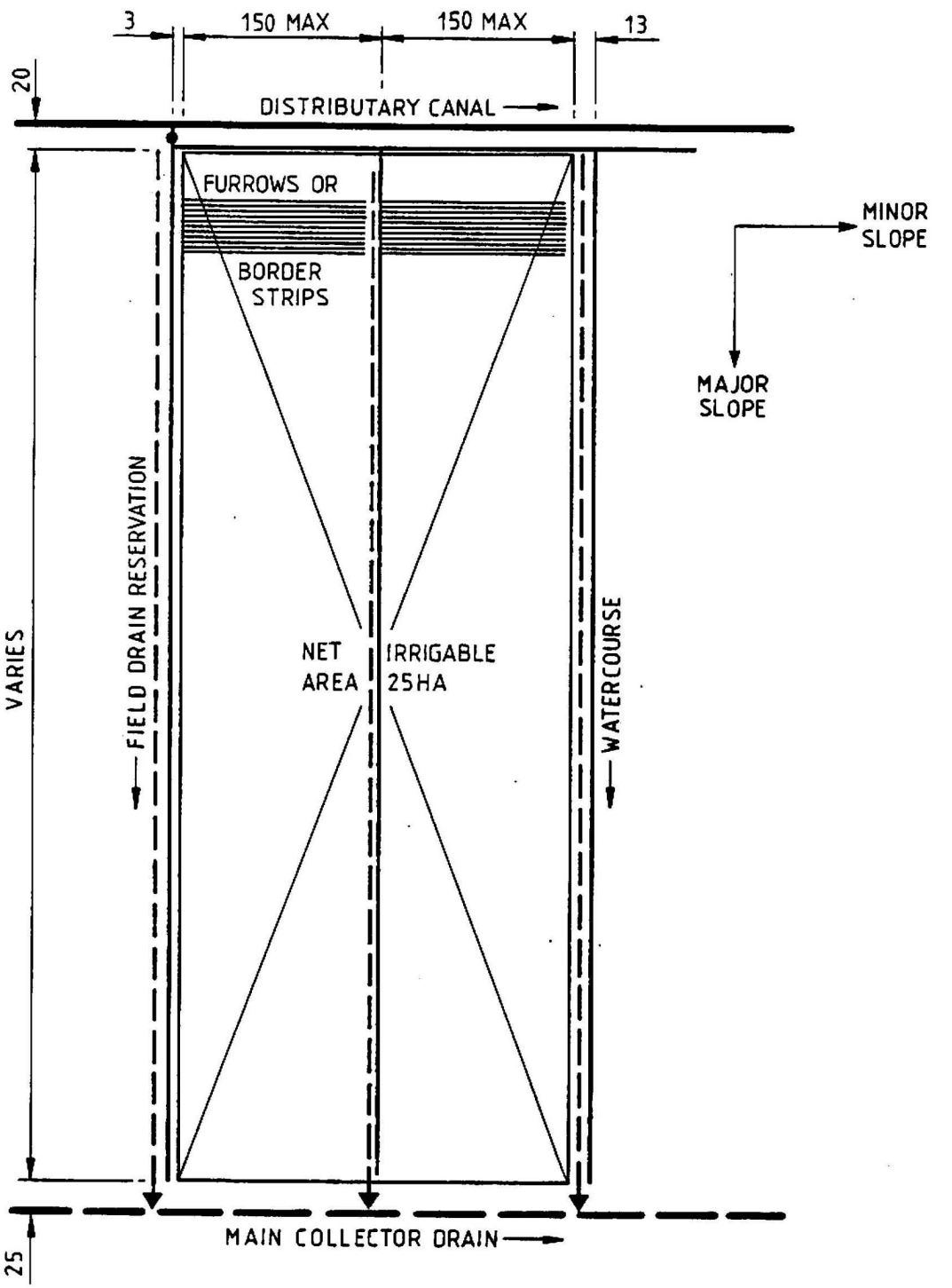


NOTE: ALL DIMENSIONS IN METRES

SCALE
m 0 100 200 m

Figure 4.3

Typical Watercourse Unit
Bananas

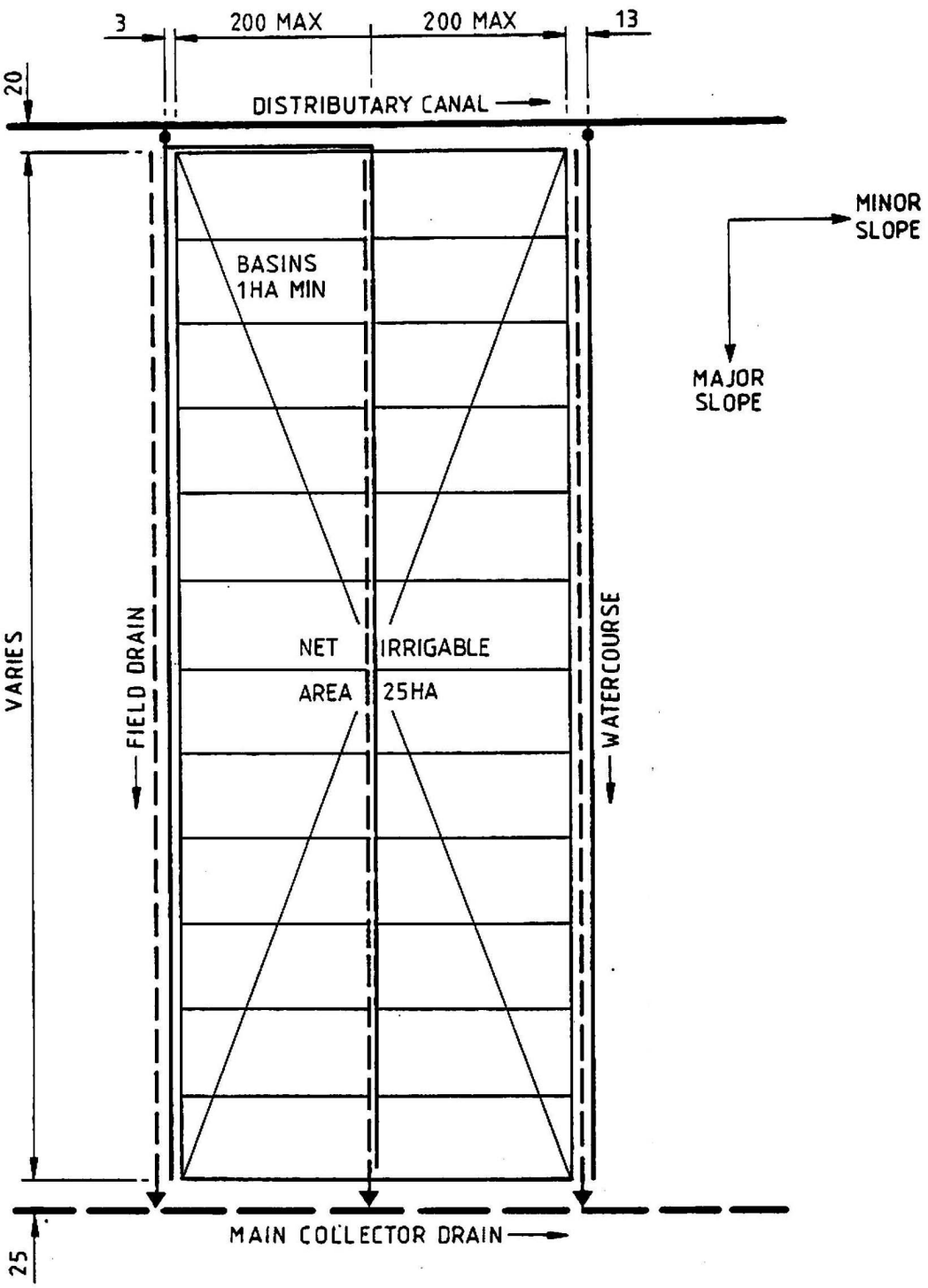


NOTE: ALL DIMENSIONS IN METRES

SCALE
m 0 100 200m

Figure 4.4

Typical Watercourse Unit
Paddy Rice



NOTE: ALL DIMENSIONS IN METRES

SCALE
m 0 100 200m

The irrigation system at Homboy is long, being some 42 km from the head of the Supply Canal to the tail of the most remote branch canal and the time taken for water to travel the length of the system will be about 20 hours. If daytime irrigation only is practised it will be impossible to operate the canal network intermittently and storage of water at night will be necessary. Continuous irrigation, however, does not require storage facilities but requires the farmers to irrigate at night. The two systems are discussed in further detail below.

4.9.2 Night Storage

The 1980 study concluded that a night storage system should be adopted primarily to simplify operation for the inexperienced and possibly low motivated refugee settlers. Various ways of achieving this were examined, namely, storing the water in the Main or distributary canals, or in night storage reservoirs at the heads of the distributaries. Storage reservoirs were recommended on cost considerations and the proposed system comprised continuously flowing Main and branch canals supplying 12 storage reservoirs located throughout the area. The distributary canals were designed for 12 hour daytime flow only and were fed from the night storage reservoirs.

4.9.3 Continuous Irrigation

Under this system all the canals would flow continuously and hence irrigation must be carried out for 24 hours a day otherwise wastage and bank overtopping will occur.

4.9.4 Comparison and Recommendations

The choice of which system to adopt depends primarily on operation and cost considerations as described below.

(a) Operation

Operation should be considered at two levels - the canal system and field irrigation. In terms of the canals a continuous system is simpler to operate, since in theory at least, canal discharges and levels should be constant throughout the day and night and adjustments would only be necessary two or three times a month following a change in irrigation scheduling. In a night storage system much more attention must be paid to the operation of the distributary canals. They must be opened and closed each morning and evening respectively and cross regulators will require adjustment until flows have stabilised. In addition, the water level in the reservoirs will fall during the day necessitating periodic adjustment of the distributary canal head regulators in order to maintain a constant discharge.

However at field levels there is little doubt that continuous irrigation is more problematic due to the night irrigation requirements. This can be difficult, socially unacceptable and is wholly dependent on the attitude of the smallholders to night irrigation. Continuous irrigation also tends to cause wastage of water, since any reluctance from the farmers to irrigate at night will lead to wastage to the drainage system. On Homboy, however, this is not considered too critical, since no pumping is involved and any unused water eventually returns to the river and can be utilised by downstream developments.

(b) Costs

Of the two alternatives, continuous irrigation has the lower costs. There are several reasons for this:

(a) The distributary canals and associated structures will only have half the capacity of a night storage system.

(b) Since operation of the distributary canals is easier in a night storage system, cross-regulation can be simplified. More specifically gated structures would not be necessary and could be replaced with cheaper fixed weirs.

(c) The night storage reservoirs and their head regulating structures are not required.

(d) The Supply, Main and branch canals will have the same capacity whichever system is adopted. However, with night storage, additional head must be provided to account for the head loss into the night storage reservoir and its live storage. This will total about 0.75 m, thus requiring the main supply system to be 0.75 m higher with a subsequent increase in earthworks.

We have carried out an estimate of the cost savings associated with a continuous system and these are summarised below.

TABLE 4.2

Cost Savings - Continuous Irrigation System

Item	Cost saving ($ x 10^6)
Distributary canal earthworks	0.1
Distributary canal structures	0.6
Night storage reservoir head regulators	0.4
Supply/Main canal and storage reservoir earthworks	0.9
Total	2.0

This is equivalent to a saving of nearly 14% of the irrigation and drainage system costs and about 3% of overall project costs.

There are two additional disadvantages of a night storage system which have not been described above. Firstly, the reservoirs may occupy potentially irrigable land, and secondly they form large areas of water which can involve health hazards by promoting such diseases as malaria and bilharzia.

Primarily in view of the significant cost savings afforded by continuous irrigation, this is the recommended system for Homboy. However, we must re-emphasise the potential difficulties of night irrigation and the need to educate and motivate both management and smallholders accordingly.

4.10 Canal Seepage

Seepage losses will always occur to some extent from unlined canals. Provided that embankments are reasonably well compacted, these losses depend primarily on the type of soil from which the canal is constructed. The hydraulic conductivities described in Chapter 4 of Section A show a variation of 3 to over 100 mm/d. Taking a conservative value of 150 mm/d then the canal seepage losses will be 1.5 m^3/s per million square metres of wetted surface. Introducing this figure into the canal design equations (see Section 4.12) the following expression is derived which relates seepage loss to canal discharge:

$$S = 0.007\, Q^{\frac{1}{2}}\, L$$

where S = seepage loss (m^3/s)

Q = canal discharge (m^3/s)

L = length of canal reach (km)

Thus for a distributary canal of 1 m^3/s capacity the seepage losses will be 7 l/s per kilometre, and a 5 m^3/s section of the Main canal will have losses of 16 l/s per kilometre.

These seepage rates are very low and indicate that canal lining will not be necessary. In addition, the hydraulic conductivities are below the figure of 0.8 m/d above which USBR recommend canal lining should be considered. It is possible, however, that in some areas sand lenses may be exposed by canal excavation and short sections of lining may be required. The most appropriate form of lining would be of imported clay (probably from drain excavation) in accordance with USBR specifications (USBR, 1976), and a typical detail is shown on Plate 36. The recommended material should be an inorganic clay of medium to low plasticity with a liquid limit of 30 to 60 and a plasticity index of 12 to 30.

4.11 Canal Capacities

The canal and watercourse capacities are based on the crop water requirements described in Chapter 3.

Watercourses are designed for a 24 hour irrigation day, and a net watercourse unit size of 25 ha. The design flow depends on the cropping pattern served, as shown in Table 4.3.

TABLE 4.3

Watercourse Capacities

Cropping pattern	Peak gross daily requirement (mm)	Design flow for 25 ha net unit (l/s)	Watercourse capacity (l/s)
General arable	10.6	30	60
Banana	10.2	30	60
Paddy rice	16.8	50	50

The table shows that watercourse capacities have been standardised at 50 l/s for the paddy rice units and 60 l/s elsewhere, which will allow the same distributary outlet and watercourse channel to be adopted. Thus in the paddy rice areas one watercourse can serve one 25 ha unit, whereas elsewhere one watercourse can serve two 25 ha units.

The capacity of the canals has been based on requirements of 50 l/s for each paddy rice unit and 30 l/s for each unit of other crops, with an additional allowance for canal seepage losses as described in Section 4.10.

4.12 Canal Hydraulic Design

The Supply, Main, branch and distributary canals have been designed using the Lacey regime theory which should ensure that neither deposition of silt nor scour occur in the canals when operating under design conditions.

The Lacey equations are:

$$D_m = 2.46\, v^2/f$$

$$W_s = 4.83\, eQ^{\frac{1}{2}}$$

$$S = \frac{0.0003\, e^{1/3}\, f^{5/3}\, E}{Q}$$

where Q = design flow (m^3/s)

S = channel slope

W_s = water surface

D_m = mean depth = A/W_s (m)

A = area of flow (m^2)

V = flow velocity = Q/A (m/s)

E = shape factor = P/W_s

e = width factor = 0.83

f = Lacey silt factor

The Lacey silt factor f can vary between certain limits which correspond to the commencement of silt deposition or scour. For Homboy a range of 0.4 to 1.1 is proposed.

The broken topography and low overall ground slope result in the canals having a fairly high command and being constructed mainly in fill. However, the original canal designs (MMP, 1980) resulted in excess amounts of fill in places and the designs have been critically examined with the aim of reducing costs. The following changes to the canal design criteria have been adopted.

(a) Water surface slopes have been reduced to generally correspond to a Lacey silt factor of 0.4, with corresponding increases in the head loss across the cross regulators where necessary. This will reduce the embankment heights and hence volumes of fill in the upstream length of each canal reach.

(b) Canal commands were originally adopted which would allow the distributary outlets to operate satisfactorily when the flow was one-third of design flow. The use of canals with a flatter slope and the change to continuous irrigation should result in less fluctuations in canal discharges and levels, thus allowing canal commands to be reduced.

(c) Inspection roads have been provided along one canal bank only, with access at ground level alongside the other bank. Widths have been standardised at 4 m for branch and distributary canals (considered to be the minimum allowable for maintenance plant) and 5 m for the Supply and Main Canals.

(d) The inside slopes of branch and distributary canals have been steepened from 1 in 2 to 1 in 1.5.

(e) Outside bank slopes have been designed to resist a seepage gradient, measured from water level to ground level, of 1 in 5 rather than 1 in 7 as originally proposed.

The longitudinal and cross-sections are shown in Plates 13 to 23 and 36, and details of the cross-sections are given below.

TABLE 4.4

Canal Cross-section Details

Canal	Bank top width (m)	Side slopes (vertical : horizontal) inside	outside	Freeboard (m)
Supply	5 and 1	1 : 2	varies	0.55
Main	5 and 1	1 : 2	varies	0.50
Branch	4 and 1	1 : 1.5	varies	0.50
Distributary	4 and 1	1 : 1.5	varies	0.40

The watercourses have been designed, using the Manning equation with a roughness coefficient of 0.025, to be V-shaped channels as shown on Plate 36 and Table 4.5. Although the design discharges for the paddy rice and other watercourses are slightly different the same channel section has been adopted for ease of construction.

TABLE 4.5

Watercourse Cross-section Details

Watercourse type	Capacity (l/s)	Side slopes	Water depth (m)	Freeboard (m)
General arable and banana	60	1 : 1.5	0.55	0.25
Paddy rice	50	1 : 1.5	0.55	0.25

Watercourses have an allowable range of slopes. A minimum of 0.10 m/km has been chosen to determine the channel section which for simplicity is maintained at all slopes. A maximum of 2 m/km has been adopted to limit erosive velocities; for ground slopes steeper than this drop structures will be necessary.

Watercourses are normally constructed using a ditcher which cuts the channel and forms the banks in the same operation. In order to achieve the required command it is necessary to provide a formation level above ground level before the ditching operation begins. This is done by laying a strip of fill of the required thickness, the fill normally being obtained from the adjacent field drain.

4.13 Canal Command

Minimum canal commands have been standardised at 0.40 m for paddy rice areas and 0.30 m elsewhere. This is made up as shown in Table 4.6.

TABLE 4.6

Canal Commands

Crop	Loss through distributary outlet (m)	Average field ponding (m)	Water-course command (m)	Total (m)
General arable and banana	0.10	-	0.20	0.30
Paddy rice	0.10	0.10	0.20	0.40

An additional allowance of 0.10 m/km for watercourse slope has been allowed where applicable.

4.14 Irrigation Layout

4.14.1 Irrigable Areas

As far as possible all irrigable land has been included, although some small areas have been omitted due to inaccessibility, topography or the presence of villages and other infrastructure.

Three main cropping patterns have been proposed - general arable (maize, cotton, sesame, cowpea, vegetables), bananas and paddy rice, although there may be small areas of other crops such as fruit. Due to soils considerations, bananas and paddy rice are only suitable for certain parts of the project area, as shown on Plate 4. The bananas are located along the levee and lighter cover flood-plain soils adjacent to the old Shebelle channel, with the paddy rice in the depression soils mainly in the south of the project. The net irrigable area is 8 850 ha comprising 4 900 ha of mixed arable crops, 3 000 ha of bananas and 950 ha of paddy rice.

The area has been sub-divided into ten irrigation blocks, as shown on Plate 4. Block boundaries habe been chosen to ensure that each block is self-contained in terms of irrigation operation and to allow a phased development of the area to be carried out.

The areas of each block are shown in Table 4.7.

TABLE 4.7

Irrigable Areas

Block Nr	Irrigable area (ha) General arable	Banana	Paddy rice	Total
1	650	125	50	825
2	325	225	50	600
3	400	275	25	700
4	75	850	0	925
5	675	350	0	1 025
6	425	275	100	800
7	225	900	0	1 125
8	550	0	25	575
9	1 025	0	500	1 525
10	550	0	200	750
Total	4 900	3 000	950	8 850

4.14.2 Supply Canal

The Supply Canal has a maximum capacity of 12.7 m^3/s and offtakes from the Fanoole Main Canal by gravity about 1 km north of Jilib. The canal crosses the Mogadishu surfaced road just west of Jilib and runs parallel to the road for about 15 km where it enters the project area and becomes known as the Main Canal.

4.14.3 Main Canal

The Main Canal is aligned approximately from north to south through the centre of the project area along the elevated levee soils. The total length is about 21 km. Its capacity varies from 11.9 m^3/s at its head to 4.3 m^3/s at its tail.

4.14.4 Branch Canals

There are two branch canals offtaking from the Main Canal at the southern end of the project and are essentially sub-divisions of the Main Canal.

4.14.5 Distributary Canals

The distributary canals offtake from the Main or branch canals and will operate continuously. Some of the larger distributaries sub-divide, and including sub-divisions there are a total of 32 distributary canals having a total length of about 115 km.

The distributary canals supply watercourses, each watercourse feeding one 25 ha net paddy rice watercourse unit or two 25 ha units of other crops.

4.14.6 Summary of Canal System

Details of the canals are given in Table 4.8 and a schematic plan of the water distribution network is shown in Figure 4.5.

4.15 Canal Structures

The canal structures have been designed bearing in mind the need for economy and minimum amount of operation. A brief discussion of the structures is given below, and typical drawings are shown on Plates 38 to 44.

(a) Supply Canal Head Regulator

The Supply Canal head regulator has already been constructed by the Fanoole Project. The structure is located on the left bank of the Fanoole Main Canal about 1 km north of Jilib and comprises an offtake with two lifting gates each 2 m wide x 2.5 m high.

Assuming a preliminary design water level in the Fanoole Main Canal of 26.35 m and a level at the head of the Homboy Supply Canal of 24.17 m then the regulator has a capacity in excess of 13 m^3/s and can adequately supply the Homboy project.

(b) Canal Culverts

A reinforced concrete box culvert has been provided where the Supply Canal crosses the Jilib-Mogadishu surfaced road. All other canal road crossings will be at control structures such as head or cross regulators so that no further culverts will be necessary.

(c) Canal Cross Drainage Culverts

Pipe culverts have been provided under the canals to provide cross drainage where required by topography. Only two such locations have been identified - Km 9.76 on the Supply Canal and Km 1.58 on the Main Canal. The structure comprises a simple 0.45 m diameter pipe culvert with pitching protection at the inlet and outlet.

Figure 4.5

Canal System

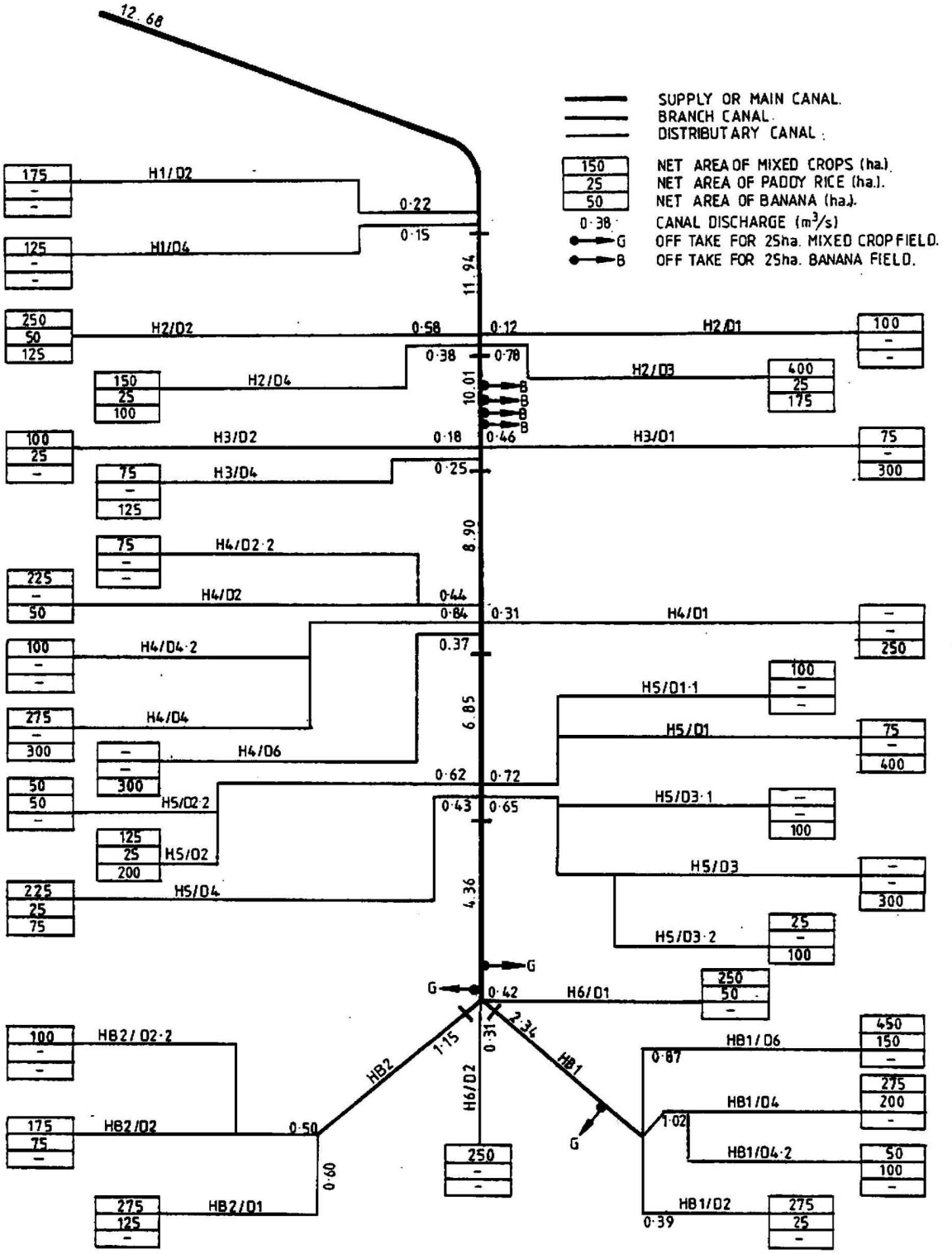


TABLE 4.8

Details of Canals

Canal type	Canal number	Head capacity (m^3/s)	Length (km)
Supply	-	12.68	15.04
Main	-	6.85	21.01
Branch	HB1	2.34	2.79
	HB2	1.15	6.20
Distributary	HB1/D2	0.39	4.62
	HB1/D4	1.02	6.15
	HB1/D4.2	0.26	1.27
	HB1/D6	0.87	6.74
	HB2/D1	0.60	3.92
	HB2/D2	0.50	4.35
	HB2/D2.2	0.12	1.46
	H6/D1	0.42	6.56
	H6/D2	0.31	4.95
	H5/D1	0.72	6.70
	H5/D1.1	0.12	3.01
	H5/D2	0.62	4.79
	H5/D2.2	0.16	1.29
	H5/D3	0.65	5.73
	H5/D3.1	0.12	1.36
	H5/D3.2	0.15	1.11
	H5/D4	0.43	5.79
	H4/D1	0.31	2.98
	H4/D2	0.44	3.13
	H4/D2.2	0.10	1.11
	H4/D4	0.84	6.21
	H4/D4.2	0.12	1.65
	H4/D6	0.37	3.39
	H3/D1	0.46	3.78
	H3/D2	0.17	0.88
	H3/D4	0.25	2.17
	H2/D1	0.12	1.62
	H2/D2	0.58	3.49
	H2/D3	0.78	6.38
	H2/D4	0.38	4.24
	H1/D2	0.22	2.30
	H1/D4	0.15	1.88

(d) Main Canal Cross Regulators

Cross regulators have been provided just downstream of each offtaking group of distributary canals to control Main Canal levels and discharges. The alternatives of lifting gate or movable weir structures have been considered. Movable weirs have the advantage that direct flow measurement is possible but they are more expensive than lifting gates (typically by $5 000 per structure). They can also be more difficult to operate since their discharge is very sensitive to changes in head. Lifting gate regulators have therefore been adopted.

At its tail the Main Canal divides into two branch canals, and similar structures are used as the branch canal head regulators, giving a total of seven structures in all.

The structure is very simple, of single or multi-bayed mass concrete construction with pitching protection at the inlet and outlet. A reinforced concrete bridge deck is provided to give regular crossing points along the Main Canal.

(f) Distributary Canal Head Regulators

These structures control the flow of water from the Main or branch canals into the distributary canals. They consist of simple gated pipes through the canal banks with a reinforced concrete outlet box to dissipate energy.

Flow measurement is considered essential at the distributary canal head regulators and to assist this a crest tapping and measuring well has been provided downstream of the gate. The gate operators can then be provided with simple calibration charts so that they can estimate the flow from water level and gate opening measurements.

(g) Distributary Canal Cross-regulators

Distributary canal cross regulators are necessary to control water levels along the distributary canals, thus ensuring efficient operation of the distributary outlets. Since a continuous irrigation system is proposed, flows in the distributary canals should be relatively stable and gated regulators are not necessary. It is recommended therefore that simple fixed duckbill weirs are adopted with crest length set for a maximum head over the weir of 0.10 m.

These structures are cheaper than gated pipes and have the added advantage that since they are not gated no operation is required. To keep costs low the regulators have generally only been provided with a footbridge although at certain locations, where access is required, the structure has been lengthened to accommodate a reinforced concrete bridgedeck.

(h) Canal Escapes

Each distributary canal has been provided with a tail escape to protect the canal from breaching or overtopping. The structure consists of an inlet box with crest level 0.05 m above design water level, connected to a pipe passing through the canal bank to an escape drain which discharges into the main drainage system. The escape can discharge 0.35 m^3/s with a head over the weir of 0.20 m.

The need for these structures has been reviewed but it is concluded that they are essential. With a continuous flow system there is a danger that under irrigation at night will lead to excess water in the canal network. This will eventually gravitate to the tails of the distributary canals causing breaching or overtopping if escapes are not provided.

For economy no escape structures have been provided on the Main Canal. However, it is considered desirable to provide a lowered section of canal bank so a degree of controlled overtopping will occur in an emergency. A suitable location would be on the right bank at Km 1.58 where the main canal crosses a natural drainage channel. The embankment should be pitched over the lowered section to prevent erosion.

(i) Field Outlets

Field outlets control the flow of water from the distributary canals to the watercourses and consist of a simple gated pipe through the canal bank with an inlet and outlet box. A pipe diameter of 0.30 m has been adopted throughout to serve either the paddy rice watercourses (50 l/s) or watercourses for other crops (60 l/s), the variation in discharges being achieved by adjustment of the gate.

(j) Watercourse Structures

These comprise falls, road culverts and cross drainage culverts and are necessary to give good flow control and access at field level.

Watercourse falls are of pre-cast mass concrete and have been designed for standard drops in water level of either 0.30 m or 0.50 m. Cross drainage and road culverts are simple pipes with no other civil works. The location and numbers of watercourse structures are normally determined as construction proceeds and the infield requirements become apparent.

CHAPTER 5

DRAINAGE SYSTEM

5.1 Introduction

Two basic requirements must be met by a drainage system. Firstly, surface drains are required to prevent excessive flooding of the cropped area after rain storms, and also to collect excess irrigation water although this will be small in comparison with storm runoff. Secondly, deeper drains may be required to keep the watertable at an acceptable depth so that waterlogging and increasing salinity in the root zone do not occur. These two requirements are discussed in this chapter.

5.2 Deep Drainage

Inflows to groundwater occur from rainfall, canal seepage and deep percolation below the irrigated fields. Outflow comprises the flow of groundwater through continuous aquifers of lower potential and any abstractions for irrigation or domestic purposes. If outflow is less than the inflow a rise in groundwater table will occur. In the project area the groundwater table is presently some 20 m below ground level (HTS, 1980) and it is most unlikely that the watertable will rise to dangerous levels within the economic life of the project.

It is concluded therefore that a deep subsurface drainage system is not required although a monitoring system should be installed prior to the commencement of irrigation to record the movement of watertable levels.

5.3 Surface Drainage

5.3.1 General Arable and Banana Areas

To reduce the runoff and hence the required drainage capacity, it is assumed that ponding of water on the fields could be tolerated for short periods. Evaporation and infiltration from the ponded areas was allowed for in the daily water balance.

Retention times of ponded water for several drainage rates were computed for all significant rainfall events by carrying out a daily water balance of rainfall, infiltration, evaporation, storage and runoff using the Alessandra rainfall records (1930 to 1939 and 1953 to 1960). The annual maxima of days of ponding for each assumed drainage rate were extracted, ranked and plotted using a Gumbel Distribution to determine the length of field ponding for a given return period. The results are summarised in Table 5.1.

TABLE 5.1

Drainage Runoff Rates - Non-paddy Rice Areas

Drainage rate (l/s/ha gross)	Field storage (days) for return period		
	2 years	5 years	10 years
1.0	2.7	4.1	4.8
1.5	1.7	2.7	3.2
2.0	1.0	2.0	2.5

In the 1980 designs a return period of 5 years and a drainage rate of 1.5 l/s per hectare were adopted, giving a maximum period of ponding on the fields of 2.7 days. The Terms of Reference for the present study recommend that the drainage system should be designed for the 1-in-10 year rather than the 1-in-5 year event, a criterion which would normally be considered severe for agricultural land. With this return period and a drainage rate of 1.5 l/s per hectare, Table 5.1 indicates that there would be a small increase in the flooding period to 3.2 days. This will not be unduly injurious to the crops and therefore a drainage rate of 1.5 l/s per hectare gross has been adopted. The gross area of a watercourse unit is about 30 ha and therefore the design runoff from one unit is 45 l/s.

5.3.2 Paddy Rice Areas

Drainage rates for paddy rice have also been calculated from a daily water balance, assuming a certain amount of storage in the fields - the maximum storage level being no higher than the emergent crop to avoid drowning. The critical case of newly planted rice was taken as described below.

Under the proposed cropping pattern rice will be planted over a one-month period in May, water being applied under a 10-day irrigation cycle. At the end of this one-month period the area may be viewed as consisting of 10 equal sized blocks, with stages of growth varying from zero (for newly seeded areas) to seedlings approximately 200 mm high, with corresponding irrigation depths varying from zero to 100 mm.

The available storage in the 10 blocks determines the required drainage rate for any given storm and this storage may be at a minimum or maximum value depending on when the storm occurs in relation to the irrigation cycle. This is shown in Tables 5.2 and 5.3.

TABLE 5.2

Minimum Storage - Paddy Rice Areas

Block Nr	1	2	3	4	5	6	7	8	9	10
Seedling height (mm)	200	178	156	133	111	89	67	44	22	0
Irrigated depth (mm)	100	89	78	67	56	44	33	22	11	0
Days since irrigation	4	3	2	1	0	9	8	7	6	5
Water loss (mm)	40	30	20	10	0	44	33	22	11	0
Water depth (mm)	60	59	58	57	56	0	0	0	0	0
Available storage (mm)	140	119	98	76	55	89	67	44	22	0

Average storage: 71 mm

TABLE 5.3

Maximum Storage - Paddy Rice Areas

Block Nr	1	2	3	4	5	6	7	8	9	10
Seedling height (mm)	200	178	156	133	111	89	67	44	22	0
Irrigated depth (mm)	100	89	78	67	56	44	33	22	11	0
Days since irrigation	9	8	7	6	5	4	3	2	1	0
Water loss (mm)	90	80	70	60	50	40	30	20	10	0
Water depth (mm)	10	9	8	7	6	4	3	2	1	0
Available storage (mm)	190	169	148	126	105	85	64	42	21	0

Average storage: 95 mm

Averaging the maximum and minimum conditions gives an available storage of 83 mm. Adopting this figure in the daily water balance, runoff rates were calculated and plotted using a Gumbel Distribution for any return period. The results are summarised in Table 5.4.

TABLE 5.4

Drainage Run-Off Rates - Paddy Rice Areas

Return period (years)	Run-off (l/s/ha gross)
2	0.5
5	1.2
10	1.8

A drainage rate of 1.5 l/s per hectare has been adopted to give a return period approaching 10 years and ensure uniformity with the non-paddy rice areas.

5.3.3 Areal Reduction Factor

To allow for non-uniformity of rainfall over the project area, an areal reduction factor of 0.9 has been applied to the design flows in the main collector drains at their junction with a branch drain or the Lower Outfall Drain.

5.4 Drainage System

The drainage system is essentially made up of two parts, field drainage serving the watercourse unit and the main disposal system.

Drains are defined briefly as follows:

Upper Outfall Drain	-	the drain taking flood flows from the north of the Jilib-Mogadishu road to the Eastern Reservoir. This has been discussed in Chapter 2 - Flood Protection
Lower Outfall Drain	-	the drain taking flood flows from the Eastern Reservoir to the Juba river outfall. This drain also collects drainage water from the project area
Branch drain	-	the two large drains D2 and D20 running along the western and eastern boundaries of the project area into which main collector drains discharge
Main collector drain	-	a drain into which two or more field drains discharge
Escape drain	-	a drain taking distributary canal escape flow which discharges into the main drainage system
Field drain	-	a shallow drain collecting excess surface water from a watercourse unit.

The drain numbering system is referenced to the Lower Outfall Drain. Drains discharging directly into the Lower Outfall Drain are numbered consecutively from the downstream end in a similar manner to canals: e.g. D2 is the first drain on the right (measured from the downstream end) discharging into the Lower Outfall Drain. Further drain sub-divisions are marked by suffixes: e.g. D2/1 and D2/7/1. The large drains D2 and D20 have been classified as branch drains, with the remainder as main collector drains.

The field drainage and main drainage systems are outlined below:

(a) Field Drainage System

Field drainage is required to collect and discharge the water from the fields into the main drains. In the flat depression soils it will be necessary to construct shallow trapezoidal field drains to collect the water. Elsewhere drainage water should naturally flow to the lower end of the field and field drains have not been provided. An uncropped reservation should be left, however, where the farmers can construct a field drain at a later date, should the need arise. In both cases a structure will be required to control the flow of water into the main drains. This will serve the dual purpose of throttling the flow to avoid surcharging of the main drainage system and preventing erosion due to the large head drop into the main drains. One such structure will be required for each 25 ha watercourse unit.

(b) Main Drainage System

The main drainage system comprises main collector and branch drains discharging into the Lower Outfall Drain and thence into the Juba river by gravity. In order to maximise the periods when gravity flow can be achieved, the Lower Outfall Drain has been designed to be as high as possible and is in fill for part of its length. Because of this, five of the main collectors serving low lying land in the south of the project area (D4, D6, D10, D12 & D14) will not be able to discharge into the Lower Outfall Drain under gravity at all times. Consideration has been given to providing pump stations for these drains but it is concluded that the costs and potential operation and maintenance problems are not justified. The drains have therefore been provided only with flap gated junction culverts.

This means that when the Eastern Reservoir is being emptied and levels in the Lower Outfall Drain are high, drainage of some fields will be imperfect. This period should however not exceed six months and at other times gravity flow into the Lower Outfall Drain will be possible. If problems are experienced, then portable pumps could be utilised in critical periods to pump water out of the main collector drains into the Lower Outfall Drain.

A summary of the main drainage system is presented in Table 5.5.

TABLE 5.5

Summary of Main Drainage System

Drain	Number	Total length (km)
Upper Outfall Drain	1	6.3
Lower Outfall Drain	1	24.2
Branch drains	2	54.9
Main collector drains	22	63.6
Total		149.0

5.5 Drain Hydraulic Design

The drains have all been designed using with the Manning equation (n = 0.025) with a trapezoidal section and 1-in-1.5 side slopes. Typical cross sections are shown in Plate 37 and further details are given below.

(a) Field Drains

The field drains have been designed for a nominal discharge of 45 l/s and are of trapezoidal section with a minimum depth of 0.5 m and bed width of 1.0 m.

(b) Escape Drains

The escape drains have been designed for a nominal discharge of 0.35 m^3/s and are of trapezoidal section with a depth of 0.80 m and bed width of 1.50 m.

(c) Branch and Main Collector Drains

Branch and main collector drains have been designed using a trapezoidal section with a width to depth ratio of 3, and a minimum bed width of 1.0 m. The drain discharge is determined from the number of watercourse units served with no allowance for transit losses.

(d) Lower Outfall Drain

The Lower Outfall Drain serves two purposes - it disposes of flood waters from the Eastern Reservoir and also collects drainage water from the project area. As the occurrence of maximum discharge from both the Eastern Reservoir and the project area is small, the Lower Outfall Drain has been designed to carry the greater of the flow from the Eastern Reservoir (10 m^3/s) or the total of the incoming drains from the project area. At its outlet to the Juba river the Lower Outfall Drain has a design capacity of 16.5 m^3/s. A protective embankment of minimum height 0.75 m has been provided on the left side of the Lower Outfall Drain to protect against local runoff.

A 5 m wide access road has been provided on one side only of the main drains. In addition, it is recommended that a reservation of 5 m should be retained on the other bank for maintenance plant and possible road construction at a later date.

5.6 Drain Structures

Drain structures comprise junction and road culverts, canal underpasses and the outfall to the Juba river. A brief discussion of the structures provided is given below, and typical drawings are shown on Plates 46 to 53.

(a) Field Drain Culvert

A small number of these culverts has been provided to allow vehicles to cross the field drains, thereby maintaining good access around the watercourse unit. The structure is a simple 0.3 m diameter pipe culvert.

(b) Drain Culvert, Type 1

These structures are required to control the flow of drainage water from the watercourse unit to the main drains. Where field drains are provided the culverts would be located at the junction between the field drains and the main drains. Where field drains are not provided the culvert would be sited at a suitable low point in the watercourse unit adjacent to the main drain.

The structure comprises a mass concrete inlet box with an orifice and a mass concrete outlet box linked by a 0.30 m pipe. The inlet box orifice provides a throttle on the inflow to avoid flooding of the main drainage system downstream and is designed for a flow of 45 l/s.

(c) Drain Culvert, Type 2

These structures are low head loss pipe culverts provided where roads cross a drain, with pitching protection at the inlet and outlet.

(d) Drain Culvert, Type 3

These are used at low head loss drain junctions and comprise a pipe culvert with mass concrete inlet box and mass concrete outlet box. Flap gated, Type 3 culverts will be required to replace the four drainage pump stations.

(e) Drain Culvert, Type 4

These are similar to the Type 3 culverts, but are provided with a reinforced concrete outlet box for use at drain junctions where there is a high head loss.

(f) Box Culvert

Reinforced concrete box culverts are provided where the drain design discharge is too large for pipe culverts to be used.

(g) Drain Underpass

Drain underpasses are necessary in the isolated instances where drains are required to cross canals. The structure is basically a simple Type 2 culvert.

(h) Outfall to River Juba

This structure is required to discharge the flow from the Lower Outfall Drain into the Juba river when the relative levels are suitable. The design discharge is 16.5 m^3/s at a nominal head loss of 0.25 m.

The structure consists of a triple 1.8 m square box culvert with a reinforced concrete outlet box. Flap gates are fitted to the inlet box breast wall to prevent the river backing up into the drainage system at times of high flow. In addition standard penstocks are provided at the inlet as a safeguard should the flap valves be wedged open by large items of debris.

CHAPTER 6

INFRASTRUCTURE

6.1 Introduction

The development of an efficient and adequate infrastructural sector is of fundamental importance to the project. The proposed infrastructural and organisational planning is discussed in detail in Section D of this Annex, and this chapter deals with the engineering considerations.

The basic components of the project infrastructure are roads, buildings (both housing and project buildings) and services. These need to be provided not only to the extent required for efficient operation of the project, but to ensure that the scheme is an attractive place for the smallholders and managerial staff to live and work.

We are, however, aware of the need to keep costs to a minimum and the infrastructure has been planned accordingly. It is assumed that additional facilities could be added at a later stage as the need becomes apparent.

6.2 Villages

The basis of the infrastructural planning is the concept of five project villages to serve the net project area of 8 850 ha. These are necessary to provide the degree of decentralisation considered essential, and also ensure that the smallholders are housed not more than 4 to 5 km from their fields.

At present there are effectively only two existing villages in the project area - Homboy (including Aminow) which is located just inside the project boundary, and Burgaan which is just to the south of the project. Other settlements in the area comprise only a few families and are often seasonal. Both Homboy and Burgaan will be adopted as project villages, and it is proposed that three new villages are established to meet the project requirements. The location of the villages is shown on Plate 2 and the three new villages have been located using the following criteria:

(i) Walking distance from village to fields generally not to exceed 4 to 5 km.

(ii) Length of access roads and canal and drain crossing points to be minimised.

(iii) Villages to be sited on elevated unirrigable land wherever possible.

(iv) Villages to be located on soils with good foundation conditions, i.e. the heavier swelling clays and marine plain soils to be avoided wherever possible.

The project headquarters will be established at Aminow, just west of Homboy, with a subsidiary service centre in each of the five project villages.

The smallholders will be allocated either 2 ha or 2.5 ha net of irrigable land depending on the crops to be grown. The three types of holding are:

(a) rice 1 ha/arable 1 ha (2 ha total)

(b) arable, 2.5 ha

(c) banana, 2.5 ha

This leads to a total required number of smallholders of about 3 730. These will be divided amongst the five villages in relation to area served and to minimise walking distance from village to field. Details of the villages are given in Table 6.1.

TABLE 6.1

Village Details

Village	Required number of smallholders
1	875
2 (Homboy)	780
3	700
4	675
5 (Burgaan)	700
Total	3 730

6.3 Roads

The project is well placed for access to the national road network, being adjacent to the surfaced Jilib - Mogadishu and Jilib - Kismayo roads at its northern and southern boundaries respectively. There is also an earth track connecting Homboy to the Jilib - Kismayo road.

Good access within the project is necessary to ensure that the movement of agricultural and maintenance machinery, farm inputs and produce is not restricted. To achieve this, earth roads have been provided alongside the canals and drains as described below:

(a) Inspection roads have been provided on one of the canal banks, of width 5 m for the Supply and Main Canals and 4 m for the branch and distributary canals. A width of 4 m is considered the minimum allowable for maintenance plant. A reservation width of 5 m or 4 m at ground level has been provided adjacent to the opposite bank for additional access.

(b) Access roads of width 5 m and minimum height 0.15 m have been provided along the main drains, and these will form the major access routes around the project area. A 5 m wide reservation at ground level has been provided on the opposite bank of the drain primarily for inspection and maintenance purposes.

(c) Field roads consisting of 4 m reservations at ground level have been located adjacent to the watercourses to give access in and around the watercourse units.

The layout of the major access routes between the project villages is shown on Plate 2.

Consideration has been given to the provision of gravel surfacing for the major access roads, particularly in view of the danger of heavy vehicles damaging earth roads in the rainy season. The cost, however, would be considerable - approximately US$ 7 million for 35 km of road. Although surfaced roads are desirable, the high cost may not be justified and it is not proposed to provide surfacing initially except for a short distance within the project headquarters compound. This can be reviewed as the project proceeds should additional funds become available.

It must be recognised that the proposed system, consisting, at least initially, of all earth roads is not ideal. Past experience in Somalia has shown that earth roads are frequently impassable in the rainy season, and a considerable maintenance effort will be necessary at Homboy to keep the roads open and in good condition all year round.

6.4 Smallholder Housing

Houses for the smallholders will be required in each of the three new project villages and at Burgaan to accommodate the projected expansion from 500 to 700 families. Homboy is a relatively large village and no new houses should be needed. In total it is estimated that 2 450 new houses will be required.

The level of housing and services provided has been aimed at minimising costs whilst providing a suitable environment to attract smallholders. Details are given below.

(a) Housing

Houses will follow traditional construction methods, and be built by the smallholders themselves on a self-help basis. A typical design is shown in Figure 6.1, comprising wattle and daub walls and a thatch and bituminous paper roof all on a timber frame. The materials for house construction would be provided to the smallholders free of cost by the project authority.

Each family would be allocated a compound area of about 200 m^2 in which to construct its house and to keep livestock. It is suggested that the houses are laid out as shown in Figure 6.2, with eight dwellings built as a group. Adequate space should be left for some expansion of the village and sites laid out for buildings such as community centres, schools, clinics, shops, mosque, etc., which would be constructed by other agencies or self-help schemes. Taking this into account a gross village area of about 30 ha is envisaged.

(b) Water Supply

The potable water demands of the villages could be met from either groundwater or canal water. The utilisation of canal water would be expensive, requiring pumps, pipelines and chemical treatment, and is not considered further. Groundwater, provided both quality and quantity are acceptable, is the preferred alternative.

As part of the 1980 study (HTS, 1980) a review of groundwater resources and an inventory of wells in the area were carried out. The conclusion, based on very limited information, was that shallow dug wells could supply sufficient water, although the quality was questionable. World Health Organisation quality standards for drinking water (WHO, 1963) suggest a maximum permissible figure for total dissolved solids (TDS) of 1 500 ppm, whereas the wells sampled in the vicinity, and Homboy in particular, exhibited TDS values in the range 1 000 to 4 000 ppm. It should be mentioned, however, that the criteria stipulated by the WHO are generally observed in developed countries, but many developing countries use potable supplies with one or more characteristics outside the permissible limits, without any great damage to public health. Indeed those villagers interviewed at Homboy had no complaints about the quality of the water from their wells, and no adverse effects were apparent.

The relief agency CARITAS is currently carrying out a programme of installation of hand dug wells around the project area. This includes six wells within 10 km of Homboy (including one each at Homboy and Aminow villages) and six wells at Burgaan. The wells are typically 20 m deep, lined with 1 m diameter concrete pipes, with a watertable at about 18 m. Hand pumps are utilised which can deliver about 1 300 l/h. Water quality is variable with TDS values of 1 000 to 4 000 ppm, confirming the findings of the 1980 study. It is also noted that the quality varies with time of year, with better quality in the rainy seasons.

It is recommended that the water supply system for the villages is provided from dug wells with hand pumps similar to those provided by CARITAS. As the water quality is marginal no treatment works are envisaged initially, although the situation should be closely monitored. A sufficient number of wells should be constructed so that no family is more than 200 or 300 m from a water source, and a provisional density of one well per 100 families is proposed.

(c) Sanitation

The use of the surrounding bush for hygienic purposes must be discouraged and a health eduction programme initiated by the project authority. The smallholders should be encouraged to construct their own privy in their compound, and in addition a number of communal long drop pit latrines should be provided at suitable locations around the villages.

(d) Other Services

Village roads will comprise graded reservations at ground level with a minimum width of 5 m.

No electrical supply is envisaged, at least initially.

6.5 Project Headquarters

The project headquarters will accommodate the majority of the senior staff together with the main project buildings such as the workshop and office block. It is proposed that the headquarters is located at Aminow adjacent to the existing village of Homboy. This is a reasonably central location, and makes the best use of the existing facilities in Homboy itself.

Figure 6.1

Typical Smallholder House

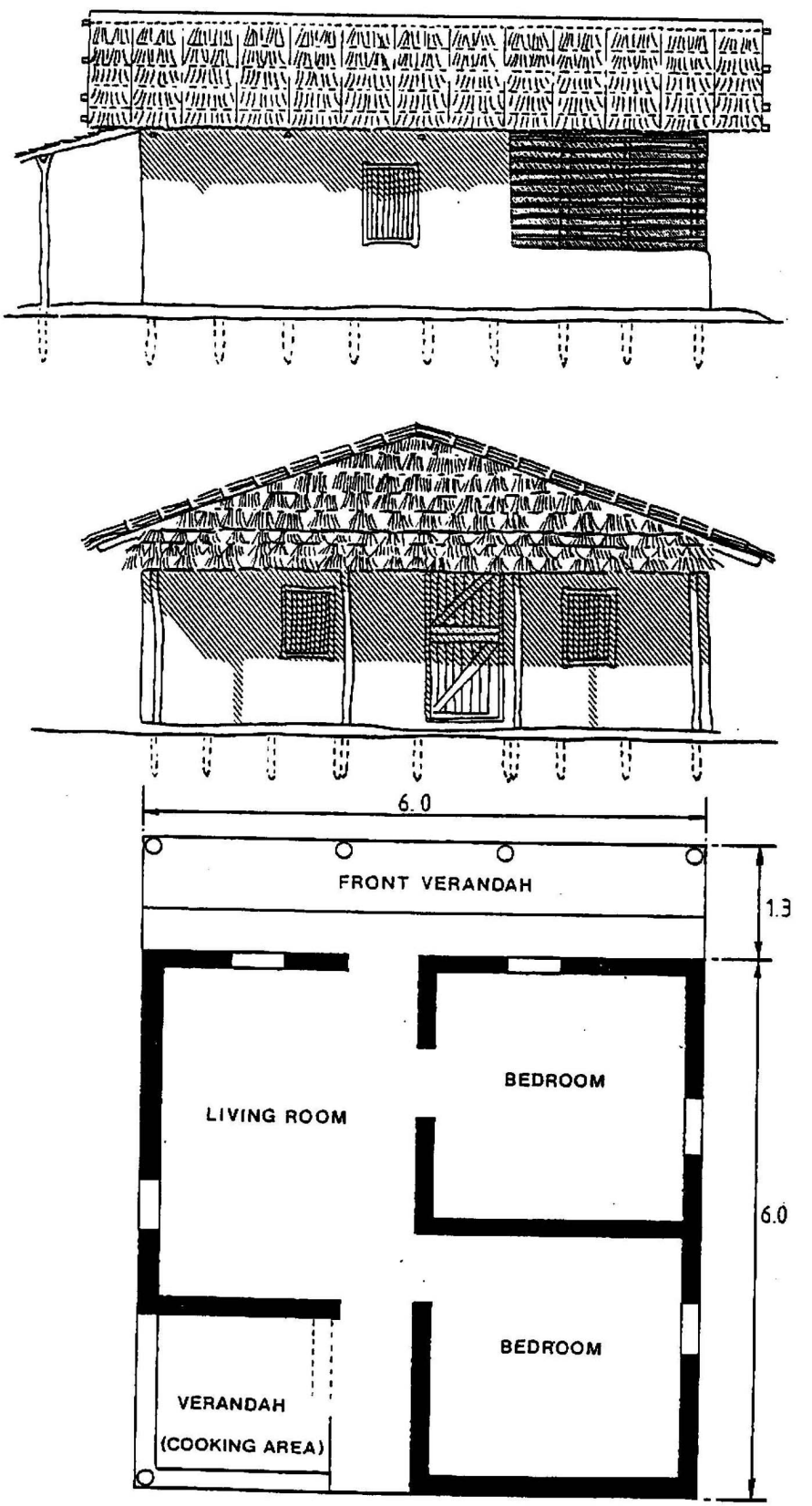
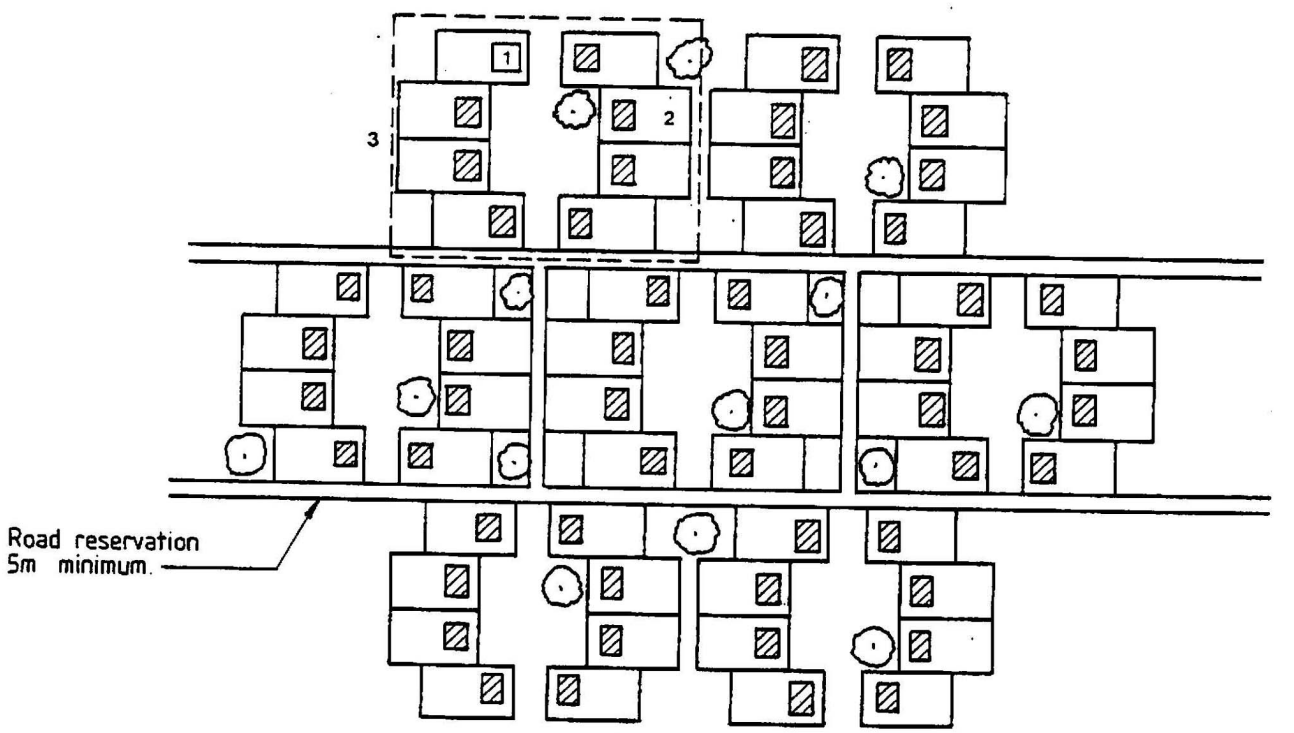


Figure 6.2

Typical Village Layout



1. Village house
2. Village house compound
3. Neighbourhood group (8 houses)

SCALE

0 1km

A sketch map of the proposed layout of the project headquarters is shown in Figure 6.3. The community and social service buildings indicated on the layout would not be constructed as a part of the project works, but could be provided by the Government or other agencies at a later date. Suitable reservations have been left in the project headquarters area.

The following buildings and facilities to be provided by the project have been kept to a minimum in order to keep costs low. The requirements are listed below:

- housing;
- office;
- workshop and vehicle park;
- stores;
- fuel station;
- meteorological station;
- roads;
- services (electricity and water).

(a) Housing

Housing at the project headquarters will comprise accommodation for the expatriate and senior executive staff (houses Types A and B), smaller houses for junior staff (Type C) and self-help type houses for drivers, labourers, etc. Details of the houses are given in Table 6.2 and Figures 6.4 and 6.5.

TABLE 6.2

Housing Details at Project Headquarters

Type	House area (m^2)	Number
A	200	6
B	100	20
C	50	50
Self-help	-	200

The houses Types A, B and C would be located within the housing compound and provided with water and electricity. The self-help houses could be located either in Aminow or Homboy.

(b) Office

An office block of about 500 m^2 has been provided as shown in Figure 6.6. This comprises 14 separate offices, laboratory, kitchen, store, toilets and a conference/training room.

(c) Workshop

The workshop compound is located adjacent to the stores area and fuel station. The fully equipped workshop would have a building area of 500 m^2 supplemented by 1 000 m^2 of open gravel hardstanding for routine maintenance operations.

(d) Stores

The majority of seeds, chemicals, fertiliser, etc. will be kept at village level, but a main store building of 100 m^2 will be required at the project headquarters. This should be sited near the workshop compound and should incorporate a small office for the storeman.

(e) Fuel Station

The fuel station will comprise bulk storage for both petrol and diesel and will act as a distribution point for fuel supplies for the four other project villages. A small building will be required for the storeman.

(f) Meteorological Station

A meteorological station should be established in a small fenced-off area near to the office block.

(g) Roads

Roads within the project headquarters will generally be of graded earth, although it is considered that some gravel roads should be provided along the major routes to provide all-weather access.

(h) Electricity

Electrical power will be required for the management housing and the project buildings. Two options were considered for the supply of electrical power to the project headquarters. The first option, consisting of a 12 km long 33 kV spur from the proposed 33 kV powerline south of Jilib, would use hydroelectric power generated by Bardheere dam. The cost of the line would amount to about US$ 200 000 at 1987 prices.

A second option would be diesel powered generators but, although the capital cost would be far less than for the first option, recurrent costs for diesel fuel and upkeep of the generator equipment would be greater than the annualised cost of hydro-electric power.

It is recommended therefore that the first option of linking the project headquarters to the new electrical grid be adopted. The total cost of such a connection and a power distribution network will be about US$ 550 000. It is estimated that annual power consumption will be in the order of one million kilowatt hours with a peak requirement of about 300 kW.

(j) Water Supply

Water for the project headquarters will be supplied from a tubewell. As quality is marginal and the water will be serving the management housing compound treatment may be required, although this will need to be studied further prior to project implementation. From the tubewell the water will be pumped into an elevated storage tank and then distributed by a pipe network around the area.

Figure 6.3
Project Headquarters

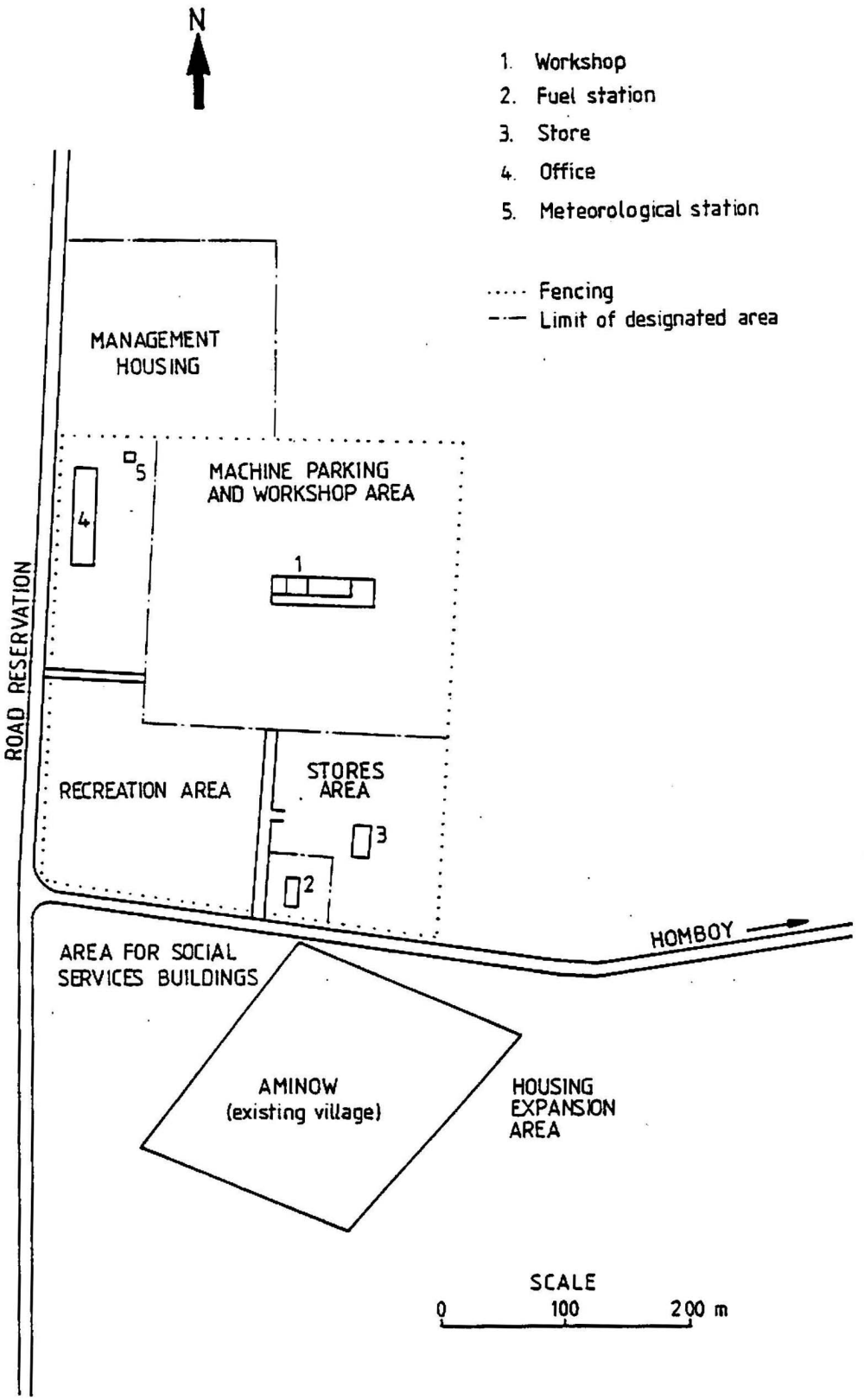
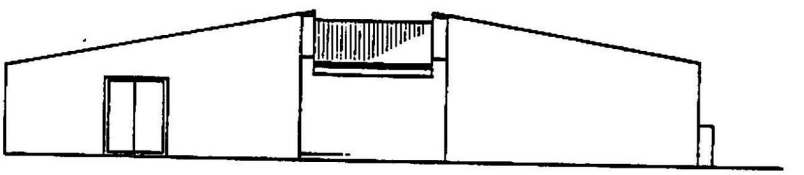
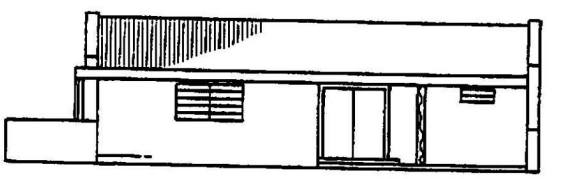


Figure 6.4

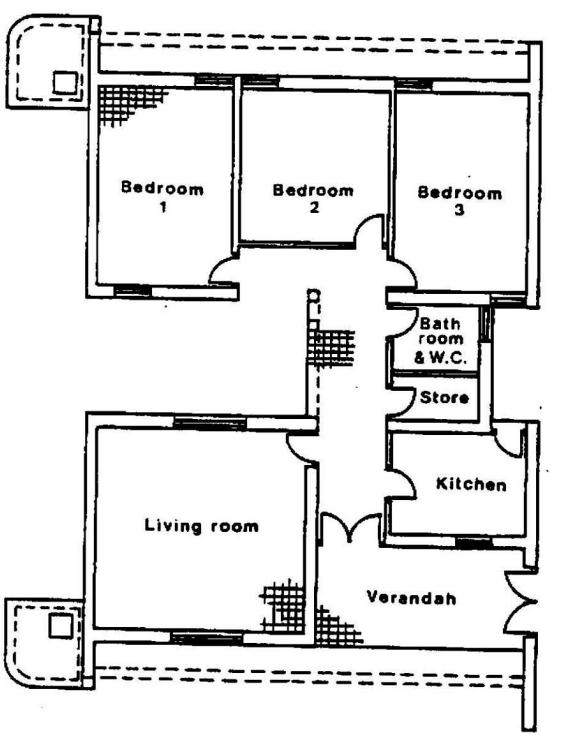
House Type A



Side elevation



Front elevation



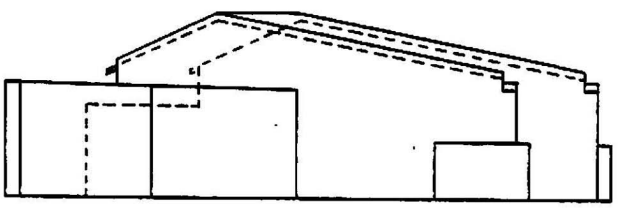
Plan

SCALE

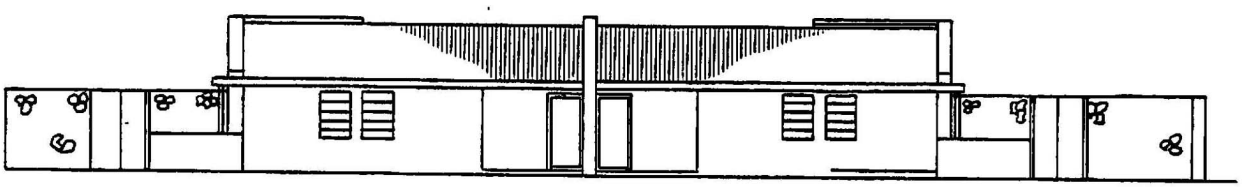
0 10 m

Figure 6.5

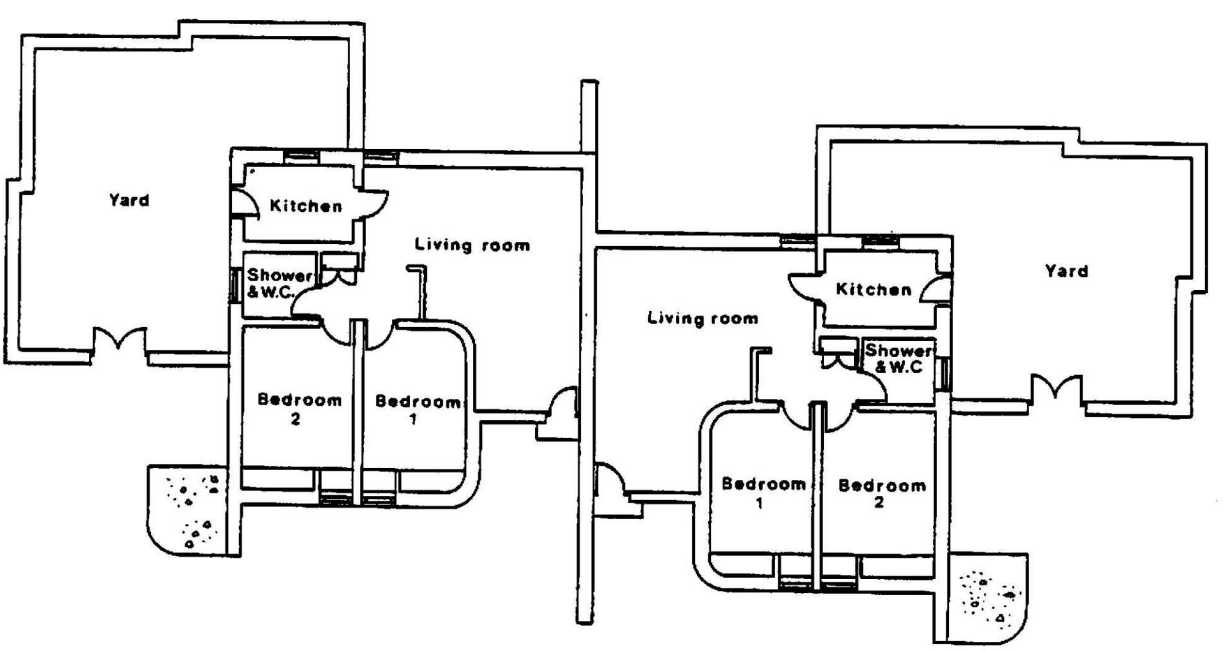
House Type B



Side elevation

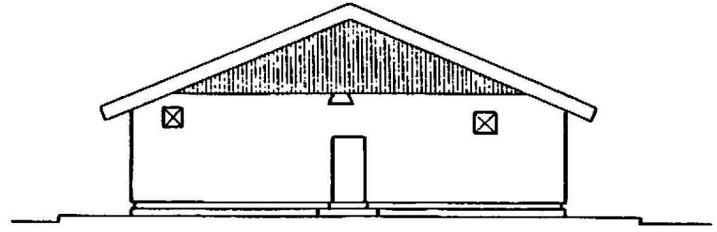


Front elevation

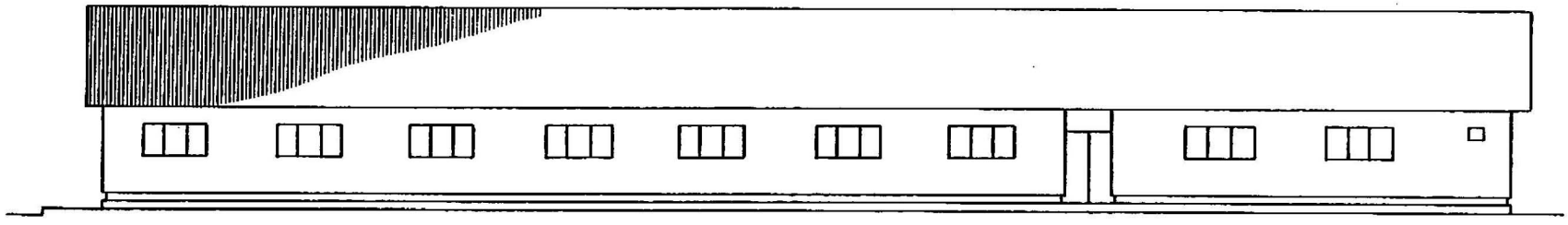


Plan

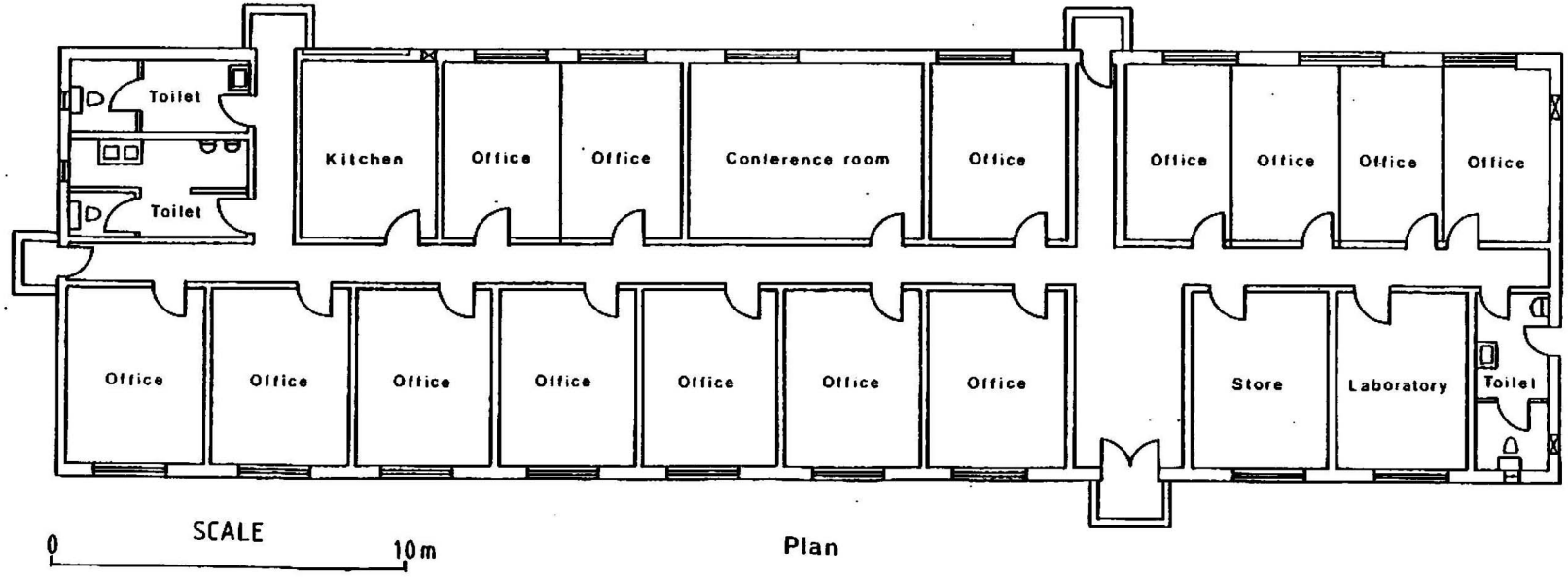
SCALE 0 10m



Side elevation



Front elevation



Plan

Figure 6.6
Office Block

6.6 Service Centre

A service centre is provided at Homboy, Burgaan and at each of the three new villages incorporating the buildings and facilities necessary for operation of the irrigation blocks served by the village. The service centre would cover an area of about 2 ha and be surrounded by a perimeter fence. Each service centre comprises:

- housing
- office
- workshop
- store
- services (electricity and water).

(a) Housing

Five Type C houses would be provided at each service centre for the service centre manager and other staff. A further 30 self-help type houses would be required for labourers and field staff, etc.

(b) Office

A small office of about 25 m^2 would be provided at each service centre.

(c) Workshop Area

The main workshop facilities will be at the project headquarters, but a small workshop area should be provided at each service centre. This will comprise a small building of 15 m^2 and an area of gravel hardstanding of 250 m^2, of which about 50 m^2 should be covered.

(d) Store

The stores will comprise a covered area of 150 m^2 plus a building of about 50 m^2 for storage of chemicals and workshop equipment.

(e) Electricity

No central electricity supply is envisaged for the service centres, although the workshop would be provided with a 10 kW generator.

(f) Water Supply

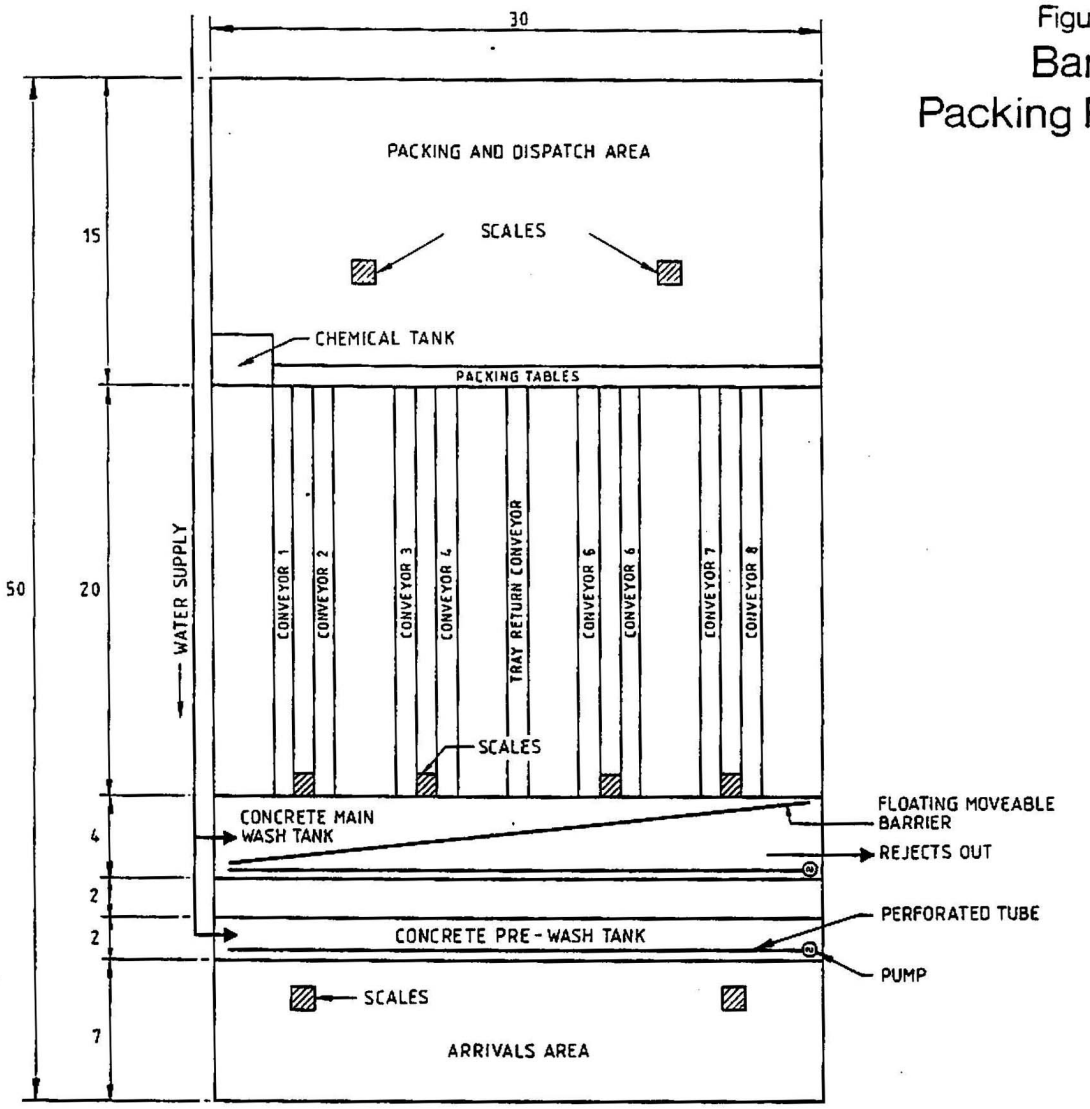
Water for the service centre would be obtained from dug wells. No piped supply would be provided initially, although this could be reviewed at a later date should funds be available.

6.7 Banana Packing Station

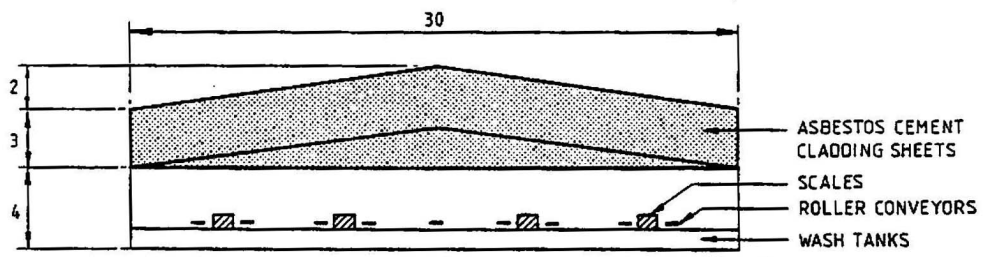
One packing station is required per 600 ha of bananas and thus five stations will be needed for the total banana area of 3 000 ha. These would be located at suitable positions within the banana areas so as to minimise distances from the banana fields and be close to main access routes. Each station would be supplied complete with all equipment including a borehole pump for fruit washing purposes and a generator. Full details are given in Annex 2, Chapter 5 and a sketch of the proposed station is shown in Figure 6.7.

One house, Type B, for the Banana Farm Manager and 4 houses, Type C, for other staff will be required at each packing station together with an office/store building. The houses would be provided with water and electricity which would be shared with the packing station supplies.

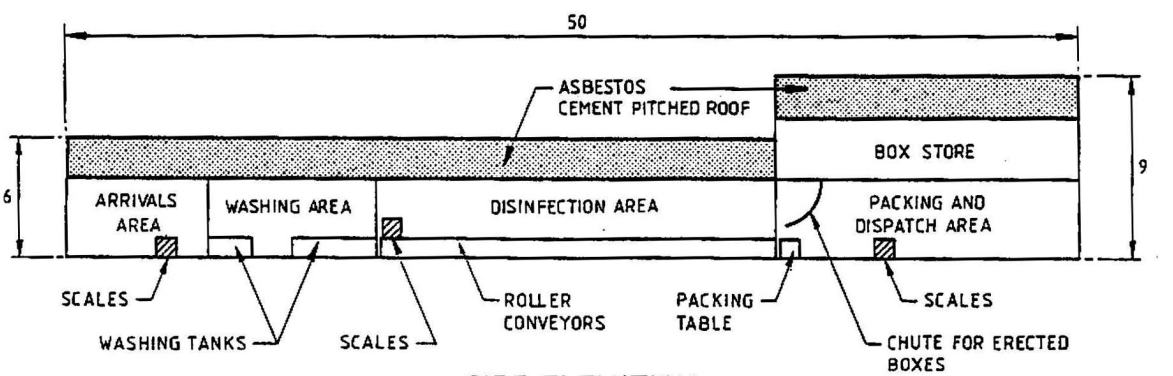
Figure 6.7
Banana Packing Plant



PLAN



END ELEVATION



SIDE ELEVATION

NOTES
1. ALL DIMENSIONS IN METRES
2. SIDE AND END CLADDING NOT SHOWN FOR CLARITY

SCALE
m 0 5 10 m

CHAPTER 7

PROJECT IMPLEMENTATION

7.1 Introduction

The Homboy project is a large and complex development, involving not only extensive civil engineering works, but the resettlement and introduction of organised irrigated agriculture to over 3 000 families. A phased development over a relatively long period is therefore essential, and the division of the irrigable area into self-contained irrigation blocks will facilitate this.

The implementation of a complete project such as the Homboy irrigation project normally involves three separate parties:

(a) the Employer (Project Authority)

(b) the Project Consultant

(c) the contractor executing the works.

The Project Consultant may be assisted by sub-consultants and other specialists, and there will probably be more than one contractor participating in the execution of the works.

Implementation concerns the organisation of three basic activities:

(a) Setting up the Employer's organisation which will ultimately operate and maintain the project.

(b) The engineering construction.

(c) The agricultural planning and execution.

This chapter deals with engineering construction: organisation, management and agriculture are discussed in Section D, and operation and maintenance are dealt dealt with in Section E.

7.2 Implementation Programme

The project is dependent on perennial supplies in the Juba river and therefore agricultural development can only take place after the construction of Bardheere dam. Assuming the dam is commissioned in the gu season, 1995, then the earliest that construction works could commence is January, 1993. This would allow the first part of the area to be cropped as soon as the dam is operational.

An implementation programme showing the commencing of design studies in 1991 and completion of construction at the end of 1998 is presented in Figure 7.1.

7.3 Construction Works

The large scale of the works makes it essential that a major contracting organisation is appointed. This could be an international contractor or a Somali contractor in association with an international contractor.

A minimum overall construction period of six years is envisaged. This implies an average development of about 1 500 ha per year which is considered reasonable.

A detailed construction programme showing the block by block development and build up of irrigable area is given in Figure 7.2. This shows that the first agricultural land becomes available two years after commencement of the works, after which there is a continual increase in area to reach the total of 8 850 ha net by the end of Year 6.

The long lead in time of two years before commissioning of the first irrigation block is necessary because of the need to construct the long Supply Canal and the flood protection works. A list of the works required to complete each irrigation block is given in Table 7.1. It has been assumed that for each block the internal drainage works would be completed with temporary outfall arrangements where necessary.

The concept of block development allows the project to be constructed if required in distinct phases. For example a two stage development of 4 075 ha and 4 775 ha could be achieved by construction of blocks 1 to 5 and 6 to 10 respectively.

7.4 Pilot Area

Due to the major works involved in bringing water to the area and providing flood protection, the project does not lend itself to the construction of a pilot area prior to the major works. In addition, a separate pilot area for bananas is provided to the south of the project as described in Annex 2. Therefore no specific pilot area has been proposed at Homboy, although part or all of Block 1 (825 ha net) could be adopted. This would require the construction of the supply canal and part of the main canal but not necessarily the flood protection works, although some temporary bunding would be required.

7.5 Project Consultant

It is usual on projects of this nature to appoint a Project Consultant at an early stage and this is recommended for Homboy. The Project Consultant would be responsible to the General Manager for co-ordinating and advising on all aspects of development. This would include:

(i) Preparation of designs and tender documents for civil works, housing and infrastructure.

(ii) Preparation of documents and obtaining quotations for procurement of the necessary plant, equipment and materials and placing orders following approval by the Project Authority.

(iii) Assistance with selection and appointment of expatriate staff.

(iv) Supervision of construction.

(v) Supervision of agricultural implementation.

(vi) Advising the Project Authority on the planning and co-ordination of the various activities, including operation and maintenance.

Figure 7.1

Implementation Programme

Figure 7.2

Construction Programme

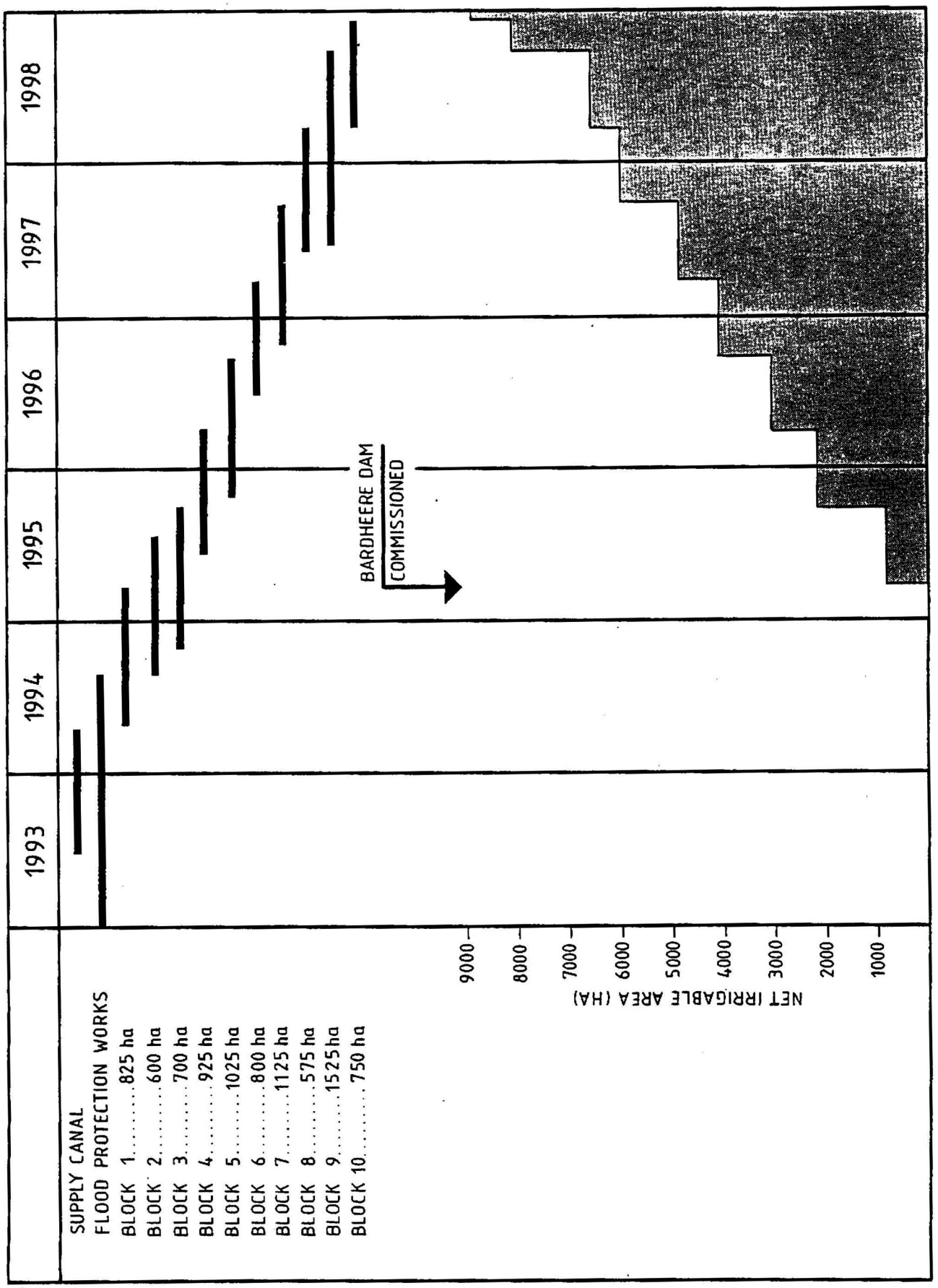


TABLE 7.1

Project Works by Block

Block	Net area (ha)	Project works Canals	Drains	Other
1	825	Supply Main km 0-2.68 H1/D2 H1/D4 H2/D1 H2/D2	Upper Outfall Drain Lower Outfall Drain D2, km 32.44-27.93 D2/17 D2/15	Eastern Reservoir
2	600	Main km 2.68-7.63 H2/D4 H3/D2 H3/D4	D2 km 27.93-25.47 D2/13	Village 1
3	700	H2/D3	D20 km 22.47-12.72 D20/4 D20/2	
4	925	Main km 7.63-11.90 H3/D1 H4/D1 H4/D6	D20 km 12.72-5.35 D2/7 D2/7/1	
5	1 025	H4/D2 H4/D2.2 H4/D4 H4/D4.2	D2 km 25.47-17.98 D2/11 D2/9	Village 2 (Homboy) Project HQ
6	800	Main km 11.90-15.38 H5/D2 H5/D2.2 H5/D4	D2 km 17.98-10.55 D2/5 D2/3	
7	1 125	H5/D1 H5/D1.1 H5/D3 H5/D3.1 H5/D3.2	D20 km 5.35-0 D18 D16 D16/2 D14	Village 3
8	575	Main km 15.38-21.10 HB1 HB1/D2 H6/D2	D6 D6/1 D2/1	Village 4
9	1 525	H6/D1 HB1/D4 HB1/D4.2 HB1/D6	D12 D10 D8	Village 5 (Burgaan)
10	750	HB2 HB2/D1 HB2/D2 HB2/D2.2	D2 km 10.55-0 D4	Bund

CHAPTER 8

COSTS

8.1 Unit Rates

The unit rates used in the engineering cost estimates have been derived from the following sources:

(a) Rates obtained from local contractors during the study period;

(b) Tendered rates for several on-going projects in Somalia, notably the Mogambo Irrigation Project;

(c) Rates for similar schemes in other parts of Africa.

The rates obtained from local contractors showed large variations and have been viewed, therefore, with extreme caution. The major source has been the Mogambo project which is close to Homboy and contains similar works.

The rates reflect the cost of the works carried out by an international contractor or a local contracting organisation with expatriate management and include contractor's overheads and profits. A list of the major rates adopted is given in Table 8.1, the rates being at early 1987 prices. Due to the recent major fluctuations in the value of the Somali shilling, the currency adopted is the US dollar. It should be noted that all the rates and costs given in this chapter are economic costs as opposed to financial costs so that no taxes or duties are included.

The costs of vehicles, machinery, water control equipment and other mechanical items which have to be imported into Somalia have been obtained from suitably qualified manufacturing firms. Included in the rates is the basic manufacturer's price, the cost of freight and, where applicable, installation and commissioning.

TABLE 8.1

Typical Unit Rates

Item	Unit	Rate (US$)
Supply of Materials		
Cement (OPC)	t	80
Cement (sulphate resisting)	t	100
Timber	m^3	210
Aggregate	m^3	40
Sand	m^3	25
Steel	t	350

TABLE 8.1 (cont.)

Earthworks	Unit	Rate (US$)
Bush clearance	ha	800
Land levelling	ha	825
Excavation for canal or drain and form embankments,		
haul < 200 m	m^3	2.75
haul < 1 000 m	m^3	3.20
haul < 3 000 m	m^3	3.50
Excavation in borrow area and form embankment,		
haul<200 m	m^3	2.15
haul<1 000 m	m^3	2.60
haul<3 000 m	m^3	2.90
Structure		
Excavation for foundations	m^3	8
Compacted backfill	m^3	6.10
Mass concrete	m^3	210
Reinforced concrete	m^3	280
Reinforcement	t	1 300
Back shuttering	m^2	22
Face shuttering	m^2	25
Stone pitching 0.3 m thick on 0.15 m thick gravel backing	m^2	30
Concrete Pipework		
0.3 m diameter on gravel bedding	m	110
0.3 m diameter on concrete bedding	m	135
0.6 m diameter on gravel bedding	m	225
0.6 m diameter on concrete bedding	m	270
0.9 m diameter on gravel bedding	m	420
0.9 m diameter on concrete bedding	m	500
1.2 m diameter on gravel bedding	m	800
1.2 m diameter on concrete bedding	m	960
Water Control Gates		
Lifting gate		
2.5 m x 1.55 m	Nr	5 500
1.8 m square	Nr	5 000
0.9 m diameter	Nr	2 000
0.3 m diameter	Nr	300
Flap gate		
1.8 m square	Nr	4 000
1.05 m diameter	Nr	1 800
Building Works		
Blockwork	m^2	25
Asbestos cement roof sheeting	m^2	18
Housing	m^2	600
Office blocks, etc.	m^2	500

8.2 Costs

Construction costs for the project have been drawn up in the form of Bills of Quantities and are presented in Tables 8.2 to 8.10. The costs have been divided into two development phases, as discussed in Chapter 7. Phase 1, com-comprising irrigation blocks 1 to 5 has a net irrigable area of 4 075 ha, and Phase 2 comprising blocks 6 to 10, has a net irrigable area of 4 775 ha. An allowance for physical contingencies of 10% has been included and an estimate made of the foreign exchange requirements.

Table 8.10 shows the total capital cost of the engineering works to be US$ 49.2 million at early 1987 prices. The estimated foreign exchange component is US$ 38.7 million which is about 79% of the total cost.

TABLE 8.2

Bill Nr 1 - Flood Protection Works

Item	Unit	Rate ($)	Phase 1		Phase 2		Total	
			Quantity	Amount ($ x 10^3)	Quantity	Amount ($ x 10^3)	Quantity	Amount ($ x 10^3)
1. Excavate Upper Outfall Drain and form adjacent embankment	m^3	2.75	251 500	692	-	-	251 500	692
2. Excavate in borrow area and form Eastern Reservoir embankment	m^3	2.15	624 300	1 342	-	-	624 300	1 342
3. Excavate drains within Eastern Reservoir area	m^3	2.15	65 000	140	-	-	65 000	140
4. Excavate Lower Outfall Drain and form adjacent embankment	m^3	2.75	201 000	553	-	-	201 000	553
5. Excavate Lower Outfall Drain and dispose of material	m^3	2.15	712 400	1 531	-	-	712 400	1 531
6. Eastern Reservoir outlet structure	Sum	-	-	288	-	-	-	288
7. Lower Outfall Drain outfall structure	Sum	-	-	408	-	-	-	408
Sub-total				4 954		-		4 954
Contingencies (10%)				495		-		495
Total				5 449		-		5 449
Foreign exchange (80%)				4 359		-		4 359

TABLE 8.3

Bill Nr 2 - Land Preparation

Item	Unit	Rate ($)	Phase 1		Phase 2		Total	
			Quantity	Amount ($ x 10^3)	Quantity	Amount ($ x 10^3)	Quantity	Amount ($ x 10^3)
1. Bush clearance	ha	800	2 000	1 600	4 500	3 600	6 500	5 200
2. Land levelling	ha	825	4 075	3 362	4 775	3 939	8 850	7 301
Sub-total				4 962		7 539		12 501
Contingencies (10%)				496		754		1 250
Total				5 458		8 293		13 751
Foreign exchange (85%)				4 639		7 049		11 688

TABLE 8.4

Bill Nr 3 - Canal and Drain Earthworks

Item	Unit	Rate ($)	Phase 1 Quantity	Phase 1 Amount ($ x 10^3)	Phase 2 Quantity	Phase 2 Amount ($ x 10^3)	Total Quantity	Total Amount ($ x 10^3)
1. Excavate in canals and dispose	m^3	2.15	312 300	671	-	-	312 300	671
2. Excavate in canals and form canal embankments	m^3	2.75	242 400	667	66 600	183	309 000	850
3. Excavate in drains and dispose	m^3	2.15	42 800	92	43 000	92	85 800	184
4. Excavate in drains and form drain embankments	m^3	2.75	138 900	382	236 500	650	375 400	1 032
5. Excavate in drains and for canal embankments, haul < 200 m	m^3	2.75	-	-	68 700	189	68 700	189
6. Ditto, haul > 200 m but < 1 000 m	m^3	3.20	77 200	247	234 300	750	311 500	997
7. Ditto, haul > 1 000 m but < 3 000 m	m^3	3.50	199 800	699	237 900	833	437 700	1 532
8. Excavate in borrow area and form canal embankments haul < 200 m	m^3	2.15	49 900	107	190 800	410	240 700	517

TABLE 8.4 (cont.)

Bill Nr 3 - Canal and Drain Earthworks (cont.)

Item	Unit	Rate ($)	Phase 1 Quantity	Phase 1 Amount ($ x 10^3)	Phase 2 Quantity	Phase 2 Amount ($ x 10^3)	Total Quantity	Total Amount ($ x 10^3)
9. Ditto, haul 200 m but 1 000 m	m^3	2.60	70 400	183	128 600	334	199 000	517
10. Ditto, haul 1 000 m but 3 000 m	m^3	2.90	44 500	129	217 200	630	261 700	759
11. Excavate field drain and form watercourse formation	km	900	30	27	120	108	150	135
12. Excavate in borrow area and form watercourse formation	km	700	470	329	480	336	950	665
13. Form watercourse channel	km	500	500	250	600	300	1 100	550
Sub-total				3 783		4 815		8 598
Contingencies (10%)				378		482		860
Total				4 161		5 297		9 458
Foreign exchange (85%)				3 537		4 502		8 039

TABLE 8.5

Bill Nr 4 - Canal Structures

Item	Unit	Rate ($)	Phase 1		Phase 2		Total	
			Quantity	Amount ($ x 10^3)	Quantity	Amount ($ x 10^3)	Quantity	Amount ($ x 10^3)
1. Supply canal box culvert 3 x 1.8 m square	Nr	66.3	1	66	-	-	1	66
2. Main canal cross regulator:								
- 3 x 2.5 x 1.55 m	Nr	160.0	3	480	-	-	3	480
- 2 x 2.5 x 1.55 m	Nr	115.0	1	115	1	115	2	230
- 1 x 2.5 x 1.55 m	Nr	50.0	-	-	1	50	1	50
- 1 x 2.5 x 1.05 m	Nr	38.0	-	-	1	38	1	38
3. Distributary canal head regulator:								
- 1 x 1.05 m diameter	Nr	17.4	1	17	2	35	3	52
- 1 x 0.90 m diameter	Nr	14.0	3	42	5	70	8	112
- 1 x 0.75 m diameter	Nr	11.2	4	45	4	45	8	90
- 1 x 0.60 m diameter	Nr	8.8	3	26	5	44	8	70
- 1 x 0.45 m diameter	Nr	6.6	6	40	7	46	13	86
4. Distributary canal cross regulator with road bridge. Weir length:								
- 8.7 m	Nr	15.6	3	47	5	78	8	125
- 6.5 m	Nr	13.8	1	14	2	28	3	42
- 4.3 m	Nr	10.6	1	11	2	21	3	32
- 2.7 m	Nr	9.4	-	-	1	9	1	9

TABLE 8.5 (cont.)

Bill Nr 4 - Canal Structures (cont.)

Item	Unit	Rate ($)	Phase 1		Phase 2		Total	
			Quantity	Amount ($ x 10^3)	Quantity	Amount ($ x 10^3)	Quantity	Amount ($ x 10^3)
5. Distributary canal cross regulator with footbridge. Weir length:								
- 8.7 m	Nr	12.5	4	50	5	63	9	113
- 6.5 m	Nr	11.0	2	22	2	22	4	44
- 4.3 m	Nr	8.5	1	9	2	17	3	26
- 2.7 m	Nr	7.5	1	7	1	8	2	15
6. Cross drainage culvert, 0.45 m diameter	Nr	11.5	2	23	-	-	2	23
7. Distributary canal escape	Nr	6.0	15	90	17	102	32	192
8. Field outlet	Nr	2.5	93	233	128	320	221	553
9. Watercourse fall	Nr	0.5	100	50	100	50	200	100
10. Watercourse road culvert	Nr	1.2	100	120	100	120	200	240
11. Watercourse cross drainage culvert	Nr	1.4	5	7	5	7	10	14
Sub-total				1 514		1 288		2 802
Contingencies (10%)				151		129		280
Total				1 665		1 417		3 082
Foreign exchange (65%)				1 082		921		2 003

TABLE 8.6

Bill Nr 5 - Drain Structures

Item	Unit	Rate ($)	Phase 1 Quantity	Phase 1 Amount ($ x 10^3)	Phase 2 Quantity	Phase 2 Amount ($ x 10^3)	Total Quantity	Total Amount ($ x 10^3)
1. Box culvert:								
- 3 x 2.0 m square	Nr	78.9	2	158	-	-	2	158
- 3 x 1.8 m square	Nr	66.3	-	-	1	66	1	66
- 3 x 1.6 m square	Nr	58.6	-	-	1	59	1	59
- 3 x 1.2 m square	Nr	49.2	1	49	-	-	1	49
2. Culvert type 4:								
- 2 x 1.05 m diameter	Nr	42.7	-	-	1	43	1	43
- 1 x 0.90 m diameter	Nr	23.4	2	47	1	23	3	70
- 1 x 0.45 m diameter	Nr	5.9	16	94	16	94	32	188
3. Culvert type 3:								
- 2 x 1.05 m diameter	Nr	23.5	1	24	1	24	2	48
- 1 x 1.20 m diameter	Nr	17.7	1	18	1	18	2	36
- 1 x 0.90 m diameter	Nr	8.8	-	-	2	18	2	18
- 1 x 0.75 m diameter	Nr	7.3	3	22	-	-	3	22
- 1 x 0.60 m diameter	Nr	5.4	1	5	1	5	2	10
4. Culvert type 3 with flap gate:								
- 3 x 1.05 m diameter	Nr	40.4	-	-	1	40	1	40
- 2 x 1.05 m diameter	Nr	28.5	-	-	1	57	1	57
- 1 x 1.20 m diameter	Nr	20.7	-	-	2	41	2	41
- 1 x 1.05 m diameter	Nr	15.0	-	-	1	15	1	15
- 1 x 0.90 m diameter	Nr	11.3	-	-	1	11	1	11

TABLE 8.6 (cont.)

Bill Nr 5 - Drain Structures (cont.)

Item	Unit	Rate ($)	Phase 1 Quantity	Phase 1 Amount ($ x 10^3)	Phase 2 Quantity	Phase 2 Amount ($ x 10^3)	Total Quantity	Total Amount ($ x 10^3)
5. Culvert type 2:								
- 3 x 1.05 m diameter	Nr	33.7	1	34	-	-	1	34
6. Underpass:								
- 2 x 1.05 m diameter	Nr	41.3	-	-	1	41	1	41
- 1 x 1.05 m diameter	Nr	27.5	-	-	1	28	1	28
7. Culvert type 1	Nr	2.4	163	391	191	458	354	849
8. Field drain culvert	Nr	1.2	10	12	20	24	30	36
Sub-total				854		1 065		1 919
Contingencies (10%)				85		107		192
Total				939		1 172		2 111
Foreign exchange (65%)				610		762		1 372

TABLE 8.7

Bill Nr 6 - Buildings and Infrastructure

	Unit	Rate ($)	Phase 1 Quantity	Phase 1 Amount ($ x 10^3)	Phase 2 Quantity	Phase 2 Amount ($ x 10^3)	Total Quantity	Total Amount ($ x 10^3)
Project Headquarters:								
1. House type A	Nr	120 000	6	720	-	-	6	720
2. House type B	Nr	60 000	20	1 200	-	-	20	1 200
3. House type C	Nr	30 000	50	1 500	-	-	50	1 500
4. Self-help houses	Nr	200	200	40	-	-	200	40
5. Office	Nr	250 000	1	250	-	-	1	250
6. Workshop	Nr	250 000	1	250	-	-	1	250
7. Store	Nr	40 000	1	40	-	-	1	40
8. Fuel station	Nr	20 000	1	20	-	-	1	20
9. Meteorological station	Nr	10 000	1	10	-	-	1	10
10. Water supply system	Sum	-	-	250	-	-	-	250
11. Electricity supply system	Sum	-	-	550	-	-	-	550
12. Fencing	km	50 000	1.6	80	-	-	1.6	80
13. Gravel roads	km	125 000	1	125	-	-	1	125
Villages and Service Centres								
14. House type C	Nr	30 000	10	300	15	450	25	750
15. Self-help houses	Nr	200	900	180	1 750	350	2 650	530
16. Office	Nr	12 000	2	24	3	36	5	60
17. Workshop	Nr	16 000	2	32	3	48	5	80
18. Store	Nr	25 000	2	50	3	75	5	125
19. Wells	Nr	3 000	9	27	18	54	27	81
20. Fencing	km	50 000	1.2	60	1.8	90	3.0	150

TABLE 8.7 (cont.)

Bill Nr 6 - Buildings and Infrastructure (cont.)

	Unit	Rate ($)	Phase 1 Quantity	Phase 1 Amount ($ x 10^3)	Phase 2 Quantity	Phase 2 Amount ($ x 10^3)	Total Quantity	Total Amount ($ x 10^3)
Banana Packing Stations								
21. Packing shed (including services)	Nr	250 000	3	750	2	500	5	1 250
22. House type B	Nr	60 000	3	180	2	120	5	300
23. House type C	Nr	30 000	12	360	8	240	20	600
24. Office	Nr	2 500	3	75	2	50	5	125
Sub-total				7 073		2 013		9 086
Contingencies (10%)				707		201		908
Total				7 780		2 214		9 994
Foreign exchange (70%)				5 446		1 550		6 996

TABLE 8.8

Bill Nr 7 - Equipment

Item	Unit	Rate ($)	Phase 1 Quantity	Phase 1 Amount ($ x 10^3)	Phase 2 Quantity	Phase 2 Amount ($ x 10^3)	Total Quantity	Total Amount ($ x 10^3)
1. Furniture for houses, offices, etc.	Sum		-	300	-	50	-	350
2. Office equipment and stationery	Sum		-	40	-	5	-	45
3. Laboratory equipment	Sum		-	20	-	-	-	20
4. Workshop equipment	Sum		-	350	-	50	-	400
Sub-total			-	710	-	105	-	815
Contingencies (10%)			-	71	-	11	-	82
Total			-	781	-	116	-	897
Foreign exchange (75%)			-	586	-	87	-	673

TABLE 8.9

Bill Nr 8 - Design and Supervision of Construction

Item	Unit	Rate ($)	Phase 1		Phase 2		Total	
			Quantity	Amount ($ x 10^3)	Quantity	Amount ($ x 10^3)	Quantity	Amount ($ x 10^3)
Estimated cost	Sum		-	2 598	-	1 851	-	4 449
Foreign exchange (80%)			-	2 078	-	1 481	-	3 559

TABLE 8.10

Summary of Construction Costs (US$ '000)

Bill Nr	Title	Phase 1		Phase 2		Total	
		Total cost	Foreign exchange	Total cost	Foreign exchange	Total cost	Foreign exchange
1	Flood protection works	5 449	4 359	-	-	5 449	4 359
2	Land preparation	5 458	4 639	8 293	7 049	13 751	11 688
3	Canal and drain earthworks	4 161	3 537	5 297	4 502	9 458	8 039
4	Canal structures	1 665	1 082	1 417	921	3 082	2 003
5	Drain structures	939	610	1 172	762	2 111	1 372
6	Buildings and infrastructure	7 780	5 446	2 214	1 550	9 994	6 996
7	Equipment	781	586	116	87	897	673
8	Design and supervision of construction	2 623	2 098	1 851	1 481	4 474	3 579
Totals		28 856	22 357	20 360	16 352	49 216	38 709

SECTION D

ORGANISATION AND MANAGEMENT

CHAPTER 1

INTRODUCTION

1.1 Original Project Concept

The project, as proposed in the 1980 Homboy study by HTS/MMP, was based on resettlement of former nomads from the resettlement project at Dujuuma with the addition of a few local farmers. The project was to have been managed by the Settlement Development Agency (SDA). Since 1980 many of the settlers at Dujuuma have either left the area or have been resettled elsewhere. At the same time the population within the Homboy area has increased and will continue to increase rapidly. By 1995 it is estimated that there will be about 3 000 farm families resident within the project area. As it is proposed that individual plot allocations should be increased from 1 to 2 or 2.5 ha the majority of project participants could be drawn from local farmers. The balance of 880 farmers required for full project development may come from the area flooded by the Bardheere reservoir; although it has been suggested that it would be better to draw people from just outside the project area who would have fewer problems in adjusting to the Homboy environment. A separate project could then be considered for the families displaced by Bardheere. In any event management of the Homboy project by the SDA is no longer appropriate.

1.2 Changes in Government Policy and 'Planners' Thinking Since 1980

Since 1980 there have been significant changes in government policy; that is, there has been a strong trend towards a mixed economy combined with a liberalisation of marketing. The role of highly centralised state institutions is being reduced in favour of decentralisation and privatisation. For those services which cannot be privatised plans are underway for strengthening existing local government institutions.

At the same time planners are placing more emphasis on a 'bottom up' approach to project planning and the development of community self-help schemes. While this is more difficult for a technologically sophisticated irrigation scheme it is realised that without effective community participation in every aspect of project development long-term project success will be difficult to achieve.

In keeping with government policy and current thinking on project planning, the first part of this section on organisation and management looks at the socio-economic organisation of the intended participants with a view to evolving systems which take into account community practices and which stand a reasonable chance of being sustained by the community in the long term. The role of government institutions operating in the project area, which could usefully play a part in the provision of project services, is also examined. This analysis has been made easier by the wealth of information provided in MJVD/GTZ/AHT reports, the GTZ/EPI publication 'Somalia - Agriculture in the Winds of Change' and unpublished papers produced by the JESS team. Further information was obtained from field interviews with farmers and officials operating in or near the project area. Chapter 8 onwards describes the proposed organisation and management structure.

CHAPTER 2

SOCIO-ECONOMIC ORGANISATION

2.1 Introduction

It is believed that the long-term success of the project depends on the extent to which the intended beneficiaries participate in the planning, implementation and evaluation of the project. Experience in Somalia and elsewhere shows that externally imposed systems, which concentrate almost entirely on the technological aspects of agricultural development, nearly always fail when external support is withdrawn; whereas, systems which emphasise the human factor and which take into account existing practices are more likely to be taken up by the beneficiaries and be sustained by them long after initial project establishment. Therefore, the purpose of this sub-section is an attempt at understanding the broader aspects of socio-economic organisation in the project area with a view to formulating an appropriate project organisation and management structure.

2.2 Socio-Economic Groups and Historical Origins

In the rural areas of Somalia it is possible to distinguish numerous socio-economic groups. At the most basic level one can differentiate between nomadic pastoralists, semi-nomadic agro-pastoralists, sedentary farmers of nomadic origin and traditionally sedentary farmers.

About 50 to 60% of the total Somali population leads a nomadic or semi-nomadic life-style. The transition from nomadism to semi-nomadism and sedentary farming has been going on for at least a century and is increasing rapidly due to drought, war and the influences of the modern state. In the nineteenth century and the early colonial period, waves of Somali nomads from the northern Somali peninsula migrated into southern Somalia in search of more fertile pastures. Around the Juba and Shebelle rivers and the inter-riverine areas they found conditions sufficiently attractive to settle and start farming. However, they tended to settle away from the tetse infested areas close to the rivers so that they could continue to keep their livestock and maintain linkages with their nomadic cousins.

Much closer to the rivers one finds sedentary farmers, many of whom were brought in as agricultural labour during the last century. These farmers keep very few livestock and provide most of the labour for the medium to large scale irrigated farms along the river banks.

So far as the project is concerned most of the participants would come from 2 000 semi-nomadic and sedentary families of nomadic origin already living in the area. The former are herders who settle and farm in the gu season while the latter still own large numbers of livestock and retain close bonds with the nomads who pass in and out of the area. Detailed descriptions of the three largest villages in the project area, that is Homboy, Burgaan and Aminow, were obtained from interviews and these will be referred to throughout the rest of this sub-section.

2.2.1 Homboy Village

Homboy is the main village of Homboy Beel, and with about 640 households (1986) is the the largest settlement in the project area.

The village was founded by a religious sheikh and his students some 60 years ago. They came from Buulo Balay, near Hiloshid. At that time the Shebelle river used to reach the village. This now only occurs every two or three years, the last time being in 1983.

Since the foundation of the village the community has grown through the continuous settlement of nomads. In the last ten years about 200 people have resettled in the village. The majority of these have come to join relatives.

Every family has a farm although less than 20% farm in the desheks. Most of the deshek farmers are related to the founding families. This does not appear to be a case of the founders monopolising the best resources because there is still plenty of land available in the desheks. It is rather a case of deshek farming requiring more labour and entailing greater risk due to the threat of flooding. About one third of the families practise semi-nomadic agro-pastoralism and nearly all families keep livestock, mainly cattle and goats. Nobody keeps camels. However, nomads bring in camels to water at the village wells during the jilaal season.

2.2.2 Aminow Village

Aminow is a small village with only 70 families situated within the Homboy Beel.

The village was also founded some 60 years ago by a nominee of the same sheikh that founded Homboy. However, the founders of Aminow came from Maanya Gaabo near Jilib and have always been sedentary farmers of Bantu origin.

In contrast to Homboy most families farm in the desheks and keep few livestock. In the last ten years no new people have settled in the village.

2.2.3 Burgaan Village

Burgaan is situated on the southern boundary of the project area and lies within Kamsuuma Beel. The village was founded about 150 years ago by the followers of a sheikh from Mauna Muffo. There are about 150 permanently settled farming families of both nomadic and Bantu origins in the village. There are also 250 houses in the village belonging to nomads who settle and farm in the gu season. Other nomads also come into the area and farm during the wet season. However, they erect their nomadic huts on their farms. Nearly all of the settled farmers farm in the desheks. The majority of villagers keep large numbers of livestock.

In the last ten years about 30 people have come to settle in the village.

2.3 Family Structure

The nomadic family units consist of extended families headed by a patriarch. These families belong to clans which tend to operate as autonomous units without rulers. However, when nomads make the transition to agro-pastoralism and sedentary farming the extended family breaks up. For example, when married they establish a new family unit with their own land and livestock.

2.4 Village Structure

For sedentary farmers living in villages the social organisation is much more hierarchical and more closely linked with state institutions than for nomads.

Each village is run by a village committee called a guddi. The village head or chairman of the guddi is known as the guddoomiye. The guddoomiye is nominated by the district party secretary. The guddoomiye in consultation with the district authorities selects the other members of the guddi. The guddis of the larger villages such as Homboy have some authority over an administrative area called a beel which contains several smaller villages like Aminow.

The main objective of the guddi is to transfer and enforce instructions from the district authorities. Other functions include land allocation and dealing with village problems as and when they arise.

Conflicts between the guddi and 'traditional' clan leaders are rare because nominations to the guddi usually take into account the preferences of traditional leaders.

The composition of the guddi seems to vary from 7 to 13 members depending on the size of the village. In each of the villages visited there were two women members on the guddi.

Each village is sub-divided into sections called hafaads. The number of hafaads depends on the size of the village. New hafaads may be formed when a new group joins a village. Homboy is divided into four hafaads.

2.5 Division of Labour

In general men are responsible for clearing land but most other agricultural operations are shared by men and women. Amongst the settled nomads young men are often occupied exclusively in looking after the family herds.

A number of different means are used to break labour bottlenecks at clearing, planting, weeding and harvesting. For example the sharing of labour between friends and neighbours is common. An example of a more institutionalised association for the sharing of agricultural labour is the barbaar. The barbaar is composed of young men and women under a leader called an aaw. These young people will help the older members of the community cultivate their farms. A more temporary arrangement for reciprocal labour sharing is the goob. A farmer will invite a large number of other farmers to work on his farm for one day in exchange for food and a promise of further assistance.

Apart from these unpaid reciprocal arrangements, farmers increasingly hire labour and tractors if available.

2.6 Land Tenure

Since the 1975 Land Reform Law Nr 73 all agricultural land is state-owned and the Government has the authority to issue land use permits to individuals or groups. Maximum size for private holdings is 30 ha of irrigated land or 60 ha of rainfed land with the exception of private banana plantations which may go up to 100 ha of irrigated land. All land is registered by the MOA. Permits are valid

for 50 years but can be extended. The leaseholder must develop the land within 2 years and is not allowed to rent, sell or subdivide the land. Private holdings can be inherited. Permits for state farms, co-operatives, municipalities, autonomous agencies and private companies are not subject to the same size and time limits. Permits can be cancelled if their conditions are not adhered to or if the land is nationalised for the benefit of the economy in general. Farmers who have their registered land repossessed by the state are eligible for compensation. The compensation payable depends on the value of the improvements carried out by the farmer.

In practice very few smallholders have registered their land; for example, in Homboy only five farms have been registered, in Burgaan two and in Aminow none. One reason for the low level of registrations may be that farmers are trying to avoid paying land taxes. Another reason may be the ignorance of smallholders with regard to the law and the complex, time-consuming and expensive procedures.

Where land is not registered, land tenure is still based on traditional customary rights. That is each village has claims on an area which includes common and private land. Common land is used for grazing and for collecting firewood and other useful materials. Private land consists of housing and farmland owned by household heads. Even widowed and divorced woman can own land and become household heads. The owners of private land may pass it on to their children or lease or sell it to others from the village or outside.

The purchasing, selling and leasing as well as the distribution of common land are controlled by the village committees or sheikhs who charge an appropriate fee. Outsiders who acquire common land or buy or lease private land have to cultivate it. If they stop cultivating for more than 2 years the land use right reverts either to the community or to the previous owner.

Conflicts between farmers and nomads are rare as herdsmen are allowed to graze their livestock on crop residues remaining in harvested fields.

Allegations of 'land grabbing' have been made. This has arisen because civil servants as well as an increasing number of businessmen have started investing in agriculture since the deregulation of marketing. Not unnaturally there is greater interest in the most fertile land with irrigation facilities and easy access. Careful consideration will therefore have to be given to protecting the interests of farmers already resident in the project area and in the allocation of individual plots.

2.7 Traditional Cropping and Livestock Practices

While the farmers in the project area vary in their degree of sedentariness, in their relationships with nomads and the importance of livestock in their farming system they are all smallholders and practise a similar rainfed cropping system.

The risk of crop failure due to drought is ever present and the main objective of the cropping system is to ensure family survival under all but the most extreme conditions. The strategy includes planting in desheks, intercropping, planting at wide spacing to reduce competition for moisture, use of drought-resistant crops and varieties.

There are two rainy seasons. The most important is the gu season from March to June. In the der season, from September to December, there is a higher risk of crop failure due to insufficient rainfall. Nearly all the farmers have access to desheks which are flooded by rainwater and surface runoff. Every two or three years the desheks are flooded by the Shebelle although excessive flooding sometimes destroys immature crops.

The main crops grown in the project area are:

	Deshek	Dryland
Gu	maize cotton sesame (if cotton flooded)	maize cotton groundnuts
Der	sesame sorghum cowpeas tomatoes watermelon	sorghum sesame

Maize, sorghum and cowpeas are the staple foods, whereas cotton and sesame are the main cash crops. All planting is done on the flat and in rows. Maize is planted with the early gu rains and intersown 6 to 8 weeks later with sesame, cotton, cowpeas or groundnuts. Similarly, cotton, cowpeas and groundnuts may be intercropped with sesame. Sorghum is grown as a sole crop.

Cotton is the most important cash crop in the project area. Somaltex provides seed, sacks and pesticides when necessary. Somaltex also provides interest free credit and tractor hire services as well as buying all of the cotton produced.

Whenever possible farmers like to hire tractors for land preparation either from Somaltex, ONAT or private large scale farmers. The use of tractor hire services varies between villages; for example, in Burgaan it was claimed that all farmers hired tractors; in Homboy the figure was less than half, while in Aminow, the poorest of the villages, only a few farmers could afford tractor hire. Most farmers believed that limited access to tractors was a major constraint on production. No farmers used animal traction.

Other than for cotton, inputs such as improved seed, seed dressing, other pesticides and fertiliser are not available and it is assumed that farmers would require considerable training in their use. Moreover, farmers do not even seem to be aware of the value of farmyard manure.

Most farmers plant and store their own seeds. A high seed rate is used to compensate for poor germination under dry conditions. Crops are intentionally planted at wide spacing to save labour and to reduce moisture stress. While the low population density reduces yields it does help to minimise the risk of crop failure in very dry years. Re-sowing and gapping are common practice.

Weeding is a major labour bottleneck. Those farmers that can afford it employ hired labour but the demand for labour at this time causes wage rates to rise.

Farmers complained that their crops were often damaged by wild animals, particularly, rats, baboons and monkeys; however, no mention was made of damage inflicted by domestic and nomads' livestock.

Maize and sesame are usually cut and stacked in the field for further drying. Sometimes cobs are removed from the stalks and taken directly to the villages. Yields are generally low. Crop residues are collected and kept in trees.

Crops are commonly stored in pits covered with a layer of maize stalks and earth. Storage losses are estimated to be as low as 5% to 10%. It is also common practice to store grain in trees or in sealed 200 litre cooking oil drums that can be bought from merchants for SoSh 1 000.

Livestock provide additional security against crop failure and add considerably to family income. Most villagers keep some animals, mainly cattle, goats and sheep. Some of the village livestock graze in the surrounding common land. Lactating cattle are herded together and brought into the villages at night. Larger herds of cattle and camels are looked after by farmers' relatives. In the dry seasons the herders and nomads bring their livestock into the villages to water at the village wells.

2.8 Transport

The majority of farmers in the project area use carts drawn by oxen rather than by donkeys because of problems with tetse and ticks.

There are very few owners of vehicles in the project area. In Homboy there were two small pickups and three large lorries, while in Burgaan and Aminow there were none.

Other transport comes into the villages especially during the maize and cotton harvests; for example, lorries come into Homboy three times a week bringing goods for the 31 shops. Transport also comes into Homboy to pick up about 150 people employed on the Fanoole project.

2.9 Traditional Trading Patterns and Contemporary Marketing Systems

Traditionally there has always been exchange in kind between nomads and farmers of livestock products for food crops and household articles. It now appears that all transactions are conducted in cash. Nomads' access to crop residues seems to be free.

Surplus grain is sold to private traders or to neighbours. Higher prices are obtained in the markets of the main villages such as Homboy and Kamsuuma, which have covered markets with concrete floors, and the district centres of Jilib and Jamaame.

Cotton is sold to Somaltex. The price is agreed before planting and Somaltex collects the crop from the villages.

Sesame is sold to local mills or to private traders who come mainly from Mogadishu.

ADC buyers also come into the villages but their prices are lower than private traders.

2.10 Farmers' Attitudes towards Government Institutions, the Project and New Ideas

In general, it can be said that farmers are wary of government intervention in that government has the power to appropriate land, levy taxes and to force them to carry out instructions which they would not otherwise willingly perform. Therefore, it would be necessary for the project to win farmers' confidence from the outset.

All of the farmers interviewed were aware that the area had been designated for a major irrigation scheme. They were ignorant of the timescale or the way in which the project would be carried out. They were enthusiastic towards the scheme although they were concerned that a large number of unwanted settlers would be attracted to the area. When it was mentioned that the project would involve development of nearly all of their rainfed land and re-allocation of 2 to 2.5 ha plots per household head they became most agitated about the project implications. The village heads with larger than average farms complained that equal allocations would be unfair on them as they had to support larger families.

It is evident that annual production has increased considerably since 1982 when the enforced sale of produce to ADC was abolished. Just as these farmers have responded to price incentives, it is expected that they will rapidly adopt appropriate technical inputs provided the outputs can be easily marketed.

2.11 Implications for Project Design

There can be no doubt that the implementation of the project will involve major changes to villagers' traditional way of life. In the interests of the villagers and long-term project success, it would be necessary to involve participants in planning and preparation of the project. It has been noted that village committees already exist. The implications of the scheme would have to be explained to the village committees and villagers at an early date. Representatives of the village committees would then be invited to participate in project planning committees.

To ensure effective farmer participation in water management, maintenance of infrastructure and other services, the basic unit of project organisation and management at the watercourse unit level should be some form of farmer organisation. While various voluntary labour groups already exist, the project's farmer organisations would require a higher degree of co-operation than is presently practised. The project would have to provide considerable guidance in the formation and modus operandi of these organisations. Because it is not known how different socio-economic groups would work together it is recommended that participants should be left to form their own, hopefully compatible, groups.

Clearly the most contentious issue would be the allocation of plots. The present rush for land by outsiders and absentee farmers could endanger the rights of existing residents. Therefore, farmers should be encouraged to register their land at the earliest opportunity. Once the farmer organisations have been formed, the project would, in consultation with the village committees, allocate each farmer organisation to a watercourse unit. Individual plots could then be allocated to household heads. Farmers with more than one wife and larger than average families may be deemed to have more than one household and could be made eligible for additional plots.

The transition to high input irrigated cultivation of new and traditional crops would require an intensive training and extension programme to begin operation before irrigation commences.

The large numbers of livestock owned by farmers and nomads in the project area could cause considerable damage to irrigation infrastructure and crops. The project would have to provide watering and feeding points for livestock outside the irrigated area as well as walkways through the project. In addition, farmer organisations would be encouraged to accept responsibility for providing security against livestock vandalism.

There should be an abundance of crop residues for livestock feeding which would have to be removed from the field to permit timely operations.

Figure 3.1

Organisation of Ministry of Agriculture (MOA)

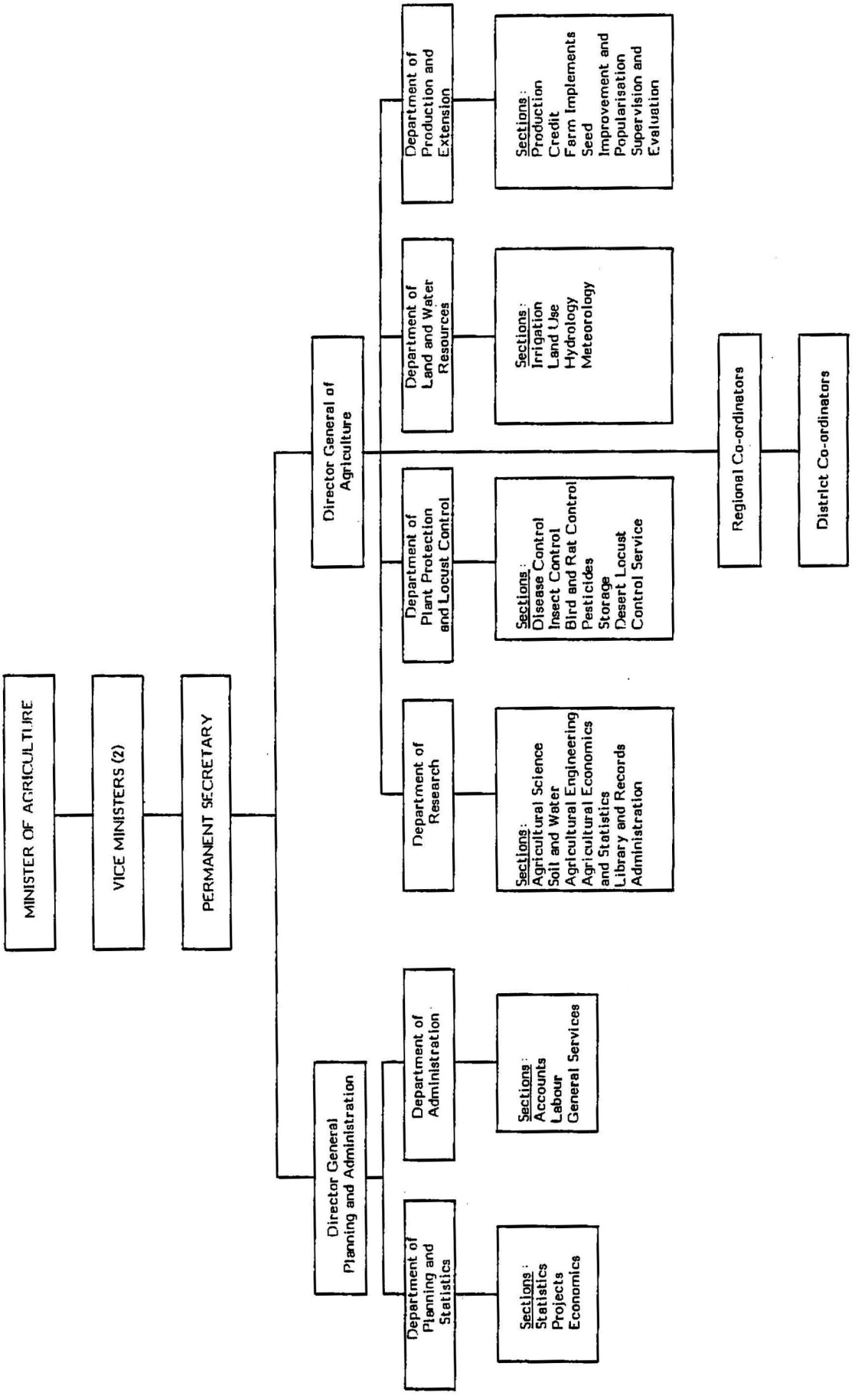
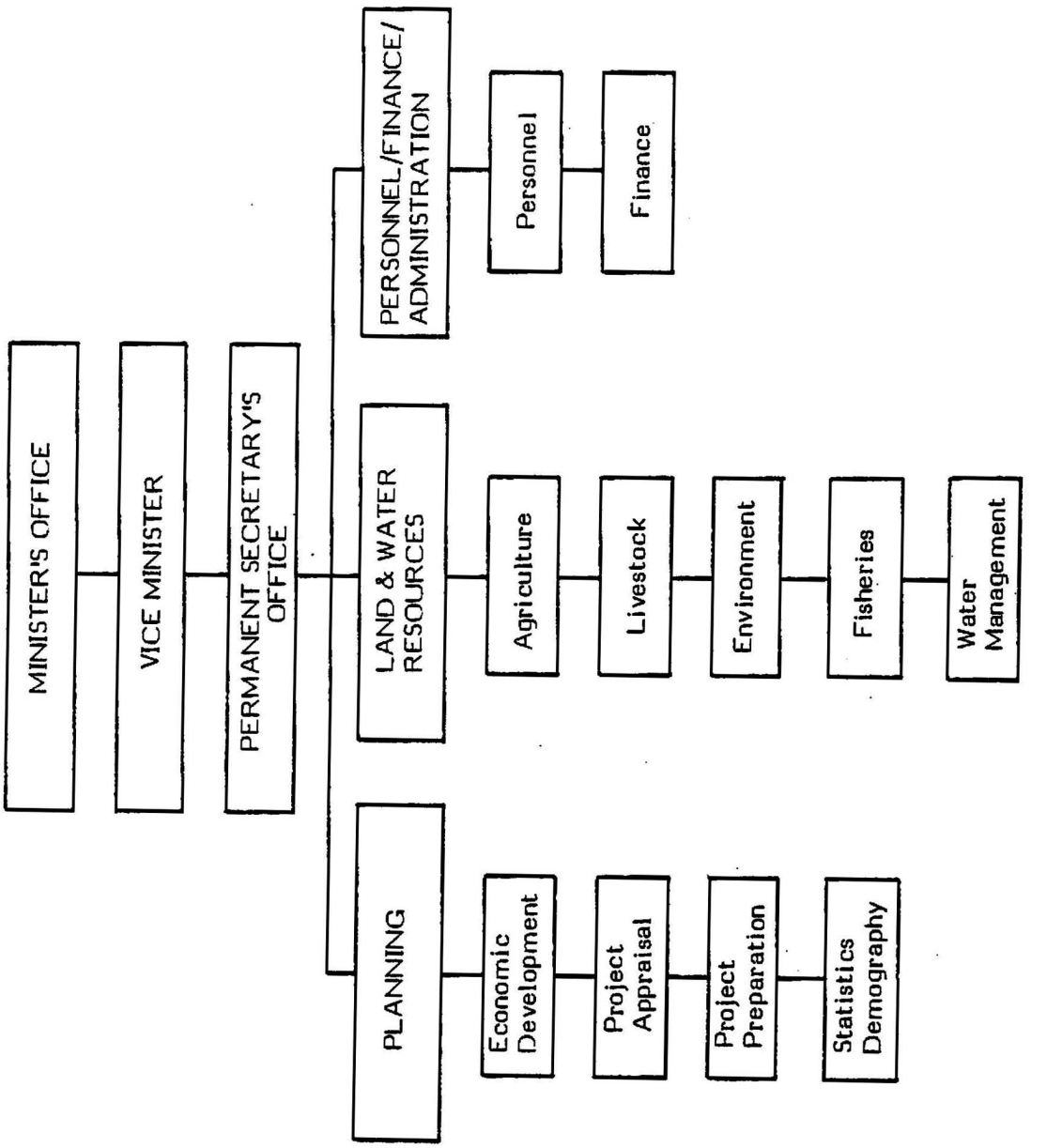


Figure 3.2

Present Structure of Ministry of Juba Valley Development (MJVD)



CHAPTER 3

INSTITUTIONAL FRAMEWORK

3.1 Introduction

This sub-section looks at the structure and administration of government relevant to the project with a view to making recommendations on the inter-linkages between these structures and the project.

Somalia is administratively divided into regions, districts, sub-districts and villages. One can also distinguish between three different structures; that of the Ministry of the Interior, that of the sectoral ministries, such as the Ministry of Agriculture (MoA), and the party structure.

3.2 Central Government

The Ministry of the Interior is primarily responsible for the administrative control and maintenance of peace and security within the country. It is also responsible and increasingly involved in the promotion of rural development.

So far as the project is concerned, the most important sectoral ministries are the MoA, the MJVD and the Ministry of Finance. The organisation of the MoA is shown in Figure 3.1. It has both implementing and co-ordinating functions at every administrative level. The organisation of MJVD is shown in Figure 3.2. MJVD is responsible for the economic and social development of the Juba valley. Its main functions are the planning and promotion of government and private projects in the valley. It has no staff below central government level and, at present, lacks the resources to manage projects.

Also under the responsibility of the sectoral ministries come the semi-autonomous agencies, such as ONAT (the national machinery hire service), which are also represented at regional district levels.

Either the MJVD or MoA could run the Homboy Project. The question of which Ministry should do it is outside the scope of this study and is being considered by Price Waterhouse in their current "Study of Institutional and Organisational Development of the Ministry of Juba Valley Development and other Ministries and Agencies concerned with the Bardheere Dam Project," which is being undertaken for the MJVD.

3.3 Regional Level

The project comes within the Middle and Lower Juba regions. Central government is represented by the Governors who reside at Bu'aale and Kismayo respectively. the Governors are responsible for executing the instructions of the Ministry of the Interior as well as supervising and co-ordinating all government activities in their regions.

The MoA is represented by Regional Co-ordinators also at Bu'aale and Kismayo.

3.4 District Level

The northern part of the project is located in the Jilib district of the Middle Juba region while the southern half of the project area lies in the Jamaame district of the Lower Juba region.

The Governors are assisted at district level by District Commissioners. The MoA also has District Co-ordinators at Jilib and Jamaame. The functions of the agricultural co-ordinators include land registration, crop protection, input supply and flood protection. Their extension function has been taken over by AFMET which is discussed in the next chapter on agricultural services.

Another important body at the district level is the Local Peoples Assembly (LPA). The Chairman of the LPA is called the Mayor and he is the highest authority in the district. The LPAs are responsible for governing their districts. They have the power to collect taxes and other contributions as well as inspect and control all government activities in their districts. They are also responsible for appointing village committee chairmen and members.

3.5 Sub-district and Village Levels

The main villages are designated as sub-districts called beels. Homboy is the only beel within the project area and belongs to Jilib district. Beels have some authority over an area which includes several smaller villages; for example, Aminow comes under Homboy beel while Burgaan comes under Kamsuma beel. The latter beel is located outside the project area. Each beel and village has a committee or guddi consisting of seven persons. The Chairman of the guddi is always appointed by the district authorities. The Chairman in consultation with the district authorities then appears to select his fellow members. The guddis are responsible for carrying out the instructions of government as well as dealing with general village problems.

3.6 Issues Relevant to Project Design

The creation of semi-autonomous projects has long been favoured by financing agencies and project planners as a means of bypassing bureaucratic and inefficient government ministries. Unfortunately, the proliferation of independent projects does lead to duplication of services and costs. When resources are limited competition for those resources further weakens government services. For example, there is a shortage of skilled staff in Somalia and to attract and retain competent personnel projects not only offer better conditions of service than the ministries but they are also forced to compete with one another. Newer projects flush with foreign aid and projects which are popular with the government can offer better terms than projects which have exhausted their foreign aid or lost favour. As a consequence the best staff leave the ministries and leap-frogging from one project to another is common.

It is desirable to avoid duplication of services, the creation of new structures and administrative systems but this can only be done if there are national and regional plans to rationalise and strengthen existing services. Homboy would be an enclave project. Its limits are defined by the area under irrigation and although it only covers some 14 000 ha it straddles two district and two regional boundaries. It would not be possible for such a small project to strengthen all of the national, regional and district institutions operating in the project area. What the project can do is to strengthen the ability of project beneficiaries to maintain and operate many of their own services.

Those services which cannot be managed by the community would have to be managed and co-ordinated by a Project Management Unit (PMU). Some of these services could be provided by other government institutions and the next sub-section looks at those institutions which could play a role in the project. However, if the PMU is to operate efficiently it would have to have the power to take management decisions without constant referrals to a parent ministry. The project must also have the authority to administer its own budget.

While it is argued that the project should be given semi-autonomous status, the project should also establish formal co-operation with local government as well as the structures of useful sector ministries and their agencies. The Governors, Regional and District Co-ordinators, LPAs and village committees should be involved in planning and be kept informed about project implementation. This could be achieved by inviting representatives from these different institutions to participate in various project advisory committees.

CHAPTER 4

AGRICULTURAL AND LIVESTOCK SERVICES IN THE PROJECT AREA

4.1 Introduction

The provision of agricultural and livestock services in the Juba valley has been analysed in some detail by AHT (AHT, 1984) and a more up-to-date overview of agricultural services in Somalia has been provided by Bogulawski (EPI, 1986). In general, government services are very weak and have been neglected in favour of semi-autonomous projects independent of government services. At the same time government policy has until recently relied on government intervention and state control of all services. Government policy now emphasises privatisation of services and strengthening of existing services which cannot be privatised. The purpose of this sub-section is to examine the operation of agricultural and livestock services within the project area with a view to making recommendations on the organisation of project services.

4.2 Agricultural Extension

Compared with other African countries the level of agricultural extension in Somalia has been very limited. There are two organisations providing technical advice to farmers in the project area; AFMET and Somaltex.

4.2.1 AFMET

In the late seventies a National Extension Service (NES) was formed under the MoA Department of Production and Extension. In 1980 the NES was taken over by a multi-financed Agricultural Extension and Farm Management Training Project (AFMET). The main objective of AFMET is the expansion and strengthening of the NES by improving pre-service and in-service training and through the application of the Training and Visit System (T&V). The project management unit was constituted as a separate and semi-autonomous department under the MoA with its headquarters at Afgoi. Figure 4.1 shows AFMET's organisational structure.

The T&V system adopted by AFMET follows the standard model except that Field Extension Agents (FEAs) attend monthly two-day training sessions conducted at three Extension Training Centres (ETCs). Otherwise FEAs are expected to keep a fortnightly schedule of visits to 48 contact farmers divided into eight groups. Each group comprises 60 to 70 farm families giving an FEA to farm family ratio of 1 : 500. In practice the ratio is nearer 1 : 900. Initially the system emphasises individual contacts but over the last 3 years FEAs have been expected to visit individual farmers in the morning followed by a group meeting in the afternoon. The fields of progressive farmers are used as demonstrations for other farmers. Visits are also supplemented by regular field days. To date extension messages have concentrated on rainfed farming because of the shortage of research recommendations on irrigated agriculture. Moreover, AFMET has concentrated on the Lower Shebelle, Middle Shebelle and Bay regions.

In 1983, AFMET extended into the Juba regions. The Regional Extension Officer (REO) for both Middle and Lower Juba regions is located at Yontoy with three District Extension Officers (DEOs) at Jilib, Jamaame and Kismayo. There are thirteen FEAs in the two regions. One of these is supposed to be stationed at Homboy and another at Kamsuma but neither of these FEAs were living in their

respective villages and there was little evidence of an extension programme. The REO was not aware of this situation because his Land Rover had been broken down for 6 months and none of the FEAs have working motorbikes. The problem is that AFMET's first phase funding ended in early 1986 and the second phase is still in preparation. The second phase is expected to continue until 1992. The emphasis will be on consolidation rather than expansion. There will be a small increase in the number of FEAs to arrive at a ratio of one FEA to 800 farm families. Training and supervision will be improved. At present the Juba region FEAs attend monthly training sessions at Genale. However there are plans to build a training centre with a 30-bed dormitory at Yontoy. The ETC will also be used for farmer training.

So far as the Homboy project is concened, the AFMET FEA coverage is too low. An irrigation scheme requires a more intensive FEA to farm family ratio. Moreover, AFMET concentrates on rainfed farming and the training content is generalised, whereas the needs of the Homboy project would be very specialised. The project would require its own extension staff and an extension and training system specifically tailored to project conditions. The T&V system can be adopted but more emphasis would have to be given to group contact and more frequent field training. AFMET could play a useful role providing: linkages with research, training facilities and occasional subject matter specialists, as well as audio-visual aids.

4.2.2 Somaltex

Somaltex is a state owned company under the Ministry of Industry, which has the monopoly on cotton buying and processing. In addition to providing marketing facilities Somaltex is actively involved in encouraging farmers to grow cotton. Technical advice is offered as part of a package which includes free seed, interest free credit, tractor hire and pest control. While the company has its headquarters in Mogadishu farmers in the Juba valley are serviced from Jamaame. Most of the farmers in the project appeared to grow cotton in the gu season and had received far more assistance from Somaltex than AFMET. The different components of the Somaltex package will be explained under the appropriate headings but there seems no reason why project farmers should not continue to take advantage of Somaltex services. The project could help by providing a co-ordinating role and establishing formal linkages with Somaltex. For example Somaltex would be asked to provide subject matter specialists for cotton related training sessions.

4.2.3 Somalfruit

The role of Somalfruit is explained in detail in Chapter 6. While there are no banana growers in the project area at the present time it is envisaged that banana production would become a significant component of the project. As with Somaltex, the project would take advantage of technical advisory services provided by Somalfruit through its technical office in Arare near Jamaame and would need to establish appropriate linkages with the company.

4.3 Research

The MoA Department of Research is responsible for agricultural research in Somalia. Most of the research on irrigated crops is carried out at the Central Agricultural Research Station (CARS) at Afgoi. Some research on irrigated crops

Figure 4.1

Organisation of AFMET

is also being undertaken at Alessandra research station in Jilib district and on the Mogambo project. CARS suffers from a severe shortage of qualified staff and as with all public sector institutions low pay and inadequate resources result in a meagre output. It is expected that agricultural research will be strengthened before project implementation begins. Therefore, no provision for a major project research component should be made. The project would establish linkages with research through AFMET and the project's subject matter specialists would be required to visit research stations regularly. The project could also carry out some on-farm trials under the guidance of AFMET, and the CARS or Alessandra research stations.

4.4 Input Supply

The present input supply system is fragmented and inefficient. Inadequate amounts of inputs are imported because of foreign exchange constraints. It was hoped that the construction of a urea manufacturing plant in Mogadishu would provide adequate sources of nitrogen. However, it appears that the level of production will never be sufficient or cheap enough to meet demand. Inputs are distributed through ADC, ONAT, MoA, AFMET, Somaltex and Somalfruit. Only Somalfruit is in a position to meet the needs of the banana sector. So far as the project area is concerned only cotton farmers have access to seed and pesticides supplied by Somaltex.

4.4.1 Somaltex

One person in each village takes a list of the farmers who want to grow cotton and how many hectares each has. This list is then given to Somaltex so that they know how much seed is required. The seed is delivered to the villages. The company also provides insecticides and a spraying service.

4.4.2 Somalfruit

Somalfruit supplies fertiliser and pesticides to banana growers. Inputs are purchased with foreign exchange earned from banana exports.

4.4.3 MoA

The MoA Plant Protection and Pest Control Department is supposed to provide insecticides and fungicides free of charge when outbreaks of pests and diseases occur. In practice the department does not have the inputs or the transport to meet demand. For example the Regional Co-ordinator in Kismayo, who is himself a plant protection specialist, explained that it has only a small amount of seed dressing available and that he is the only officer in the region with transport.

4.4.4 AFMET

In 1983 AFMET was supposed to take over responsibility from ONAT for the import and distribution of inputs. In practice very few inputs were procured and AFMET's second phase plans make no provision for input procurement or distribution.

4.4.5 ADC and ONAT

Both ADC and ONAT have been responsible for input procurement and distribution. In 1986 ADC and ONAT had 35 and 21 distribution points respectively. Both have stores in Jilib and Jamaame districts but neither organisation has sufficient foreign exchange to procure inputs.

4.4.6 Seed Supply

A Seed Production and Improvement Project under the direction of the Seed Multiplication Centre within the MoA Department of Production is responsible for the production and distribution of seed. To date insufficient seed has been produced and has only been issued to large scale farms.

4.4.7 Project Implications

Timely and adequate supplies of inputs are clearly crucial to project success. Unless one body is given overall responsibility for input procurement and provided with sufficient resources to carry out this function effectively the project would have to be provided with sufficient foreign exchange to purchase its own inputs. Procurement should be co-ordinated by the project management unit but could be organised in such a way that it strengthens the ability of commercial agents to import commodities. Similarly, some centralised project distribution system would be required but commercial retailers could be encouraged to on-sell smaller amounts.

4.5 Credit

Potential courses of credit in the Juba valley are the Somali Development Bank (SDB), the Commercial and Savings Bank of Somalia (CSBS), Somalfruit and Somaltex. But apart from banana and cotton growers the vast majority of farmers have no access to credit. A major problem is the lack of farmers collateral as all land is owned by the state and land permits are non-negotiable.

4.5.1 Somali Development Bank

The SDB is a limited company under the Ministry of Finance. The shareholders are all state agencies. The nearest branch to the project area is at Kismayo.

The bank only provides medium-term loans up to 5 years to a few large scale farmers for the purchase of machinery and equipment.

4.5.2 Commercial and Savings Bank of Somalia

CSBS is a purely government institution which also comes under the Ministry of Finance. It has a more extensive network than SDB. For example, it has branches in regional and district centres such as Jilib and Jamaame. CSBS does provide short-term loans up to one year but nearly all its loans go to the trade and commercial sectors. A few loans are now being given to the agriculture sector under an FAO pilot project but it is too early to evaluate the results. Loans have also been provided to finance livestock exports.

4.5.3 Somalfruit

Somalfruit provides banana growers with inputs such as fertiliser and pesticides on short-term credit. Medium-term credit is also available. Credit repayments are deducted from sales to Somalfruit. As the project would have a large number of banana growers and its own packing sheds, the smallholders could take advantage of this service. Co-ordination would be provided by the Project Management Unit (PMU) and the banana packing stations.

4.5.4 Somaltex

Cotton growers receive interest free loans for tractor hire, insecticides and labour. Repayments are deducted from cotton sales. This is the only source of credit which has been used by farmers within the project area. It appears to have worked well and should continue to be taken advantage of.

4.5.5 Project Implications

Because of past poor repayment records, lack of security and the cost of administering small loans, neither the SDB nor CSBS are well disposed towards providing short-term pre-season loans to smallholders. The credit requirements of banana and cotton growers could continue to be taken care of by Somalfruit and Somaltex respectively. The project would assist with co-ordination. However, there is also a need to provide credit for growers of other crops for tractor hire and input purchases. As the project will have to provide staff to administer the recovery of service costs the same personnel could be used to administer a revolving credit fund to project farmers. To encourage repayment, credit should be disbursed to individuals through groups. Should an individual farmer fail to pay back his loan none of the group would be eligible for credit the following season. In this way it is expected that group sanctions would force the individual to repay.

4.6 Mechanisation

Farm machinery services are provided by ONAT (Organisazione Nationale Altresi Trattore), Somaltex, Somalfruit and some private large scale farmers.

4.6.1 ONAT

ONAT is a semi-autonomous institution under the MoA whose main objective is providing a machinery hire service to private farmers and projects for land preparation. ONAT is also involved in the construction of irrigation and flood control measures. The ONAT facilities nearest to the project are found at Jilib and Jamaame. However, ONAT is unable to meet the demand for machinery services in the project area. Not only is the quantity of equipment inadequate but the level of operating efficiency is very low due to shortages of skilled staff, fuel and spare parts. The service is heavily subsidised. Operators are poorly paid. Homboy farmers complained that it was necessary to provide food and special payments to ONAT drivers to induce them to work on their farms.

4.6.2 Somaltex

Somaltex keeps two tractors permanently fueled and stationed in Homboy to serve cotton farmers. Two farmers have been trained to drive the tractors. Farmers prefer to use Somaltex rather than ONAT tractors but demand is greater than supply.

4.6.3 Somalfruit

Somalfruit offers equipment hire services to banana growers. However, it is unlikely that the company would be able to meet the demand from the planned number of banana growers on the project.

4.6.4 Project Implications

There is no reason to believe that a fresh injection of capital into ONAT for the procurement of additional equipment and spare parts would result in an improved service. Experience in most countries shows that government operated machinery hire services are costly and inefficient. On the other hand equipment operated by commercial concerns and private individuals who have an interest in optimum utilisation and maintenance is cheaper and lasts longer. Somalfruit and Somaltex presently offer a reasonable service to banana and cotton growers but they would not be able to meet the demands of all the project's farmers. Mechanisation is one of the project components which could be privatised. The project could procure equipment and spare parts but the operators would not be permanently employed by the project. The project would train operators from the project area and through various leasing, renting and contractual arrangements encourage these operators to run their own machinery hire services.

4.7 Livestock Services

The Department of Animal Health of the Ministry of Livestock, Forestry and Range (MLFR) is responsible for veterinary services and vaccination campaigns. There are officers in every district including one officer located at Homboy. Shortages of transport, drugs, equipment and qualified staff hamper this service.

Livestock improvement would not be a major project component but the importance of livestock to project farmers has to be recognised. The project would provide surplus crop residues for livestock feeding. Extension in improved feeding practices could be included by attaching a livestock subject matter specialist to the Training Department. Similarly, the project would want to ensure that project farmers have access to veterinary services. The MLFR officer in Homboy could be given project assistance to carry out his work more effectively.

4.8 Crop Marketing

Crop marketing was formerly the monopoly of the state owned Agricultural Development Corporation (ADC). Prices were fixed so low that farmers had very little incentive to produce a surplus. Since 1983, ADC has become the buyer of last resort as marketing has been liberalised and farmers are free to sell to private traders. Banana and cotton crops are purchased by Somalfruit and Somaltex respectively.

4.8.1 ADC

ADC has an extensive network of stores covering the country including stores at Jilib and Jamaame. ADC buyers continue to come into the villages after harvest but as they offer lower prices than private traders they can only mop up unwanted surpluses.

4.8.2 Somaltex

Somaltex has the monopoly on cotton buying. At the beginning of each season farmers are told how much they will be paid for cotton at the end of the season. After harvest the cotton is collected from the villages and taken to the ginnery at Balad. Another ginnery at Jamaame, and closer to the project, is no longer in use. Future Somaltex plans include rehabilitation of the Jamaame ginnery.

4.8.3 Somalfruit

Somalfruit provides a market for export quality bananas. Their service includes packing and transport. The prices and service offered to producers seems quite attractive as the area under production is expanding rapidly.

4.8.4 Private Traders

The purchase of surplus grain by private traders works efficiently and should not be interfered with.

4.8.5 Project Implications

The PMU could usefully co-ordinate with Somaltex, Somalfruit and ADC on behalf of project farmers. Representatives from these institutions would be invited to participate in various project advisory forums. In addition, the project could encourage the development of specialist producers associations to better serve the interests of individual producers. The project would also have to provide packing facilities for banana producers. Otherwise the marketing of most crops should be left to the open market.

CHAPTER 5

MANPOWER DEVELOPMENT AND TRAINING IN SOMALIA

5.1 Introduction

Somalia suffers from a lack of trained technical and managerial personnel. This situation is compounded by the emigration of skilled and professional staff to the Gulf States and elsewhere in search of better conditions of service.

5.2 University of Somalia - Faculty of Agriculture

The Faculty of Agriculture of the Somali National University was established in 1971 and is located at Afgoi near Mogadishu. The faculty is divided into six departments:

Plant Production and Protection
Agricultural Engineering (Farm Machinery and Irrigation)
Agricultural Economics
Animal Husbandry
Agricultural Chemistry (Soil Science and Food Science)
Range and Botany (funded by USAID)

There are 8 expatriate and 38 Somali staff. The faculty has an enrolment capacity of up to 60 undergraduates each year selected from holders of the secondary school certificate that pass an admission examination. The syllabus is similar to that offered by the University of Florence. For the first two years students follow a common curriculum. From the third year they specialise in several options leading to a BSc degree in General Agriculture after four years. About 30 students graduate each year. The faculty does not aim to produce irrigation engineers but in the future there are plans to offer more courses in irrigation and drainage. There is very little emphasis on practical training. The faculty does not have its own farm but has access to MoA facilities nearby. Most graduates are recruited by the MoA and related institutions.

5.3 Agricultural Secondary Schools

Basic agricultural training for field assistants is provided by agricultural secondary schools of which there are seven in Somalia. Training is for three years and leads to a Certificate in Agriculture. Three of the schools come under the Ministry of Education and the other four under AFMET. Of the AFMET schools two are located in the north, one at Jowhar and the other at Afgoi. In practice only the school at Afgoi received support from AFMET in the first two years of the project but with the cessation of external funding, teaching stopped from early 1984 until late 1985 and the supply of graduates was frozen. AFMET's 1986 second phase proposals include plans to support the schools at Afgoi and Jowhar by providing them with buildings, equipment, training materials and teaching staff.

5.4 Farm Management and Extension Training Centre

Since the National Extension Service was brought under the AFMET project all extension staff and farmer training has been conducted at the new Farm Management and Extension Training Centre (FMETC) at Afgoi, and Extension Training Centres (ETCs) at Genale, Jowhar and Bonka. Training is provided in the form of short one to four week pre-service and in-service courses for both field and supervisory staff. In addition, farmers' training courses have been carried out once a season for selected contact farmers, as well as courses for farmers from refugee camps. Second phase proposals include plans to establish an ETC at Yontoy near Jamaame. Facilities would include a dormitory capable of accommodating 30 persons, a classroom, kitchen and refectory. These facilities could be used on occasion by the Homboy project. The lack of irrigation facilities however does not make the centre an ideal venue for training Homboy staff and farmers.

5.5 Other Projects In-service Training Programmes

In general few projects conduct systematic in-service training programmes. The main exception is the Juba Sugar Project (JSP). JSP offers a comprehensive range of short in-service courses to all grades of staff. JSP uses the facilities of a training centre near Moagambo but is seeking to transfer the centre to its project headquarters. The number of staff being trained means the centre has limited spare capacity.

5.6 Project Implications

The project requires highly trained staff with practical experience of irrigated agriculture. It is feared that the standard of graduates from the agricultural secondary schools would be too low to meet the needs of project farmers. Rather than recruit a large number of poorly trained field assistants it would be better to employ fewer and better qualified staff. They would preferably be graduates from the University or have supervisory experience on other projects or commercial farms. Even so there would be gaps in knowledge and practical experience. These gaps would have to be identified and appropriate project related training programmes organised for all staff. This would require training staff and a training centre. These facilities would have to be provided in any case to meet the training needs of farmers. Indeed the demands of the project mean that training would be one of the project's most important components.

At senior levels the shortage of suitably trained and experienced Somali staff means that the project would also have to rely on expatriate technical assistance in its initial stages while counterpart staff are being trained.

CHAPTER 6

HEALTH AND EDUCATION

6.1 Health

The good health of the project's participants is an essential prerequisite for successful project implementation.

When the JESS team visited Homboy village in April 1986, the villagers complained of endemic malaria and bilharzia. They also mentioned cases of gonorrhea and 'chest problems'; however, they had never seen cholera. The team also noted a high level of polio and meningitis (JESS, 1987).

The Swedish Church Relief (SCR) team working in the Middle Juba region has identified a very high death rate among small children and women and has instigated a programme aimed at reducing infant mortality. Assisted by villagers working without pay the SRC team has been constructing health posts in numerous villages. The Swedes supply the materials and an expert to supervise the construction. The supply of village labour is based on the traditional system of neighbourhood help. Since the 1969 revolution, the system has become institutionalised by the State. Thus, lists of men capable of contributing labour to community projects are kept in each village. In cases of unjustified absence, the gudoomiye is empowered to impose heavy fines (AHT, 1986). Within the project area, only Homboy has been equipped with one of these health posts. It is staffed by two paramedics. The SCR programme also aims to improve rural water supplies through the rehabilitation and construction of wells and boreholes. For example, the village of Aminow has benefited from an SCR borehole.

Apart from the SCR programme, health facilities and disease prevention measures are almost non-existent in the Juba valley. There is a hospital at Kismayo and a clinic at Jilib, however, they are under-equipped, under-staffed and lacking in medicines. For those that can afford them, medicines are available at private pharmacies in Kamsuuma and Homboy.

The expansion of irrigated agriculture following the construction of the Bardheere dam will inevitably increase the incidence of waterborne diseases. The need to improve the health system should therefore be an important component within the Juba valley development programme.

6.2 Education

With an estimated 50 to 60% of the Somali population leading a nomadic or semi-nomadic lifestyle and with only a small proportion of former nomads and sedentary farmers' children attending school regularly, the level of illiteracy in the rural areas is very high. An SCR study of the Middle Juba region estimates illiteracy at 36 to 48% but this is thought to be an under-estimate (AHT, 1986).

Moreover, as with every other sector in Somalia, education suffers from inadequate resources. Where schools do exist, they are poorly equipped and staffed. Teachers are poorly trained and paid, and there are no incentives for them to live in the rural areas.

In the Juba valley where most agricultural development has been concentrated, the demand for labour is greater than the supply. As a result, a greater proportion of the labour burden has fallen on children at the expense of school attendance.

However, within the project area there is one primary school at Homboy village. The school has 9 teachers and 170 students; the latter are all from Homboy. The school was built in 1952 by the Italian colonial administration and so pre-dates many of the schools in the area (JESS, 1987).

According to the villagers of Aminow, a teacher was sent to the village in 1980 to establish a school. However, the teacher complained to the local authorities that Aminow was too far from Homboy where he wanted to continue living. As a result, the villagers were forced to establish the new village of Aminow on the outskirts of Homboy. But in 1982, when the teacher left, the majority of the villagers returned to the old Aminow site.

Outside the project area, the nearest primary schools are at Kamsuuma and Jilib. There is also a secondary school at Jilib.

Most villages have Koranic schools and there are six in Homboy. The smallest school had 35 students and the largest, 100 students. Koranic schools tend to meet in the afternoon.

6.3 Implications for Project Designs

So far as attracting project staff is concerned, managers of several irrigation project opined that with limited resources priority should be given to conditions of service and the provision of health facilities. These same managers observed that most project staff live on the projects as bachelors or have children below school age.

Nevertheless, the provision of improved education facilities is also a pre-requisite for sustained long-term community development.

CHAPTER 7

SELECTED REVIEW OF LARGE SCALE IRRIGATION PROJECTS

7.1 Introduction

Irrigated agriculture has been practised by smallholders along the Juba and Shebelle rivers for centuries. Large scale controlled irrigation of cash crops such as banana, cotton and sugar cane was introduced by the early colonial period. Since then governments have laid strong emphasis on irrigated agriculture as a means of overcoming the problems of inadequate and irregular rainfall. To achieve self-sufficiency in food production, crops such as rice, maize and vegetables are also being grown by irrigation projects.

It has been estimated that there are about 50 000 ha irrigated under semi-controlled or controlled conditions (Boguslawski, 1986). The largest area under irrigation is found around Genale where 30 000 had been developed by 1926. Some areas which have been developed for irrigation have fallen into disuse or have become the objects of rehabilitation schemes; for example Genale Bulo Marerta and Afgoi Mordile.

There are ten state farm large scale irrigation projects. With the exception of Juba Sugar and Mogambo all of these projects are behind schedule, and in general their performance has been disappointing. Boguslawski concluded that they have directly involved only a small proportion of the population while absorbing a high proportion of the development budget. They have become an enormous recurrent cost burden for the government. At the same time their output relative to smallholders remains small.

In order to learn from their experience Afgoi Mordile and Mogambo have been selected for detailed reviews.

7.2 Afgoi Mordile Irrigation Project (AMIP)

AMIP is located about 19 km downstream of Afgoi on the left bank of the Shebelle river, and approximately 35 km west of Mogadishu.

The project was originally planned in the early seventies as a settlement scheme but at the request of the government was appraised and financed by the ADB as a state farm. Phase I scheduled for 1972 to 1977 envisaged the development of 3 000 ha under irrigation for the production of seed cotton, sesame, groundnuts and maize. The commencement of civil works was delayed until 1974 but by 1975 all the land had been cleared and nearly all the irrigation and drainage infra-structure completed. However, due to acute shortages of labour and inadequate provision of machinery only 50% of the land was ever levelled and brought into production. Then as a result of cost over-runs, attributed to the oil price boom and continuing shortages of labour, spare parts and fuel, the area under production declined to 402 ha by 1980 and only 92 ha by 1982.

The African Development Fund (ADF) conducted a reappraisal in 1981. This followed a feasibility study which recommended that the project could be made viable by returning to the original idea of introducing settlers to overcome the labour problem. However, at the request of the government, the project was reappraised as a large scale estate farm on the assumption that labour could be recruited from nearby villages. Finance was provided for the rehabilitation and completion of the project.

By mid-1983, however, there were still only 96 ha under cultivation. Then in the 1983 der season, as an experiment, 244 volunteer tenants were allocated 200 ha. They successfully grew maize and in some cases interplanted with sesame. In the 1984 gu season the number of tenants was increased to 614 on 620 ha, and by the 1984 der season there were 1 087 tenants on 1 054 ha all growing maize occasionally interplanted with sesame. Encouraged by the results of this trial the ADF reappraised the project yet again in 1985. The success of the tenancy system was seen as the solution to the labour shortages on the estate farm in that tenants as part of their tenancy agreement would be expected to hire their surplus labour to the estate farm. The third phase objectives were revised as follows:

- the total irrigated area to be reduced from 3 132 ha to 2 520 ha. The remaining area to be set aside for a livestock project;
- 1 512 ha to be given over to 1 073 tenants, with a maximum of 2 ha per family, to grow maize, sesame, cotton, rice and some vegetables at a cropping intensity of 157%;
- the balance of 1 008 ha to be operated as a partly mechanised estate farm to grow mainly fruit crops for export such as bananas, citrus, pawpaws and water melon as well as seed for the tenants.

Finance has therefore been provided for:

- rehabilitation of existing infrastructure, construction of a new pumping station and additional facilities;
- procurement of new equipment and spare parts;
- five new wells for supplementary irrigation.

Establishment and reorganisation of a new Project Management Unit (PMU) was seen as an essential ingredient for success and would be divided into three departments: Administration and Finance, Production and Engineering.

Recruitment of 6 expatriate staff for the new PMU was delayed until mid-1986. This has in turn delayed project implementation. By February 1987 about 1 300 tenants were farming 1 300 ha but only 200 ha of estate farm were under cultivation. Labour shortages continue to affect the estate farm as the majority of tenants find the wages offered unattractive. Moreover, it is administratively impossible to keep track of each tenant's labour contribution and to enforce the rules of the tenancy agreement.

The majority of tenants are from neighbouring villages. Depending on the size of their family they are allocated plots varying in size from ½ to 2 ha. The actual location of the plot may change from season to season which together with the cropping pattern is determined by project management. To date they have been limited to maize and sesame.

The tenant is expected to pay a fixed rent each season, 50% in advance and 50% after harvest. The ADF budgeted SoSh 40 000 per hectare per year to include the cost of all inputs and proportional charges for administration and general operating costs. However, in 1986, tenants were only charged SoSh 5 000 although even this is reckoned to overcharge for the services actually received. Should services improve the figure for 1987 is likely to be nearer SoSh 10 000.

7.3 Mogambo Irrigation Project (MIP)

MIP is located in the Lower Juba valley about 400 km from Mogadishu.

The project was originally designed in the early 1980s as a state farm under the responsibility of the MoA although it was also planned that 10% of the project area would be given over to smallholders for rice cultivation. The project is financed by KFW, KFAED and the Somali Government.

Project implementation began in 1984 and the target for the first phase, to be completed by 1986, was 1 500 ha of rice and cotton under gravity irrigation and 750 ha of fallow at an overall cropping intensity of 150%. Second phase development is planned up to 6 500 ha.

Whilst first phase infrastructural development has been completed on time only 900 ha were under cultivation at the end of 1986. The plans to grow cotton on the 150 ha sprinkler unit were revised because of problems with labour and pest control. Instead of cotton the project has been growing sesame, safflower, cowpeas and mung beans. The main problems experienced by the project have been long delays in procurement of inputs and machinery and inadequate funding of recurrent costs. Subject to the availability of inputs the project plans for 1987 include 1 100 ha of rice, 300 ha of sesame, 200 ha of safflower and 150 ha of legumes making a total of 1 750 ha under cultivation. Also by 1988 the construction of a rice mill/grain cleaning facility will have been completed.

The project comes under the MoA but is semi-autonomous. A Somali General Manager heads the PMU and is based in Mogadishu. The expatriate Deputy General Manager is in day-to-day charge of running the farm. There are five other expatriates distributed between the Agriculture, Engineering, Administration and Accounting departments. The MIP organogram in Figure 7.1 illustrates present project organisation and the division of responsibilities. An interesting feature of this organogram is the appointment of a National Consultant who deals with all settler problems.

The PMU committee holds monthly meetings. There are also disciplinary, procurement, workers and settlers committees which report to the PMU. There are occasional non-formal meetings with local government authorities. A quarterly report is prepared for the MoA and the financing agencies.

In general, staff recruitment has not been a problem because of the relatively attractive conditions of service. Good housing and training opportunities are believed to be just an important as salaries. Whilst salaries are low by Juba Sugar Project standards, the basic rates are still 8% higher than in the MoA and there are additional allowances, overtime and productivity bonuses payable. However, problems are experienced particularly in workshops, research and finance where most staff are lacking in skills and experience.

There is no training officer and no training facilities on the project. Because of the emphasis on production and the urgency of field operations all training is conducted on the job. Nevertheless some members of the PMU believe organised in-service training is necessary.

The allocation of land to smallholders has not been a success. When the land was taken over by MIP only 30 families out of 323 in the Mogambo village were allocated plots within the project area. None of the farmers who lost land had registered holdings and therefore received no compensation. The displaced farmers now had to clear new farms further away from the village in areas more

susceptible to flooding. Moreover, fewer than 50 villagers are employed as labourers on the project. There is therefore some resentment towards the project which occasionally manifests itself by acts of vandalism to the irrigation infrastructure.

The majority of project land allocated to smallholders has been given to settlers from Mogadishu. About 300 were selected in 1985 but only 180 took up residence and 160 have stayed. Of these 120 have been allocated rice plots and 40 maize plots. Each smallholder is allocated 2 ha but the terms of the lease have yet to be finalised. It is thought that the length of the lease will be 30 years on completion of a 2 year probationary period.

The original concept of allocating 10% of the land to smallholders has been revised to 25%. However, an immediate increase in numbers is considered undesirable by the PMU until the project is better established.

At present all cultivations are performed by the project and the smallholders are supposed to weed, apply fertiliser and keep the irrigation channels clean. In practice the majority of the settlers, who are ex-civil servants and townspeople, do very little other than bird scaring. The smallholders from the Mogambo area are much harder-working and better suited to farming.

Smallholder training is not formally organised. The expatriate agricultural staff and supervisors conduct training sessions in the field as and when necessary.

Plots are individually harvested and the crops then transported to Fanoole, about 35 km away, for weighing, drying and cleaning. This is obviously very expensive and illustrates the need to establish these facilities from the start. The smallholders then receive a bill for the cost of services. To date only the better smallholders are said to be making a profit.

7.4 Lessons for Homboy Project Design

Both projects have suffered from shortages of inputs, spare parts, unskilled and skilled labour as well as procurement delays. The problems at Afgoi Mordile have been compounded by staffing and engineering problems, although at Mogambo a strong management team has been successful in achieving physical targets. However, the biggest problem is that both projects have concentrated primarily on the technical aspects of irrigated agriculture rather than develop the communities ability to manage project services once technical and financial assistance ends.

Shortages of farming labour can be overcome by selecting smallholders from the project area that already has farming experience and which is more likely to have the commitment and skills necessary for successful project implementation. This commitment can be nurtured by involving the community from the outset in project planning. This will also ensure that the systems evolved reflect the interests and abilities of the community. Then as much as possible the responsibility for services should be transfered to individuals and community organisations which have a strong interest in maintaining those services.

Other problems such as delays in procurement can be dealt with by forward planning. In this respect early establishment of a strong PMU is vital. In order to recruit and retain adequate skilled staff at all levels it would also be necessary to provide attractive conditions of service. An intensive training and extension programme would also be necessary to further develop project related skills.

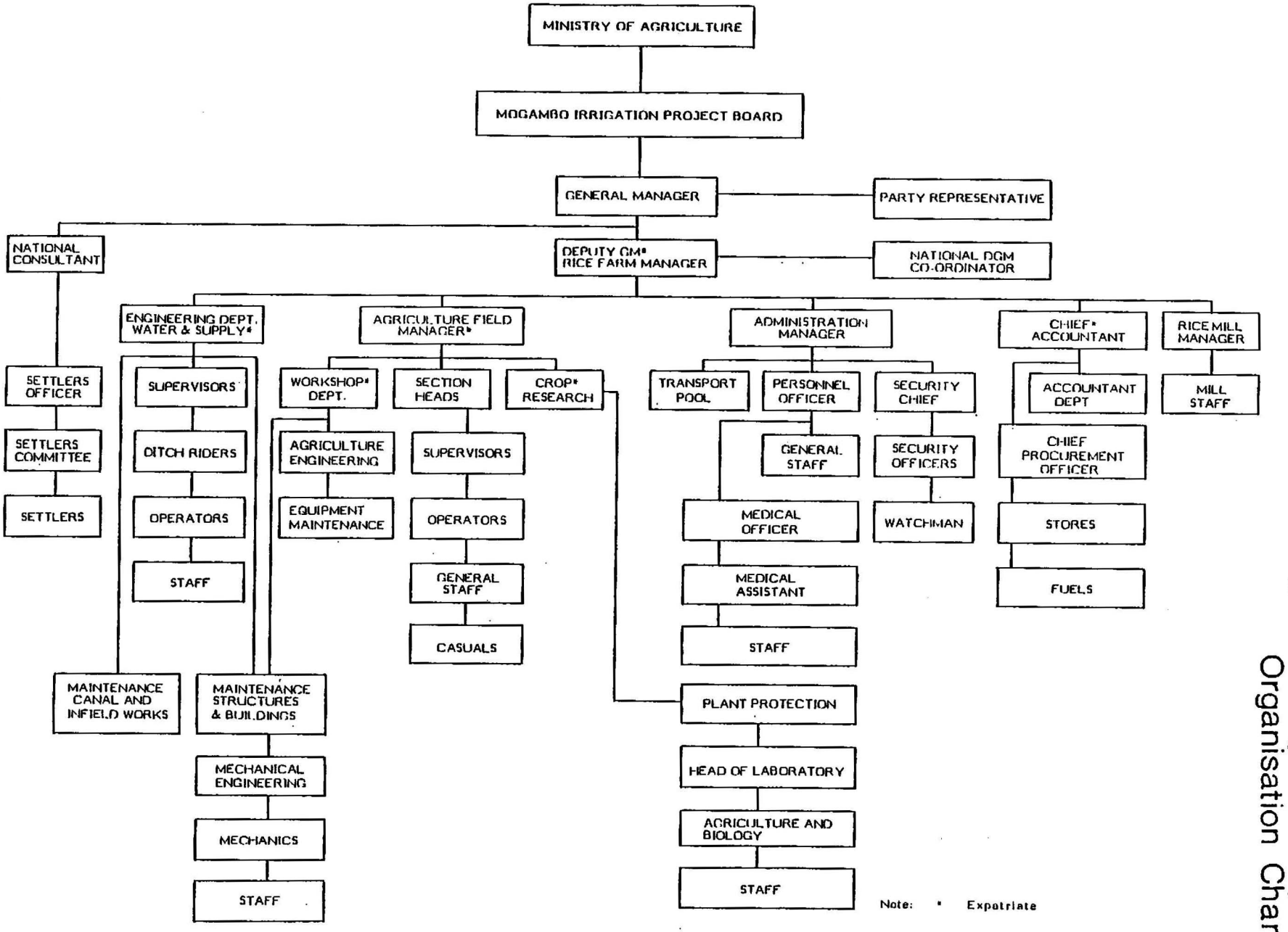


Figure 7.1
Mogambo Irrigation Project
Organisation Chart

CHAPTER 8

PROPOSED ORGANISATION STRUCTURE

8.1 Introduction

The aim of the project organisation would be to provide those common facilities to the project's participants that they cannot obtain independently, while at the same time involving the participants as much as possible in the planning, management and maintenance of those facilities.

8.2 Principles and Methodology

It is inconceivable that farmers practising traditional low input rainfed farming system can successfully change to high input irrigated cultivation of new crops in a short period without a high degree of project management intervention. On the other hand, if the project adopts a too highly centralised management system the short term gains in production efficiency would be lost at the expense of genuine farmer participation. In the long term, this would probably result in project failure as management efficiency declines when external financial and technical assistance ends. Therefore, the recommended approach would aim at the establishment of an effective management/co-ordinating unit which involves the community in every aspect of project implementation. The guiding principles behind this approach would be as follows:

- to be responsive to the needs, knowledge, attitudes and practices of the community by involving the community in the planning, implementation, evaluation and replanning of the project;

- to develop a project which can be sustained in the long term both by the community and the responsible Ministry;

- to strengthen the ability of the community to be responsible for as many as possible of the project's services;

- for those services which cannot be managed by the community: strengthening of government institutions already working in the area with financial and personnel support, and planning/management advice;

- provision of those services which cannot be managed by the community or other existing institutions, including overall project co-ordination by a Project Management Unit (PMU).

8.3 General Project Organisation

A PMU would have to be established at least one year before irrigation begins. The function of the PMU would be to manage and co-ordinate the planning, implementation and evaluation of services to participating families. It is recommended that the PMU would come under the authority of the appropriate Ministry but would have the power to administer its own budget. The PMU would be headed by a General Manager who would be directly responsible to the Ministry. The proposed organisation structure is illustrated in Figure 8.1.

It comprises departments of Administration and Finance, Commercial Services, Engineering and Training. Agriculture responsibilities would be split between two Deputy General Managers (DGMs). One DGM would be responsible for banana development and the other for annual crops. The PMU headquarters would be located at New Aminow, adjacent to Homboy village.

To ensure effective co-operation with Central, Regional and District authorities there would be regular meetings with their representatives on Project and Local Authority Advisory Committees. To encourage genuine participation in project implementation, there would also be regular meetings at all levels with farmers and Village Committee representatives. The functions and membership of these different committees is shown in Table 8.1.

Field services to farmers would be provided from five Village Service Centres (VSCs) and five Banana Packing Shed Service Centres (BPSCs). Farmers would be responsible for the management and labour inputs on their individual plots but would be expected to form Farmers' Organisations (FOs) at the watercourse unit level for the purpose of co-operating on water scheduling, channel maintenance, machinery use, extension and credit distribution.

To achieve the expected benefits, the project would require a high degree of management competence from both staff and farmers. In view of the shortage of local skilled and experienced staff it is recommended that technical assistance should be provided during the first few years to establish the necessary organisation and to undertake on-the-job training of project personnel.

Figure 8.1

Homboy Irrigation Project Organisation

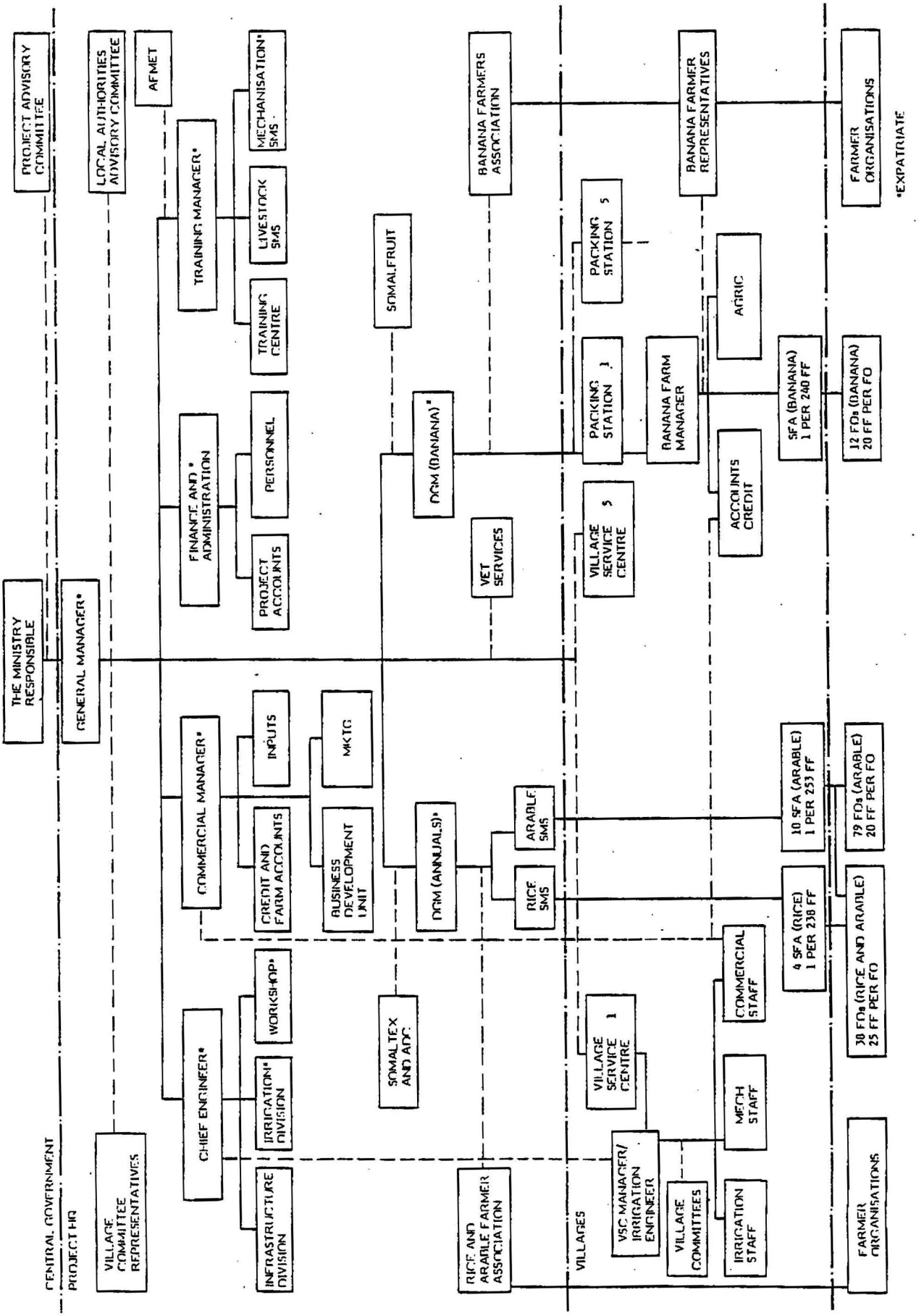


TABLE 8.1

Functions and Membership of Project Committees

Committee	Participants	Functions
Project Advisory Committee Meets: annually	Director General of Agriculture (MOA) Director of Planning (MJVD) Ministry of Finance Representative Regional Governors Project General Manager	Review and discuss project progress. Approve work plan and budgets.
Project Management Committee Meets: monthly	GM DGMs Heads of Departments Village Committee Representatives	Overall responsibility for project execution and co-ordination of services.
Local Authorities Advisory Committee Meets: quarterly	District Commissioners Party Secretaries Mayors District Agricultural Co-ordinators District Livestock Co-ordinators Village Committee Representatives PMU Representatives	Review and discuss project progress. Co-ordinate non-project services
Banana Farmers Association Meets: quarterly	DGM (Banana) Somalfruit Representative Banana Farm Managers Banana Farm Representatives	Review and discuss banana farm progress. Discuss co-ordination of services.
Banana Farm Committee Meets: monthly	Banana Farm Manager FOs Representatives Accounts Manager Agriculturalist Irrigation Representative	Review and discuss farm progress Discuss co-ordination of services.

TABLE 8.1 (cont.)

Committee	Participants	Functions
Rice and Arable Farmers Association Meets: quarterly	DGM (Annuals) Somaltex Representative ADC Representative Rice SMS Arable SMS Rice FOs Representatives Arable FOs Representatives Irrigation Representative	Review and discuss farmer progress. Discuss co-ordination of services.
Farmer Organisations Meets: fortnightly	All farmers	Training, co-operation on maintenance and use of services.

CHAPTER 9

ADMINISTRATION AND FINANCE

9.1 Organisation

The Administration and Finance Department would be headed by a Financial Controller/Administration Manager. The department would be responsible for operating the accounting and administrative systems for the project, preparation of annual budgets, maintaining budgetary control and would carry out all functions connected with hiring of permanent staff. It would also be responsible for supervision and monitoring of the Commercial Services and Banana Packing Stations' accounts.

9.2 Timing

Early recruitment of the Finance Controller/Administration Manager would be necessary to establish administrative and accounting systems before full project implementation begins.

9.3 Costs

Costs are given in Section F of this Annex, and provide for:

Vehicles (Purchase and Running Costs):

Financial Controller/Administration Manager	4WD/SW

Buildings:

Project Headquarters Offices

Equipment:

Office furniture
Photocopier
Electric typewriter
Manual typewriter
Desk calculators
Safe

Staff	Salary level
Financial Controller/Administration Manager	EXP
Financial Controller/Accountant	SE
Administration and Personnel Manager	SE
Secretary	PA
3 Nr Accounts Clerks	C
General Clerk	C
Driver	SL
Messenger/Cleaner	L

Miscellaneous:

e.g. Stationery and office materials

Contingencies:

10% of the above items.

CHAPTER 10

AGRICULTURAL AND LIVESTOCK SERVICES

10.1 Introduction

The responsibility for agricultural development would be split between two DGMs. One DGM would be responsible for banana enterprises and the other for annual crops. The Training Manager would be responsible for co-ordinating livestock services.

10.2 Banana Development

It is proposed that five separate banana farms would be developed, of about 600 ha each, and equipped with their own packing stations. The DGM, with responsibility for bananas, would have overall responsibility for each of the five farms although these would be run as individual commercial farms within the project. He would be responsible for liaison with Somalfruit through which the fruit would be marketed and inputs for bananas purchased. The staffing requirements and the organisation and management structure are given in Annex 2.

Staff training would be organised through the PMU while engineering services would be provided from the VSCs.

10.3 Annual Crops

Overall responsibility for annual crops would come under the DGM responsible for annual crops. He would be assisted at project headquarters by a Rice Specialist and a General Arable Crops Specialist

10.3.1 Rice

The Rice Specialist would be responsible for managing rice extension to rice farmers. It is estimated that there would be 950 rice farmers each with 1 ha plots. As rice cropping would be limited to the heavier soils it is expected that contiguous blocks of rice would be developed within 25 ha watercourse units. This would also facilitate combine harvesting. It follows, therefore, that there should be 25 farmers per FO and 38 FOs (rice). Working under the Rice Specialist there would be four Senior Field Assistants (SFA) or one SFA (rice) for every 9 to 10 FOs (rice).

10.3.2 General Arable Crops

The general arable crops specialist would be responsible for managing general arable crops extension. It is estimated that there would be 1 580 farmers cultivating 3 500 ha (divided into 2.5 ha plots) of general arable crops. Based on one FO for every two 25 ha watercourse units there would be 79 FOs. In addition, the 950 rice farmers, grouped into 38 FOs, would also have 1 ha each of general arable crops located on different watercourses from their rice plots. Therefore, there would be a total of 117 FOs cultivating 4 900 ha of arable crops. To provide these arable farmers with extension advice the General Arable Specialist would be supported by 10 SFAs (arable). The ratio of SFAs (arable) to FOs (arable) would be 1 to 12.

10.4 Livestock Services

The Training Manager would be responsible for co-ordination with the regional and district livestock co-ordinators.

A Livestock Specialist under the Training Manager would be responsible for training all SFAs in important aspects of animal husbandry; for example, improve feeding of crop residues.

Veterinary services would be taken care of by the Ministry of Livestocks Animal Health Department. One of their officers is permanently stationed in Homboy village. As he is hampered by lack of transport, drugs and equipment the project would provide support by supplying a motorcycle and other essential items such as vaccines.

10.5 Extension System

10.5.1 Objectives

The objective of the extension programme would be to provide intensive, frequent and systematic training of farmers in irrigated cultivation of banana, rice and other arable crops.

Principles and Methodology

AFMET which is responsible for the National Extension Service has adopted a modified training and visits (T&V) system of extension.

The basic principles of this T&V system are:

- an extension service which is responsive to farmer problems;
- a single line of technical and administrative command;
- a single line of technical and administrative command;
- removal of non-extension activities from the responsibilities of extension staff; for example, organising inputs;
- a fixed schedule of visits by extension staff to selected individual farmers on their farms supplemented by group meetings;
- frequent field supervisory visits by staff at all levels;
- minimal time spent in offices and on paperwork;
- regular and frequent training on key points which also permits two-way flow of information between farmers, extension and research;
- close two-way linkages with research.

These principles could also be applied to the extension system adopted by the project with the exception that more emphasis would be given to working through farmer organisations.

10.5.2 Senior Field Assistants

In 1986 AFMET had 185 Field Assistants (FA) operating at a ratio of 1 FA to 900 farm families (FF). The second phase plans, still in preparation, aim to consolidate the National Extension Service through improved training and supervision. The FA and FF ratio will probably increase to no more than 1 to 800 by 1992 with a total of 274 FAs covering ten regions. However, it is generally accepted that on an irrigation scheme the extension agent to farmer ratio should be more intensive. Thus the 1980 study proposed 90 FAs serving 8 850 families; that is a ratio of about 1 to 98 FFs. In view of the limited number of qualified FAs being produced by the agricultural secondary schools, the demands of AFMET and other projects, this level of intensity would not be practical. Fortunately, due to the increased farm size allocated to farmers participating in the project and the consequent reduction in farmers required to 3 730, the number of FAs required can also be reduced.

It is also important to take into account that the quality of young FAs is often unsatisfactory, particularly for a scheme as demanding as Homboy. If the farmers are going to be successful in the transition from low input rainfed farming to high input, management-intensive irrigated farming the extension agents will require a higher level of skills than is normally found amongst the AFMET FAs. It is therefore proposed that the project would recruit fewer but better qualified and more experienced extension agents. Ideally, they would be graduates or have the equivalent qualification of supervisors in other projects. In order to attract such staff it would be necessary to provide conditions of service comparable with supervisors employed on the Juba Sugar Project. In recognition of their superior qualifications they would be called Senior Field Assistants (SFAs).

The specialist needs of the minority of rice and banana farmers together with the semi-independent organisation for banana growers dictates that SFAs should specialise in one of the three cropping systems although they should all be capable of giving advice on any crop.

It is recommended that the project should have four SFAs (rice), five SFAs (banana) and ten SFAs (arable) making a total of 19 SFAs. This gives an overall SFA to farmer ratio of about 1 : 200. However, because rice farmers will have separate arable plots on different watercourses they will receive extension advice from both an SFA (rice) and an SFA (arable) so that each SFA will in effect cover about 240 farmers.

Each SFA would be given responsibility for ten to twelve Farmer Organisations (FOs). The composition of FOs would be based on cropping system and sharing of one or two 25 ha watercourse units. SFAs would be expected to live in the villages nearest to their FOs.

The SFAs work programme would be divided into fortnightly periods. At the beginning of each period the SFAs would receive training in the recommendations to be extended over the forthcoming fortnight; for example, training in optimum spacing would be given just before the time farmers should start planting. Training would be co-ordinated by the Training Manager in project headquaters and conducted by the appropriate Subject Matter Specialist (SMS); for example, the Rice Specialist would be responsible for training the rice SFAs. Training sessions would concentrate on practical skills, showing the SFAs how to demonstrate recommended methods on farms. At the end of each session SFAs would be given simple illustrated aide-memoires and samples of inputs to be used. Whenever possible training would be conducted in the field. Sometimes training would be conducted at the project headquarters Training Centre.

These training sessions would also provide an opportunity to raise field problems and feed back farmer response to recommendations. Administrative details would be dealt with on the same day as training.

After training SFAs would follow a fixed schedule of fortnightly visits to FOs. At peak periods this interval could be reduced to weekly visits. It would be impossible for an SFA to maintain frequent contacts with all the farmers for whom he is responsible. The SFA would therefore focus his attention on meetings with the entire group of farmers belonging to an individual FO. These meetings would be conducted in the mornings whilst the afternoons would be reserved for follow-up visits to selected individual farmer's plots.

FOs would be visited on the same day every fortnight so that they always know when to expect a visit from their SFA. The SFA would try to persuade as many farmers as possible to follow the project's technical recommendations. There would be no formal demonstration plots. However, farmers that had been successful in adopting a particular recommendation would be used for demonstration purposes. This will be made easier by the close proximity of different farmers plots. At the end of each fortnightly period SFAs would have one free day for report writing, administration and catching up on missed meetings. An example of an SFA's timetable is shown in Table 10.1. Weekly visits would require SFAs to hold meetings with two FOs every day.

TABLE 10.1

Example of an SFA's Timetable

Weekday	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday
Week 1	Training and Admin.	Visit FO1	Visit FO2	Visit FO3	Visit FO4	Visit FO5
	a.m. Group meetings p.m. Visits to individual farmers					
Week 2	Visit FO6	Visit FO7	Visit FO8	Visit FO9	Visit FO10	Report writing
	a.m. Group meetings p.m. Visits to individual farmers					

10.5.4 Equipment

Each SFA would be equipped with a motorbike, a measuring tape, a small spring balance, sampler of different inputs (with colourful caps that clearly identify them) a diary, a crop manual in a waterproof cover, and waterproof boots. In addition notice boards would be put up in prominent locations. SFAs would post their schedules on these noticeboards as well as key points of the current message and details on items of special interest; for example, marketing and credit information.

SFAs would be required to keep simple diaries to record their activities, problems arising and farmer response to technical recommendations. These would then be discussed at the fortnightly training sessions. Unnecessary paperwork would be avoided.

10.5.5 Supervision

SMSs would be expected to spend the majority of their time checking that SFAs are doing their work in a correct, timely and effective manner. Morever, contact with farmers would provide an indication of the quality of extension work and of those aspects of the project that are not working properly. To facilitate supervision SMSs would also have to be equipped with motorbikes.

10.5.6 Subject Matter Specialist

The project would require one Rice Specialist, a General Arable Crops Specialist and five Banana Specialists. They would be responsible for the fortnightly training of SFAs as well as supervising and co-ordinating the requirements of their specialist farmers. The Banana Specialists would also be the Banana Farm Managers. Other specialists would be co-ordinated by the Training Manager; for example, there would be Livestock and Mechanisation Specialists under the Training Manager. In addition, specialists in pest control could be provided by the MOA or from agro-chemical companies as and when necessary.

10.5.7 Research - Extension Linkages

If the project is going to be capable of responding to farmers' problems, there will have to be strong linkages between the agricultural staff and research. These linkages would be provided through AFMET and by SMSs visiting research stations.

The project would not become involved in research other than on-farm trials.

10.6 Farmer Organisations

One year before the first farmers start farming under irrigation, senior project staff would start by explaining to every VC in the project area the objectives of the project and the need for FOs.

Each VC would then organise a meeting of the community to which the same project staff would be invited to explain the objectives of the project and the role of FOs.

FOs would be composed of 20 to 25 farm families willing to operate with one another on one or two 25 ha watercourse units. The number of farmers per FO would depend on the cropping system recommended for a particular watercourse unit; that is, all of the units recommended for banana and most of the units suitable for growing general arable crops would be sub-divided into 2.5 ha plots; however, heavier land only suitable for rice cropping would be sub-divided into 1 ha plots. Rice farmers would be allocated land in another 25 ha watercourse unit, subdivided into 1 ha plots, in an area suitable for other arable crops. The number of FOs would eventually reach 177.

The members of each FO would be expected to elect an 'aaw' or leader, a deputy leader, a secretary and a treasurer. They would also be asked to agree on a simple constitution which regulates the replacement of office holders, the responsibilities of office holders, and the management of materials and finance. The responsibilities of the FOs would be as follows:

- to agree with the VCs, and in consultation with senior project staff, the allocation of two 25 ha watercourse units;
- to allocate individual plots within each watercourse unit to household heads;
- to co-operate with the project on the registration of individual plot holders;
- to co-operate on water scheduling with other FOs;
- to co-operate on the maintenance of watercourses and field drains;
- to co-operate on services such as receiving extension advice, credit and input distribution, cost recovery, and use of machinery;
- to select, in consultation with senior project staff, one farmer for an intensive induction training course in irrigated cultivation of the crops recommended for their particular watercourse unit.

The induction training of selected farmers would be conducted in the year before they start irrigated cultivation. The FOs would be encouraged to select bright and preferably literate young men who would be easier to train. The induction course would last two months.

The first farmers would have to be trained in locations where practical experience of irrigated agriculture can be obtained, for example, at the CAR irrigated farm near Afgoi. In this case, the facilities of the nearby AFMET training centre including a dormitory could be utilised. Should training have to be conducted where accommodation is not freely available, trainees would be given allowances to rent accommodation in nearby towns and villages. However, as project development would be phased most farmers will be trained on site.

The farmers graduating from these induction courses would be given the title of Farmer Assistant (FA). They would be expected to take a progressive attitude to adopting technical recommendations. Moreover, they would also be expected to help their fellow farmers with the adoption of innovations.

Before the start of irrigated farming an SFA would visit each FO once a fortnight to provide training in what farmers would be expected to do under irrigated conditions. SFAs would cover such topics as:

- the difference that access to irrigation water will make to their farming system;
- the need to co-operate with other FOs on water scheduling and the importance of maintaining watercourses and field drains;
- the characteristics of improved varieties;
- how to use seed dressing;

- the importance of high plant population, recommended spacing and the reduced importance of inter-cropping;
- the importance of early and frequent weeding and thinning;
- the use of pesticides;
- the use of fertiliser;
- the value of farmyard manure;
- the importance of rotations;
- improved livestock practices.

Before the start of each irrigated planting season the FO and SFA together with other senior project staff such as SMSs would jointly agree qualitative and quantitative objectives with standards of success; for example, areas under different crops, inputs to be used, spacing, frequency of weeding, target yields, watercourses and field drains to be maintained. These pre-season meetings with FOs would also help project management to elaborate an annual action plan. During the season fortnightly group training would concentrate on the key points in the forthcoming fortnight's cropping cycle supplemented by follow up visits of the SFA and FA to individual farmers' plots.

Every six months and after a harvest the FO, FA and SFA together with the appropriate SMS, would jointly evaluate the performance of the FO and the SFA against the pre-season objectives and standards of success. This meeting would help to identify problems, the reasons why success was not achieved, and how these problems can be solved either by the FO itself or through some project management adjustment.

If the FO has been successful in achieving its objectives the SFA and SMS would recommend to the Commercial Services Department an increase in the FO's credit rating; for example, the FO would be eligible to apply for credit to finance a project of its own choosing. Similarly the FO and SMS would jointly recommend the award of a bonus by the project to the SFA.

Should the performances of the FA and SFA be considered unsatisfactory the FO and senior project staff could jointly decide on a change of FA. In this case a new FA would have to be selected and trained. Unsatisfactory SFAs would forfeit opportunities for further training, salary increments and promotion. The ultimate sanction of project management would be dismissal.

10.7 Timing

Early recruitment of both DGMs would be necessary to establish systems, and in particular the FOs, before irrigation begins. The build-up of extension and banana staff would increase in proportion with the areas brought under irrigation each year. The phased staffing requirements are shown in Chapter 15.

10.8 Costs

The project will provide for the following items which are costed in Section F of this Annex.

Vehicles - Purchase and Running Costs

Deputy General Manager (Annuals)	4WD/SW
Rice Specialist	Motorcycle
Arable Specialist	Motorcycle
Senior Field Assistants (Rice)	Motorcycle x 4
Senior Field Assistants (Arable)	Motorcycle x 10
Deputy General Manager (Banana)	4WD/SW
Banana Farm Managers	Pick-up x 5
Assistant Banana Farm Managers	Pick-up x 5
Agriculturalists	Pick-up x 5
Nursery/Packhouse Foremen	Motorcycle x5
Senior Field Assistants	Motorcycle x 5

Buildings

Project Headquarters Offices
Banana Packing Station x 5

Equipment

Project Headquarters - Annual Division
Office Furniture
Photocopier
Electric Typewriter
Manual Typewriter

Project Headquarters - Banana Division
Office Furniture
Photocopier
Electric Typewriter
Manual Typewriter

Packing Station x 5
Office Furniture
Packing Equipment and Materials
Manual Typewriter

Field Kit for 43 staff to include:

Sampler of all inputs (seed, pesticides, sprayers, fertiliser)
Measuring Tape
Spring Balance
Diary
Crop and Livestock Manual
Waterproof Boots
Notice board x 20

Staff	Salary level
DGM (Annuals)	EXP
Assistant DGM	SE
Rice Specialist	SE
Arable Specialist	SE
SFA (Arable) x 10	T
SFA (Rice) x 4	T
Secretary	PA
Driver	SL
Messenger/Cleaner	L
DGM (Bananas)	SE
Banana Farm Manager x 5	EXP
Assistant Farm Manager x 5	SE
Accountant x 5	SE
Agriculturist x 5	SE
Nursery/Packhouse Foreman x 5	T
Secretary	PA
Clerk x 20	C
Driver x 6	SL
Nursery Labour x 30	L
Night Watchman x 5	L
Messenger/Cleaner x 65	L

Miscellaneous

Stationery and Office Materials
Nursery Tools

Contingencies

10% of the above items.

CHAPTER 11

COMMERCIAL SERVICES

11.1 Introduction

Perhaps the most radical departure from the 1980 Homboy study is the proposal to commercialise as many services as possible. To co-ordinate the provision of commercial services a Commercial Services Department would be established.

The function of this department would include co-ordination of marketing, input procurement, credit distribution, cost recovery as well as privatisation of services such as tractor hire, maintenance and repair, and input distribution.

11.2 Organisation

At project headquarters, the Commercial Services Department would be headed by a Commercial Manager. The department would comprise four sub-sections:

Credit and Farm Accounts
Input Procurement and Distribution
Marketing
Business Development.

The Commercial Department would be represented by one Commercial Agent at each VSC and by the Accounts Section at each BPSC.

11.3 Marketing

Formerly ADC was the sole agent for purchasing grain crops but low prices, which favoured urban consumers, offered little incentive to farmers to increase production. Then the liberalisation of producer prices in 1983/84 attracted a large number of private traders to the market. The higher prices paid by private traders encouraged farmers to considerably increase output. As long as the marketing of grain crops through the private sector continues to function efficiently, there can be no justification for project or Government intervention. Indeed, provided prices remain favourable and production can be marketed easily, it is expected that farmers will respond rapidly to extension advice and inputs. Nevertheless, since 1985, ADC has continued to purchase surplus grain at lower prices than those offered by private traders, with the intention of selling off grain during periods of low supply. In this way it is anticipated that ADC can contribute to price stabilisation as well as providing a strategic grain reserve against drought. The Commercial Department, in co-operation with the DGM (annual crops), would co-ordinate with ADC such grain purchases.

The Government still keeps a monopoly on cotton marketing through Somaltex while Somalfruit has a monopoly on banana marketing. Thus, as with ADC, the Commercial Department, in co-operation with the respective DGMs, would co-ordinate banana and cotton marketing through Somalfruit and Somaltex respectively.

11.4 Credit and Cost Recovery

The project would have to provide staff to administer the cost recovery of project services; for example, farmers would be charged for maintenance of infrastructure, land levelling, administration and a proportion of the development costs. In addition, banana growers would be charged for packing and rice growers for harvesting. However, there would also be a need to provide short-term credit for input purchases and tractor hire services. As there are no institutions providing credit for smallholders, other than Somaltex for cotton growers and Somalfruit for medium- to large-scale banana growers, the staff involved in cost recovery would also be employed in the administration of a revolving credit fund as well as co-ordination of any credit provided by Somaltex and Somalfruit.

A flat rate for the cost of project services would be worked out by the Finance Department. Additional charges would be levied on banana and rice growers as appropriate. Individual farm accounts for the rice and general arable funds would be kept by the Credit and Farm Accounts sub-section at project headquarters, while banana farm accounts would be kept by accountants at the BPSCs.

Pre-season credit would be distributed through the FOs to individual farmers by the Commercial Agents at VSCs, and the Accounts sub-section at BPSCs. Credit would be given in the form of vouchers which could then be exchanged for inputs at either project or privately operated sales points, as well as for private tractor hire services. Private input salesmen and tractor operators could then have their vouchers redeemed for cash by either the headquarters' Credit Section or the BPSC Accounts sub-section. Project charges and credit repayments would be collected post-harvest by the Commercial Agents and BPSC Accounts sub-section. Non-repayment by one or more members of an FO would endanger that FOs entitlement to credit the following season. In this way it is expected that group sanctions would force bad debtors into repayment. Should an individual farmer fail to co-operate, the project, in consultation with the FO representatives and the nearest VC, would be empowered to appropriate the farmer's lease. The lease would then be offered either to new applicants or to other members of the FO who would be capable of taking on a larger area.

11.5 Input Procurement and Distribution

The adequate and timely supply of inputs is another essential pre-requisite for project success. The Commercial Department, through its Commercial Agents, and in consultation with the DGMs for annual crops and bananas, would be responsible for assessing farmers' input requirements and co-ordinating input procurement.

The supply of farm inputs is presently limited to a small number of banana and cotton growers supplied by Somalfruit and Somaltex, respectively. The project would aim to strengthen and expand the linkages between these input suppliers and their growers by providing a co-ordinating function. Similarly, the Commercial Department would co-ordinate with other institutions responsible for input supplies such as the MOA, AFMET and ONAT. However, due to shortages of foreign exchange and administrative inefficiency, none of these institutions are presently capable of supplying most project farmers input requirements. The project would, therefore, seek permission to import its own requirements. Looking to the long term when external project finance ends, the project would encourage the growth of commercial importers by handling procurement through private traders in Mogadishu and Kismayo.

Farm inputs would be stored at the VSCs and BPSCs. The Commercial Agents would be responsible for input sales from these stores. The store would only be open for sales on one day each week. However, retailers within each village would be encourged to sell inputs from their shops on a commission basis. Eventually input distribution would be given over entirely to private traders.

11.6 Mechanisation and Business Development

It will be necessary, because of the high intensity of cropping proposed, for a number of farm operations to be mechanised; for example, ploughing, disc harrowing, levelling, bunding and rice harvesting would all be mechanised. The 1980 Homboy study envisaged that the project would be entirely responsible for the operation of the mechanised services. However, experience with Government operated mechanisation services in Somalia and other countries provide few grounds for optimism that the service would operate efficiently or could be sustained once external technical and financial assistance ends. Instead, it is recommended that the mechanisation services would be privatised. It is believed that privately operated machinery and equipment would be better maintained, work more efficiently and last longer. Moreover, the savings in salaries, spare parts and running costs would considerably reduce the burden on Government resources. It is estimated that 120 tractors would be required by the fifth year of operation; that is about one tractor per 74 ha.

Each season the Commercial Department's Business Development Unit would, with the assistance of the Mechanisation Specialist, select suitable candidates for training. The number of candidates would be based on the area to be brought into production each year plus 50% for replacements and failed candidates. The phasing of equipment operator training is shown in Table 11.1.

Preference for training would be given to candidates from within the project area. It is believed that such candidates would be less likely to leave the project after training and would be more constrained by community sanctions into providing a reasonable service. Candidates would not be chosen from farmers allocated plots on the scheme as it is thought they would have insufficient time to provide, in addition, a mechanisation service to their neighbours.

The training in tractor operation and daily maintenance procedures would be conducted by the Mechanisation Specialist. Training in the commercial aspects of running a private tractor hire service would be provded by the Business Development Unit. The course would last two months. At the end of the course and on successful completion of a test, selected graduates would be given the opportunity to lease a project tractor. The terms of the lease would stipulate that the operators would be committed to providing a service to project farms only.

Tractors used off the project would be liable to confiscation. Similarly, other safeguards could be written into the lease. However, within certain upper limits the operators would be free to negotiate hire rates with farmers. This would provide an element of competition between operators. Operators would also be responsible for the cost of fuel, spare parts and maintenance charges. This would encourage them to look after their tractors. After a fixed period of three trouble-free years, the six-monthly lease charges would be considered as payments towards the cost of outright tractor purchase by the operator.

TABLE 11.1

Schedules of Equipment Operator Training Programme

Year	1994	1995		1996		1997		1998		1999		Total
		Gu	Der	Gu	Der	Gu	Der	Gu	Der	Gu	Der	
Cumulative area (ha)		825	2 125	2 975	3 050	4 075	4 875	6 000	6 575	8 100	8 850	8 850
Operators required	0	12	29	41	41	55	66	81	89	109	120	120
Operators trained	18	25	19	0	21	16	22	13	30	16	0	180

The project would purchase a comprehensive set of tractor implements. These would be kept at VSCs and rented out to tractor operators on a daily or weekly basis.

The profit would also purchase and hire out specialist equipment such as combine harvesters to selected tractor operators who had successfully completed a training course conducted by the Mechanisation Specialist.

For those operations for which the project, rather than the farmer, would be responsible, private operators would be contracted to carry out the work.

Simple workshop facilities for repairs, maintenance and fuel supplies would be available at each of the five VSCs. These facilities would also be operated privately on a leasehold basis by qualified individuals or companies. The project would provide the buildings and all other fixed assets. It would also be responsible for procurement of spare parts. The leaseholder would be expected to provide their own tools, and purchase spare parts and fuel from the project headquarters workshop.

Leaseholders would be free to charge their own rates. Competition between workshops would be encouraged. Other commercial activities which could be promoted by the Business Development Unit include crop processing, marketing and livestock fattening; for example, an FO which had been successful in achieving their cropping objectives would be given priority on credit for the purchase of crop processing equipment such as rice mills.

11.7 Timing

The Commercial Manager would be a key member of the project start-up team and would be recruited one year before irrigation begins. This would be necessary for the establishment of marketing arrangements, credit and cost receiving systems, and various privatised services as well as timely procurement.

11.8 Costs

Detailed costs are given in Section F of this Annex and will provide for the following items:

Vehicles:

Commercial Managers	4WD/SW
Commercial Agents	Motorcyle x 5
General duties	5-tonne truck

Buildings:

Project headquarters and Village Service Centre offices

Equipment:

Project headquarters
- office furniture
- photocopier
- electric and manual typewriters
- safe.

Village Service Centres	-	office furniture
	-	tractor implements
	-	heavy equipment
	-	tractor purchases
	-	crop processing equipment purchases.

Inputs:

Seed
Fertiliser
Pesticides

Staff:	Salary level
Commercial Manager	EXP
Assistant Commercial Manager	SE
Credit and Farm Accounts Officer	SE
Inputs Officer	SE
Marketing Officer	SE
Business Development Officer	SE
Commercial Agent x 5	JE
Secretary	PA
Clerk x 4	C
Driver	SL
Messenger/Cleaner	L

Miscellaneous:

Stationery and office materials

Contingencies

10% of above items

CHAPTER 12

ENGINEERING SERVICES

12.1 Organisation

The proposed organisation of engineering services would remain similar to the 1980 proposals. However, because of the proposed reduction in project participants from 8 850 to 3 730 families and the introduction of banana packing stations the number of villages and corresponding service centres (VSC) would be reduced from ten to five. Moreover, because of the semi-independent structures for annual and banana crops it is no longer considered appropriate for VSCs to be managed by agriculturalists. The VSCs would be managed by irrigation engineers responsible for co-ordinating water management to the different agricultural enterprises.

12.2 The Engineering Department

The engineering department would be headed by the Chief Engineer. It would have three sub-sections; irrigation and drainage, workshops and infrastructure. Together they would ensure that irrigation works and drains were maintained and operating correctly; vehicles, plant and agricultural machinery were repaired and maintained; and that all buildings and civil works were kept in an adequate state of repair. The Chief Engineer would be an experienced Irrigation and Drainage Engineer.

This section would have overall responsibility for the operation of the system from the offtake from the Fanoole canal to field level. However, routine work at VSC level would be the responsibility of the Service Centre Manager.

The Chief Engineer would be assisted at Project Headquarters by an Irrigation and Drainage Engineer and two assistant irrigation engineers, responsible for irrigation and drainage operation and maintenance.

A rigid hierarchy of management is proposed for the irrigation and drainage network so that wastage of water is reduced to an absolute minimum. The Irrigation and Drainage Engineers will supervise the operation and maintenance of the supply canal and irrigation and drainage systems. It is essential for the efficient running of the Project that all these items are carefully operated and maintained.

Under the irrigation engineers will be a team of operators and maintenance personnel with appropriate equipment and vehicles to enable them to undertake the daily running and repair of the systems. These will come under the direct supervision of the Irrigation Engineer.

The irrigation programme will be co-ordinated by the Chief Engineer and should not only be modified with the season and the cropping pattern but also as a result of experience gained in field trials. The release and allocation of water to individual blocks will be centrally managed, but within the block the VSC manager and irrigation supervisor will arrange the distribution of supplies and any rotation required. This information will be passed to the project headquarters and the canal operators to enable any necessary adjustments to be made.

The main workshop would be located at the project headquarters at Aminow and would operate under the supervision of a Workshop Manager. It would be staffed by a complement of skilled mechanics, fitters and electricians and other tradesmen. The workshop would have the capability to carry out major repairs and overhauls to all plant, vehicles and machinery and maintain an adequate supply of spare parts. Daily maintenance and minor repairs of agricultural machinery would be carried out at the VSCs and BPSCs. Facilities at the main workshop would include fuel stores, mechanical and electrical workshops, body and paintwork repair shops and a machine shop for making some spare parts where necessary. Provision is also made for mobile workshops.

The infrastructure section of the engineering department would be responsible for the maintenance of all buildings and services throughout the project. It would also be located at the project headquarters at Aminow and would be staffed by an engineer, skilled tradesmen and machine operators. Details of the requirements and costs are given in Sections E and F of this Annex.

CHAPTER 13

TRAINING

13.1 Introduction

It has already been noted that Somalia suffers from a shortage of trained technical and managerial personnel. Thus the project would have to depend on expatriate technical assistance in the first few years while counterpart staff are being trained. In addition, the rapid transition for project farmers from a low input rainfed system to a high input irrigated system, including new crops, makes it necessary for these farmers to undergo intensive training before and during project implementation.

Therefore, an important feature of project design would be the strong emphasis on a project related training component. It is recommended that the importance of training should be recognised by the elevation of training to the status of a separate department within the project organisation. The Training Department would be headed by a Training Manager.

13.2 Identification of Training Needs

The first task of the Training Manager would be to establish, in consultation with other departmental heads, job descriptions for every member of staff giving details of tasks to be performed and standards of performance. The project would aim to recruit staff with the ability to match the required standards, but there would be skill gaps. The Training Manager would systematically identify these skill gaps and the corresponding training needs at half-yearly performance reviews, using both interview and workshop techniques. The majority of training needs would then be met by on-the-job training and in-service training courses conducted at the project's own Training Centre. The Training Manager would arrange for appropriate Subject Matter Specialists (SMSs) to conduct these in-service training courses. For those training needs which could not be met by the project, the Training Manager, in co-operation with institutions such as AFMET would make arrangements for training to be conducted at other national institutions and projects.

Similarly, in consultation with SMSs, the Training Manager would co-ordinate farmer and community training programmes.

13.3 Induction Training

Before irrigation begins, induction training courses would be arranged for each department and sub-section. In addition to specific task-related training, these courses would aim to explain general project objectives, organisation and strategy. Some suggestions on the types of courses and general course content are given in Table 13.1.

As it is proposed that the project would privatise mechanisation services, special attention would be given to training of machinery and equipment operators. Training would be conducted mainly by a Mechanisation Specialist, while business management aspects would be covered by the Commercial Department's Business Development Unit. The scheme is explained more fully under the section on commercial services.

TABLE 13.1

Suggested Staff Induction Course

Department	Type of training	Staff to be trained
All departments	General induction in project objectives, organisation and strategy.	All staff
	Supervisory skills	All supervisory staff
	Office practices	All clerical and secretarial staff
Engineering	Workshop procedures	All workshop staff
	Building and maintenance procedures	All infrastructure staff
	Irrigation procedures	All irrigation staff
	Stores procedures	Storekeeper
	Operation of machinery and equipment	Operators
Commercial	Credit distribution and cost recovery procedures	All staff
	Input distribution procedures	All staff
	Marketing procedures	All staff
Finance and Administration	Accounting procedures	All accountants
	Administration procedures	All administration staff
Agriculture	Communication skills	All SFAs
	General crop recommendations	All SFAs
	Irrigation and water management principles	All SFAs

Also, before irrigation commences a community orientation and farmer training programme would have to be organised. The principles behind this programme have been explained in detail under Farmer Organisations.

In brief, senior project staff would explain to Village Committees and community meetings project objectives, organisation and strategy, including the need to establish Farmer Organisations (FOs). Each FO, in consultation with project staff, would then select one of their number to undergo an intensive two-month course in irrigated high input agriculture. As project implementation would be phased, only the first few farmers would have to go on courses off the project site. For these farmers it should be possible to use the AFMET and CAR facilities at Afgoi. However, once irrigation has begun at Homboy all training would be conducted at the project Training Centre and in the field.

13.4 In-Service Training

The most frequent form of in-service training would be the fortnightly training of SFAs on crop-specific recommendations conducted by the appropriate SMS in the field and at the Training Centre. These training sessions would be harmonised with the cropping calendar. Similarly, FOs would benefit from fortnightly group training sessions and individual problem-solving visits conducted by their respective SFAs.

In addition, the Training Manager would, on the basis of the half-yearly performance reviews, organise job skills training programmes. Some of these would be conducted at the Training Centre whilst others would be conducted where the facilities for learning practical skills are available; for example, the workshop.

13.5 Specialised Training

Some training needs could not be met by the project: for example, SMSs need to visit research stations and be exposed to new ideas. The Training Manager would be responsible for identifying these specialist training needs and for arranging appropriate off-project training.

13.6 Training Centre

The Training Centre would be located within the main office block at the project headquarters. Three individual offices would be allocated and the large conference room would be utilised as a classroom.

Training Centre equipment would include white marker boards, an overhead projector, simple video equipment and an industrial photocopier.

13.7 Timing

The Training Manager should be recruited one year before irrigation begins. This is to give him time to identify training needs and organise an induction training programme well before full project implementation begins.

13.8 Costs

The project will provide for the items set out below which are costed in Section F of this Annex.

Training Centre - Building and Maintenance

Vehicles - Purchase and Running Costs

Training Manager	4WD/SW
Mechanisation Specialist	Pick-up
Livestock Specialist	Motorcyle

Equipment:

Office and classroom furniture
Industrial photcopier (up to 6 000 copies/month)
Overhead projector and 60 rolls of transparent film
Industrial slide projector plus 12 spare bulbs
35 mm camera and 72 x 36-frame films
26 inch colour monitor
Portable VHS video recorder
VHS video camera
Batteries
Electric typewriter
Manual typewriter
White marker boards and pens
VHS cassettes, 30 mins. x 30
Samples of all inputs.

Staff	Salary level
Training Manager	EXP
Mechanisation Specialist	EXP
Assistant Training Manager	SE
Assistant Mechanisation Specialist	SE
Secretary	C
Drivers x 2	SL
Messenger/Cleaner	L
Night Watchman	L

Miscellaneous

Stationery and office materials

Contingencies

10%

CHAPTER 14

HEALTH AND EDUCATION PROPOSALS

14.1 Health

The Ministry of Health is currently preparing a project, to be financed by ADB, for the provision of improved health facilities in the Jilib area. While several permutations are still under consideration provisional proposals are to provide one 150 bed hospital at Jilib; five primary health care clinics in areas of high population density and easy accessibility; and one community health post staffed by a single paramedic for every 3 000 persons, (Stein, 1987).

The size and location of the Homboy project would appear to justify the siting of one clinic in Homboy village and one health post in every other project village.

It is anticipated that the health post paramedics will be trained to provide extension in preventive health care as well as providing a dispensary for various prophylactics and treatment of common ailments. More serious cases will be referred to the clinic and hospital.

The Homboy project's contribution to the health of the project's participants will however be confined to the provision of clean drinking water. Moreover the project should increase the quantities and quality of food consumption through increased yields, greater consumption of fresh vegetables and improvements in incomes and living standards.

14.2 Education

Whilst education comes under the responsibility of the Ministry of Education it is proposed that the project would assist in the following ways:

- stimulation of self help groups or farmer organisations which would provide the labour for the construction of simple village schools;
- provision of materials and building supervisors for the construction of village schools;
- stimulation of village communities and farmer organisations to top up the salaries of teachers provided by the Ministry of Education.

CHAPTER 15

PROJECT STAFFING

15.1 Expatriate Staff

The requirement for expatriate staff during the project implementation is shown in Table 15.1 and a total of 10 expatriates would be required over a six-year period. This does not include the requirement for staff to carry out or supervise the construction of the engineering works. The table shows the expatriate staff being phased out in Years 4 and 5 when they would hand over to their Somali counterparts. It may, however, be necessary to retain some of the expatriates for a longer period, and a decision on this could be made at the appropriate time.

The number of expatriate staff is not considered excessive in the light of the expatriate input on smaller projects; e.g. Mogambo and Afgoi Mordile, each with less than 2 500 ha under irrigation, have six expatriates each. Moreover, the Homboy concept of smallholder participation and banana development would be more demanding of managerial skills than any project previously undertaken in Somalia. On the other hand, the estimate of expatriate staff requirements is based on the present availability of Somali staff with the skills and experience required for the project. If, as is hoped, the supply of such staff is substantially increased in the next few years by appropriate training programmes, it should be possible to reduce the number of expatriates.

The expatriate staff would all work in close co-operation with Somali counterparts who would take over full responsibility for the project on the departure of the expatriates.

15.2 Phased Staffing Requirements

Overall staff requirements and phasing are shown in Table 15.2.

It is strongly recommended that a start-up team including the General Manager, Financial Controller, Commercial and Training Managers, and the Mechanisation Specialist is recruited one year before the first irrigation begins. The objective of the start-up team would be to: establish project systems and linkages with other institutions; arrange for procurement of inputs, machinery and equipment; recruit and train operations staff; prepare and involve the community in systems planning and implementation; train farmers in high input irrigated cropping. Initially the start-up team would be provided with offices in the MOA. At the earliest possible date the team would move to the project area.

15.3 Conditions of Service

Government salaries in Somalia are very low which in turn leads to low morale and low productivity. Moreover, young people are attracted to the better facilities available in towns and the higher status of white collar jobs. Only the autonomous agencies with the power to set higher salary levels and offer other benefits are able to attract more capable staff. However, when external financial aid ends the responsible Ministries are often unable to sustain the recurrent cost burden.

TABLE 15.1

Requirement for Expatriate Staff

Designation	Year 0 94	1 95	2 96	3 97	4 98	5 99	6 00	7 01	8 02	Total (man years)
General Manager	1	1	1	1	1	-	-	-	-	5
Deputy General Manager (Annuals)	-	1	1	1	1	-	-	-	-	4
Deputy General Manager (Bananas)	-	1	1	1	1	-	-	-	-	4
Financial Controller/Administrative Manager	1	1	1	1	-	-	-	-	-	4
Commercial Manager	1	1	1	1	1	-	-	-	-	5
Training Manager	1	1	1	1	1	-	-	-	-	5
Mechanisation Specialist	1	1	1	1	1	-	-	-	-	5
Chief Engineer	-	1	1	1	1	-	-	-	-	4
Irrigation and Drainage Engineer	-	1	1	1	1	-	-	-	-	4
Workshop Manager	-	1	1	1	1	1	-	-	-	5

Note: Year 0 = 1994

Bardheere dam commissioned gu season, 1995

TABLE 15.2

Staffing Requirements

Designation	Nr	Grade	Year 0 94	1 95	2 96	3 97	4 98	5 99	6 00	7 01	8 02
General Manager	1	EXP	1	1	1	1	1	-	-	-	-
Deputy General Manager (Annuals)	1	EXP	-	1	1	1	1	-	-	-	-
Deputy General Manager (Bananas)	1	EXP	-	1	1	1	1	-	-	-	-
Financial Controller/Administration Manager	1	EXP	1	1	1	1	-	-	-	-	-
Commercial Manager	1	EXP	1	1	1	1	1	-	-	-	-
Training Manager	1	EXP	1	1	1	1	1	-	-	-	-
Mechanisation Specialist	1	EXP	1	1	1	1	1	-	-	-	-
Chief Engineer	1	EXP	-	1	1	1	1	-	-	-	-
Irrigation and Drainage Engineer	1	EXP	-	1	1	1	1	-	-	-	-
Workshop Manager	1	EXP	-	1	1	1	1	1	-	-	-
General Manager	1	SE	1	1	1	1	1	1	1	1	1
Deputy General Manager (Annuals)	1	SE	1	1	1	1	1	1	1	1	1
Rice Specialist	1	SE	1	1	1	1	1	1	1	1	1
General Arable Specialist	1	SE	1	1	1	1	1	1	1	1	1
Deputy General Manager (Banana)	1	SE	1	1	1	1	1	1	1	1	1
Financial Controller/Accountant	1	SE	1	1	1	1	1	1	1	1	1
Administration and Personnel Manager	1	SE	-	1	1	1	1	1	1	1	1
Commercial Manager	1	SE	1	1	1	1	1	1	1	1	1
Credit and Farm Accounts Officer	1	SE	-	1	1	1	1	1	1	1	1
Input Procurement Officer	1	SE	-	1	1	1	1	1	1	1	1
Marketing Officer	1	SE	-	1	1	1	1	1	1	1	1
Training Manager	1	SE	1	1	1	1	1	1	1	1	1
Mechanisation Specialist	1	SE	1	1	1	1	1	1	1	1	1
Livestock Specialist	1	SE	-	1	1	1	1	1	1	1	1
Chief Engineer	1	SE	-	1	1	1	1	1	1	1	1
Irrigation and Drainage Engineer	1	SE	-	1	1	1	1	1	1	1	1
Assistant Irrigation and Drainage Engineer	2	JE	-	1	2	2	2	2	2	2	2
Infrastructure Engineer	1	SE	-	1	1	1	1	1	1	1	1
Workshop Manager	1	SE	-	1	1	1	1	1	1	1	1
Assistant Accountant	2	JE	-	1	1	2	2	2	2	2	2
Surveyor	1	JE	-	-	1	1	1	1	1	1	1
Assistant Surveyor	2	T	-	-	1	1	2	2	2	2	2
Storeman	6	T	-	2	4	6	6	6	6	6	6
Mechanics, Fitters and Electricians	5	T	-	5	5	5	5	5	5	5	5
Workshop Assistants	10	L	-	10	10	10	10	10	10	10	10
Secretary/Typist	7	PA	2	7	7	7	7	7	7	7	7
Accounts Clerks	6	C	-	2	4	6	6	6	6	6	6
General Clerks	4	C	-	2	3	4	4	4	4	4	4
Building and Service Maintenance Artisans	12	Sh	-	5	10	12	12	12	12	12	12
Building and Services Maintenance Labour	20	L	-	10	20	20	20	20	20	20	20
Irrigation and Drainage Operators	182	SL	-	22	58	98	138	182	182	182	182
Irrigation and Maintenance Foremen	19	SL	-	4	7	10	15	19	19	19	19
Maintenance Plant Operators	28	SL	-	2	14	18	28	28	28	28	28
Irrigation System Maintenance Labour	46	L	-	12	20	28	40	46	46	46	46
Drivers	29	SL	5	15	20	22	29	29	29	29	29
Cleaners/Messengers	6	L	1	6	6	6	6	6	6	6	6
Night Watchmen	4	L	-	4	4	4	4	4	4	4	4
Field Staff:											
Banana Farm Manager	5	SE	1	1	4	5	5	4	2	-	-
Assistant Banana Farm Manager	5	SE	1	1	4	5	5	5	5	5	5
Banana Farm Accountant	5	SE	-	1	4	5	5	5	5	5	5
Banana Farm Agriculturalist	5	SE	-	1	4	5	5	5	5	5	5
Nursery/Packhouse Foremen	5	T	-	1	4	5	5	5	5	5	5
Clerks	20	C	-	4	12	16	20	20	20	20	20
Banana Nursery Labour	30	L	-	6	18	24	30	30	30	30	30
Senior Field Assistants (Bananas)	5	T	1	1	3	4	5	5	5	5	5
Village Service Centre Manager/ Irrigation Supervisor	5	SE	-	1	2	3	4	5	5	5	5
Mechanisation Supervisor	5	SE	-	1	2	3	4	5	5	5	5
Commercial Officer	5	JE	-	1	2	3	4	5	5	5	5
Senior Field Assistants (Rice)	4	T	1	1	2	4	4	4	4	4	4
Senior Field Assistants (Arable)	10	T	3	4	6	10	10	10	10	10	10
Irrigation Foremen	5	JT	-	1	3	4	5	5	5	5	5
Vehicle Drivers	10	SL	-	2	4	6	8	10	10	10	10
General Clerks/Typists	10	C	-	2	4	6	8	10	10	10	10
Storemen	10	C	-	2	4	6	8	10	10	10	10
Cleaner/Messenger	10	L	-	2	4	6	8	10	10	10	10
Night Watchmen	10	L	-	2	4	6	8	10	10	10	10

Notes:

EXP	-	Expatriate
SE	-	Senior Executive
JE	-	Junior Executive
PA	-	Personal Assistant
C	-	Clerical
T	-	Technical
JT	-	Junior Technical
SL	-	Skilled Labour - Artisan
L	-	Labour - Semi-skilled

Somali Salary Scale

A Scale
B Scale
C Scale
C Scale
B Scale
C Scale
C Scale
C Scale

Nevertheless, if the project is to recruit and keep competent staff it will be necessary to offer competitive conditions of service. However, it is anticipated that through privatisation of services and by encouraging community involvement in project maintenance and implementation staff numbers will be reduced and efficiency increased.

It is recommended that salary levels should be comparable with JSP. Other inducements will be provided by housing and transport benefits as well as training opportunities.

15.4 Overall Transport Requirements

The overall transport requirements are shown in Table 15.3.

TABLE 15.3

Schedule of Staff Transport

Location	Designation	Type	Number
HQ	General Manager	4WD S/W	1
	Deputy General Managers	4WD S/W	2
	Financial Controller	4WD S/W	1
	Commercial Manager	4WD S/W	1
	Training Manager	4WD S/W	1
	Mechanisation Specialist	Pick-up	1
	Rice Specialist	Motorcycle	1
	Arable Specialist	Motorcycle	1
	Livestock Specialist	Motorcycle	1
	Chief Engineer	4WD S/W	1
	Irrigation and Drainage Engineer	Pick-up	1
	Assistant Irrigation and Drainage Engineers	Motorcycle	2
	Infrastructure Engineer	Pick-up	1
	Mechanics	Pick-up	1
	Surveyor	Pick-up	1
	Building and Services Maintenance	Pick-up	2
	Irrigation Maintenance Foremen	Pick-up	5
	General Duties	5 ton truck	1
Field	Banana Farm Managers	Pick-up	5
	Assistant Banana Farm Manager	Pick-up	5
	Agriculturalists	Pick-up	5
	Nursery/Packhouse Foremen	Motorcycles	5
	Senior Field Assistants (Bananas)	Motorcycles	5
	Irrigation Supervisors	Pick-up	5
	Mechanisation Supervisors	Pick-up	5
	Commercial Agents	Motorcycles	5
	Irrigation and Drainage Operators	Bicycles	100
	Senior Field Assistants (Rice)	Motorcycles	4
	Senior Field Assistants (Arable)	Motorcycles	10

SECTION E

OPERATION AND MAINTENANCE

CHAPTER 1

INTRODUCTION

1.1 General

The importance of good operation and maintenance cannot be over-emphasised. Without closely controlled operation and maintenance of the irrigation system, it becomes impossible to get sufficient water onto the fields in the time available. The resulting delays cannot easily be made up and the effect becomes cumulative causing overall loss of yield, increased costs and reduced income. Poor maintenance of the drainage system over a period can cause waterlogging and a build-up of salinity which can also have a serious effect on crop yields. Additionally, poor maintenance of the road network causes access problems for harvesting equipment and crop transporters with a possible consequence of crop over-ripening.

A further point worth mentioning is that good operation and maintenance will enhance the smallholders' confidence in the project management, hence encouraging them to perform their own tasks efficiently.

1.2 Responsibilities for Operation and Maintenance

Responsibilities for the operation and maintenance of the project are divided between the management staff and the smallholders.

The smallholders will be responsible for the infield works, that is, all works between the distributary outlet and the unit drain junction with the collector drain. To ensure efficient operation and maintenance of the infield works and to encourage co-operation between smallholders using the same watercourse, the Village Farmers Association will administer infield operations.

All other parts of the irrigation and drainage system and the project infrastructure will be the responsibility of the management staff.

CHAPTER 2

IRRIGATION AND DRAINAGE SYSTEM - OPERATION

2.1 Irrigation System - General

Operation of the irrigation system basically involves conveying water from the supply canal headworks to the fields in the most efficient and economic manner. The quantity of flow at the headworks is based on the crop water requirements with allowances for seepage and deep percolation losses, wastage and uneven distribution. With well constructed canals and efficient land-levelling, losses due to seepage, deep percolation and uneven distribution can be kept to a minimum, but it is the operation of the system which will determine the losses due to wastage. It is important to realise that there are time lags between the various stages in the distribution system, from the headworks through the Supply and Main canal, branch canals, distributary canals and watercourses. If sequential operations are not well timed, there is a danger not only that water will be lost but also that time will be wasted for water levels to reach the required value.

2.2 Daily Irrigation Period

To minimise construction costs of the irrigation system, 24-hour continuous irrigation is proposed for the Homboy project. Adopting this irrigation duration leads to simple operation of the canal system since, in theory at least, canal discharges and levels should be constant throughout the day and night with adjustments only necessary two or three times a month following a change in irrigation scheduling. However, at field level there is little doubt that continuous irrigation is more problematical due to the night irrigation requirements. This can be difficult, socially unacceptable and wasteful of water and is wholly dependent on the attitude of the farmers to night irrigation.

2.3 Crop Water Requirements and Irrigation Scheduling

The canal design is based on water requirements presented in Chapter 3 of Section C. Field efficiencies of 0.50 for the general arable crops and bananas and 0.80 for paddy rice have been adopted. These losses are estimates only and should be confirmed on site by the operations staff.

Net irrigation requirements are given in Tables 2.1 and 2.2 and are detailed more fully in Tables 3.7 to 3.9 of Section C.

In calculating the irrigation requirements shown in Tables 2.1 and 2.2, an allowance has been made for the anticipated effective rainfall in each month. Due to the localised nature of rainfall in this region of Somalia, it is recommended that a system of rainfall gauges is established in each block. Rainfall will be monitored by the Agricultural Department staff who will make changes in the irrigation requirements after reviewing the rainfall quantities.

TABLE 2.1

Crop Water Requirements - General Arable Areas

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evapotranspiration ETo (mm)	195	188	217	171	158	135	140	158	171	171	156	171
Effective rainfall (mm)	-	-	-	58	47	21	15	5	-	1	18	10
Maize:												
- Net requirement (mm)	-	-	-	-	41	117	98	8	-	-	-	-
Cotton:												
- Net requirement (mm)	176	88	-	-	-	-	-	22	60	143	146	170
Sesame:												
- Net requirement (mm)	158	15	-	-	-	-	-	-	-	4	23	140
Cowpea:												
- Net requirement (mm)	-	-	7	45	106	88	-	-	-	-	-	-
Vegetables:												
- Net requirement (mm)	135	28	-	-	34	105	82	19	-	31	62	149
Cropping pattern requirement:												
Maize - 60% (mm)	-	-	-	-	25	70	59	5	-	-	-	-
Cotton - 48% (mm)	84	42	-	-	-	-	-	11	29	69	70	82
Sesame - 48% (mm)	76	7	-	-	-	-	-	-	-	2	11	67
Cowpea - 36% (mm)	-	-	3	16	38	32	-	-	-	-	-	-
Vegetables - 8% (mm)	5	1	-	-	1	4	3	1	-	1	2	6
Total net requirement (mm)	165	50	3	16	64	106	62	17	29	72	83	155

TABLE 2.2

Crop Water Requirements - Banana and Paddy Rice Areas

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evapotranspiration ETo (mm)	195	188	217	171	158	135	140	158	171	171	156	171
Effective rainfall (mm)	-	-	-	58	47	21	15	5	-	1	18	10
(a) Banana areas:												
Bananas:												
- Net requirement (mm)	146	113	158	58	57	75	104	153	176	177	138	161
Maize:												
- Net requirement(mm)	-	-	-	-	41	117	98	8	-	-	-	
Sesame:												
- Net requirement (mm)	158	15	-	-	-	-	-	-	-	4	23	140
Cropping pattern requirement:												
Banana - 80% (mm)	117	90	126	46	46	60	83	122	141	142	110	129
Maize - 20% (mm)	-	-	-	-	8	23	20	2	-	1	5	28
Sesame - 20% (mm)	32	3	-	-	-	-	-	-	-	-	-	-
Total net requirement (mm)	149	93	126	46	54	83	103	124	141	143	115	157
(b) Paddy Rice Areas												
Paddy rice - gu:												
- Net requirement	-	75	347	355	282	278	140	-	-	-	-	-
Paddy rice - der:												
- Net requirement	185	-	-	-	-	-	-	70	319	417	304	333

2.4 Design Flows

2.4.1 Watercourses

Watercourses are designed for a 24-hour irrigation day, and a net watercourse unit size of 25 ha. The design flow depends upon the cropping pattern as shown in Table 2.3.

TABLE 2.3

Watercourse Capacities

Cropping pattern	Peak gross daily requirement (mm)	Design flow for 25 ha net unit (l/s)	Watercourse capacity (l/s)
General arable	10.6	30	60
Banana	10.2	30	60
Paddy rice	16.8	50	50

The table shows that watercourse capacities have been standardised at 50 l/s for the paddy rice units and 60 l/s elsewhere. This will allow standardisation of the distributary outlet and unit feeder channel. Thus in the paddy rice areas one watercourse can serve one 25 ha unit, whereas elsewhere one watercourse can serve two 25 ha units.

2.4.2 Distributary, Branch and Main Canals

These canals have a design capacity based on 50 l/s for the paddy rice units and 30 l/s elsewhere. A seepage loss calculated from:

$$S = 0.007Q^{\frac{1}{2}}L$$

where S = seepage loss (m^3/s)

L = length of reach (km)

Q = reach discharge (m^3/s)

has been added to the required discharges at the field outlets to calculate design discharges in the distributary, branch and main canals.

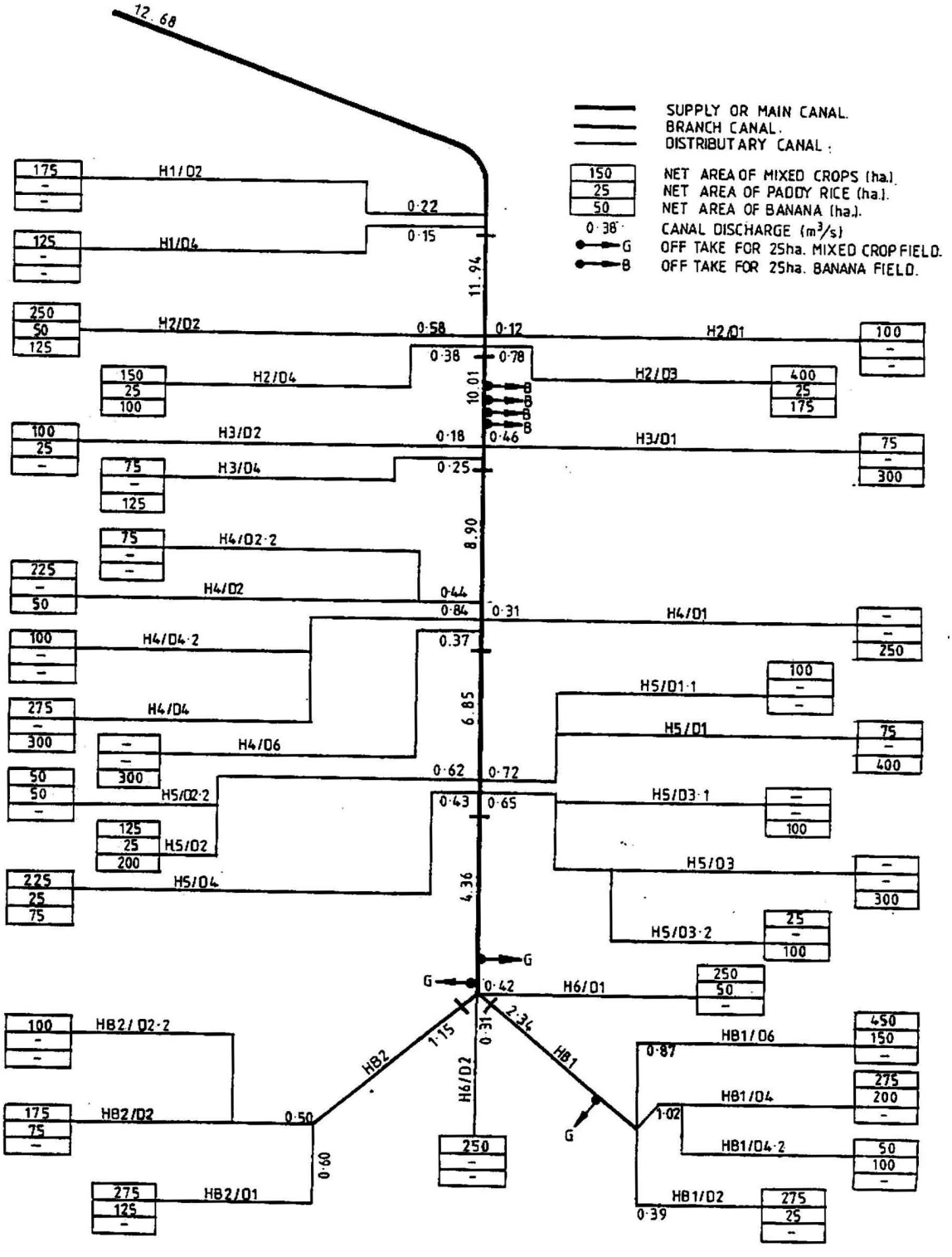
Design flows in the distributary, branch and Main canals are shown in Figure 2.1.

2.4.3 Design Water Levels

The irrigation supply system for the Homboy project has been designed assuming 24-hour irrigation during the peak months of water demand.

Figure 2.1

Canal System



During the off-peak periods the system should be operated as follows:

(a) watercourses should always operate at their design discharges;

(b) the distributary canals upstream of the watercourses can be operated in three ways:

  (i) run the canals at reduced discharge and rotate watercourses;

  (ii) run the canals at design discharge and rotate canals;

  (iii) run the canals at design discharge for shorter periods;

(c) the Supply and Main Canal will operate continuously at reduced discharge.

The Irrigation and Drainage Engineer should carry out trials of the various alternative methods of operation before one is finally adopted.

Whichever system is adopted, design water levels upstream and downstream of each cross regulator should be indelibly marked on the structure and the basic aim of gate operation should be to maintain the upstream design levels irrespective of the flow in the canal.

Downstream water levels at cross regulators are less important than those upstream but must still be monitored. These levels depend on discharge and channel conditions. For example, if sediment deposits or weed growth occur the water level will rise above the normal level for that particular discharge. This may necessitate larger gate openings for the gated pipe structures. A rise in downstream water level, which will also reduce the canal freeboard thus increasing the danger of overtopping, is a good indication that channel maintenance works are required.

2.5 Canal Operation

2.5.1 General

In order to operate the system efficiently, it is important that the following points are understood:

(i) the canal system is an upstream control system. This means that individual field units are given a pre-determined supply and water must not be abstracted at random;

(ii) crop water requirements are the responsibility of the Agricultural Department which should indent for water on a 10-day schedule;

(iii) the irrigation supervisor calculates required distributary canal flows within his block and passes this information to project headquarters. The Assistant Irrigation and Drainage Engineer calculates the required flows in the branch, Main and Supply canals and the corresponding gate settings. He then communicates his instructions via the irrigation supervisors to the operations staff.

2.5.2 Canal Filling

With all new canal systems, or when refilling canal systems which have been allowed to dry out, it is essential that the filling of the canal is carried out slowly in order that the soil can take up moisture gradually. Close supervision of the canal during the filling operation is required in case excessive seepage occurs at any location, whilst men and materials must be at hand to cater for such an eventuality. Before filling commences the dry canal should be inspected and any animal holes, breaches or gulleys should be repaired.

The canals are mostly in fill and thus particular care is required during initial filling and on refilling from a dry state if the canal has been dewatered. The maximum recommended rate of filling under these circumstances is 0.02 m/h increase in water level. During normal operation when the soil is already wetted the filling rate should not exceed 0.10 m/h.

2.5.3 Canal Emptying

Under certain circumstances it may be necessary to direct water out of the canals. This should not be required under normal operation, but may be unavoidable in the following circumstances:

- to empty a canal for maintenance;
- to facilitate rapid canal closure in an emergency.

There are two ways in which water can be diverted from the canal system:

- through distributary canal tail escapes into the drainage system (only when canal levels are high since the tail escape crest is set 0.05 m above design water level);
- through distributary outlets into the watercourses and thence into the drainage system.

2.5.4 Operation Following Rainfall

It is difficult to make recommendations on how to change an irrigation schedule after rainfall. It should be borne in mind that the calculated crop water requirements assume that rainfall corresponding to a 1-in-5 dry year occurs, so rain in itself does not necessarily mean that changes to the schedule are required.

However, if rainfall has filled the root zone there is no point in irrigating immediately, and irrigation can be delayed several days, so long as it is then possible to irrigate all the fields under crop before they reach the allowable depletion level.

The procedure to be followed must be determined in advance after consultation with the Agricultural Department which has responsibility for determining field irrigation requirements. It is recommended that various alternative procedures such as 'half-waterings' should be adopted, based on daily readings of antecedent rainfall.

2.6 Structures Operation

2.6.1 Supply Canal Head Regulator

The Supply Canal Head Regulator has been constructed by the Fanoole project and comprises an offtake with two lifting gates each 2 m wide x 2.5 m high. The discharge can be controlled by raising or lowering the gates. Once the required flow is set for a 10-day period, the gates should need little attention although small adjustments may have to be made for changes in the water level of the Fanoole Main Canal. The Supply Canal Head Regulator should have a radio link with the project headquarters so that in the event of a breach in the canal system the gates can be quickly closed.

2.6.2 Main Canal Cross Regulators

These structures are multi-bayed sluice gated structures with the number of bays and gate height being dependent on canal discharge. Their purpose is to control the upstream water levels by adjustment of the gates so that the offtaking distributary canals can receive their full design discharge regardless of the flow in the Main or branch canals.

2.6.3 Branch Canal Head Regulators

These structures are similar to the Main Canal cross regulators and control flow into the two branch canals. The gates should be adjusted to maintain the required downstream discharge.

2.6.4 Distributary Canal Head Regulator

Each distributary canal offtakes from the Main or branch canals through a head regulator. This comprises a single gated pipe structure with a concrete outlet box. It is important to accurately measure flow at the head of the distributary as there are no flow measurement facilities downstream of this structure. To facilitate flow measurement, a crest tapping and measuring well is provided downstream of the gate and by measuring gate opening and head loss across the gate the discharge can be estimated.

2.6.5 Distributary Canal Cross Regulator

These structures are fixed duckbill weirs and, as such, require no operation.

2.6.6 Distributary Outlet

The distributary outlet structure diverts flow from the distributary canal into the unit feeder channel. It consists of a simple gated pipe through the canal bank with an inlet and outlet box.

2.7 Operating Procedures

2.7.1 General

During peak months the irrigation system will run continuously at design discharge. During non-peak months the system has insufficient storage or escape capacity to pass the design flow when the distributary outlets are closed. Flows are therefore reduced in the system by adjusting regulator gate settings. Flows in the watercourses are maintained at design values irrespective of the crop requirement.

2.7.2 Calculation of Requirements

Field irrigation requirements are determined by staff of the Agricultural Department, normally at 10-day intervals. They then indent for a supply to each feeder over the interval. The irrigation supervisor makes an allowance for losses and inefficiencies as previously discussed and calculates the required flows and gate settings in the distributary, Main and Supply canals.

2.7.3 Operation of the Supply Canal

The Supply Canal offtakes from the Fanoole Main Canal via a head regulator with undershoot gates. The discharge through the structure is regulated by raising or lowering the gates. Once the 10-day flow requirements have been set, the gates should need little attention although small adjustments may have to be made if fluctuations in the Fanoole Main Canal water levels occur.

The head regulator's importance to the project cannot be overstated and the operators must be competent and well trained. Two operators per shift will be provided and to ensure their presence at all times, an operator's quarters will be provided at the regulator site.

As a safety measure, an escape structure is recommended. This is simply a pitched length of lowered canal bank situated near a natural depression.

2.7.4 Operation of the Main and Branch Canals

Cross regulators are located along the Main Canal to maintain upstream levels required to divert design flows into the distributary canals. One operator will be provided per shift at each cross regulator who will also monitor the condition of the canal upstream to the next cross regulator.

2.7.5 Operation of the Distributary Canals

Operation of the distributary canals will be the responsibility of the ditchriders, each having responsibility for one canal. The ditchriders will ensure that the correct discharge is passed through the head regulator and will open field outlets that have been closed during off-peak periods. The ditchriders will also be required to travel down the canal periodically checking embankments, clearing obstructions, monitoring water levels and checking distributary outlet gates. To enable the ditchriders to carry out these tasks efficiently, bicycles will be provided. Two ditchriders per shift will be provided to ensure continuity of operation.

2.7.6 Operation of the Infield Works

An irrigation unit size of 25 ha net has been adopted with furrow (or border strip) and basin irrigation used. Furrow or border strip methods will be used for bananas and the arable crops with basin irrigation for the paddy rice. Each watercourse can serve one paddy rice unit or two banana/arable crop units thus each paddy rice unit will receive water continuously, whereas the other units will be rotated on an equal time basis. For ease of operation only one cropping pattern is adopted for any one watercourse unit.

Water is conveyed into the watercourse through the field outlet which is regulated by the ditchrider. All operations downstream of the field outlet are carried out by the farmers themselves and administered by the Village Farmers Associations. These Associations are further discussed in Section D of this Annex.

To transmit the water from the watercourse to the field, a header ditch will be constructed by each farmer. When irrigation is due, the farmer breaks the watercourse banks and bunds off the watercourse thus diverting the full flow into the header ditch. The header ditch banks are broken at the head of the furrow or border and, in the case of paddy rice, several places along the basin. An alternative to constructing a header ditch is to convey the water directly from the unit feeder to the field using plastic siphon pipes although this is not recommended as these pipes are susceptible to damage and are easily stolen.

At the end of the irrigation period, one farmer removes the earth bund in the watercourse and repairs the banks so that water is passed downstream to the next farmer. Obviously this system of infield management is totally dependent on farmer attitudes and every effort should be made through the various user committees to encourage co-operation among farmers who receive water from the same watercourse.

2.8 Drainage System - General

The drainage system consists of field drains, canal escape drains, collector, branch and outfall drains. Over 70% of the project area can drain by gravity at all times and requires little operation as no gates are involved. The remaining 30% of the project area (drained by main collectors D4, D6, D10, D12 and D14) cannot be drained when water levels in the Lower Outfall Drain are high. This situation will occur infrequently and the cost of construction and maintaining drainage pumping stations cannot be justified. Water will back up in the drainage system and may cause short duration flooding in some of the lower fields. Back flow from the Lower Outfall Drain into the collecor drains is prevented by flap gates attached to the drain junction culverts.

2.9 Operation of the Drainage System

2.9.1 Field Drains

Field drains are required to collect and discharge water from the fields into the collector drains. Water flows directly from the furrows into the field drains, and in the case of basins and border strips water is diverted into the drains by breaking the field bund.

2.9.2 Collector Drains

Flow passes from the field drains into the collector drains through Type 1 culverts. Road culverts and junction culverts on the collector drains are either Type 2, 3 or 4 culverts or box culverts depending on the discharge and head loss. None of these culverts is gated and therefore requires no operation other than periodic clearance of trash and debris.

2.9.3 Outfall Drains

There are two outfall drains in the Homboy project, the Upper Outfall Drain which conveys flood flows from north of the Jilib-Mogadishu road to the Eastern Reservoir and the Lower Outfall Drain which conveys water from the Eastern Reservoir to the Juba river. There are no structures along the Upper Outfall Drain.

At the upstream end of the Lower Outfall Drain is the gated Eastern Reservoir Outlet. The gates should be left open at all times except when Juba river levels are too high to allow gravity flow from the Eastern Reservoir.

Despite the infrequent operation of the gates, one operator per shift will be provided. The outfall to the Juba river is located at the downstream end of the Lower Outfall Drain and is also gated. Flap gates are fitted to the inlet box to prevent the river backing up into the drainage system at periods of high river levels. In addition, standard sluice gates are provided as a safeguard should the flap valves be wedged open by large items of debris. One operator per shift will be provided.

2.10 Operational Staff Requirements

The total operational staff requirements are presented in Table 2.4. Overall control will be the responsibility of the Irrigation and Drainage Engineer. The irrigation supervisors will determine the flows required in the distributary canals within their blocks and report to an Assistant Irrigation and Drainage Engineer who will determine the flows required in the Supply Canal and communicate gate settings to the operators. Transportation and general administrative staff are discussed in Section D of this Annex.

The expatriate Irrigation and Drainage Engineer will only be required during the first few years of project implementation. The Somali Irrigation and Drainage Engineer Designate will then assume full responsibilities for the operation and maintenance of the irrigation and drainage system.

TABLE 2.4

Staff Requirements for Operation of the Irrigation and Drainage System

Job title	Number of shifts	Total	Location
Irrigation and Drainage Engineer (Expatriate)	1 x 1	1	Project headquarters
Irrigation and Drainage Engineer Designate	1 x 1	1	Project headquarters
Assistant Irrigation and Drainage Engineer	2 x 1	2	Project headquarters
Block Supervisors	5 x 1	5	Block headquarters
Operator	2 x 2	4	Supply Canal Head Regulator
Operator	5 x 2	10	Main Canal cross regulators
Operator	2 x 2	4	Branch canal head regulators
Operator/Ditchriders	80 x 2	160	Distributary canal head regulators
Operator	1 x 2	2	Eastern Reservoir Outlet
Operator	1 x 2	2	Juba river outfall

CHAPTER 3

IRRIGATION AND DRAINAGE SYSTEM MAINTENANCE

3.1 Introduction

Regular and timely maintenance is essential for proper functioning of the irrigation and drainage system. There is always a tendency to neglect maintenance, particularly of a minor nature, but this is extremely bad practice because deterioration develops into major faults requiring not only expensive corrective works, but possibly closure of canals affecting agricultural production. Regular inspection and maintenance must be carried out to a carefully organised programme concentrating on the periods when canals and drains are used infrequently. The importance of regular maintenance cannot be overstressed and a realistic annual programme and budget is required from the outset of operation.

The responsibility for maintenance of the in-field works (i.e. the watercourses and associated structures downstream of the field outlet and the field drains and associated structures upstream of the junction culvert with the main drain) will be the responsibility of the smallholders. All other maintenance works will be carried out by the project authority.

3.2 Types of Maintenance

There are four categories of maintenance - routine, continuous, periodic and emergency. They are defined as follows:

Routine Maintenance

This comprises simple minor maintenance carried out by the farmers or maintenance gangs. It includes cleaning and greasing of gates, removal of debris from channels and other minor repairs.

Continuous Maintenance

This comprises continuous cleaning of the canal and drain systems and road maintenance, and would be undertaken by the maintenance gangs. The annual inspection by the Irrigation and Drainage Engineer (see Section 3.3) will highlight any problems and the continuous maintenance programme can be revised if necessary.

Periodic Maintenance

This comprises regular maintenance of all parts of the system not covered by the continuous maintenance programme. The requirements for periodic maintenance are planned in accordance with the findings of the annual inspection.

Emergency Repairs

These are generally related to major canal breaches when prompt action is necessary to prevent prolonged shortage of water or further damage. Requirements for men, machines and materials for this work must take priority over all other work.

3.3 Maintenance Planning

The Irrigation and Drainage Engineer should develop a detailed programme for carrying out routine and continuous maintenance. This should list the type and location of the maintenance works to be carried out together with assigned personnel. The foreman of each maintenance gang should keep a weekly record of work carried out and submit this to the Irrigation and Drainage Engineer.

Periodic maintenance requirements will be planned by the Irrigation and Drainage Engineer following the annual inspection. Accurate records should again be kept so that recurrent problem areas can be highlighted and the necessary action taken.

Recommendations for inspection of each major component of the works are given below.

3.3.1 Canal System Inspection

(a) Annual Inspection

An annual inspection of the canals when empty is recommended. Owing to the cropping patterns proposed, the canal system will operate for 12 months of the year. It will therefore be necessary to close each canal briefly in a systematic manner to facilitate this inspection. Particular points to look for are:

(i) weed growth and siltation in channels;

(ii) deterioration of embankments;

(iii) leakage from canals.

Any minor repair work required below water level should be carried out immediately. More extensive damage requiring prolonged closure of the canal should be organised in collaboration with the agricultural staff so as to keep loss of production to a minimum.

(b) Peak Demand Inspection

An additional inspection should be made during peak demand periods to determine the following:

(i) the ability of canals to pass the maximum discharge;

(ii) areas where bank repairs are required;

(iii) which control structures are 'drowned' and therefore operating with inadequate head.

3.3.2 Drain System Inspection

The drainage system should be inspected at the end of the heavy rains (say July/August) so that any damage can be repaired promptly. Particular points to look for are:

(i) blocked drains;

(ii) gulleying in side slopes.

As cleaning of the drains is a continuous operation this inspection serves to highlight any problems which may indicate a required change in the continuous maintenance programme. It should be noted that it will not be possible to completely empty the drainage system and thus the inspection cannot be fully comprehensive. It is therefore important that any problems in the drainage system operation are reported by the field staff as soon as possible. It is also essential that the inspection includes the lengths of drain outside the irrigated area as these tend to receive less attention than drains within the irrigated area.

3.3.3 Road System Inspection

The unsurfaced access roads should be inspected at the same time as the adjacent canal or drain. Particular attention should be paid to the deterioration of the surface and gulleying of the side slopes.

3.3.4 Structures Inspection

The structures inspection should be carried out at the same time as the canal and drain inspections and includes the head and cross regulators, escapes, underpasses, culverts and minor structures. Particular attention should be given to the following:

(i) condition of upstream and downstream protection;

(ii) condition of gates - each gate should be examined over its full range of travel; any repairs or painting required should be noted;

(iii) condition of concrete - damaged, cracked or loose concrete should be noted together with any subsidence or leaking joints;

(iv) condition of upstream and downstream backfill - any leakage should be noted;

(v) condition of upstream and downstream water level gauges;

(vi) condition of all joints - need for joint sealer to be replaced;

(vii) condition of any protection work;

(viii) condition of steelwork - any painting requirements should be noted;

(ix) blocked culverts.

3.4 Maintenance Operations

3.4.1 General

For canals and drains the most time-consuming maintenance activities will be control of weeds, desilting and maintenance of correct channel profiles. To a large extent the problems of silt deposition and weed growth are interrelated. Weed control is discussed in Section 3.6.

Silt deposition should not be a major problem as the majority of silt will drop out of suspension upstream of the Supply Canal Head Regulator. A long reach hydraulic excavator will be employed to clear the channels of silt.

Routine maintenance of structures will mainly involve clearance of trash that might otherwise impede flow, and maintenance of gates.

The maintenance of access roads will involve maintaining the roads to correct grade and crossfall, and keeping associated drainage ditches and culverts clear of debris and weeds.

3.4.2 Routine Maintenance

(a) Control Structures

At control structures the following routine activities should be carried out:

(i) clearance of trash from upstream of structures as necessary;

(ii) clearance of weed growth upstream of structures as necessary;

(iii) cleaning and greasing of lifting mechanisms of canal and drain structure gates every month;

(iv) checking full range of opening and closing of gates at least twice a year;

(v) minor repairs to gates as necessary.

All of these activities are to be carried out by the maintenance gangs, although trash and weed removal from minor structures would also be carried out by the farmers as necessary.

Provided the works are inspected annually and repairs carried out, there should be little need for routine maintenance of the concrete and pitching of structures.

(b) Earthworks: Canals, Drains and Roads

The following routine activities should be carried out as necessary:

(i) removal of debris from canals;

(ii) removal of debris from drains;

(iii) clearance of weeds from channels;

(iv) small repairs at low places in banks adjacent to offtakes, etc.;

(v) repairs to potholes in roads;

(vi) repair of earth ramps at road crossings, etc.

3.4.3 Continuous Maintenance

(a) Canal and Drain System

The hydraulic excavators will be continuously in use for desilting the canal and drain system.

The operation should be carried out so that each canal and drain is desilted at least once every two years. Some limited reaches may require desilting more frequently and this will become apparent during the annual inspection. It is important to ensure that the sections of drains outside the irrigated area are not overlooked.

All material should be deposited outside the canal or drain banks so that the inspection roads on these are not rendered impassable. Clearance should generally start from upstream so that silt and weeds are not carried back into recently cleared areas.

Frequent maintenance will be required on banks and side slopes to repair gulleying caused by rain. Repairs to the horizontal and outside slopes to canal banks can be achievd by grader. The inside banks will have to be repaired by hand as far as possible in the dry season. This also applies to the flood bunds and reservoir embankments, but here maintenance can be carried out most of the year mainly by grader.

Extensive gulleying can be avoided if the banks are properly graded. The bank top should be sloped away from the canal and no low spots or lips should be left which would cause ponding of the water or the outflow to be concentrated at one point. If the rain water runs off evenly over the whole bank length, there will be very little gulleying.

After the channels have been operating for some time, weed growth will establish itself on the banks. This helps to reduce rain damage but must be kept in control. This is discussed in detail in Section 3.6.

Continuous minor maintenance of the watercourses and field drains will be the responsibility of the farmers. However, any major repair work or realignment will be carried out by the maintenance gangs.

(b) Road System

Earth roads should be graded regularly with the grader blade angled so that the material is pushed towards the centre of the road. If the material is pushed to the sides, the road is gradually reduced in level and becomes a channel where water will accumulate thus making the road impassable for long periods.

3.4.4 Periodic Maintenance

(a) Canal and Drain System

If it is found to be necessary at the annual inspection, canals should be closed for cleaning or repair, the date of closure must be organised in collaboration with the agricultural staff but should preferably be in the period of least flow requirement.

Once the canal in question has been closed down and as much water as possible drained off, silt and weed removal should commence from the upstream end of each reach.

Damage to the canal and reservoir embankments should be repaired as follows :

(i) any holes should be excavated to expose the extent of the damage;

(ii) the hole should then be refilled using material imported from a recognised borrow area. It should be wetted and compacted using hand rammers.

(b) Road System

After periods of heavy rain, the roads should be closed completely to vehicular traffic especially tractors which, when rain starts, should remain wherever they are at that time. Tractors cause very deep rutting on wet roads and make them virtually impassable for other vehicles. Some damage after rain is inevitable and the following treatment should be carried out:

(i) loosen the surface with the grader ripper bar;

(ii) water the surface;

(iii) grade the surface to the grades shown on the as constructed drawings.

Gulleying and damage to road embankments should be repaired as detailed in Section 3.4.4(a).

3.5 Machine Requirements

An efficiently controlled and maintained fleet of machinery and vehicles is required for the operation and maintenance of the irrigation and drainage system. Machinery requirements are shown in Table 3.1 and exclude items specifically required for agricultural operations. Personnel transport vehicles are included in Section D of this Annex.

The responsibility for servicing and repair of the plant and equipment is that of the workshop manager, and should be carried out in accordance with the operation and maintenance manuals supplied by the manufacturers. However, the Irrigation and Drainage Engineer should ensure that the machinery in his command is in good working order and serviced at regular intervals.

3.6 Weed Control

The canals and drains will all be subject to the establishment and growth of aquatic weeds and bank vegetation, and measures will have to be taken for their control. In the absence of proven alternatives such as chemical or biological methods, the recommended system of weed control is a combination of hand and mechanical clearance as follows:

(i) Canals and Drains

These should be kept clear of weeds by using hydraulic excavators. Additional hand cutting of weeds in the drains will probably be necessary as these are particularly susceptible to weed growth.

TABLE 3.1

Maintenance Plant and Equipment

Item	Use	Number
Hydraulic excavator	Small channels	5
Crawler tractor (72 kW)	General earthworks	3
2WD tractor (45/50 kW)	General	6
4WD tractor (45/50 kW)	General	2
Trailer (5 tonne)	General	6
Water tank trailer (2 000/2 500 litres)	General	2
Fuel tank trailer (2 000/2 500 litres)	Vehicles and machinery	2
Low loader trailer (15 tonnes)	Transport of plant	2
Motor grader (150 hp)	General earthworks	3
Wheeled loader (90 hp)	Loading materials	1
Mobile workshop	General	1
10 tonne truck with crane	General - heavy loads	1
10 tonne flat truck	General - light loads	6
10 tonne tipper truck	General	2
Flail cutter	Canal banks	2
Concrete mixer	Structure repairs	2
Water pump	Dewatering	2
Portable generator	Field repairs	2
Portable compressor	Tyre inflation	1
Vibrators	Structure repairs	3

(ii) Watercourses and Field Drains

The maintenance of these channels is the responsibility of the farmers who will almost certainly adopt hand cutting as their method of weed control.

(iii) Roads and Embankments

The tractor mounted flail cutter can be used to cut weeds or embankments above water. If possible cutting should take place before the weeds have seeded to avoid reinfestation. If canals can be briefly emptied in the non-peak months then it will be possible to clear the whole bank face.

Residues from all weed clearance operations should be left where they are deposited adjacent to the canal, drain or embankment, since removal is costly and time consuming. When dry they should be stacked and burned with suitable safety precautions.

3.7 Maintenance Organisation

The responsibility for maintenance of the complete irrigation and drainage system is that of the Irrigation and Drainage Engineer.

The maintenance work is to be carried out by separate gangs. Each gang would comprise a foreman, a small number of permanent workers (plant operators, labourers) with additional labourers being utilised as required. Each gang would be responsible for a separate aspect of the maintenance work as described below:

(i) Canal and Drain Cleaning (4 gangs)

Continuous desilting of the canal and drain system using the hydraulic excavators.

(ii) Roads/Earthworks (3 gangs)

Grading and repair of earth roads and repair of all embankments.

(iii) Weed Control (5 gangs)

Weeding of all canals, drains and embankments using the tractor mounted flail cutter plus hand labour as required.

(iv) Structures (2 gangs)

Repair of canal and drain structures, cleaning and greasing of gates and clearing blockages in culverts.

The total staff requirements for maintenance operations are summarised in Table 3.2 The Irrigation and Drainage Engineer, who has overall responsibility for maintenance has already been included in Table 2.3.

TABLE 3.2

Staff Requirements for the Maintenance of the Irrigation and Drainage System

Staff			Number
Assistant Irrigation and Drainage Engineer			1
Surveyor			1
Assistant Surveyors			2
Mechanic			1
Maintenance Foremen			14
Labourers			46
Carpenters			2
Stonemason			1
Plant Operator	-	Excavators	10
Plant Operator	-	Crawler Tractors	6
Plant Operator	-	Graders	6
Plant Operator	-	Wheeled Loaders	2
Plant Operator	-	Flail Cutter	4
Drivers	-	Trucks	9
Drivers	-	Tractors	8
Drivers	-	Low Loaders	2
Drivers	-	Mobile Workshop	1

CHAPTER 4

INFRASTRUCTURE OPERATION AND MAINTENANCE

4.1 Introduction

The operation and maintenance of an efficient infrastructure sector within the project is most important. Without an efficient system the operation of the project is hindered and the project will become unattractive to the managerial and farm staff who are required to operate it.

4.2 Operation and Maintenance Requirements

Sections will be established to deal with various infrastructure components of the project as follows:

1. Workshops
2. Buildings
3. Power supply
4. Potable water supply
5. Roads
6. Sanitation

Section 1 will be the responsibility of a Workshop Manager and Sections 2 to 6 the responsibility of an Infrastructure Engineer except for Item 5 which will be undertaken by the Irrigation and Drainage Department as it operates the motor graders.

The central project workshop will be located in the project headquarters and will be under the control of a Workshop Manager. All project vehicles, plant, agricultural machinery and equipment will be repaired and maintained by these workshops. One mobile workshop will be provided for routine servicing and minor repairs in the field.

The central workshop will include stores holding a fully comprehensive supply of spare parts.

The low loaders can be used to transport vehicles and machinery which break down and need major repairs at the central workshops.

The Infrastructure Engineer will be responsible for the maintenance and repair of all project housing, offices, workshops, stores and other community buildings.

There should be a storage area in the project headquarters for all building materials and equipment. Staff will be attached to this section to operate, maintain and repair the services to the buildings and the villages as a whole. Ten skilled labour personnel have been allowed for, including electricians, carpenters and masons, supported by twenty assistants.

4.3 Staffing

The staffing of the infrastructure section will comprise:

Name	Number
Infrastructure engineer	1
Building foremen	2
Artisans (carpenters, masons, plumbers)	10
Labourers	20
Storemen/clerks	1

CHAPTER 5

COSTS

5.1 Irrigation and Drainage System

5.1.1 General

Vehicles, plant and machinery are required for the operation and maintenance of the irrigation and drainage system. The total cost of this equipment is made up of the capital purchase cost and the annual running cost as shown in Section F. The capital cost of the equipment was obtained from recent manufacturer's quotes and includes the basic price, transport costs to Somalia and an allowance for handling charges at the port-of-entry in Somalia. Details are presented in Table 5.1. The running costs are made up of the costs of spare parts, materials, fuels, lubricants and operators.

5.1.2 Spare Parts and Materials

Annual costs for spare parts and materials cover the price of spare parts for vehicles and machinery and the price of materials for repairs to structures. These costs have been assessed on a percentage basis of the original capital cost, the values being 10% for vehicles and machinery and 0.5% for canal and drain structures.

5.1.3 Fuel and Lubricants

Annual fuel and lubricant costs for vehicles and heavy machinery are based on the number of hours of operation, the fuel consumption and the current price of diesel. An additional 15% has been allowed for lubricants.

5.1.4 Operators

Operator costs are detailed in Section F, Chapter 8 of this Annex.

5.2 Infrastructure

Annual operation and maintenance costs for the project infrastructure have been assumed to be 1.5% of the original capital cost. These costs are detailed in Section F, Chapter 8 of this Annex.

TABLE 5.1

Vehicle and Machinery Costs for Operation and Maintenance of the Irrigation and Drainage System

Item	Unit cost (US$)	Lifespan (years)	Number and year of purchase				
			1994	1995	1996	1997	1998
Hydraulic excavator	111 000	10			2	1	2
Crawler tractor with blade (72 kW)	60 000	8			1	1	1
2 WD tractor (45/50 kW)	14 000	5		1	2	1	2
4 WD tractor (45/50 kW)	16 000	5		1			1
Trailer (5 tonne)	3 000	10		1	2	1	2
Water tank trailer (2 500 l)	3 000	10				1	1
Fuel tank trailer (2 500 l)	3 000	10			1	1	
Low loader tractor and trailer	35 000	8			1		1
Motor grader (150 hp)	80 000	10			2		1
Wheeled loader (90 hp)	51 000	10		1			
10 tonne truck with crane	60 000	8		1			
10 tonne flat truck	44 000	8		1	2	1	2
10 tonne tipper truck	50 000	8		1			1
Mobile workshop	60 000	8		1			
Flail cutter	7 000	5			1		1
Concrete mixer	500	8		1			
Water pump	3 100	5		1			1
Portable generator	800	10		1			1
Portable compressor	1 100	10		1			
Vibrators	350	10		2		1	

SECTION F

FINANCIAL AND ECONOMIC STUDIES

CHAPTER 1

INTRODUCTION

1.1 General

This section presents the financial and economic analyses for the proposed Homboy Irrigation Project. Full details of the financial and economic prices used in the analyses are given and the latter are also used in the report's assessment of agricultural benefits from Bardheere dam (Annex 3).

The section also provides a review of the market prospects for the crops that it is proposed to grow on the Homboy Project. These include bananas, rice and cotton as major cash crops and a variety of well established crops to be grown for subsistence and sale.

CHAPTER 2

PROJECT DEVELOPMENT

2.1 Commencement and Phasing

The Homboy Irrigation Project is dependent upon the Juba river waters regime that will result from the operation of the Bardheere dam. The 8 850 ha scheme will need regular and adequate flows in the Juba river if it is to achieve the target 200% cropping upon which the project's benefits are based. It has been assumed that, while a start can be made on construction before the dam is completed, cropping will not commence until 1995 when the dam starts being used. Details of the phasing of construction are given in Section C. The commissioning of farming blocks and land by crop suitability is summarised in Table 2.1. Further details of the three farming systems which are related to land-crop suitability are given in Chapter 5 - Farming Systems.

Two phases are proposed - Phase 1 over 45 months will result in the settlement of 1 655 families in five irrigation blocks. There will be a net irrigable area of 4 075 ha. Phase 2 will be developed over the next 27 months and accommodate a further 4 775 ha in five more irrigated blocks for another 2 075 families. Table 2.2 gives the build-up of farm families by farming system type over the 72-month development period. Details of the three proposed farming systems and cropping development are given in Chapters 5 and 6.

2.2 Source of Settlers

2.2.1 Sources of Data

Estimates of the area's population have been derived from the original Homboy Irrigated Settlement Project study (HTS, 1980) and from information given by village headmen during field visits in November 1986. Forecasts from the 1975 National Population census are unlikely still to be valid, since they are now 11 years old. In late November and December 1986 the government conducted a national census of sedentary households and this was to be followed in the first quarter of 1987 by a census of the nomadic population. The data were, however, not available for this study. It is recommended therefore that, when the census data are available, the figures for the present and future projected population be reviewed and recalculated.

2.2.2 Future Population

As noted in Chapter 4 of Section B - Agriculture, nomadic groups annually visit the area and vary from 200 to over 400 families depending upon the season.

The 1980 Homboy study found a population of 8 220 persons in 1 500 families in 1978/79. Eight hundred families were in Homboy and its related villages, including Aminow, the balance being elsewhere, mostly to the south in the Burgaan area. In late 1986 the village authorities reported a settled population of about 1 200 families permanently living in the Homboy area. This gives a growth rate of almost 50% during the eight year period, an annual rate of 5.2%. Accepting a natural increase of 2.7% per annum, the figures imply a net immigration rate of 2.5%. The new arrivals are reported to be mainly from the seasonal nomadic communities. In the absence of pressure on the available

TABLE 2.1

Summary of Homboy Irrigation Project Development Phasing

Year	Cumulative months	New commission area (ha) Total	Rice	Banana	Other	Cumulative area (ha) Total	Rice	Banana	Other
1993 (January) – 1994	Construction and pre-project activities								
1995	27	825	50	125	650	825	50	125	650
	33	1 300	75	500	725	2 125	125	625	1 375
1996	39	925	-	850	75	3 050	125	1 475	1 450
	45	1 025	-	350	675	4 075	125	1 875	2 125
1997	51	800	100	275	425	4 875	225	2 100	2 550
	57	1 125	-	900	225	6 000	225	3 000	2 775
1998	63	575	25	-	550	6 575	250	3 000	3 325
	69	1 525	500	-	1 025	8 100	750	3 000	4 350
	72	750	200	-	550	8 850	950	3 000	4 900

TABLE 2.2

Proposed Settlement Schedule

Month	Block Nr	Families by farm type				Cumulative Nr of families			
		Rice arable	Banana	General arable	Total families	Rice arable	Banana	General arable	Total
Phase 1:									
27	1	50	50	240	340	50	50	240	340
33	2	50	90	110	250	100	140	350	590
33	3	25	110	150	285	125	250	500	885
39	4	-	340	30	370	125	590	530	1 245
45	5	-	140	270	410	125	730	800	1 655
Sub-total		125	730	800	1 655				
Phase 2:									
51	6	100	110	130	340	225	840	930	1 995
57	7	-	360	90	450	225	1 200	1 020	2 445
63	8	25	-	210	235	250	1 200	1 230	2 680
69	9	500	-	210	710	750	1 200	1 440	3 390
72	10	200	-	140	340	950	1 200	1 580	3 730
Sub-total		825	470	780	2 075				
Total		950	1 200	1 580	3 730				

cultivable land new residents are willingly accommodated and can obtain land fairly easily. That settled communities are growing at a higher rate than explained by natural population growth was also found in the 1983/84 Southern Rangelands Survey, although the results were based upon the increase in numbers of 'fixed' or permanent houses. It should be noted that the 1986 Homboy population figure of 1 200 families is approximate and may overstate the numbers, particularly in respect of families living in villages associated with the main village of Homboy. Alternative growth rates for the numbers of new arrivals have therefore been calculated at 1.0% and 1.5%, as well as the 2.5% per annum calculated above. The figures are applied in Table 2.3 to all the population that have access to, and cultivate land, in the project area.

TABLE 2.3

Estimated Population and Households 1978/79, 1986/87 and 1994/95

	Annual growth rate					
	5.2%		4.2%		3.7%	
	Population	Families	Population	Families	Population	Families
1978/79(a)	8 223	1 500	8 223	1 500	8 223	1 500
1986/87(b)	12 340	2 240	11 430	2 090	11 000	2 010
1994/95	18 500	3 380	15 880	2 900	14 710	2 680

Note: Growth rates each year:

5.2% to 2.7% population plus 2.5% new arrivals
4.2% to 2.7% population plus 1.5% new arrivals
3.7% to 2.7% population plus 1.0% new arrivals

Sources: (a) HTS, 1980.
(b) See text. Based on village authorities estimate, Homboy, November 1986.

The figures vary from 3 380 households or families at the highest base assumption of 5.2% per year growth, to 2 680 households at 3.7% per year. The approximate nature of the base data is such that none of the three growth rates can be considered the most reliable. For planning purposes a figure of 3 000 households (16 440 persons) has been taken as the total number of local families with land in the project area in 1994/95. With no new arrivals, the population growth of 2.7% per annum would give 1 860 and 2 300 households in 1986/87 and 1994/95 respectively (10 180 and 12 600 persons).

To conclude, the population forecast for 1994/95 indicates that 3 000 families will be farming in the project area in 1994/95. While it can be expected that not all families will wish to join the scheme, discussions in the area indicated a high level of interest in irrigated cropping, so a reduction of only 5% has been made to the total number of families, to give 2 850 potential farming families. This is equivalent to 7 125 ha with 2.5 ha holdings and 5 700 ha with 2.0 ha holdings.

As illustrated earlier, and in Chapter 5, the proposed mix of 2.0 and 2.5 ha holdings will provide for 3 730 families. A further 880 families will therefore need to be brought in from other areas to fully populate the project area.

2.2.3 Settler Selection

The need to establish and operate strict settler selection procedures should be stressed. The first priority should be given to farming families and semi-sedentary nomads who already use land in the project area. As noted above, these may total about 2 850 families by 1994/95. The remaining 880 families should be selected on a voluntary basis with strong preference to those with previous farming experience. These could include those, rather few, families which will have to be moved from the reservoir area of the Bardheere dam.

The need for careful selection is illustrated by experience on the Mogambo and Afgoi-Mordile irrigation projects where high settler drop-out was experienced. Families with little or no farming experience, were chosen mainly from Mogadishu for these projects. At Mogambo, of the 300 settlers first selected only 180 arrived and by the end of the first three seasons only 120 remained.

CHAPTER 3

CROP MARKET PROSPECTS

3.1 Introduction

The crops selected as suitable for the Homboy project area are discussed in detail in Section B of this Annex.

The criteria used included: soils and environmental suitability, general market conditions, processing and handling requirements, available varieties and yields. Consideration was also given to local consumer acceptance and farmers' present knowledge of specific crops. As a result, although a number of oilseed and legume crops could be grown in the area, sesame and cowpeas were chosen to illustrate returns from such crops. Sesame is already widely grown and its oil is preferred to others to the extent of commanding, in late 1986, a price premium of 120% over imported sunflower and soya oils. Legumes are represented by cowpeas which together with local bean varieties are already widely grown. While these legume crops produce a relatively low gross margin they will, together with maize, undoubtedly continue to be produced when irrigation is available since they are staple elements of the population's diet. Similarly onions were chosen as representative of vegetable crops. Others are and will continue to be grown, such as tomatoes, sweet potatoes and leaf vegetables.

This chapter considers the market conditions of specific crops further with particular reference to future prospects. First, consideration is given to the general marketing background in Somalia.

3.2 Background

3.2.1 Project Access and Location

The proposed project area is close to the main, tarred, roads from Jilib to Kismayo and to Mogadishu. The proposed location of project villages ensures good access for inputs and crop marketing. Two rice mills, at Fanoole and Mogambo, will be operational by the time the project starts and Somaltex has plans, though no firm funding, to renew the equipment and facilities at their cotton ginnery at Jamaame about 30 km to the south of Homboy. Somalfruit's export operations are centred on Jamaame and Kismayo port. Jilib, only 12 km from Homboy village, is a major centre with an Agricultural Development Corporation (ADC) depot, and local merchants operating from Kismayo and Mogadishu have easy access to the project area.

3.2.2 Marketing Policy

Law Nr 51 of July 1971 designated the Ministry of Agriculture as the sole agency for storing and marketing cereals in Somalia. Producers were prohibited from storing more than limited and specified quantities of maize and sorghum for their own consumption. The Secretary for Agriculture was made responsible for fixing producer, wholesale and retail prices for these and other crops. Marketing and importation of certain crops was undertaken by the ADC, and the Ente Nazionale Commercia (ENC) was also involved in commercial imports of various commodities including wheat and vegetable oils.

All private trading was prohibited under Law Nr 51, 1971. In 1982 the Presidential Circular Nr 9 concerning the harvesting and storage of crops was widely considered to allow farmers to store greater quantities of maize and sorghum and although Law Nr 51, 1971, has not changed there occurred in effect, some liberalisation of the marketing system. Movement in this direction continued and in 1984 ADC's monopoly was formally removed. Private commercial trading is now encouraged. ADC still operates but as a buyer in competition with others. The Corporation's purchases fell sharply in 1983 and 1984 as a result but increased in 1985 as shown in Table 3.1. ADC ceased to purchase rice in 1984.

TABLE 3.1

Agricultural Development Corporation
Crop Purchases and Sales(1) 1980 to 1985

	1980	1981	1982	1983	1984	1985
Maize:						
- purchase	3 788	5 891	2 224	437	696	12 407
- sale	54 364	59 059	34 801	16 934	1 002	4 826
Sorghum:						
- purchase	12 336	22 918	8 096	10 026	392	14 436
- sale	32 199	4 365	12 747	21 312	6 088	6 759
Rice(2):						
- purchase	528	824	1 602	1 881	-	-
- sale	842	464	605	1 625	138	-
Sesame:						
- purchase	455	87	79	65	4	42
- sale	652	161	115	64	3	24

Notes: (1) Sales - local purchases plus imports.
(2) Rice - all types and grades.

Source: Agricultural Development Corporation, Mogadishu.

The current position is therefore that marketing has been significantly liberalised and ADC is in competition with private traders. As shown in Table 3.2, ADC buying prices have risen substantially as a result, prices actually received by growers have generally been higher than the official ADC prices as shown below:

	ADC official price (SoSh/100 kg)			Price received by producers (SoSh/100 kg)		
	Maize	Sorghum	Sesame	Maize	Sorghum	Sesame
1983	220	180	700	325	265	870
1984	360	220	850	323	272	910
1985	1 500	1 300	5 200	2 000	1 700	5 000
1986	1 500	1 300	6 100	1 400	1 300	6 000

Excess stocks in 1985, after a good season and stimulation of production through higher prices, resulted in lower maize and sorghum producer prices in 1986.

TABLE 3.2

Agricultural Development Corporation
Official Crop Purchase and Selling Prices 1980 to 1986

	SoSh/100 kg						
	1980	1981	1982	1983	1984	1985	1986
Maize:							
- purchase	120	180	180	220	360	1 500	1 500
- sell	180	250	250	325	700	1 850	1 850
Sorghum(1):							
- purchase	120	150	150	180	220	1 300	1 300
- sell	180	220	220	265	450	1 700	1 700
Rice(2):							
- purchase	350	320	320	420	420	(3)	3 200
- sell	390	490	490	475	800	na	na
Sesame:							
- purchase	300	450	450	700	850	5 200	6 100
- sell	350	530	530	870	1 500	6 000	7 000(4)

Note: (1) White sorghum.
(2) Long grain rice.
(3) Rice not purchased
(4) 1986 sesame price not yet confirmed.

ADC official buying prices exceeded by private buyers in 1984:

Maize private 1 400 SoSh/100 kg)
Sorghum private 1 600 SoSh/100 kg) AHT, Agriculture and livestock services in the Juba valley
Sesame private 4 000 SoSh/100 kg)

Source: Agricultural Development Corporation, Mogadishu.

3.3 Cereals

3.3.1 General Prospects

Table 3.3 summarises Somalia's cereal production and imports from 1979 to 1984 with estimates for 1985, 1986 and 1990. The latter data are based on two population projections - A with a total population of 7.45 million, B with 6.50 million.

The data show the high proportion of imports - 48% (1979 to 1984) and of this the high proportion imported as food aid during the same period, 56%, especially in 1983 and 1984. This has undoubtedly affected local producer prices. There are many gaps in the present understanding of Somalia's grain market operations as noted in the Somalia Agricultural Sector Survey. Nevertheless it is apparent that aid and other concessional imports have reduced the scope for local production.

3.3.2 Maize

While local production is increasing as shown in Table 3.3, imports remain high. By 1990, however, assuming the higher population growth rate, Case A, supply and consumption may be in balance, or with the lower population, Case B, surpluses may be available for export. The forecasts do, however, rely upon reasonable drylands farming conditions, rainfall particularly, and a steady increase in average yields from 800 kg/ha in 1986 to 1 200 kg/ha in 1990, a 50% rise. The projected financial price of SoSh 14 600/t compared with SoSh 14 000/t in 1986 does take this possibility of over production into account (see Chapter 4). From the viewpoint of estimating future economic prices, however, it would be prudent to assume that Somalia will continue to be a net importer of maize in most years.

3.3.3 Rice

As illustrated in Table 3.3, Somalia is expected to remain an importer of rice in both Cases A and B population projections. The local market prospects are therefore good, especially if government curbs exceed imports. Current prices in the project area vary from SoSh 32 000 (Fanoole) to SoSh 30 000 (Mogambo) per tonne. The future, projected, financial price is discussed in Chapter 4.

3.4 Oilseeds

Sesame is the main oilseed crop in Somalia. As shown in Table 3.4 vegetable oil imports supply between 40% and 50% of national consumption. Sesame is the preferred oil with a price premium over imported vegetable oils in Jilib of about 120%. Consumption based on the figures in Table 3.4 indicate an increase of 68% between 1979 and 1985 (local production plus imports). This is extremely high and probably reflects under estimation of production in the early years or over estimation in recent years. What is clear, however, is that vegetable oil imports increased from an annual average of almost 17 500 t between 1979 and 1982 to over 29 200 tonnes per year between 1983 and 1985. Demands will therefore remain high for some years and the preference for sesame oil is not likely to change.

TABLE 3.3

National Grain Production and Imports 1979 to 1986 and Forecasts for 1990 ('000 t)

	Domestic production				Imports					Production and imports	Proportion	
	Maize	Sorghum	Rice	Total	Maize	Sorghum	Rice	Other (1)	Total		Aid of imports (%)	Imports of total (%)
1979	108	140	9	258	30	-	79	100	209	467	39	45
1980	110	140	11	262	110	-	100	91	301	563	58	53
1981	142	222	13	378	91	11	85	200	387	765	47	51
1982	150	235	13	400	25	10	86	181	302	702	44	43
1983	235	120	2	358	175	25	52	125	377	735	67	51
1984	270	221	3	495	105	10	89	155	359	854	81	42
1985(2)	280	233	10	524	83	-	85	165	333	857	-	39
1986(2)	298	241	11	551	75	-	83	162	320	871	-	37
1990(2):												
A	420	277	18	716	1	-	57	114	172	888	-	19
B	420	277	18	716	(46)(3)	-	48	51	99	769(4)	-	13

Notes: (1) Predominantly wheat.
(2) Estimated.
(3) (46) = projected surplus for export.
(4) Net of exports.

Source: Somalia Agricultural Sector Survey. Task Force Nr 5. Planning and Statistics Draft Report, 1985. Figures may not total due to the inclusion in the production total of locally grown wheat.

TABLE 3.4

Oilseed and Vegetable Oil Production and Imports 1979 to 1985 ('000 tonnes)

	1979	1980	1981	1982	1983	1984	1985(1)
Oilseed production:							
Total	46.10	44.0	59.00	63.50	65.70	53.40	67.7
Sesame	40.60	38.40	53.00	57.00	60.0	46.0	60.00
Vegetable oil:							
Local production	14.21	13.44	18.55	19.95	21.00	16.10	24.90
Imports	18.49	12.60	19.80	19.00	29.00	28.70	30.00

Note: (1) Estimate.

Source: State Planning Commission and Ministry of Agriculture.

As shown in Table 3.2 and discussed in Section 3.2.2, the crop was mainly marketed through the ADC. With market liberalisation private trading has increased and producer prices have also increased substantially in recent years: from SoSh 8 700/t in 1983 to SoSh 60 000/t in 1986. While production has risen there is as yet no sign that prices have been affected.

3.5 Legumes

Table 3.5 sets out recent estimates of legume production. It also shows the low level of imports. Legumes, including various varieties of beans, cowpeas and some groundnuts are widely grown in Somalia but on a small scale compared with maize and sesame; about 30 000 ha compared with 800 000 ha in 1984.

Demands can be expected to grow in line with population and the present estimated low per capita consumption of 2 to 3 kg can be expected to rise. The data are, however, uncertain and forecasts can only be very approximate.

Nevertheless farmers on the Homboy scheme will continue to grow legumes - mainly cowpeas and beans - for their own consumption and sale as at present.

TABLE 3.5

Legume Production and Imports 1977 to 1985 ('000 tonnes)

	1977	1978	1979	1980	1981	1982	1983	1984	1985
Total production	12.0	12.9	11.0	12.1	16.6	18.2	23.8	23.4	37.0
Imports	na	0.2	0.7	1.0	0.4	0.3	0.3	0.5	0.5

Source: Agriculture Sector Review, 1986. IBRD and Ministry of Agriculture.

3.6 Cotton

Seed cotton is the major cash crop in the project area at present. Grown under rainfed conditions on a low-input, low-output basis, the crop is marketed through Somaltex. The company operates from Jamaame and provides a tractor service, seed and pesticides, seasonal credit and technical advice. The seed cotton is taken to Balad about 30 km from Mogadishu for ginning. Somaltex's ginnery at Jamaame, 30 km south of the project, has not operated since 1984. The ginnery has 26 Platt simple roller gins installed 45 years ago and is in very poor condition. Its capacity was 1 800 t of seed cotton over a 120 day season. The Middle and Lower Juba districts nevertheless remain an important cotton production area where the area planted has grown rapidly since producer prices rose from SoSh 3.5/kg in 1982 to SoSh 25/kg in 1985 and SoSh 45/kg in 1986. Seventeen Somaltex buying points, including Homboy and Burgaan in the project area, are open over a 90-day buying period in the two districts. Their locations vary according to production location and producers recieve cash-on-the-spot for ungraded seed cotton.

As shown in Table 3.6, recent production has been about 4 000 t a year with, however, low purchases by Somaltex. The company's textile mill at Balad has an annual capacity of 18 million metres of cloth representing a lint requirement of 4 000 t, equivalent to 10 600 t of seed cotton.

TABLE 3.6
Cotton Production and Somaltex Purchases and Imports
1978 to 1985

	1978	1979	1980	1981	1982	1983	1984	1985
Local seed cotton ('000 tonnes):								
Production	3.2	3.0	3.3	1.6	4.7	4.0	4.0	na
Somaltex purchases	2.3	2.7	1.0	-	0.6	0.3	0.1	-
Imports ('000 tonnes):								
Cotton lint	1.45	1.28	0.74	0.51	0.66	0.49	0.57	0.41

Sources: Ministry of Agriculture and Somaltex

As shown in Table 3.6 lint is imported by Somaltex as well as ready made yarn and cloth for finishing to the extent shown below: (SoSh '000)

	Imported yarn	Imported grey cloth	Total SoSh '000
1981	15 819	-	15 819
1982	14 080	190	14 270
1983	7 734	5 485	13 219
1984	774	3 743	4 517
1985	113	2 373	2 486

While the value of imports has declined significantly this has been related more to underuse of the textile mills capacity than replacement by local cotton. By 1983 and 1984 respectively textile production fell by 39% and 24% to 6.8 and 5.2 million yards: the decline is illustrated below:

	1978	1981	1982	1983	1984
million yards	13.8	10.1	11.1	6.8	5.2

Difficulties encountered in obtaining spare parts, a shortage of skilled staff and, in particular, shortages of diesel were major factors.

While the industry's performance over the past few years has not been encouraging, the country does have large unused textile capacity and good potential demand. Somaltex indicates that it wishes to resume higher output levels and the recent significant increases in seed cotton producer prices would support this. Ginning capacity remains a bottleneck but one which could, with some expenditure, be remedied relatively easily. Cotton is therefore expected to remain an important cash crop in the project area, where it is already well established.

3.7 Vegetables

It is proposed to include a small area of vegetables, 0.1 ha each family, equivalent to 373 ha in total at full development. While these are primarily for home and on-project consumption surpluses will be available for sale to local markets such as Jilib, Jamaame and Kismayo. While onions have been taken as representative of vegetables in the study's analyses a variety of vegetables will be grown. Based on present reported consumptions these could be:

	Per cent	Area (ha)	Output (t/ha/year)	Losses (%)	Net tonnes
Onion	45	168	20	7.5	3 108
Tomato	45	168	10	10.0	1 512
Sweet potato	5	19	30	5.0	542
Leaf vegetable	5	18	4	5.0	68
Total		373			5 230

Note: Output on basis of double cropping.

Local families may now consume from 0.5 to 1.0 kg per family each week (Source: local enquiries). With vegetables freely available this could increase to 1.2 kg a week or about 350 kg a year for a family, taking into account seasonal availability (290-day year). At this level the producers, 3 730 families, would consume a quarter of net output. Project staff and non-farming families in and near the project may account for another 4% (based on 560 additional households). Thus a total immediate market of about 1 520 t would be available leaving 3 710 t for disposal. This is a considerable quantity and local demand is not known. As a result the price assumed for the representative crop is modest at SoSh 20/kg.

3.8 Bananas

Bananas are marketed for export through Somalfruit. The company has also expressed interest in organising marketing within Somalia. Full details of the marketing system are given in Annex 2 of the report.

CHAPTER 4

PRICE ASSUMPTIONS

4.1 Introduction

This chapter covers the financial and economic price calculations and assumptions used for agricultural inputs, except farm machinery, and crop output. Farm machinery operation and capital costs are discussed in Section 4.10.

Wherever possible, economic prices have been based on border parity values, in terms of import prices in the case of imported inputs and crop outputs which replace imports, and in terms of FOB prices for commodities which would be exported, such as bananas. World market prices have been taken from the World Bank Commodity Price Forecasts published in October 1986. These values are presented in US dollars at 1985 constant prices. Values for labour, transport, non-fertiliser agrochemicals and crops for which world market prices are either not available or not appropriate have been based on existing local market prices.

The normal convention is to use the most recent long-term projected IBRD prices in the economic analysis of projects like Hornboy and Bardheere. In this case, however, the validity of following this approach is questionable because, as shown in Table 4.1, the October 1986 projections for most of the crops are in many cases very pessimistic and predict world market prices well below recent (1980 to 1985) levels or those prevailing in 1970, which is presented in the October 1986 forecasts as a reference year.

Despite the reasoning presented in the October 1986 forecasts, it could be argued that, if prices really fall as far as predicted, world output would decline and prices would then begin to rise again in response to market forces. Moreover, there are clear signs that the politically-inspired over-production of recent years (for example, the EEC's Common Agricultural Policy) is now being brought under control.

TABLE 4.1

World Market Actual and Projected Prices of Selected Commodities (US$/tonne at 1985 constant prices)

Commodity	IBRD-projected price in year 2000	Actual Prices 1970	1980-1985 average
Crops			
Rice	206	395	316
Maize	94	160	122
Sorghum	89	142	116
Soya bean (as representative of oilseeds)	200	321	263
Cotton lint	1 650	1 730	1 700
Sugar	253	222	255
Banana	321	453	382
Fertilisers			
Urea	171	132	169
Triple superphosphate	147	116	141
DAP	206	148	186
Muriate of potash	88	86	90

Source: IBRD Commodity Forecasts, October 1986

All the crop commodities listed in Table 4.1 had substantially higher prices in 1980 to 1985 and 1970 than is predicted for the long-term future, except for sugar and cotton lint. By contrast, the projected fertiliser prices are the same as or higher than past levels.

It is, of course, notoriously difficult to predict future price trends, as IBRD acknowledges in its October 1986 review. Given the major uncertainties involved, we have therefore based our analyses on two pricing alternatives, a Low Price Scenario using the year 2000 projected prices and a High Price Scenario using the average prices recorded in the 1980 to 1985 period. This was a period of slow growth and sometimes even stagnation in the world economy, rather than an economic boom, so in most cases the values are unlikely to be atypically high.

Only one set of financial prices has been used. These are based on local market prices obtaining in 1986, adjusted by the projected percentage change in farmgate economic prices in the year 2000 as compared with 1986.

All prices used in the analyses are presented in terms of 1987 constant values. The IBRD prices quoted above have been adjusted up to 1987 levels by applying the IBRD Manufacturing Unit Value (MUV) Index, which is commonly used in studies of this type as an indicator of world inflation. Values for this index are as follows:

1985	100
1986	113.0
1987	116.5

Prices in 1987 terms are thus 16.5% above 1985 constant values.

4.2 Exchange Rates

The base value of most items of machinery and equipment was obtained in pounds sterling. In mid-January 1987 this was quoted at about US$ 1.50 = £1.00. The pound is generally considered weaker than most other European currencies, however, and is expected to fall back to a value around US$ 1.45. Currency futures in the Financial Times of 15th January, 1987, were quoted at US$ 1.47 for six months and US$ 1.44 for 12 months. The exchange rate with the US dollars used in both the financial and economic costings has therefore been taken at US$ 1.45 = £1.00.

The official value of the Somali Shilling has shown a downwards trend since the second half of 1986, from SoSh 50 = US$ 1 to SoSh 85 to 90 = US$ 1. Government sponsored currency auctions have resulted in much lower rates, with a trend towards the black market rates of SoSh 150 = US$ 1.

There is no clear indication where the shilling will settle but the adoption in this report of a shadow foreign exchange rate of SoSh 135 = US$ 1 (i.e. 50% above the financial exchange rate) is considered to be of an acceptable order. This is assumed to take adequate account of the scarcity value of foreign exchange (FE) in the Somali economy.

In the financial analysis, the official rate of SoSh 90 = US$ has been applied. This is the rate quoted as being used for the commercial importation of agricultural machinery and equipment in early 1987.

4.3 Duties and Taxes

The prices used in the economic analysis exclude the various fiscal and customs duties and sales taxes levied on imports. For the most part, these are not applied to agricultural inputs, including machinery, except in the case of some agrochemicals. The Administration and Statistical Fee (ASF) which is levied on certain imports at 20% of CIF value has also been excluded, since it is in effect an import duty.

Taxes on wages and salaries are also excluded from project staff costs in the economic analysis. Details are given in Chapter 5.

4.4 Port Handling Costs and Marketing Margins

The cost of handling and administration of imports varies. The analysis, however, assumes the typical levels set out in Table 4.2. For crops and crop inputs, these amount to the harbour fee of 3% of the CIF value plus SoSh 2 720 per tonne. A marketing margin on these commodities is also included at 5% of CIF, plus port handling charges, to cover import financing, the importer's administration and miscellaneous costs and profit margins to the port-of-entry wholesale warehouse. Marketing margins between this point and the project area are also taken into account. These rates for local marketing in the Jilib market in late 1986 varied as follows:

		Percentage on farmgate price
Maize -	from Homboy area	8.7
Sesame -	from Homboy area	14.4
Beans -	from Homboy area	16.8
Sorghum -	from Saakow area	25.1

Taking into account likely seasonal variations, a flat rate of 10% has been used in the price calculations detailed in Section 5.1. Machinery and equipment prices include the 3% harbour fee, SoSh 2 000/unit and SoSh 950/t costs as shown in Table 4.2.

4.5 Transport Costs

Transport costs used in the analyses are based on late 1986 rates quoted by the National Transport Agency (NTA). These were: for 6 to 10 tonne vehicles SoSh 4.70/t-km for vehicles and So/Sh 4.10/t-km for 20 to 25 tonne trucks. The rates assume good roads, which will be the case between port-of-entry and the project. These rates were increased by 12% to bring them up to anticipated 1987 levels. The composite cost rate used in the financial and economic analyses is SoSh 5/t-km, calculated as follows:

Vehicle	Rate 1986 SoSh/t-km	Rate 1987 SoSh/t-km	Proportion %	Assumed SoSh/t-km
6-10 tonnes	4.70	5.26	70	3.68
20-25 tonnes	4.10	4.59	30	1.38
Assume: SoSh 5/t-km			Total	5.06

TABLE 4.2

Breakdown of Port Handling Charges and Fees

	Crops and crop inputs		Machinery and equipment	
Harbour fees		3% of CIF value		
	Unit	Rate (SoSh)	Unit	Rate (SoSh)
Port handling charges				
Agency fees	tonne	2 000	each	2 000
Handling	tonne	300(1)	tonne	750(2)
Storage	tonne	200(3)	tonne	200(3)
Transport to local warehouse	tonne	220(4)		

Notes:
(1) SoSh 15/100 kg x 2 for unloading from ship and loading onto vehicle. Source: Mogambo Irrigation Project.
(2) Source: commercial machinery importers.
(3) Assume 20 days: first 10 days free, thereafter SoSh 2/100 kg a day. Source: commercial machinery importers.
(4) Source: National Transport Agency, Mogadishu.
(5) Included in transport cost to project.

The port-of-entry for the project has been taken as Kismayo, for both project inputs and the calculation of import and export parity prices. At present, Mogadishu is the harbour used for most commodities, except for banana exports and Somalfruit fertiliser imports. The project is not scheduled to start until 1994/95, however, and work is already underway to improve access to Kismayo port through a major dredging programme. The construction of the Bardheere dam, upon which the project is dependent, can be expected to stimulate both agricultural and other economic activity in the Juba valley. This can be expected to lead to increased demands to use Kismayo's harbour facilities, especially in view of the deteriorating paved road conditions between Mogadishu and the valley. Even if this route is resurfaced, as is planned, Kismayo will have the advantage, in terms of distance, over most parts of the valley. With this port-of-entry assumption, the following distances have been used in the transport cost calculations:

	km
Project to Jilib	12
Project to Kismayo	100
Project to Jamaame cotton ginnery	30
Jamaame to Balad Somaltex cotton mill	480

4.6 Labour

Daily wage rates for unskilled and semi-skilled hired labour in the two districts in which the project is situated vary between enterprises and the nature of tasks. The latter is illustrated below by data from Somalfruit. In late 1986, the company's farm and packing shed labour costs showed the following pattern:

Farm labour		Packing shed labour		
Daily rate (SoSh)	Percentage of payroll	Monthly rate (SoSh '000)	Percentage of payroll	Daily rate (26 days)
30-70	36	1.5-1.8	1	60-70
130-170	17	2.0-2.8	33	75-110
180-220	39	3.0-4.0	33	115-155
230-270	5	4.3-6.5	23	165-250
280-320	3	7.2-9.5	6	280-365
		10.0-13.0	3	385-500
		14.0-20.0	1	540-770

The differences reflect different operations - from SoSh 30/day for crop surveillance to SoSh 300/day for tractor drivers - and differences in levels of responsibility. At the Juba Sugar Project (JSP), daily rates, including an allowance for food rations, vary from SoSh 70 for general fieldwork to SoSh 120 for cane cutting.

There is a significant variation in wages between the gu season, April to June/July, and the rest of the year. This is illustrated in Table 4.3 by data collected in November 1986 by the Consultants.

TABLE 4.3

Daily Wage Rates in the Middle and Lower Juba Valley, November 1986 (SoSh/day)

Employer	Gu season	Other periods
Homboy - smallholder rainfed farms	160	60
Juba Sugar Project (1)		
general fieldwork	(70+)	70
cane cutting	125	125
Fanoole Irrigation Project (1)	150	100
Mogambo Irrigation Project (1)	150	80
Commercial banana estates	140	60

Notes: (1) Including estimated food rations value.
(2) Excluding Juba Sugar Project general fieldwork rate. At JSP the additional educational, medical and recreational facilities which are provided and are a significant attraction to staff have not been included in these rates.

Source: Consultants' field data from quoted enterprises.

From July/August to February/March, depending upon the season, the supply of labour is generally adequate, depending on an enterprise's location and the nature of the work. Most commercial enterprises have to provide either accommodation or, more usually, transport to and from home for their employees. Certain work, particularly sugar cane cutting, is unpopular and commands premium rates. In this 8 to 9 month period, daily rates vary between SoSh 60 and SoSh 125, with an average of SoSh 83 (Table 4.3).

In the gu season, when labour requirements on traditional rainfed holdings are highest, the average rate is SoSh 145/day, varying from SoSh 125 to SoSh 160 - excluding the probably under-reported JSP general fieldwork rate (see Table 4.3 footnote).

Discussions with managers of government and commercial enterprises and with villagers in the proposed project area confirmed the labour availability pattern outlined above. In the economic analysis different on-farm shadow wage rates have therefore been used, SoSh 145/day for the gu season and SoSh 80/day at other times.

Wages and salaries of project staff are subject to personal taxes, which are not included in the economic analysis. Taxes are levied at the following rates:

Earnings SoSh/month	Tax rate %
Up to 200	0
Up to 800	6
801 to 1 500	12
over 1 500	18

In addition, there is a local government tax of 5% of the monthly tax payable.

As noted in Chapter 6, in the crop budgets, the economic benefits are net of land taxes which are raised on the basis of SoSh 20/ha for irrigated land and SoSh 5/ha for rainfed land.

4.7 Economic Prices

4.7.1 Crops

Calculations of projected low and high and 1986 crop prices are set out in Table 4.4 for bananas, Table 4.5 for maize, Table 4.6 for sorghum, Table 4.7 for rice and Table 4.8 for cotton. The calculations are self-explanatory and incorporate the handling, transport and other cost components discussed above.

TABLE 4.4

Economic Prices of Export Bananas
(SoSh/tonne at Constant 1987 Prices)

	Projected prices High	Low
Price FOB Kismayo (US$)	328	276
Equivalent in SoSh:		
- at the official exchange rate (SoSh 90/$)	29 520	24 840
- at the shadow exchange rate (SoSh 135/$)	44 280	37 260
Marketing and other Somalfruit costs, at 50% of FOB prices at the official exchange rate	14 760	12 420
Farmgate economic price (FE shadow priced at SoSh 135/$)	29 520	24 840
Say	29 500	24 800

TABLE 4.5

Economic Prices of Maize (SoSh/tonne) at Constant 1987 Prices

		1986	Projected High	Projected Low
US Nr 2 yellow FOB Gulf Ports	US$	90	142	110
Quality premium 5%(1)	+	5	7	6
Insurance and freight to Kismayo	+	60	60	60
CIF Kismayo US$	=	155	209	176
equivalent to:				
at official exchange rate	SoSh	13 950	18 810	15 840
at shadow exchange rate	SoSh	20 925	28 215	23 760
Harbour fees (3% of CIF cost at official exchange rate)	+	419	564	475
Port handling	+	2 720	2 720	2 720
Landed value	=	24 064	31 499	26 955
Importer's other costs and margin (5% of CIF cost)	+	698	940	792
Value at Kismayo wholesale	=	24 762	32 439	27 747
Transport from project 100 km x SoSh 5	-	500	500	500
Marketing margin (10% of farmgate value)	-	2 206	2 903	2 477
Farmgate value		22 056	29 036	24 770
Say		22 100	29 000	24 800

Notes: (1) Local maize grown and consumed locally is mixed, with a predominance of yellow grains.

TABLE 4.6

Economic Prices of Sorghum (SoSh/tonne) at Constant 1987 Prices

		1986	Projected High	Projected Low
US Nr 2 Milo yellow FOB Gulf Ports	US$	85	135	104
Insurance and freight	+	60	60	60
CIF Kismayo US$	=	145	195	164
equivalent to: at official exchange rate	SoSh	13 050	17 550	14 760
at shadow exchange rate	SoSh	19 575	26 325	22 140
Harbour fees 3% official rate	+	391	526	443
Port handling	+	2 720	2 720	2 720
Landed value	=	22 686	29 577	25 303
Importer's other costs and margin (5% CIF cost)	+	652	877	738
Value at Kismayo wholesale	=	23 338	30 448	26 041
Transport Kismayo to project 100 km x SoSh 5	-	500	500	500
Marketing margin (10% of farmgate value)	-	2 076	2 722	2 322
Farmgate value		20 760	27 226	23 219
Say		20 800	27 200	23 200

TABLE 4.7

Economic Prices of Rice (SoSh/tonne)
at Constant 1987 Prices

			1986	Projected	
				High	Low
Thai milled white 5% brokens FOB Bangkok		US$	191	368	240
Quality discount 7.5%(1)		-	14	28	18
Insurance and freight		+	60	60	60
CIF Kismayo US$		=	237	400	282
equivalent to:					
at official exchange rate		SoSh	21 330	36 000	25 380
at shadow exchange rate		SoSh	31 995	54 000	38 070
Harbour fees (3% of CIF cost at official exchange rate)		+	640	1 080	761
Port handling		+	2 720	2 720	2 720
Landed cost		=	35 355	57 800	41 551
Importer's other costs and margin (5% CIF cost)		+	1 066	1 800	1 269
Value at Kismayo wholesale		=	36 421	59 600	42 820
Transport from mill to Kismayo 80 km x SoSh 5		-	400	400	400
Value ex mill		=	36 021	59 200	42 420
Milling and drying costs		-	4 500	4 500	4 500
Value at mill		=	31 521	54 700	37 920
Paddy equivalent (65%)			20 489	35 555	24 648
Transport from project to mill 20 km x SoSh 5		-	100	100	100
Marketing margin (10% of farmgate price)		-	1 853	3 223	2 232
Farmgate value		=	18 536	32 232	22 316
Say			18 500	32 200	22 300

Note: (i) Assuming the use of a project dryer - not sun dried - and the new Mogambo rice mill being in operation.

TABLE 4.8

Economic Prices for Cotton (SoSh/tonne) at Constant 1987 Prices

		1986	Projected High	Projected Low
Lint CIF Europe middling (1-3/32") equivalent to CIF Mogadishu[1]	US$	917	1 980	1 922
Equivalent to				
at official exchange rate	SoSh	82 530	178 200	172 980
at shadow exchange rate	SoSh	123 795	267 300	259 470
Harbour fees (3% of CIF cost at official exchange rate)	+	2 476	5 346	5 189
Port handling	+	2 720	2 720	2 720
Landed value (lint)	=	128 991	275 366	267 379
Transport to Balad and importer's other costs (6% of CIF cost)	+	7 739	16 522	16 043
Value at Balad textile mill	=	136 730	291 888	283 422
Transport Jamaame ginnery to Balad: 480 km x SoSh 5	-	2 400	2 400	2 400
Value lint ex-ginnery	=	134 330	289 488	281 022
Ginnery cost net of seed value	-	5 000	5 000	5 000
Value at Jamaame ginnery	=	129 330	284 488	276 022
Seed cotton equivalent 33%	=	42 679	93 881	91 087
Transport from project to Jamaame 30 km x SoSh 15[2]	-	450	450	450
Handling, marketing and administration (10% of farmgate value)	-	3 839	8 494	8 240
Farmgate value	=	38 390	84 937	82 397
Say		38 400	84 900	82 400

Note: (1) Assuming that insurance and freight cost USA or other source to Europe costs the same as I&F to Mogadishu.
(2) SoSh 5 x 3 for bulk product

Further explanation is necessary for bananas. The international value of bananas (FOB US ports) has been forecast as US$ 374/t (1987 constant prices) in year 2000, an expected fall of 10.5% from the equivalent 1986 world price of US$ 418/t. Under the High Price assumption the price would be US$ 445/t; 6% above the 1986 level. These proportions have been applied to the actual FOB Kismayo price obtained in 1986 by Somalfruit of US$ 300/t (US$ 309 in 1987 constant price terms) to give the following FOB values:

Assumption	US$/tonne
Low price	278
High price	328

In the last 2 years farmgate prices paid to growers for export quality bananas have been about half the FOB prices, whereas in 1984 and the 1976 to 1978 period (figures for the intervening years are not available) they were about 60% of the FOB values. Though high, Somalfruit's margin has to cover numerous costs, including:

- harbour fees (3% of FOB value);
- shrinkage (3% of FOB value) waste (2%); these estimates were provided by Somalfruit;
- port handling charges, at SoSh 2 720/t, or 10% of the 1986 FOB value (at 1987 constant prices);
- transport from packing station to Kismayo. Taking the assumed rate of SoSh 5/t-km and 100 km from producing area to Kismayo, this would cost 2% of FOB value;
- operation of packing stations; based on the difference of SoSh 750/t, the prices paid by Somalfruit for fruit packed in the grower's own station and in fruit delivered to Somalfruit stations - this is equivalent to at least 3% of FOB value;
- the cost of banana cartons which is very high. At 12.5 kg of banana per carton and a cost of SoSh 47 per carton and SoSh 33 per plastic liner, the cost per tonne is SoSh 3 920 or 14% of the FOB value.

Total Somalfruit costs as a percentage of the 1986 FOB value would thus be:

	Percentage of FOB value
Harbour fees	3
Shrinkage and waste	5
Port handling	10
Transport	2
Packing station operation	3
Cartons and liners	14
Total	37

To this should be added administration, finance, technical assistance, quality control and inspection and a reasonable allowance for profit. Since these costs would be substantial, the total Somalfruit costs have been taken to be 50% of the FOB value. Table 4.4 shows the resultant farmgate economic prices of export bananas.

Bananas sold on the local market fetched SoSh 3 000/t in 1986. In both the financial and economic analyses this has been increased by 15% to SoSh 3 450/t. The increase anticipates the possible involvement of Somalfruit in internal banana marketing and distribution. This is under consideration by the company and would involve some quality control and improved handling to reduce current loss levels.

The farmgate export banana prices used in the analysis have been rounded to SoSh 29 500/t and 24 800/t for the High and Low Price scenarios, respectively. These assume that Somalfruit does the packing. If packed by the grower or project, the price has been taken to be SoSh 750/t higher.

The assumed project cropping includes three other crops for which international price data are not available, namely, sesame, cowpeas and onions. These are all traded under free market conditions in Somalia, in which case, their financial prices recorded in the study can be taken to represent genuine market prices reflecting supply and demand. The procedure adopted to derive future economic prices for these commodities has therefore been as follows:

(i) The ratio between the 1986 economic and financial market prices of maize was first derived and was found to be 1.58 : 1. Maize was the crop taken for this calculation because it is the staple in the area and is freely traded, like sesame, cowpeas and onions.

(ii) This ratio was then applied to the 1986 market prices of the three crops, to give their present economic prices, as follows:

Crop	1986 financial prices (Table 4.15) (SoSh/t)	1986 economic prices (SoSh/t)
Sesame	60 000	94 700
Cowpeas	40 000	63 100
Onions	20 000	31 600

Projected economic prices have then been calculated on the basis of the ratios of present and projected economic prices for maize (See Table 4.5). Future economic farmgate prices have been taken to be as follows:

Crop	Projected High Price (SoSh/t)	Projected Low Price (SoSh/t)
Sesame	124 300	106 300
Cowpeas	82 800	70 800
Onions	41 500	35 500

4.7.2 Fertiliser

Somalia has a urea production plant at Balad near Mogadishu. However, its production history has been very poor and in view of its high production costs, which have been estimated as anything up to six times the cost of imported urea, its future must be uncertain. As with other fertilisers, therefore, urea has been valued on the basis of import prices. The price calculations are set out in Tables 4.9 to 4.13.

TABLE 4.9

Economic Prices of Urea (SoSh/tonne) at Constant 1987 Prices

		1986	Projected price[1]
Urea FOB Northwest Europe	US$	105	198
Insurance and freight to Kismayo	US$	60	60
CIF Kismayo	US$	165	258
Equivalent in SoSh:			
- at official exchange rate	SoSh	14 850	23 220
- at shadow exchange rate	SoSh	22 275	34 830
Port handling	+	2 720	2 720
Harbour fees (3% of CIF cost at official exchange rate)	+	445	697
Landed value	=	25 440	38 247
Importer's other costs and margin (5% of CIF cost)	+	742	1 161
Value at Kismayo warehouse	=	26 182	39 408
Transport from Kismayo to project 100 km at SoSh 5	+	500	500
Supplier's margin and costs (10%)	+	2 668	3 991
Farmgate price	=	29 350	43 899
Say		29 300	43 900

Note: (1) Since there is only US$ 2 per tonne difference between the high price (1980-85 average) and low price (IBRD projected year 2000 price) the average of the two has been taken for the projected future price.

TABLE 4.10

Economic Prices of Di-ammonium Phosphate (DAP) (SoSh/tonne at 1987 Constant Prices)

		1986	Projected price[1]
DAP FOB US Gulf	US$	158	167
Insurance and freight to Kismayo	US$	60	60
CIF Kismayo	US$	218	227
Equivalent in SoSh:			
- at official exchange rate	SoSh	19 620	20 430
- at shadow exchange rate	SoSh	29 430	30 645
Port handling	+	2 720	2 720
Harbour fees (3% of CIF cost at official exchange rate)	+	589	613
Landed value	=	32 739	33 978
Importer's other costs and margin (5% of CIF cost)	+	981	1 021
Value at Kismayo warehouse	+	33 720	34 990
Transport from Kismayo to project 100 km at SoSh 5	+	500	500
Supplier's margin and costs (10%)	+	3 422	3 550
Farmgate price	=	37 642	39 049
Say		37 600	39 000

Note: (1) Since the difference between the projected low and high prices of DAP is very small (US$ 7 per tonne), the average of the two has been taken as the projected price.

TABLE 4.11

Economic Prices of Muriate of Potash (SoSh/tonne) at Constant 1987 Prices

		Present and projected price[1]
Muriate of potash, bulk		
FOB Vancouver	US$	104
Bagging	US$	15
FOB price	US$	119
Insurance and freight to Kismayo	US$	60
CIF Kismayo	US$	179
Equivalent to:		
- at official exchange rate	SoSh	16 110
- at shadow exchange rate	SoSh	24 165
Port handling	+	2 720
Harbour fees (3% of CIF cost at official exchange rate)	+	483
Landed value	=	27 368
Importer's other costs and margin (5% CIF cost)	+	805
Value at Kismayo warehouse	+	28 173
Transport from Kismayo to project 180 km x SoSh 5	+	500
Supplier's margin and costs (10%)	+	2 867
Farmgate value	=	31 540
Say		31 500

Note: (i) Since the present, 1980 to 1985 and IBRD projected price for 2000 are all similar, an average of the projected low and high prices has been taken.

TABLE 4.12

Economic Prices of Triple Superphosphate (SoSh/tonne at 1987 Constant Prices)

		1986	Projected price[1]
TSP bulk, FOB US Gulf	US$	118	168
Bagging	US$	15	15
FOB price	US$	133	183
Insurance and freight to Kismayo	US$	60	60
CIF Kismayo	US$	193	243
Equivalent in SoSh:			
- at official exchange rate	SoSh	17 370	21 870
- at shadow exchange rate	SoSh	26 055	32 805
Port handling	+	2 720	2 720
Harbour fees (3% of CIF cost at official exchange rate)	+	521	656
Landed value	=	29 296	36 181
Importer's other costs and margin (5% CIF cost)	+	868	1 093
Value at Kismayo warehouse	+	30 164	37 274
Transport from Kismayo to project 100 km at SoSh 5	+	500	500
Supplier's margin and costs (10%)	+	3 066	3 777
Farmgate price	=	33 730	41 551
Say		33 700	41 600

Note: (1) Since the difference between high (1980-85 average) and low projected prices is only US$ 6 per tonne, the same figure has been applied for both scenarios.

In the absence of world price forecasts for compound fertilisers the 15:7:24 fertiliser recommended for bananas has been estimated from the unit farm-gate economic costs of N, P_2O_5 and K_2O nutrients respectively in urea, triple-superphosphate and muriate of potash, with an allowance of US$ 20/t for blending costs.

Experience at the Mogambo Irrigation Project indicates the need to apply zinc in the form of zinc sulphate monohydrate at 10 kg/ha every seventh year. In 1986 this cost the MIP US$ 895/t, equivalent to SoSh 81/kg (SoSh 90 = US$ 1.00). This price on the world market is forecast to rise by 30% between 1986 and 2000. The same increase has been applied to the 1986 price to obtain SoSh 157/kg at the shadow exchange rate, which is used in the economic analysis.

TABLE 4.13

Economic Prices of NPK Compound Fertiliser (SoSh/tonne at Constant 1987 Prices)

			1986	Projected
1.	Farmgate Prices of Nutrients per tonne:			
	N	based on urea with 46% N (Table 4.9)	63 700	95 400
	P_2O_5	based on TSP with 46% P_2O_5 (Table 4.10)	81 700	84 800
	K_2O	based on muriate of potash with 50% K_2O (Table 4.11)	63 000	63 000
2.	Farmgate Price of NPK Compound			
	N	15%	9 555	14 310
	P_2O_5	7%	5 719	5 936
	K_2O	24%	15 120	15 120
	Blending cost: US$ 20/tonne at shadow foreign exchange rate		2 700	2 700
3.	Cost		33 094	38 066
	say		33 100	38 100

4.7.3 Herbicides and Pesticides

Agrochemicals commonly used and available in Somalia are subsidised but others which are only occasionally used are not subsidised and attract a 10% import duty. It has been assumed that if such chemicals become widely used, government subsidies will be applied and their financial prices will bear the same relation to economic prices as for chemicals already subsidised. On this basis the financial prices shown in Table 4.14 are 67% of the known import cost.

4.7.4 Seed

In the economic analysis crop seed has been valued at 1.5 times the calculated output prices, with two exceptions. Cotton seed is valued at the estimated cost of ginning and transport back from the ginnery at Jamaame over and above the farmgate price paid for the seed cotton. This gives a price of SoSh 99.4/kg under the High Price assumption and SoSh 96.6/kg under the Low Price scenario. Planting material for bananas will be produced by the project and has been priced at SoSh 3/plant. The same price is used in both the financial and economic analyses.

4.8 Financial Prices

4.8.1 Crops

Table 4.15 sets out farmgate prices found in the project area and adjacent districts in November 1986.

Future financial prices used in the study analyses have been derived as described below using the 1986 and early 1987 prices as a base.

Cereals and Cotton

These crops, for which 1986 and future world price derived economic prices are available (Tables 4.5 to 4.8) have future financial prices calculated as shown below:

	Economic prices				Financial prices	
	1986	2000(1)		Change	1986	Future
		High	Low	+%		
Maize	22.1		24.8	12	14	15.7
Sorghum	20.8		23.2	12	13	14.5
Rice	18.5		22.3	21	32	38.6
Cotton	38.4	84.9		115	45	96.6

Note: (1) High or low base shown as usual, see text.

Maize and sorghum price inflations have been based on the low year 2000 assumption because, as shown for maize in Section 3.3.2, supply is forecast in the Somalia Agricultural Sector Survey to be almost in balance or in excess of demand by 1990. Though the assumptions used - a 50% average yield rise between 1985 and 2000 and a series of good seasons may not be universally accepted it is likely that output will rise and if so producer prices inflation will not be low to moderate.

The same low year 2000 base has been used for rice. Though demand will remain firm to good (Section 3.3.3) its price inflation will possibly be restrained by competition with the lower priced, traditional staple crops, maize and sorghum.

The national requirement for seed cotton as an import substitute to save foreign exchange will be high (Section 3.6). The future financial price has therefore been calculated from the year 2000 high assumptions to reflect the upwards pressure of demands on the crop's price.

TABLE 4.14

Herbicide and Pesticides Financial and Economic Prices (SoSh/unit)

	Unit	Financial	Economic[1]
Herbicide			
Stam 34	litre	240	360
Pesticides			
Fermisan D	kg	138	207
Bronopol dust	kg	125	188
Diazinon 109	kg	140	210
Carbofuran	kg	212	318
Polytrin C440 EC	litre	549	823
Malathion	kg	173	260
Ridomil M2 63.5%	kg	420	630
Nuvocron	litre	149	224

Note: (1) For both high and low base assumption analyses, excluding duties and taxes.

TABLE 4.15

Farmgate Crop Prices, 1986 (SoSh/kg)

Crop	August to October (1)	November (2)	November (3)	Average	ADC 1986 at farm	Assumed 1986 farmgate price
Maize	13.9	14.0	13.5	13.8	15.0	14
Sorghum	na	na	13.1	13.1	13.0	13
Rice	na	na	na	na	32.0[4]	32
Sesame	58.2	64.7	61.6	60.2	61.0	60
Cowpea	38.3	42.0	na	39.5	na	40
Beans	na	na	41.5	41.5	na	42
Cotton	45.0	45.0	45.0	45.0	45.0[5]	45
Banana[6]						
Export	na	na	na	na	15	15
Local	na	na	na	na	3	3

Sources: (1) AFMET Yontoy for Jamaame and Jilib Districts.
(2) AFMET Jamaame for Jamaame District.
(3) HTS field study Homboy, Aminow and Burgaan villages.
(4) Fanoole sale price.
(5) Somaltex.
(6) Somalfruit.

na not applicable

Sesame, Cowpeas and Vegetables

Since there are no world price data for these three crops, for future financial prices it has been assumed that they continue to bear the same relationship with maize prices as in 1985 and 1986 after the effects of market liberalisation had begun to be apparent. The comparative price data are shown in Table 4.16.

TABLE 4.16

Comparative Prices of Selected Crops
1985 and 1986

	Maize (1)	Sesame (1)	Cowpeas (2)	Onions (3)
1985:				
- SoSh/tonne	15 000	52 000	36 000	na
- ratio (crop : maize price)	1.0	3.5	2.4	
1986:				
- SoSh/tonne	14 000	60 000	40 000	20 000
- ratio (crop : maize price)	1.0	4.3	2.9	1.4
1985 to 1986 average ratio	1.0	3.9	2.7	1.4

Sources: (1) 1985 ADC, 1986 Consultants' field data.
(2) AHT rainfed agriculture in the Juba valley, 1986 for 1985. For 1986, Consultants' field data.
(3) Consultants' field data.

na not available

Using the results in Table 4.16 the future prices have been arrived at as follows:

	Base maize price (SoSh/kg) High(1)	Low	Crop to maize ratio	Future price (SoSh/kg)
Sesame	18.4		3.9	71.8
Cowpea		15.7	2.6	40.8
Onions		15.7	1.4	22.0

Bananas

In 1986 Somalfruit paid growers SoSh 15 750/t for export fruit and SoSh 3 000/t for local sales at a growers packing shed. In 1986 this was 38% of the FOB price (adjusted to 1987 prices) of SoSh 41 720/t at the shadow rate of exchange. Assuming that Somalfruit continues to provide the marketing service in much the same form as at present but that the project is able to negotiate favourable

terms as a result of the size and continuity of supply and more importantly the level of services provided by the project (technical advice, input distribution, machinery services, etc.), the future price has been calculated from the high price assumption in Table 4.4. At the same ratio of 1986 farmgate to FOB prices the future level will be 0.38 of the FOB (year 2000 high) value of SoSh 44 280, i.e. SoSh 16 800/t.

The financial price of bananas for local sales is assumed to be SoSh 3 450/t (see Section 4.7.1).

4.8.2 Fertilisers

It has been assumed that government policy toward fertiliser prices remains unaltered and that they are sold at subsidised rates as at present for urea. Future prices are based on the current 1986/1987 price relationship with farmgate economic prices. These are given in Tables 4.9, 4.10 and 4.13 and applied to the 1986 financial prices as shown below:

	Economic price (SoSh/kg)		Change	Financial price (SoSh/kg)	
	1986	2000	+%	1986	Future
Urea	29.3	43.9	49.8	21.0	31.5
DAP	37.6	39.0	3.7	31.5	32.8
15:7:24	33.1	38.1	15.1	21.0	24.2

Zinc sulphate monohydrate has been costed at SoSh 105/kg in the financial calculations as explained in Section 4.7.2. The 1986 price of SoSh 81/kg has been increased by 30% in line with forecast world prices of zinc to give the future values.

4.8.3 Herbicides and Pesticides

In the absence of international price forecasts the future financial prices adopted are those taken in early 1987. Details are given in Section 4.7.3.

4.8.4 Seeds

Except for cotton, seed has been valued at 1.5 times output values. The exception, cotton, is provided free to growers by Somaltex - it is expected that this policy will be continued.

4.9 Summary of Crop and Crop Input Prices

The future financial and economic prices discussed above are summarised in Table 4.17. These are the prices used to arrive at financial returns to farmers and for calculating benefits in the economic analyses on both the High and Low Price assumptions. These are discussed in Section 4.1.

TABLE 4.17

Projected Financial and Economic Crop and Crop Input Prices (SoSh)

Item	Unit	Financial	Economic	
			High	Low
Crops:				
- Maize	kg	15.7	29.0	24.8
- Sorghum	kg	14.5	27.2	23.2
- Rice	kg	38.6	32.2	22.3
- Sesame	kg	62.6	124.3	106.3
- Cowpea	kg	41.8	82.8	70.8
- Cotton	kg	96.6	84.9	82.4
- Onion	kg	23.2	41.5	35.5
- Banana				
export	kg	16.8	29.5	24.8
local	kg	3.45	3.45	3.45
Crop inputs				
Seed:				
- Maize	kg	23.6	43.5	37.5
- Sorghum	kg	21.8	40.8	34.8
- Rice	kg	57.9	48.3	33.5
- Sesame	kg	93.9	186.5	159.5
- Cotton	kg	free	99.4	99.6
- Onion	kg	34.8	62.3	53.3
- Cowpea	kg	62.7	124.2	106.2
- Banana	piece	3	3	3
Fertilisers:				
- Urea	kg	31.5	43.9	43.9
- DAP	kg	32.8	39.0	39.0
- 15:7:24	kg	24.2	38.1	38.1
- zinc sulphate	kg	105.0	157.0	157.0
Herbicide:				
- Stam 34	l	240	360	360
Pesticides:				
- Fermisan D	kg	138	207	207
- Brovopol dust	kg	125	188	188
- Diazinon	kg	140	210	210
- Carbofuran	kg	212	318	318
- Polytrin C440	l	549	823	823
- Malathion	kg	173	260	260
- Ridomil	kg	420	630	630
- Nuvocron	l	149	224	224
Containers:				
- Sacks	each	60	60	60
Labour:	man-day			
- Gu season		145	145	145
- Other periods		80	80	80

4.10 Agricultural Machinery and Equipment Operating Costs

4.10.1 Introduction

The calculations in this annex cover the financial and economic operating costs for farm machinery and equipment. The costs are calculated on the basis of individual items to arrive at a cost, including driver, for each cultivation operation. The results are applied to the individual crop budgets to give a cost per hectare for each crop machinery input. The next sections provide details of capital costs, tractor and combine operating costs and equipment operating costs.

4.10.2 Capital Costs

Tables 4.18 and 4.19 respectively set out the financial and economic price unit capital costs for agricultural machinery and equipment delivered to the Homboy project. CIF costs are given in US dollars which, where necessary, have been converted at US$ 1.45 = £1 sterling (Section 4.2).

Harbour fees, port handling and other costs were calculated on the basis described in Sections 4.3, 4.4 and 4.5 with 15% added to transport costs to cover administrative and miscellaneous expenses.

4.10.3 Fuel Prices

In terms of 1985 constant prices world oil prices averaged US$ 29/barrel between 1980 and 1985. In 1986 the sharpest fall in oil prices since the early 1930s then occurred, declining from US$ 26.7/barrel in 1985 to under US$ 12/barrel in early 1986. They have since recovered to about US$ 18/barrel in January 1987.

In their October 1986 forecasts IBRD predict a very slow and partial recovery in oil prices, to US$ 15/barrel (US$ 17.5/barrel in 1987 constant price terms) in 1990 and US$ 23.5/barrel (US$ 27.4 in 1987 constant prices) by the year 2000. This is some 19% below the 1980 to 1985 average. For analysis purposes the assumption made is that long-term future oil prices would be the average of the IBRD year 2000 forecast (US$ 23.5) and the 1980 to 1985 average (US$ 29). The resultant figure of US$26.2/barrel at 1985 constant prices is 120% above the actual 1986 price. This percentage has been applied to calculate the projected prices of petrol (benzine) and diesel oil.

In late 1986 petrol and diesel oil retail prices at Jilib were SoSh 28.66/l and SoSh 21.16/l respectively. Total taxes and levies on each are SoSh 5.89/l and SoSh 1.84/l respectively, in which case the prices excluding taxes would be:

	SoSh/l
Petrol	22.77
Diesel oil	19.32

TABLE 4.18

Agricultural Machinery and Equipment Unit Capital Costs at Financial Prices

Machinery Type	CIF Kismayo		Harbour fees stamp duty and handling	Transfer to project	Delivered cost
	US$	SoSh '000(1)	SoSh '000	SoSh '000	SoSh '000
Tractors					
60 kW	17 400	1 566.0	53.7	2.3	1 622.0
115 kW	21 025	1 892.3	63.7	2.3	1 958.3
Combine harvester					
rice 4.8 m	42 510	3 825.9	126.7	4.6	3 957.2
Ploughs					
chisel 5 tine	2 175	195.8	8.8	0.5	205.1
Mouldboard 3 furrow					
reversible	2 874	258.7	10.9	0.6	270.2
Disc harrow	4 350	391.5	14.9	0.6	407.0
Combine drill	6 670	600.3	21.5	0.7	622.4
Ridger	1 015	91.4	5.4	0.3	97.1
Sprayer	3 625	326.3	12.6	0.3	339.2
Trailers					
flat 5 tonne	3 770	339.3	13.8	0.9	354.0
grain 10 tonne	6 525	587.3	21.9	1.2	610.4
banana 7 tonne	5 420	487.8	18.6	1.0	507.4

Note: (1) At SoSh 90 : US$ 1.00

Source: Consultant's estimates based on 1987 quotations.

TABLE 4.19

Agricultural Machinery and Equipment Unit Capital Costs at Economic Prices

Machinery Type	CIF Kismayo		Harbour fees stamp duty and handling	Transfer to project	Delivered cost
	US$	SoSh '000[1]	SoSh '000	SoSh '000	SoSh '000
Tractors					
60 kW	17 400	2 349.0	72.3	2.3	2 423.6
115 kW	21 025	2 838.4	91.0	2.3	2 931.7
Combine harvester					
rice 4.8 m	42 510	5 738.9	181.8	4.6	5 925.3
Ploughs					
chisel 5 tine	2 175	293.6	11.7	0.5	305.8
Mouldboard 3 furrow					
reversible	2 874	388.0	14.6	0.6	403.2
Disc harrow 2.15 m	4 350	587.3	20.6	0.6	608.5
Combine drill 2.4 m	6 670	900.5	30.2	0.7	931.4
Ridger 3 row	1 015	136.0	6.7	0.3	144.0
Sprayer 800 litre	3 625	489.4	17.3	0.3	507.0
Trailers					
flat 4 wheel 5 tonne	3 770	509.0	18.7	0.9	528.6
grain and sacking					
chute 10 tonne	6 525	880.9	31.3	1.2	913.4
banana 7 tonne	5 420	731.7	25.7	1.0	758.4

Note: (1) At SoSh 135 : US$ 1.00

Source: Consultants' estimates based on 1987 quotations.

These have been taken as the present economic prices before foreign exchange shadow pricing. Assuming a foreign exchange content of 80% in this price (this makes allowance for local refining) the present and projected economic prices would be as follows:

	Present (SoSh/l)	Projected* (SoSh/l)
Economic		
Petrol	31.9	70.2
say,		70
Diesel oil	27.0	59.4
say,		59
Financial		
Petrol	28.7	63.1
say,		63
Diesel oil	21.2	46.6
say		47

Note: * 120% above present prices.

4.10.4 Machinery Operating Costs

The financial and economic cost calculations for tractors and combine harvesters are given in Table 4.20 and 4.21. These are:

	Financial (SoSh/hour)	Economic (SoSh/hour)
Tractors:		
60 kW	1 210	1 690
115 kW	1 590	2 200
Combine harvester	4 050	6 250

Note: Including cost of driver.

Allowance is made for difficult operating conditions as noted in the footnotes to the tables. Nevertheless the quality of operation and maintenance is assumed to be reasonable and higher than generally observed by the Consultants during the study.

4.10.5 Equipment and Total Costs by Field Operation

The hourly costs of operating and maintaining the field equipment recommended for the Homboy project are given in Tables 4.22 (financial) and 4.23 (economic).

To these have been added the hourly tractor costs to arrive at a total cost, excluding drivers and any ancillary labour, for each of the proposed field operations.

TABLE 4.20

Tractor Operating Costs at Financial and Economic Prices (SoSh/hour)

	60 kW		115 kW	
	Financial	Economic	Financial	Economic
Capital cost '000 SoSh	1 622.0	2 432.6	1 958.3	2 931.7
Depreciation:				
Life 6 000 hours(1) Salvage value 15%	229.8	344.6	277.4	415.3
Interest 10%	-	73.6	-	88.7
Fuel (diesel):				
12 litres/hour				
at SoSh 47 per litre	564.0	-	-	-
at SoSh 59 per litre	-	708.0	-	-
17 litres/hour				
at SoSh 47 per litre	-	-	799.0	-
at SoSh 59 per litre	-	-	-	1 003.0
Oil and greases 18% fuel cost	101.5	127.4	143.8	180.5
Repairs and maintenance(2) 90% of capital cost over 6 000 hours	243.3	364.9	293.8	439.8
Driver SoSh 350/7 hours	50.0	50.0	50.0	50.0
Miscellaneous - licence, insurance, etc. 1.5%	17.8	16.7	23.5	21.8
Total	1 206.4	1 685.2	1 587.5	2 199.1
SoSh/hour assumed	1 210	1 690	1 590	2 200

Notes: (1) Under good conditions 10 000 hours. This reduced by 40% to allow for difficult working and management conditions.

(2) Includes spare parts, tyres, regular maintenance and repairs.

Source: Consultants' estimates.

TABLE 4.21

Combine Harvester Operating Costs at Financial and Economic Prices (SoSh/hour)

	Financial	Economic
Capital cost '000 SoSh	3 957.2	5 925.3
Depreciation:		
Life 1 500 hours[1] Salvage value 15%	2 242.4	3 357.7
Interest 10%	-	431.2
Fuel (diesel):		
15 litres/hour at SoSh 47 per litre	705.0	-
at SoSh 59 per litre	-	885.0
Oil and grease 20% fuel cost	141.0	177.0
Repairs and maintenance[2] 33% of capital cost over 1 500 hour life	870.6	1 303.6
Driver SoSh 350/7 hour/day	50.0	50.0
Miscellaneous costs 1.0%	40.1	43.4
Total	4 049	6 247.9
SoSh/hour assumed	4 050	6 250

Notes: (1) Under good conditions 2 500 hours. This reduced by 40% to allow for difficult field and management conditions.

(2) Includes spare parts, tyres, regular maintenance and repairs.

Source: Consultants' estimates.

TABLE 4.22

Machinery and Implement Operating Costs by Field Operation - Financial Prices (SoSh/hour)

	Plough		Disc harrow	Combine drill	Ridger	Sprayer	General	Trailers	
	Chisel	Mould-board						Grain	Banana
Capital cost '000 SoSh	205.1	270.2	407.0	622.4	97.1	339.2	354.0	610.4	507.4
Life (hours)(1)	2 000	2 000	1 760	1 050	2 000	950	3 500	3 500	3 500
Depreciation(2)	92	122	208	533	44	321	91	157	130
Repairs and maintenance	67(3)	108(4)	150(3)	445(5)	32(3)	268(5)	61(6)	105(6)	87(6)
Total implement cost(7)	160	230	360	980	80	590	150	260	220
Tractor cost:									
115 kW		1 590	1 590						
60 kW	1 210			1 210	1 210	1 210	1 210	1 210	1 210
Total cost	1 370	1 820	1 950	2 190	1 290	1 800	1 360	1 470	1 430

Notes:
(1) Average UK and USA life less 30% for combine drill, 20% for other items.
(2) Allowing for 10% salvage value.
(3) At 65% of capital cost.
(4) At 80% of capital cost.
(5) At 75% of capital cost.
(6) At 60% of capital cost.
(7) Rounded to nearest SoSh 10.

Source: Consultants' estimates.

TABLE 4.23

Machinery and Implement Operating Costs by Field Operation - Economic Prices (SoSh/hour)

	Plough		Disc harrow	Combine drill	Ridger	Sprayer	General	Trailers Grain	Banana
	Chisel	Mould-board							
Capital cost '000 SoSh	305.8	403.2	608.5	931.4	144.0	507.0	528.6	913.4	758.4
Life (hours)(1)	2 000	2 000	1 760	1 050	2 000	950	3 500	3 500	3 500
Depreciation(2)	138	181	311	798	65	480	136	235	195
Interest 10%	28	37	54	88	13	26	42	47	39
Repairs and maintenance	99(3)	161(4)	225(3)	665(5)	47(3)	400(5)	91(6)	157(6)	130(6)
Total implement cost(7)	260	380	590	1 550	120	910	270	440	360
Tractor cost:									
115 kW		2 200	2 200						
60 kW	1 690			1 690	1 690	1 690	1 690	1 690	1 690
Total cost	1 950	2 580	2 790	3 240	1 810	2 600	1 960	2 130	2 050

Notes:
(1) Average UK and USA life less 30% for combine drill, 20% for other items.
(2) Allowing for 10% salvage value.
(3) At 65% of capital cost.
(4) At 80% of capital cost.
(5) At 75% of capital cost.
(6) At 60% of capital cost.
(7) Rounded to nearest SoSh 10.

Source: Consultants' estimates.

CHAPTER 5

FARMING SYSTEMS

5.1 Introduction

This chapter sets out the background to the three farming systems, as farm types, proposed for the Homboy Irrigation Project together with the financial incomes which settled families can expect from each system. Included is an assessment of settlers capacity to pay for services, such as the operation and maintenance of the irrigation system and other project specific services which it is proposed to provide over and above those, such as extension, which are normally considered as free service.

5.2 General Farm Organisation

The 1980 Homboy study considered three alternative farming systems - state farms, village collectives and co-operatives. The recommended system was based on 50 family/50 ha co-operatives within the ten village blocks to be located in the project area.

The Government's present policies - of market liberalisation and encouragement of private initiative and enterprise - has expanded the management options that can be considered. This is reflected in the proposed organisation of the project as set out in Section D, Organisation and Management. The proposed farming systems are aimed at providing each family with as much incentive as possible by being allocated an identifiable farm holding. This does not preclude inter-family co-operation in certain activities such as irrigation, bird scaring in the rice areas and livestock herding. Co-operation will therefore have specific and limited purposes and this is more likely to be successful than the more general, wider ranging activities associated with co-operatives. Each family's efforts will be directly related to its own crop production levels.

5.3 Objectives

The proposed farming systems have been designed with the above in mind and to meet certain specific objectives, including ones set out by the client. The objectives are:

- to involve families as much as possible in the management and farming of their holdings;
- to achieve 200% cropping intensity;
- to provide holdings of 2.0 to 2.5 ha;
- to meet the target of a minimum net family farm income of SoSh 6 000 per month (SoSh 72 000 per year);
- to keep family labour as well used throughout the year as reasonably possible;
- to avoid significant reliance on hired labour which is in short supply especially in the gu season;
- to allocate holdings within easy walking distance of a family's village residence;
- to equate the crops grown with land suitability and the available water supply.

A major element in the design of the farming systems is therefore the need to keep labour inputs within the limits that a typical family can provide each month. This results in the need to mechanise certain operations related to land preparation and, in the case of rice only, to planting and harvesting.

5.4 Labour Requirements and Availability

5.4.1 Crop Labour Requirements

The crop labour requirement data for previous studies such as Homboy (HTS, 1980), Custodial Corps Farms (MMP, 1984) and Genale/Bulo Mareita (MMP, 1978) were reviewed. The data were considered to be acceptable for the proposed Homboy scheme except for a few minor adjustments made necessary by changes in cultivation practices or yield levels. The estimated monthly labour requirements are given in Table 5.1.

5.4.2 Family Labour Availability

The average family size of 5.48 persons in the project area has been taken from the 1980 Homboy study. Figures collected in November, 1986, indicate a wide variation in family sizes but with a typical household of five to six persons; this supports the earlier, 1978/79 data.

As shown in Table 5.2, typical families can be expected to have from 2.2 to 2.8 man-equivalents (ME) available for farm work. In arriving at the proposed cropping patterns 2.4 ME have been assumed. From this, one child (0.3 ME) has been deducted to provide for livestock herding to give a maximum of 2.1 ME for crop production.

TABLE 5.2

Family Labour Availability

	Adult			Children	Infants	Total
	Male	Female				
	18-40 years	Over 40 years	18-40 years			
ME conversion factors	1.0	0.4	0.6	0.3	-	
Family A(1)						
Nr	1	1	1	2	1	6
ME	1.0	0.4	0.6	0.6	-	2.6
Family B(1)						
Nr	1	-	1	2	1	5
ME	1.0	-	0.6	0.6	-	2.2
Assumed ME	1.0	0.2	0.6	0.6	-	2.4

Note: (1) Typical families of 6 (A) and 5(B) persons

TABLE 5.1

Monthly Crop Labour Requirements

Man-days each hectare

Crop		Month Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Maize		-	-	3	20	21	4	10	15	-	-	-	-	73
Rice:	Gu	-	1	6	12	11	37	37	1	-	-	-	-	105
	Der	37	1	-	-	-	-	-	1	6	12	11	37	105
Sesame		11	11	-	-	-	-	-	-	-	7	14	12	53
Cowpea		-	-	10	17	10	12	14	-	-	-	-	-	63
Cotton		35	31	6	-	-	-	4	23	24	16	12	5	156
Vegetables:	Gu	-	15	15	36	23	10	10	40	5	-	-	-	154
	Der	10	10	40	5	-	-	-	-	15	15	36	23	154
Banana Year 1		-	-	28	28	28	26	4	8	12	18	18	14	184
Banana Years 2,3,4		21	17	17	18	17	14	20	14	15	21	20	14	208

Source: Consultants' Estimates and HTS (1980), MMP (1984) and MMP (1978).

The 2.1 ME represents 55 man-days of available family labour for a 26 to 27 day month. This figure has been taken as the usual available family labour input but could rise to 61 ME for 29 working days at peak periods.

5.5 Farming Systems

The monthly labour requirements for each of the three proposed farming systems are set out in Table 5.3. In each case they are within the 61 days that can be provided by a typical family after taking into account possible livestock herding requirements.

The three farming systems are based upon land suitability for the major cash crops: bananas, rice and in the general arable system cotton. The detailed choice of crops is given in the Section B. The three systems are outlined below:

Banana - 3 000 ha have been identified as suitable for banana growing. This will provide 1 200 family holdings of 2.5 ha each with 2.0 ha bananas and 0.5 ha of a fallow break in the banana cycle which will be used to grow other crops such as maize and sesame for home consumption. As shown in the table the monthly labour inputs for the 2.5 ha holding fall well below the maximum available 61 man-days. This farming system is expected to result in good returns at both financial and economic prices. The cropping pattern will be as shown below:

Perennial crops: Bananas 80% of holding

Annual crops: 20% of holding comprising:

	Cropping Intensity (%)		
	Gu season	Der season	Annual
Maize	80	-	80
Sesame	-	80	80
Vegetable	20	20	40
Total	100	100	200

Rice - General Arable - The farming system recommended to utilise the rice lands is a split holding of 2 ha. This comprises one hectare of paddy rice and an equal area of other crops, for example maize and vegetables, which would be grown in the areas not allocated to paddy rice. The total area of this farming system will be 1 900 ha (i.e. 950 ha paddy rice and 950 ha other crops). With sensible land allocation neither of the two plots need to be too far from the family's house. With such a holding there are no excessive labour peaks under the proposed degree of mechanisation. However, it would not be feasible to harvest rice by hand over the area proposed. The 200% cropping intensity is made up as follows:

TABLE 5.3

Monthly Labour Requirements for Farm Systems (Man-days)

Farm type	Crop	ha	Labour requirements												
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Banana	Banana														
2.5 ha	Year 1	0.5	-	-	14	14	14	13	2	4	6	9	9	7	92
200%	Years 2,3,4	1.5	32	26	26	27	26	20	30	21	23	32	29	20	312
	Maize	0.4	-	-	1	8	8	2	4	6	-	-	-	-	29
	Sesame	0.4	4	4	-	-	-	-	-	-	-	3	6	4	21
	Vegetables	0.1	1	5	11	8	2	1	1	4	4	2	4	2	45
Total			37	35	52	57	50	36	37	35	33	46	48	33	499
Rice-general	Rice	1.0	37	2	6	12	11	37	37	2	6	12	11	37	210
arable	Maize	0.9	-	-	3	18	19	4	9	13	-	-	-	-	66
2.0 ha	Sesame	0.9	10	10	-	-	-	-	-	-	-	6	13	9	48
200%	Vegetables	0.1	1	5	11	8	2	1	1	4	4	2	4	2	45
Total			48	17	20	38	32	42	47	19	10	20	28	48	369
General arable	Maize	1.5	-	-	5	30	32	6	15	22	-	-	-	-	110
2.5 ha	Cowpea	0.9	-	-	9	15	9	11	13	-	-	-	-	-	57
200%	Sesame	1.2	13	12	-	-	-	-	-	-	-	8	17	14	64
	Cotton	1.2	42	37	7	-	-	-	5	28	29	19	14	6	187
	Vegetables	0.1	1	5	11	8	2	1	1	4	4	2	4	2	45
Total			56	54	32	53	43	18	34	54	33	29	35	22	463

Source: Consultants' estimates.

	Cropping Intensity (%)		
	Gu season	Der season	Annual
Maize	45	-	45
Rice	50	50	100
Sesame	-	45	45
Vegetables	5	5	10
Total	100	100	200

General Arable - For areas not suitable for bananas or rice, a general arable farming system is proposed. This covers 3 950 ha with individual holdings of 2.5 ha. The cropping pattern incorporates cotton as the major cash crop and the 200% intensity would be made up as shown below. As with the two other farm types the labour requirements are within the limits of a typical family's capability.

	Cropping Intensity (%)		
	Gu season	Der season	Annual
Maize	60	-	60
Cowpea	36	-	36
Sesame	-	48	48
Cotton	-	48	48
Vegetables	4	4	8
Total	100	100	200

In each of the three proposed farming systems there is a major cash crop. While individual families may, and will be free to grow alternative crops (for example, beans instead of cowpeas, more maize than sesame, other oilseeds) the project analyses are based upon the cropping patterns shown above.

5.6 Summary

Table 6.4 summarises the cropping pattern in relation to the three proposed farming systems at the project's full development.

The objective of having farm holdings of over 1 ha, preferably 2 to 2.5 ha which can be cropped without the need to hire labour has been met. At the same time family labour is resonably well utilised throughout the year and a cropping intensity of 200% is shown to be feasible.

TABLE 5.4

Summary of Proposed Farming Systems and Cropping at Full Development

Farming system	Holding size (ha)	Cropping intensity (%)	Cropping Gu Crop	Gu ha	Cropping Der Crop	Der ha	Families (Nr)
Banana	2.5	200	Banana	2 400	Banana	2 400	
			Maize	480	Sesame	480	
			Vegetable	120	Vegetable	120	
Area total				3 000		3 000	1 200
Rice	2.0	200	Rice	950	Rice	950	
			Maize	855	Sesame	855	
			Vegetable	95	Vegetable	95	
Area total				1 900		1 900	950
General arable	2.5	200	Maize	2 370	Sesame	1 896	
			Cowpea	1 422	Cotton	1 896	
			Vegetable	158	Vegetable	158	
Area total				3 950		3 950	1 580
Total area of crops			Banana	2 400	Banana	2 400	
			Maize	3 705	Sesame	3 231	
			Rice	950	Rice	950	
			Cowpea	1 422	Cotton	1 896	
			Vegetable	373	Vegetable	373	
Total net irrigated area				8 850		8 850	3 730

CHAPTER 6

FARM INCOME

6.1 General

Based on guidelines provided by MJVD, the minimum net family income required has been set at SoSh 6 000 a month, SoSh 72 000 a year. As shown in this chapter this should be achieved even after reasonable charges for the operation and maintenance of the distribution system and infrastructure of direct use to the settlers.

The projected financial prices used in the calculations are discussed in Chapter 4 and summarised in Table 4.17 and, for machinery operations Table 4.22.

6.2 Crop Budgets

6.2.1 Labour

The labour requirements by month are set out in Chapter 5.4.1. In the financial analysis, however, the use of family labour is assumed and, as illustrated in Table 5.3, none of the three farm types will need to rely upon hired labour. While for reasons of their own some, farmers may wish to hire labour. This should not be essential for a typical family and has not been costed in the budgets.

6.2.2 Machinery

As outlined earlier land preparation will be mechanised for all crops to reduce labour peaks and ensure the timeliness necessary for double cropping. The high labour inputs for rice planting and harvesting have also led to the recommendation that these operations be mechanised. The machinery inputs by operation are given in Table 6.1. The financial cost of these operations for each crop is given in Table 6.2.

6.2.3 Other Crop Inputs

Table 6.3 sets out the recommended crop inputs, excluding machinery, for the crops it is proposed to grow on the scheme. The inputs are appropriate for the expected yields and are discussed in greater detail in the Agricultural Annex. To assess the increase in farmers' incomes with the project estimates have been made of incomes without the project. These are based on the Consultants' field visits and the current estimated yields and inputs are given in Table 2.4 (see also the Agricultural Annex).

6.2.4 Crop Yields

Crop yields, present and future, are discussed in detail in the Agricultural Annex. Care was taken to use realistic yield levels and to match inputs, such as fertilisers, to the expected output. As illustrated below present yields are low under rainfed, low input conditions.

	Present rainfed (kg/ha)	Future irrigated (kg/ha)	Increase kg/ha	Increase %
Maize	800	3 000	2 200	175
Sesame(1)	250	600	350	40
Cowpea(1)	213	750	537	152
Cotton	250	1 500	1 250	400
Vegetable(1)	2 125	7 000	4 875	129

Note: (1) Average gu and der season estimates.

With the exception of sesame, the future yields are very substantial, especially in the case of cotton. The increases are attributable to a reliable water supply, timely planting and cultivation operations and appropriate input levels particularly fertilisers and pesticides.

6.2.5 Crop Gross Margins

The financial gross margins, at projected future prices, are shown in Tables 6.5 and 6.6. The former are the returns that can reasonably be expected with the project to the average farmer. Table 6.6 gives estimates of gross margins under rainfed conditions without the project. As discussed in Section E of Annex 1 (Organisation and Management), improvements of any significance in existing government services - extension advice, input availability, etc., cannot be expected in the next few years. Government programmes are and will continue to be restricted by finances and donor aided services, such as AFMET for extension, are expected to enter a period of consolidation rather than expansion in the immediate future. There is therefore reason to suppose that rainfed farming will continue on the low input - low output regime as at present.

The tables show the substantial improvement in crop gross margins on a unit area basis and in terms of returns to each man-day work input. The changes are illustrated below for crops which will be grown with and without the project.

	Gross margin per hectare			Gross margin per man-day		
	Without project ('000 SoSh/ha)	With project ('000 SoSh/ha)	Change (+%)	Without project (SoSh/ha)	With project (SoSh/ha)	Change (+%)
Maize	30.2	10.4	190	414	230	80
Cowpea(1)	17.5	6.4	173	277	216	28
Sesame(1)	30.8	16.9	82	581	490	19
Cotton	124.1	20.2	514	796	374	113

Note: (1) Without project average for gu and der seasons.

The project will, in addition, enable new crops to be grown, bananas and rice, both with very good financial gross margins at the project future prices.

6.3 Farm Gross Margins

Settlers can expect to realise total annual farm gross margins, before meeting fixed costs ranging from SoSh 274 600 for general arable farmers to over SoSh 556 000 for the banana farm holdings. These are broken down in Table 6.7 for each farm system. Table 6.8 gives details of the composition of the estimated farm gross margin under present rainfed conditions. This totals just over SoSh 38 000 a year, or SoSh 3 170 a month.

The anticipated increase in farm incomes will vary by farming system and will be not less than SoSh 236 590 a year as shown below:

	Income with project	Income without project	Income increase	Income increase/ caput(1)
		(Sh '000)		
Banana	556.3	38.01	518.29	94.58
Rice-arable	321.6	38.01	283.59	51.75
General arable	274.6	38.01	236.59	43.17

Note: (1) Based on an average household of 5.48 persons.

In terms of total labour inputs the changes are:

	Labour input (man-days)		Returns		
	With project	Without project	With project	Without project	Increase (%)
			(SoSh/man-day)		
Banana	499	110.5	1 115	344	224
Rice-arable	369	110.5	872	344	153
General arable	463	110.5	593	344	72

As discussed in the next section these returns do not include deductions for fixed costs such as water supply charges, non-annual land levelling, etc.

6.4 Farm Net Income and Farmer Repayment Capacity

In addition to the variable costs accounted for in the farm gross margins settlers will be expected to meet a number of production related costs. For all growers this will include the costs of land levelling which for arable crops will be needed every second year and for banana farmers annually on the half hectare being replanted. All settlers will also be expected to meet costs related to the operation and maintenance of the water distribution and drainage system. At the tertiary and field levels this will, in part, be met through the provision of labour for the maintenance operations. It will also be necessary to meet credit repayments and the higher but very low land taxes that apply to irrigated land. Banana farmers will also be expected to meet the cost of operating their packing sheds. The figure in Table 6.9 for this covers the costs of local staff, vehicle running and the maintenance of the packing shed and associated staff houses and offices at 1.5% per year of the original capital cost. The cost of packing materials and related items is included in the net value of the crop paid to the growers.

The resulting net farm incomes are:

Farms	SoSh/holding	SoSh/hectare
Banana	525 900	210 360
Rice-arable	302 150	151 080
General arable	250 290	100 120

These represent substantial increases over average rainfed production in the project area which is estimated at SoSh 38 000 for a typical 2 ha holding (Table 6.8). The proportional increases of 1 380% for banana growers, 795% for rice-arable farmers and 658% for the general arable farmers would certainly be sufficient to encourage them to remain on their new holdings.

TABLE 6.1

Crop Machinery Requirements

(Hours/ha)

	Maize	Rice	Sesame	Cowpea	Cotton	Banana		Onions
						Year 1	Years 2,3,4	
Plough:								
- chisel	3.2	3.2	3.2	3.2	3.2	-	-	3.2
- mouldboard	-	-	-	-	-	2.65	-	-
Disc:								
- light(1)	-	-	-	-	-	2.5	-	-
- heavy	2.0	2.0	2.0	2.0	2.0	-	-	2.0
Ridger(2)	0.5		-	-	1.6	18.0	-	0.5
Sowing	-	1.2	-	-	-	-	-	-
Spray	-	0.6	-	-	-	-	-	-
Combine harvester	-	0.9	-	-	-	-	-	-
Transport(3)	0.5	0.9	0.5	0.5	0.5	(4)	(4)	0.5

Notes: (1) Light discing for bananas as disc harrow but with 60 kW tractor.

(2) Assume 1/3 area ridged over whole project for maize and onions.

(3) Including miscellaneous fieldwork costed as tractor and trailer. Except for rice and banana transport, will generally be by ox cart or other farmer arrangement.

(4) Costed as one tractor and trailer full time for 125 ha in Years 2, 3 and 4 and for 250 ha in Year 1.

Source: Consultants' estimates.

TABLE 6.2

Crop Machinery Inputs at Financial Prices (SoSh/hectare)

	Maize	Rice	Sesame	Cowpea	Cotton	Banana Year 1	Banana Years 2,3,4	Vegetables
Plough	4 384	4 384	4 384	4 384	4 384	4 823	-	4 384
Disc:								
- light	-	-	-	-	-	3 925	-	-
- heavy	3 900	3 900	3 900	3 900	3 900	-	-	3 900
Ridger	645	-	-	-	2 064	23 220	-	645
Sowing	-	2 628	-	-	-	-	-	-
Spray	-	1 080	-	-	-	-	-	-
Combine harvester	-	3 645	-	-	-	-	-	-
Transport	680	1 323	680	680	680	4 290	8 580	680
Total	9 609	16 960	8 964	8 964	11 028	36 258	8 580	9 609

Source: Consultants' estimates, Chapter 5.10.

TABLE 6.3

Crop Inputs With Project

(Units/ha)

	Unit	Maize	Sesame	Cowpea	Cotton	Onion		Rice		Banana Year 1	Banana Years 2,3,4
Yield	kg	3 000	600	750	1 500	7 000		4 000			
Banana:											
Export	kg									10 000	23 000
Local	kg									2 000	6 000
Waste	kg									500	1 000
Sub-total										12 500	30 000
Seed	kg	20	8	30	25	5		90		2 000	-
										Pieces	
Seed dressing:											
Feraisan D	kg	0.06	0.03	0.10	-	0.02		0.30		-	
Bronopol dust	kg	-	-	-	0.01	-		-		-	
Fertiliser:											
Urea	kg	110	40	-	115	75		160		700	900
DAP	kg	40	25	50	40	50		60		300	-
15.7.24	kg	-	-	-	-	-		-		600	900
Zinc sulphate	kg	1.4	-	-	-	-		-		-	-
Herbicide:											
Strain 84	l	-	-	-	-	-		15		-	-
Pesticide:											
Malathion	kg	3	-	2	-	4		-		-	-
Diazinon	kg	5	-	-	-	-		5		-	-
Polytrin	l	-	-	-	6	-		-		-	-
Ridanol	kg	-	-	-	-	1		-		-	-
Furidan	kg	-	-	-	-	-		-		120	120
Containers	Nr	10	8	5	25	20		22		3 000(2)	6 000(2)
						Gu	Other	Gu	Other		
Labour(1):											
Gu	man-	70	-	53	27	119	5	67	1	94	83
Other season	days	3	53	10	129	35	149	38	104	90	125
Total		73		63	156	154	154	105	105	184	208

Notes: (1) Onions and rice cropped twice each year.
(2) For in-field protection - packing of materials in price for fruit.

Source: Consultants' estimates

TABLE 6.4

Crop Inputs Without Project
(units/ha)

	Unit	Maize	Sorghum	Sesame		Cowpea		Cotton	Onion	
				Gu	Der	Gu	Der		Gu	Der
Yield	kg	800	600	300	200	250	175	250	2 500	1 750
Seeds	kg	25	10	10	10	35	35	20	6	6
Pesticide: Nuvacron	l	-	-	-	-	-	-	5	-	-
Labour:										
Gu	man-	45	-	38	-	33	-	54	68	-
Other season	days	-	40	-	31	-	26	-	-	60
Tractor(1)	hours	1	-	-	-	-	-	2	-	-

Note: (1) Cotton, 2 hours land preparation on all land assumed using Somaltex tractor service.
Maize, 1 h/ha makes allowance for the fact that not all land is ploughed using existing services - ONAT and private.

Source: Consultants' estimates.

TABLE 6.5

Crop Gross Margins With Project Financial Prices (SoSh/ha)

	Maize	Rice Gu and Der	Sesame	Cowpea	Cotton	Onion Gu and Der	Banana Year 1	Banana Years 2,3,4
Gross income:								
Yield, kg	3 000	4 000	600	750(1)	1 500	7 000		
Value, SoSh/kg	15.7	38.6	71.8	40.8	96.6	22.0		
Gross income	47 100	154 400	43 080	30 600	144 900	154 000	174 900(1)	407 100(1)
Variable costs:								
Seed	472	5 211	751	1 881	free	174	6 000	-
Dressing	8	41	4	14	2	3	-	-
Fertiliser	4 924	7 008	2 080	1 640	4 935	4 003	46 410	50 130
Herbicide	-	3 600	-	-	-	-	-	-
Pesticide	1 219	700	-	346	3 294	1 112	25 440	25 440
Machine operation	9 690	16 960	8 964	8 964	11 028	9 609	36 258	8 580
Containers	600	1 320	480	300	1 500	1 200	3 000	6 000
Total variable costs	16 913	34 840	12 279	13 145	20 759	16 101	117 108	90 150
Gross margin	30 187	119 560	30 801	17 455	124 141	137 899	57 792	316 950
Labour, man-days	73	105	53	63	156	154	184	208
Gross margin each man-day	414	1 139	581	277	796	895	314	1 524

Note: (1) Banana gross income:

	Export fruit tonnes	Export fruit SoSh/t	Export fruit SoSh	Local sales tonnes	Local sales SoSh/t	Local sales SoSh	Total SoSh
Year 1	10	16 800	168 000	2	3 450	6 900	174 900
Years 2, 3, 4	23	16 800	386 400	6	3 450	20 700	407 100

Source: Consultants' estimates.

TABLE 6.6

Crop Gross Margin Without Project: Financial Prices (SoSh/ha)

	Maize	Sorghum	Sesame		Cowpea		Cotton	Vegetables	
			Gu	Der	Gu	Der		Gu	Der
Gross income:									
Yield kg/ha	800	600	300	200	250	175	250	2 500	1 750
Value SoSh/kg	15.7	14.5	71.8	71.8	40.8	40.8	96.6	22.0	22.0
Gross income	12 560	8 700	21 540	14 360	10 200	7 140	24 150	55 000	38 500
Variable costs:									
Seed	590	218	939	939	2 195	2 195	free	209	209
Pesticides	-	-	-	-	-	-	745	-	-
Machinery operation	1 370	-	-	-	-	-	2 740	-	-
Containers	240	180	120	60	120	60	480	420	300
Total variable costs	2 200	398	1 059	999	2 315	2 255	3 965	629	509
Gross margin	10 360	8 302	20 481	13 361	7 885	4 885	20 185	54 371	37 991
Labour, man-days	45	40	38	31	33	26	54	58	53
Gross margin each man-day	230	208	539	431	239	188	374	937	717

Source: Consultants' estimate.

Assumes seed is purchased.

TABLE 6.7

Farm Gross Margin at Full Development at Financial Prices (SoSh '000)

Farm type	Crop	Area (ha)	Gross income	Variable costs	Gross margin Crop	Gross margin Farm
Banana	Banana:					
	- Year 1	0.5	87.5	58.6	28.9	
	- Years 2,3,4	1.5	610.7	135.2	475.5	
	Maize	0.4	18.8	6.8	12.0	
	Sesame	0.4	17.2	4.9	12.3	
	Vegetable	0.2	30.8	3.2	27.6	
Total						556.3
Rice - arable	Rice	2.0	308.8	69.7	239.1	
	Maize	0.9	42.4	15.2	27.2	
	Sesame	0.9	38.8	11.1	27.7	
	Vegetable	0.2	30.8	3.2	27.6	
Total						321.6
General arable	Maize	1.5	70.7	25.4	45.3	
	Sesame	1.2	51.7	14.7	37.0	
	Cotton	1.2	173.9	24.9	149.0	
	Cowpea	0.9	27.5	11.8	15.7	
	Vegetable	0.2	30.8	3.2	27.6	
Total						274.6

Source: Consultants' estimates.

TABLE 6.8

Farm Gross Margin Under Rainfed Conditions (Without Project) at Financial Prices (SoSh '000)

Crop	Area (ha)	Gross income	Variable costs	Gross margin Crop	Gross margin Farm
Gu season:					
Maize	1.0	12.56	2.20	10.36	
Sesame	0.4	8.62	0.42	8.20	
Cotton	0.4	9.66	1.59	8.07	
Cowpea	0.1	1.02	0.23	0.79	
Vegetable	0.1	5.50	0.06	5.44	
Sub-total	2.0				32.86
Der season: (1)					
Sorghum	0.4	3.48	0.16	3.32	
Sesame	0.08	1.15	0.08	1.07	
Vegetable	0.02	0.77	0.01	0.76	
Sub-total	0.50				5.15
Annual total	2.50	42.76	4.75		38.01

Note: (1) Assuming one season in four successfully cropped.

Source: Consultants' estimates based on field visits.

TABLE 6.9

Increase in Farm, Net Income
(SoSh '000 per holding per year)

	Farming system		
	Banana	Rice - arable	General - arable
'With' Project			
Farm gross margin	556.30	321.60	274.60
Fixed costs:			
Land levelling	2.42	4.84	6.05
O&M irrigation and drainage	18.26	16.61	18.26
Marketing costs:			
Packing shed operations	9.72	-	-
Total Fixed Costs	30.40	19.45	24.31
Farm Net Income	525.90	302.15	250.29
Net income each hectare(1)	210.36	151.08	100.12
'Without' Project			
Farm net income(2)	38.01	38.01	38.01
Net income each hectare(3)	19.01	19.01	129.01
Increase in Net Income:			
Farm	487.89	264.14	212.28
Each hectare	191.35	132.07	81.11

Notes: (1) Holding size.
Banana and general-arable 2.5 ha; rice-arable 2.0 ha.
(2) Fixed costs very low: gross margin = net income.
(3) Holding size 2.0 ha.
Excluding containers which are included in price paid to growers.

CHAPTER 7

PROJECT COSTS

7.1 General

The project costs are presented in United States dollars. The figures given in the tables are base costs excluding physical and financial contingencies. These have been included in the summary table, Table 7.12. Full details of the breakdown of costs are given in Section C for all civil works and further information is available in Section D on project staffing. Crop production costs are included in the incremental benefits described in the next chapter and these are supported in Chapters 5 and 6 of this section.

The costs are given at financial prices. Adjustments made for the economic analyses are shown in Chapter 9.

The bulk of capital costs will, however, be incurred over the first 7 years of the project. Total costs over this 7-year period are estimated at US$ 80.1 million of which 71% (US$ 56.9 million) will be required as foreign exchange. The division between capital and operating costs over this period is shown below:

	Total (million US$)	Foreign exchange (million US$)
Capital Costs		
Base cost	56.07	40.98
Contingencies[1]		
- physical	5.61	4.10
- financial	8.83	6.45
Total	70.51	51.53 (73%)
Operating Costs		
Base cost	6.99	3.81
Contingencies[1]		
- physical	0.70	0.38
- financial	1.90	1.18
Total	9.59	5.37 (55%)
Total Cost	80.10	56.90 (71%)

Note: (1) Physical 10%, financial 6% per year compound.

7.2 Capital Costs

7.2.1 Civil Works

Details of physical development costs including land clearance and levelling are given in Section C for each of the five components given in the summary table.

Total costs are estimated at US$ 43.93 million of which almost 79% will be foreign exchange costs.

7.2.2 Furniture and Equipment

The project provides US$ 815 000 for office and housing furniture and equipment for offices, workshops and to extension and training services. The latter are shown in detail in Section D. Foreign exchange will account for 75% of these costs.

7.2.3 Vehicles, Plant and Machinery

Tables 7.1 and 7.2, respectively, set out the project's requirements for vehicles and agricultural machinery and implements. Details of vehicles and plant required for the maintenance of the irrigation works, roads and other civil works are given in Section C. The unit costs and annual expenditure on all these items are detailed in Table 7.3.

The total expenditure on vehicles, plant and machinery will be:

	Total (US$ '000)	Foreign exchange component (US$ '000)	Per cent
Vehicles	444.7	422.5	95
Farm machinery and implements	3 898.4	3 703.8	95
Operation and maintenance plant	1 750.5	1 663.0	95
Total	6 093.6	5 789.3	95

These are base costs excluding physical and financial contingencies which are however included in the final cost summary table in this chapter.

The foreign exchange component is based on quoted costs assuming direct procurement by the project authority. Project staffing provides for this.

7.2.4 Credit

Farmers selected for the project will have few resources. A substantial credit fund will therefore be needed to finance individual family's crop inputs. The proposed revolving credit fund has been calculated on the basis of providing for the cost of machinery operations, fertilisers and other agro-chemicals for the major crops: bananas, rice, cotton, maize and sesame. Settlers will be expected to fund the growing costs of the minor crops themselves. The annual two-crop season costs for these inputs have been calculated for each holding at:

	Farm type		
	Banana (US$)	Rice arable (US$)	General arable (US$)
Bananas	2 930	-	-
Rice	-	904	-
Cotton	-	-	362
Maize	98	221	368
Sesame	69	155	206
Total	3 097	1 280	936

TABLE 7.1

Vehicle Requirements

Vehicle type	Project year							Total
	1	2	3	4	5	6	7	
Short wheelbase station wagon 4 WD	-	5	1	-	-	-	-	6
Light pick up 4 WD	-	2	1	4	1	-	-	8
Light pick up 2 WD	-	3	4	3	2	2	2	16
Truck (5 tonne)	-	1	-	-	-	-	-	1
Bus (30 seat)	-	1	-	-	-	-	-	1
Motorcycle (100 cc)	-	6	8	13	11	3	3	44

TABLE 7.2

Farm Machinery and Implement Requirements

Item	Project year						Total
	1	2	3	4	5	6	
Tractors:							
- 60 kW	-	-	23	17	23	39	102
- 115 kW	-	-	14	9	7	19	49
Combine harvester	-	-	1	-	1	3	5
Implements:							
- chisel plough	-	-	17	8	8	30	63
- mouldboard plough	-	-	2	2	3	1	8
- land plane	-	-	2	3	3	1	9
- disc harrow	-	-	11	7	6	20	44
- combine drill	-	-	1	-	1	4	6
- ridger	-	-	5	5	7	16	33
- sprayer	-	-	1	-	-	1	2
- trailer							
- flat 5 tonne	-	-	3	1	2	2	8
- grain 10 tonne	-	-	1	-	1	3	5
- bananas 7 tonne	-	-	1	2	8	7	18

Note: Project year 1 = 1993.

TABLE 7.3

Vehicles, Farm Machinery and Implements
Capital Costs ('000 US$)

Type	Unit cost	Project Year 1	2	3	4	5	6	7	Total
Vehicles:									
Station wagon 4 WD	15.22	-	76.10	15.22	-	-	-	-	91.32
Pick up 4 WD	9.76	-	19.52	9.76	39.04	9.76	-	-	78.08
Pick up 2 WD	7.49	-	22.47	29.96	22.47	14.98	14.98	14.98	119.84
5 tonne truck	22.86	-	22.86	-	-	-	-	-	22.86
Personnel carrier	38.02	-	38.02	-	-	-	-	-	38.02
Motorcycle	2.15	-	12.90	12.20	27.95	23.65	6.45	6.45	94.60
Sub-total	-	-	191.9	72.1	89.5	48.4	21.4	21.4	444.7
Farm machinery:									
Tractors:									
- 60 kW	18.23	-	-	419.29	309.91	419.29	710.97	-	1 859.46
- 115 kW	22.06	-	-	308.84	198.54	154.42	419.14	-	1 080.94
Combine harvester	44.58	-	-	44.58	-	44.58	133.74	-	222.90
Plough:									
- chisel	2.31	-	-	39.27	18.48	18.48	69.30	-	145.53
- mouldboard	3.04	-	-	6.08	6.08	9.12	3.04	-	24.32
Disc harrow	4.58	-	-	50.38	32.06	27.48	91.60	-	201.52
Ridger	1.09	-	-	5.45	5.45	7.63	17.44	-	35.97
Land plane	12.07	-	-	24.14	36.21	36.21	12.07	-	108.63
Combine drill	7.01	-	-	7.01	-	7.01	28.04	-	42.06
Sprayer	3.82	-	-	3.82	-	-	3.82	-	7.64
Trailers:									
- flat 5 tonne	3.99	-	-	11.97	3.99	7.98	7.98	-	31.92
- grain 10 tonne	6.89	-	-	6.89	-	6.89	20.67	-	34.45
- banana 7 tonne	5.72	-	-	5.72	11.44	45.76	40.04	-	102.96
Sub-total	-	-	-	933.4	622.2	784.9	1 557.9	-	3 898.4
Operation and Maintenance plant:									
Hydraulic excavator (72 kW)	111.00	-	-	-	222.0	111.0	222.0	-	545.0
Crawler tractor (72 kW)	60.00	-	-	-	60.0	60.0	60.0	-	180.0
2 WD tractor (45/50 kW)	14.00	-	-	14.0	28.0	14.0	28.0	-	84.0
4 WD tractor (45/50 kW)	16.00	-	-	16.0	-	-	16.0	-	32.0
Trailer (5 tonne)	3.00	-	-	3.0	6.0	3.0	6.0	-	18.0
Water tank trailer (2 500 l)	3.00	-	-	-	-	3.0	3.0	-	6.0
Fuel tank trailer (2 500 l)	3.00	-	-	-	3.0	3.0	-	-	6.0
Low loader tractor and trailer	35.00	-	-	-	35.0	-	35.0	-	70.0
Motor grader (150 hp)	80.00	-	-	-	160.0	-	80.0	-	240.0
Wheeled loader (90 hp)	51.00	-	-	51.0	-	-	-	-	51.0
10 tonne truck with crane	60.00	-	-	60.0	-	-	-	-	60.0
10 tonne flat truck	44.00	-	-	44.0	88.0	44.0	88.0	-	264.0
10 tonne tipper truck	50.00	-	-	50.0	-	-	50.0	-	100.0
Mobile workshop	60.00	-	-	60.0	-	-	-	-	60.0
Flail cutter	7.00	-	-	-	7.0	-	7.0	-	14.0
Concrete mixer	0.50	-	-	0.5	-	-	-	-	0.5
Water pump	3.10	-	-	3.1	-	-	3.1	-	6.2
Portable generator	0.80	-	-	0.8	-	-	0.8	-	1.6
Portable compressor	1.10	-	-	1.1	-	-	-	-	1.1
Vibrators	0.35	-	-	0.7	-	-	0.4	-	1.1
Sub-total		-	-	304.2	609.0	238.0	599.3	-	1 750.5
Total base costs		-	191.9	1 309.7	1 320.7	1 071.3	2 178.6	21.4	6 093.6

Source: Consultants estimates.
See Engineering Annex for details of maintenance plant.

The high figures for bananas reflect the substantial establishment costs.

Table 7.4 summarises the financial inputs required to establish the credit fund over the project's first four cropping years. The figures are based on the following assumptions.

- the provision of the full costs for each farmer in his first year and a 20% reduction in subsequent years. While the aim will be to wean farmers off credit once their holdings are established this rarely occurs in practice and it can be expected that credit demand will remain high for some years at least;

- repayment levels of 90% for banana and rice farmers where direct project control over marketing, and in the case of rice, harvesting is planned and 85% for the general arable farms;

- a 10% interest rate on loans repaid which will be credited to the fund;

- in some years there will be excess funds and these will accrue to the fund. This is expected to occur in respect of rice-arable holdings when the growth in numbers is very low in project year 5 and when banana farms have been established in year 6.

TABLE 7.4

Project Credit Funds Capital Requirements
(US$ '000)

Farm type	Project year						
	1	2	3	4	5	6	Total
Banana	-	-	619	1 415	1 029	-	3 063
Rice arable	-	-	160	-	104	905	1 166
General arable	-	-	468	217	175	551	1 411
Total	-	-	1 247	1 632	1 308	1 456	5 640
Less excess	-	-	-	-	3	406	406
Net capital injection	-	-	1 247	1 632	1 305	1 050	5 234

7.3 Operating Costs

7.3.1 Staff

Table 7.5 summarises by grade the local and expatriate staff required for the project. Details are discussed in Section D. Three broad components are shown:

- Administration and general services: This includes the project's financial and personnel administration departments, staff for training, commercial services and machinery workshops which are mainly at the headquarters level.

- Irrigation and civil works: Includes all headquarters and field staff for the maintenance and operation of the project's water distribution and drainage network and civil works infrastructure. Staff requirements are shown in Section E.

TABLE 7.5

Staff Requirements

			Project year					
			2	3	4	5	6	7
Administration and General Services								
Expatriate:	Grade	A	2	2	2	2	1	-
		B	1	1	1	1	1	-
		C	2	3	3	3	3	-
Local:	Grade	1	1	1	1	1	1	1
		2	1	1	1	1	1	1
		3	2	3	3	3	3	3
		4	1	5	5	5	5	5
		6	-	1	2	3	3	3
		7	-	7	14	16	16	16
		8	4	16	18	18	18	18
		9	-	12	13	14	14	14
		Labourers	1	10	10	10	10	10
Irrigation and Civil Works								
Expatriate:	Grade	B	-	1	1	1	1	-
		C	-	1	1	1	1	-
Local:	Grade	2	-	1	1	1	1	1
		3	-	1	1	1	1	1
		4	-	1	1	1	1	1
		5	-	2	2	2	2	2
		6	-	3	3	4	4	4
		7	-	19	30	46	66	66
		8	-	6	8	10	13	13
		9	-	2	2	2	2	2
		Labourers	-	20	35	50	70	70
Field Services								
Bananas								
Expatriate:	Grade	B	1	1	1	1	1	-
		C	1	1	1	1	1	-
Local:	Grade	2	1	1	1	1	1	1
		3	1	1	4	5	5	5
		5	1	2	8	10	10	10
		6	3	9	13	14	15	15
		9	4	12	16	20	20	20
		Labourers	6	22	32	41	41	41
Rice and Arable								
Expatriate:	Grade	B	1	1	1	1	1	-
		C	1	1	1	1	-	-
Local:	Grade	2	1	1	1	1	1	1
		3	2	2	2	2	2	2
		4	-	2	3	4	5	6
		5	-	2	4	6	8	10
		6	4	5	8	14	14	14
		7	2	4	6	8	10	10
		9	4	8	12	16	20	20
		Labourers	4	5	5	8	9	9

- Field services: All field staff for the agricultural and commercial services operations are included under this component. It is subdivided to show the costs attributable to banana growers (extension and marketing including operation of the five proposed packing sheds) and other staff to provide support at the village level and for annual cropping.

As discussed in Section D government salaries are extremely low and provide little incentive to work and live in the more rural areas, where facilities are poor. The salary and wage levels used in the analyses are therefore based on the rather higher levels paid at the Juba Sugar Project in early 1987, plus 15%. As discussed in Chapter 4 the economic costs are net of personal taxes. Tables 7.7 (financial) and 7.8 (economic) set out the annual staff costs on the basis of salaries shown in Table 7.6.

TABLE 7.6

Annual Unit Staff Costs by Grade at Financial and Economic Prices

		US$ each person	
		Financial	Economic
Expatriate:			
Grade	A	36 000	54 000
	B	29 000	43 500
	C	21 000	31 500
Local:			
Grade	1	2 500	1 945
	2	1 850	1 445
	3	1 610	1 260
	4	1 370	1 075
	5	960	760
	6	830	660
	7	690	550
	8	500	405
	9	280	235
	Labourers	220	190

Source: Consultants' estimates based on Juba Sugar Project local salary levels. (See also Chapter 4).

The costs of expatriate staff assume commercial recruitment at 1987 prices with full support services including air fares and other related allowances and expenses. It is also assumed that such staff do not pay local taxes and are provided with free accommodation and utilities.

The local costs used in the economic anlayses exclude government taxes at the rates shown in Chapter 6, including the 5% local government levy on salaries.

TABLE 7.7

Staff Financial Costs
('000 US$)

				Project year					
			1	2	3	4	5	6	7
Administration and General Services									
Expatriate:	Grade	A	-	72.0	72.0	72.0	72.0	36.0	-
		B	-	29.0	29.0	29.0	29.0	29.0	-
		C	-	42.0	63.0	63.0	63.0	63.0	-
Sub-total			-	143.0	164.0	164.0	164.0	128.0	-
Local:	Grade	1	-	2.50	2.50	2.50	2.50	2.50	2.50
		2	-	1.85	1.85	1.85	1.85	1.85	1.85
		3	-	3.22	4.83	4.83	4.83	4.83	4.83
		4	-	1.37	6.85	6.85	6.85	6.85	6.85
		6	-	-	0.83	1.66	2.49	2.49	2.49
		7	-	-	4.83	9.66	11.04	11.04	11.04
		8	-	2.00	8.00	9.00	9.00	9.00	9.00
		9	-	-	3.36	3.64	3.92	3.92	3.92
		Labourer	-	0.22	2.20	2.20	2.20	2.20	2.20
Sub-total			-	11.2	35.3	42.2	44.7	44.7	44.7
Total			-	154.2	199.3	206.2	208.7	172.7	44.7
Irrigation and Civil Works									
Expatriate:	Grade	B	-	-	29.0	29.0	29.0	29.0	-
		C	-	-	21.0	21.0	21.0	21.0	-
Sub-total			-	-	50.0	50.0	50.0	50.0	-
Local:	Grade	2	-	-	1.85	1.85	1.85	1.85	1.85
		3	-	-	1.61	1.61	1.61	1.61	1.61
		4	-	-	1.37	1.37	1.37	1.37	1.37
		5	-	-	1.92	1.92	1.92	1.92	1.92
		6	-	-	2.49	2.49	3.32	3.32	3.32
		7	-	-	13.11	20.70	31.74	45.54	45.54
		8	-	-	3.00	4.00	5.00	6.50	6.50
		9	-	-	0.56	0.56	0.56	0.56	0.56
		Labourer	-	-	4.40	7.70	11.00	15.4	15.4
Sub-total			-	-	30.3	42.2	58.4	78.1	78.1
Total			-	-	80.3	92.2	108.4	128.1	78.1
Field Services									
Bananas									
Expatriate:	Grade	B	-	29.0	29.0	29.0	29.0	29.0	29.0
		C	-	21.0	21.0	21.0	21.0	21.0	21.0
Sub-total			-	50.0	50.0	50.0	50.0	50.0	-
Local:	Grade	2	-	1.85	1.85	1.85	1.85	1.85	1.85
		3	-	1.61	1.61	6.44	8.05	8.05	8.05
		5	-	0.96	1.92	7.68	9.60	9.60	9.60
		6	-	2.49	7.47	10.79	11.62	12.45	12.45
		9	-	1.12	3.36	4.48	5.60	5.60	5.60
		Labourer	-	1.32	4.84	7.04	9.02	9.02	9.02
Sub-total			-	9.4	21.1	38.3	45.7	46.6	46.6
Total			-	59.4	71.1	88.3	95.7	96.6	46.6
Rice and Arable									
Expatriate:	Grade	B	-	29.0	29.0	29.0	29.0	29.0	-
		C	-	21.0	21.0	21.0	21.0	-	-
Sub-total			-	50.0	50.0	50.0	50.0	29.0	-
Local:	Grade	2	-	1.85	1.85	1.85	1.85	1.85	1.85
		3	-	3.22	3.22	3.22	3.22	3.22	3.22
		4	-	-	2.74	4.11	5.48	6.85	8.22
		5	-	-	1.92	3.84	5.76	7.68	9.60
		6	-	3.32	4.15	6.64	11.62	11.62	11.62
		7	-	1.38	2.76	4.14	5.52	6.90	6.90
		9	-	1.12	2.24	3.36	4.48	5.60	5.60
		Labourer	-	0.88	1.10	1.10	1.76	1.98	1.98
Sub-total			-	11.8	20.0	28.3	39.7	45.7	49.0
Total			-	61.8	70.0	78.3	89.7	74.7	49.0
Total costs:									
Expatriate			-	243.0	314.0	314.0	314.0	257.0	-
Local			-	32.4	106.7	151.0	188.5	215.1	218.4
Total			-	275.4	420.7	465.0	502.5	472.1	218.4

TABLE 7.8

Staff Economic Costs
('000 US$)

			Project year						
			1	2	3	4	5	6	7
Administration and General Services									
Expatriate: all grades			-	214.5	246.0	246.0	246.0	1 92.0	-
Local:	Grade	1	-	1.95	1.95	1.95	1.95	1.95	1.95
		2	-	1.45	1.45	1.45	1.45	1.45	1.45
		3	-	2.52	3.78	3.78	3.78	3.78	3.78
		4	-	1.08	5.38	5.38	5.38	5.38	5.38
		6	-	-	0.66	1.36	1.98	1.98	1.98
		7	-	-	3.85	7.70	8.80	8.80	8.80
		8	-	1.62	0.48	7.29	7.29	7.29	7.29
		9	-	-	2.82	3.06	3.29	3.29	3.29
		Labourer	-	0.19	1.90	1.90	1.90	1.90	1.90
Sub-total			-	8.8	28.3	33.9	35.8	35.8	35.8
Total			-	223.3	274.3	279.9	281.8	227.8	35.8
Irrigation and Civil Works									
Expatriate: all grades			-	-	75.0	75.0	75.0	75.0	-
Local:	Grade	2	-	-	1.45	1.45	1.45	1.45	1.45
		3	-	-	1.26	1.26	1.26	1.26	1.26
		4	-	-	1.08	1.08	1.08	1.08	1.08
		5	-	-	1.52	1.52	1.52	1.52	1.52
		6	-	-	1.98	1.98	2.64	2.64	2.64
		7	-	-	10.45	16.50	25.30	36.30	36.30
		8	-	-	2.43	3.24	4.05	5.27	5.27
		9	-	-	0.47	0.47	0.47	0.47	0.47
		Labourer	-	-	3.80	6.65	9.50	13.30	
Sub-total			-	-	24.4	34.2	47.3	62.8	62.8
Total			-	-	99.4	109.2	122.3	137.8	62.8
Field Services									
Bananas									
Expatriate: all grades			-	75.0	75.0	75.0	75.0	75.0	-
Local:	Grade	2	-	1.45	1.45	1.45	1.45	1.45	1.45
		3	-	1.26	1.26	5.04	6.30	6.30	6.30
		5	-	0.76	1.52	6.08	7.60	7.60	7.60
		6	-	1.98	5.94	8.58	9.24	9.90	9.90
		9	-	0.94	2.82	3.76	4.70	4.70	4.70
		Labourer	-	1.14	4.18	6.08	7.78	7.79	7.79
Sub-total				7.5	17.2	31.0	35.6	37.7	37.7
Total			-	82.5	92.2	106.0	110.6	112.7	37.7
Rice and Arable									
Expatriate: all grades			-	75.0	75.0	75.0	75.0	43.5	-
Local:	Grade	2	-	1.45	1.45	1.45	1.45	1.45	1.45
		3	-	2.52	2.52	2.52	2.52	2.52	2.52
		4	-	-	2.15	3.23	4.30	5.38	6.45
		5	-	-	1.52	3.04	4.56	6.08	7.60
		6	-	2.64	3.30	5.28	9.24	9.24	9.24
		7	-	1.10	2.20	3.30	4.40	5.50	5.50
		9	-	0.94	1.88	2.82	3.76	4.70	4.70
		Labourer	-	0.76	0.95	0.95	1.52	1.71	1.71
Sub-total			-	9.4	16.0	22.6	31.8	36.6	39.2
Total			-	84.4	91.0	97.6	106.8	80.1	39.2
Total costs:									
Expatriate			-	364.5	471.0	471.0	471.0	385.5	-
Local			-	25.7	85.9	121.7	150.8	172.9	175.5
Total			-	390.2	556.9	392.7	621.0	558.4	175.5

7.3.2 Utilities

Provision is made for the cost of utilities, mainly electricity for the project's offices, workshops and packing sheds. The total cost will rise by year 4 to US$ 66 700 giving a total 7-year development period base cost of US$ 260 100 with an estimated 15% foreign exchange element.

7.3.3 Land Levelling

The crop and farm holding budgets do not include the regular land levelling costs that will be required. Levelling will be needed every second year for annual crops and on the banana land which is planted each year, 0.5 ha for each banana holding, after the first crop on the holding. Average annual costs are estimated at US$ 26.9 for banana farms, US$ 53.8 for rice farms and US$ 67.2 for the larger general arable holdings. At full development the total annual base cost will be US$ 189 600 as shown in the summary table. The total 7-year development period cost will be US$ 430 300 with an estimated foreign exchange element of 60%, US$ 258 200.

7.3.4 Vehicle and Plant Operation

Financial and economic annual costs for project vehicles and plant are given in Table 7.9. The annual financial costs rise to US$ 812 600 by year 7 (Table 7.10). The foreign exchange component is estimated at 60% to give a total 7-year development period requirement of US$ 1.83 million in the total US$ 3.05 million that will be needed.

Table 7.11 sets out the annual costs at economic prices. As noted in Chapter 4 the economic costs provide for higher fuel and lubricant costs, and also interest at 10% per year and depreciation to allow for vehicle and plant replacement.

The cost of agricultural machinery operations are included in the crop costs for the calculation of the project's incremental benefits, as described in Chapters 3 and 5.

7.3.5 Infrastructure Maintenance

Funds are included to cover maintenance and repair of buildings and irrigation and drainage structures. These are estimated at 1.5% of capital costs a year for buildings and 0.5% a year for structures. At full development the annual costs will be US$ 162 300. The cost over the development period will be US$ 742 900 of which US$ 222 900 (30%) will be foreign exchange costs.

7.3.6 Other Operating Costs

Other costs are covered by the annual allowance of US$ 29 000 at full development. These include office expenses, staff and farmer training materials and attendance allowances and other miscellaneous items such as insurance of equipment, etc. The 7-year period cost will be US$ 89 300 with a 20% foreign exchange element (US$ 26 800).

7.4 Summary of Project Costs

The total base and contingency costs are summarised in Table 7.12. The total cost over the 7-year development period is US$ 80.1 million of which US$ 56.9 million (71%) is required in foreign exchange.

TABLE 7.9

Vehicle and Plant Operating Unit Costs at Financial and Economic Prices ('000 US$ each year)

Item	Financial	Economic
Vehicles:		
Short wheelbase 4 WD	7.2	12.0
Pick up 4 WD	5.1	8.1
Pick up 2 WD	4.8	7.1
5 tonne trucks	10.4	16.9
Personnel carrier	14.9	25.4
Motorcycles	1.6	2.3
Maintenance Plant:		
Hydraulic excavator	28.5	38.1
Crawler tractor (72 kW) with blade	24.1	30.8
2 WD tractor (45/50 kW)	7.6	9.2
4 WD tractor (45/50 kW)	8.8	10.6
Trailer (5 tonne)	0.6	0.8
Water tank trailer (2 500 l)	0.6	0.8
Fuel tank trailer (2 500 l)	0.6	0.8
Low loader tractor and trailer	12.5	16.0
Motor grader (150 hp)	26.7	35.1
Wheeled loader (90 hp)	15.6	20.6
10 tonne truck with crane	20.0	25.7
10 tonne flat truck	15.4	19.8
10 tonne tipper truck	17.7	22.7
Mobile workshop	16.3	30.0
Flail cutter	2.6	3.1
Concrete mixer	0.2	0.3
Water pump	1.1	1.4
Portable generator	3.7	4.7
Portable compressor	0.2	0.3
Vibrators	0.2	0.3

TABLE 7.10

Vehicle and Plant Operating Costs at Financial Prices ('000 US$ each year)

	Project year						
	1	2	3	4	5	6	7
Vehicles							
Short wheelbase 4 WD	-	36.0	43.2	43.2	43.2	43.2	43.2
Pick up 4 WD	-	10.2	15.3	35.7	40.8	40.8	40.8
Pick up 2 WD	-	14.4	33.6	48.0	57.6	67.2	76.8
5 tonne truck	-	10.4	10.4	10.4	10.4	10.4	10.4
Personnel carrier	-	14.9	14.9	14.9	14.9	14.9	14.9
Motorcycle	-	9.6	22.4	43.2	60.8	65.6	70.4
Sub-total	-	95.5	139.8	195.4	227.7	242.1	256.5
Maintenance Plant							
Hydraulic excavator	-	-	-	57.0	85.5	114.0	114.0
Crawler tractor (72 kW) with blade	-	-	-	24.1	48.2	72.3	72.3
2 WD tractor (45/50 kW)	-	-	7.6	22.8	30.4	45.6	45.6
4 WD tractor (45/50 kW)	-	-	8.8	8.8	8.8	17.6	17.6
Trailer (5 tonne)	-	-	0.6	1.8	2.4	3.6	3.6
Water tank trailer (2 500 l)	-	-	-	-	0.6	1.2	1.2
Fuel tank trailer (2 500 l)	-	-	-	0.6	1.2	1.2	1.2
Low loader tractor and trailer	-	-	-	12.5	12.5	25.0	25.0
Motor grader (150 hp)	-	-	-	53.4	53.4	80.1	80.1
Wheeled loader (90 hp)	-	-	15.6	15.6	15.6	15.6	15.6
10 tonne truck with crane	-	-	20.0	20.0	20.0	20.0	20.0
10 tonne flat truck	-	-	15.4	30.8	61.6	92.4	92.4
10 tonne tipper truck	-	-	17.7	17.7	17.7	35.4	35.4
Mobile workshop	-	-	16.3	16.3	16.3	16.3	16.3
Flail cutter	-	-	-	2.6	2.6	5.2	5.2
Concrete mixer	-	-	0.2	0.2	0.2	0.2	0.2
Water pump	-	-	1.1	1.1	1.1	2.2	2.2
Portable generator	-	-	3.7	3.7	3.7	7.4	7.4
Portable compressor	-	-	0.2	0.2	0.2	0.2	0.2
Vibrators	-	-	0.4	0.4	0.6	0.6	0.6
Sub-total	-	-	107.6	289.6	382.6	556.1	556.1
Total	-	95.5	247.4	485.0	610.3	798.2	812.6

TABLE 7.11

Vehicle and Plant Operating Costs at Economic Prices ('000 US$ each year)

	Project year 1	2	3	4	5	6	7
Vehicles							
Short wheelbase 4 WD	-	60.0	72.0	72.0	72.0	72.0	72.0
Pick up 4 WD	-	16.2	24.3	56.7	64.8	64.8	64.8
Pick up 2 WD	-	21.3	49.7	71.0	85.2	99.4	113.6
5 tonne truck	-	16.9	16.9	16.9	16.9	16.9	16.9
Personnel carrier	-	25.4	25.4	25.4	25.4	25.4	25.4
Motorcycle	-	13.8	32.2	62.1	87.4	94.3	101.2
Sub-total	-	153.6	220.5	304.1	351.7	372.8	393.9
Maintenance Plant							
Hydraulic excavator	-	-	-	76.2	114.3	190.5	190.5
Crawler tractor (72 kW) with blade	-	-	-	30.8	61.6	92.4	92.4
2 WD tractor (45/50 kW)	-	-	9.2	27.6	36.8	55.2	55.2
4 WD tractor (45/50 kW)	-	-	10.6	10.6	10.6	21.2	21.2
Trailer (5 tonne)	-	-	0.8	2.4	3.2	4.8	4.8
Water tank trailer (2 500 l)	-	-	-	-	0.8	1.6	1.6
Fuel tank trailer (2 500 l)	-	-	-	0.8	1.6	1.6	1.6
Low loader tractor and trailer	-	-	-	16.0	16.0	32.0	32.0
Motor grader (150 hp)	-	-	-	70.2	70.2	105.3	105.3
Wheeled loader (90 hp)	-	-	20.6	20.6	20.6	20.6	20.6
10 tonne truck with crane	-	-	25.7	25.7	25.7	25.7	25.7
10 tonne flat truck	-	-	19.8	59.4	79.2	118.8	118.8
10 tonne tipper truck	-	-	22.7	22.7	22.7	45.4	45.4
Mobile workshop	-	-	30.0	30.0	30.0	30.0	30.0
Flail cutter	-	-	-	3.1	3.1	6.2	6.2
Concrete mixer	-	-	0.3	0.3	0.3	0.6	0.6
Water pump	-	-	1.4	1.4	1.4	2.8	2.8
Portable generator	-	-	4.7	4.7	4.7	9.4	9.4
Portable compressor	-	-	0.3	0.3	0.3	0.3	0.3
Vibrator	-	-	0.6	0.6	0.6	0.9	0.9
Sub-total	-	-	146.7	403.4	503.7	765.3	765.3
Total	-	153.6	367.5	707.5	855.4	1 138.1	1 159.2

TABLE 7.12

Summary of Project Development Costs ('000 US$)

	Project year 1	2	3	4	5	6	7	Total	Foreign exchange
Civil Works:									
Flood protection	2 973	1 981	-	-	-	-	-	4 954	3 963
Land preparation	-	1 872	2 648	2 543	3 214	2 225	-	12 502	10 626
Canal and drainage work	1 600	2 662	2 237	2 131	2 770	1 919	-	13 319	10 376
Buildings and infrastructure	3 960	2 051	1 061	1 281	732	-	-	9 085	6 360
Design and supervision	859	859	666	631	647	405	-	4 067	3 254
Total Civil Works	9 392	9 425	6 612	6 586	7 363	4 549	-	43 927	34 579
Furniture and equipment	-	426	192	92	66	39	-	815	611
Vehicles and agricultural machinery	-	192	1 006	712	833	1 879	21	4 343	4 126
Construction plant	-	-	304	609	238	600	-	1 751	1 663
Credit fund	-	-	1 247	1 632	1 305	1 050	-	5 234	-
Total Capital Costs	9 392	10 043	9 361	9 631	9 805	7 817	21	56 070	40 979
Operating Costs:									
Staff	-	275.4	420.7	465.6	502.5	472.1	218.4	2 354.1	1 442.0
Vehicle operation	-	95.5	139.8	195.4	227.7	242.1	256.5	1 157.0	694.2
Plant operation	-	-	107.6	289.6	382.6	556.1	556.1	1 892.0	1 135.2
Utilities	-	-	10.0	50.0	66.7	66.7	66.7	260.1	39.0
Land levelling	-	-	-	47.1	80.7	112.9	189.6	430.3	258.2
Maintenance:									
Buildings 1.5%	-	59.4	90.2	106.1	125.3	136.3	136.3	653.6	196.1
Canal drainage structures 0.5%	-	3.1	8.3	12.7	16.9	22.3	26.0	89.3	26.8
Other costs	-	17.3	23.3	23.3	29.0	29.0	29.0	150.9	22.6
Total Operating Costs	-	450.7	799.9	1 189.2	1 431.4	1 637.5	1 478.6	6 987.3	3 814.1
Total Base Costs	9 392	10 493.7	10 160.9	10 820.2	11 236.4	9 454.5	1 499.6	63 057.3	44 793.1
Contingencies:									
- physical 10%	939.2	1 049.4	1 016.1	1 082.0	1 123.6	945.4	150.0	6 305.7	4 479.3
- financial 6%	-	629.6	1 260.0	2 066.7	2 955.2	3 195.6	628.3	10 735.4	7 626.0

CHAPTER 8

PROJECT ECONOMIC BENEFITS

8.1 Introduction

As discussed in Chaper 4, two economic analyses are presented. One is based on the 'Low' world prices given in the October 1986 World Bank Commodity Price Forecasts for the year 2000. The second - the High Price assumption - bases the economic prices on the 1980 to 1985 average actual international commodity prices from the same source. This 6 year period was one during which the world economy experienced slow growth on even stagnation and commodity prices were generally weak. The World Bank's October forecasts are very pessimistic and since by their nature they involve much uncertainty the High Price assumptions have been presented to give what can arguably be said to be a more likely, and less pessimistic scenario. Details of the prices used for crops and inputs are set out in Chapter 4 in Somali shillings.

The economic analyses have been presented in US dollars for a more uniform and simpler presentation. It should be noted that the benefits are not in terms of foreign exchange value equivalents since these have already been taken into account in deriving the farm gate crop and input values (Chapter 4). The conversion to dollars of crop and farm budgets have been at SoSh 90/US$ 1.00, the early 1987 official rate.

No direct benefits from livestock have been included in the analysis. During the development period, years 1 to 7, it is not likely that participating farmers will have significant numbers of livestock since they own few at present. Therefore a slow build-up may occur, although how many would be kept on the scheme is not clear. There will, however, be some benefit to animals passing through the project or seasonally kept in adjoining areas by nomads in the form of a plentiful supply of fodder - primarily crop residues. The quantities involved will be large and unit values are therefore likely to be very low especially if the present depressed state of the livestock and meat market continues (see Chapter 2).

8.2 Crop Budgets

The crop budgets shown in Tables 8.2 and 8.3 are based on the levels of yields and inputs given in Chapter 6.

With project:	High prices	Table 8.2
	Low prices	Table 8.3

Table 8.1 summarises the cost of mechanical operations which are the same for both price levels (see Chapter 4). The tables show the composition of the crop budgets in both Somali shillings and US dollars as outlined above.

Labour has been valued at SoSh 145 per man-day for the gu season (April to the end of August) and SoSh 80 per man-day at other times.

TABLE 8.1

Crop Machinery Inputs at Economic Prices (SoSh/ha)

	Maize	Rice	Sesame	Cowpea	Cotton	Banana		Vegetables
						Year 1	Years 2, 3 & 4	
Plough	6 240	6 240	6 240	6 240	6 240	6 836	-	6 240
Disc : light	-	-	-	-	-	5 700	-	-
Disc : heavy	5 580	5 580	5 580	5 800	5 580	-	-	5 580
Ridge	905	-	-	-	2 896	32 580	-	905
Sowing	-	3 888	-	-	-	-	-	-
Spray	-	1 560	-	-	-	-	-	-
Combine harvester	-	5 625	-	-	-	-	-	-
Transport	980	917	980	980	980	6 150	12 300	980
Total	13 705	24 810	12 800	12 800	15 695	51 267	12 300	13 705

Source: Consultant's estimates (see Chapter 4, Section 4.10)

TABLE 8.2

Crop Gross Margins at High Economic Prices (SoSh/ha)

	Maize	Rice		Sesame	Cowpea	Cotton	Onions[1]		Banana	
		Gu	Der				Gu	Der	Year 1	Years 2, 3 & 4
Gross Income										
Yield (kg/ha)	3 000	4 000		600	750	1 500	7 000			
Value (SoSh/kg)	29.0	32.2		124.3	82.8	84.9	41.5			
Gross income	87 000	128 800		74 580	62 100	127 350	290 500		301 900[1]	699 200[1]
Variable Costs										
Seed	870	4 347		1 492	3 726	2 485	312		6 000	-
Dressing	12	62		6	21	2	4		-	-
Fertiliser	6 597	9 364		2 731	1 950	6 608	5 243		65 290	73 800
Herbicide	-	5 400		-	-	-	-		-	-
Pesticide	1 830	1 050		-	520	4 938	1 670		38 160	38 160
Machine operations	13 705	24 810		12 800	12 800	15 695	13 705		51 267	12 300
Containers	600	1 320		480	300	1 500	1 200		4 500	9 000
Labour:										
- Gu	10 150	9 715	145	-	7 685	3 915	17 255	725	13 630	12 035
- Der	240	3 040	8 320	4 240	800	10 320	2 800	11 920	7 200	10 000
Total variable costs	34 004	59 108	54 818	21 749	27 802	45 463	42 189	34 779	186 047	155 295
Gross Margin:										
Somali shillings	52 996	69 692	73 982	52 831	34 298	81 887	248 311	255 721	115 853	543 905
US$	589	774	822	587	381	910	2 759	2 841	2 067	6 043

Note: (1) Banana gross income:

	Export sales			Local sales			Total
	tonnes	SoSh/t	SoSh	tonnes	SoSh/t	SoSh	SoSh
Year 1	10	29 500	295 000	2	3 450	6 900	301 900
Year 2, 3, 4	23	29 500	678 500	6	3 450	20 700	699 200

TABLE 8.3

Crop Gross Margins at Low Economic Prices (SoSh/ha)

	Maize	Rice		Sesame	Cowpea	Cotton	Onions[1]		Banana	
		Gu	Der				Gu	Der	Year 1	Years 2, 3 & 4
Gross Income										
Yield (kg/ha)	3 000	4 000		600	750	1 500	7 000			
Value (SoSh/kg)	24.8	22.3		106.3	70.8	82.4	35.5			
Gross income	74 400	89 200		63 780	53 100	123 600	248 500		254 900[1]	591 100[1]
Variable Costs										
Seed	750	3 015		1 276	3 186	2 490	267		6 000	-
Dressing	12	62		6	21	2	4		-	-
Fertiliser	6 597	9 364		2 731	1 950	6 608	5 243		65 290	73 800
Herbicide	-	5 400		-	-	-	-		-	-
Pesticide	1 830	1 050		-	520	4 938	1 670		38 160	38 160
Machine operations	13 705	24 810		12 800	12 800	15 695	13 705		51 267	12 300
Containers	600	1 320		480	300	1 500	1 200		4 500	9 000
Labour:										
- Gu	10 150	9 715	145	-	7 685	3 915	17 255	725	13 630	12 035
- Der	240	3 040	8 320	4 240	800	10 320	2 800	11 920	7 200	10 000
Total variable costs	33 884	57 776	53 486	21 533	27 262	45 468	42 144	34 734	186 047	155 295
Gross Margin:										
Somali shillings	40 516	31 424	35 714	42 247	25 838	78 132	206 356	213 766	68 853	435 805
US$	450	349	397	469	287	868	2 293	2 375	765	4 842

Note: (1) Banana gross income:

	Export sales			Local sales			Total
	tonnes	SoSh/t	SoSh	tonnes	SoSh/t	SoSh	SoSh
Year 1	10	24 800	248 000	2	3 450	6 900	254 900
Year 2, 3, 4	23	24 800	570 400	6	3 450	20 700	591 100

8.3 Farm Income

Farm incomes at full project development in terms of the total holding gross margins are set out in Table 8.4 for the two price assumptions. Again the data are given in Somali shillings with US dollars given in the last column. When considering the figures in terms of returns to each family it must be remembered that the banana growers will be expected to bear the cost of operating the packing sheds and all farmers will contribute to other costs as discussed in the last two sections of Chapter 6. In the analyses, these costs are given separately together with other project operating costs.

8.4 Build-up of Benefits

Smallholders will not immediately achieve the average crop yields assumed in the crop gross margins. It has been assumed that they will be realised in the smallholders fourth year. The build-up is unlikely to take longer since they are based upon existing crop varieties and banana cultivation practices and most smallholders will have had previous farming experience (see Chapter 2). Other factors favouring the assumed rate of yield development include the launch of project services relating to the procurement and distribution of essential crop inputs - seed fertilisers etc., - the co-ordination of crop disposal and the provision of technical advice through the extension staff. Details of the range and level of services are given in Annex 1, Section D. The overall distribution of water will also be controlled by the project authority in close liaison with settlers and their representative bodies.

The rate of average crop yield development assumed in the benefit calculations is summarised below (% of final yield):

	Year			
	1	2	3	4
Bananas	80	90	95	100
Rice	75	90	95	100
Other crops	60	75	90	100

Bananas

The progression reflects the relatively high level of extension and service inputs compared with other crops. This can be expected to result in good initial yield levels.

Rice

The high level of machinery operations and consequent likelihood of operational timeliness are the basis for assuming 75% of the final yield being obtained in the first year.

Other Crops

The rate of build-up in the first two years is assumed to be slower for the more widely grown cereal, oilseed and other crops. In practice these are likely to involve less intensive extension than bananas and the lack of mechanical harvesting could result in lower initial yields.

TABLE 8.4

Farm Gross Margins at Full Development at 'High' and 'Low' Economic Prices (SoSh '000)

Farm type	Crop	Area (ha)	Gross income	Variable costs	Gross margin SoSh '000	Gross margin US$
High						
Banana	Banana:					
	Year 1	0.5	151.0	93.0	58.0	644
	Years 2,3,4	1.5	1 048.9	232.9	816.0	9 067
	Maize	0.4	34.8	13.6	21.2	236
	Sesame	0.4	29.8	8.7	21.1	234
	Vegetable(1)	0.2	58.1	7.7	50.4	560
Total					966.7	10 741
Rice and arable	Rice(1)	2.0	257.6	113.9	143.7	1 597
	Maize	0.9	78.3	30.6	47.7	530
	Sesame	0.9	67.1	19.6	47.5	528
	Vegetable(1)	0.2	58.1	7.7	50.4	560
Total					289.3	3 215
General arable	Maize	1.5	130.5	51.0	79.5	883
	Sesame	1.2	89.5	26.1	63.4	704
	Cotton	1.2	152.8	54.6	98.2	1 091
	Cowpea	0.9	55.9	25.0	30.9	343
	Vegetable(1)	0.2	58.1	7.7	50.4	560
Total					322.4	3 581
Low						
Banana	Banana					
	Year 1	0.5	127.5	93.0	34.5	383
	Years 2,3,4	1.5	886.7	232.9	653.8	7 264
	Maize	0.4	29.8	13.6	16.2	180
	Sesame	0.4	25.5	8.6	16.9	188
	Vegetable(1)	0.2	49.7	7.7	42.0	467
Total					763.4	8 482
Rice and arable	Rice(1)	2.0	178.4	111.3	67.1	746
	Maize	0.9	67.0	30.5	36.5	406
	Sesame	0.9	57.4	19.4	38.0	422
	Vegetable(1)	0.2	49.7	7.7	42.0	467
Total					183.6	2 041
General arable	Maize	1.5	111.6	50.8	60.8	676
	Sesame	1.2	76.5	25.8	50.7	563
	Cotton	1.2	148.3	54.6	93.7	1 041
	Cowpea	0.9	47.8	24.5	23.3	259
	Vegetable	0.2	49.7	7.7	42.0	467
Total					270.5	3 006

Note: (1) Rice and vegetables double cropped.

Source: Consultants' recommendations and estimates.

The annual flow of farm incomes calculated on the basis of the above yield progressions are shown in Table 8.5. It has been assumed that the levels, and costs, of inputs are the same in each year.

TABLE 8.5

Build-up of Farm Incomes at 'Low' and 'High' Economic Prices

Farm Type	Percentage of final income for year				
	1	2	3	4	5
Banana					
Low Price	10	35	65	95	100
High Price	15	40	70	95	100
Rice arable					
Low Price	40	65	85	100	100
High Price	50	75	90	100	100
General arable					
Low Price	35	60	85	100	100
High Price	40	60	85	100	100

Source: Consultant's estimates - see text.

The longer income build-up period for banana farms reflects the gradual, half a hectare per year, planting of bananas. The cropping pattern on these holdings therefore varies during the establishment period as follows (hectares each year):

	Year			
	1	2	3	4
Bananas				
Year 1	0.5	0.5	0.5	0.5
Years 2,3 and 4	-	0.5	1.0	1.5
Total	0.5	1.0	1.5	2.0
Maize	1.9	1.4	0.9	0.4
Sesame	1.9	1.4	0.9	0.4
Vegetables	0.2	0.2	0.2	0.2

The changing pattern ensures that each holding is fully utilised every year at the target cropping intensity.

Where land becomes available in the second half of a year - as shown in Tables 2.1 and 2.2 - the farmer's first year income has been taken as one-half of a full years' income. In subsequent years the increase in income will be the same for both 'early' and 'late' start holdings.

The results of the project benefit calculations based on the above assumptions are summarised in Table 8.6 for each farming system at both the 'High' and 'Low' price assumption levels.

8.5 Project Incremental Benefits

The construction of the project will take out of production an equivalent area of rainfed cropping on land which will either be cropped already or be suitable for future rainfed farming. The opportunity cost of this land is represented by the inclusion in the crop budgets of the cost of all labour at the shadow prices given in Chapter 4. This item can be said to represent the value of rainfed production foregone as a result of the project, since only a minority of farmers work outside the area at any time. Those few that do so work at the Fanoole Irrigation Project (from the Homboy area) and on the banana estates (from the Burgaan area). The great majority, however, work their own holdings and this proportion is reported as being very high during the main cropping season.

To avoid any double counting of production foregone no additional account has, therefore, been taken of the value of rainfed crops that would be grown if the project were not implemented.

The benefits to the Homboy Project are shown in Table 8.6 at both High and Low economic prices.

TABLE 8.6

Project Benefits at High and Low Price Assumptions

	Project year								
	1	2	3	4	5	6	7	8	9
High Prices									
Farm benefits:									
- banana	-	-	252.4	1 742.2	4 428.5	8 179.3	11 115.9	12 636.8	12 889.2
- rice arable	-	-	140.7	301.8	522.4	1 245.8	2 439.4	2 821.9	3 054.3
- general arable	-	-	530.0	1 310.6	2 417.2	3 727.8	4 737.6	5 357.2	5 658.0
Total	-	-	923.1	3 354.6	7 368.1	13 152.9	18 292.9	20 815.9	21 601.5
Low Prices									
Farm benefits:									
- banana	-	-	127.2	1 089.9	3 049.4	6 057.1	8 579.1	9 979.1	10 178.4
- rice arable	-	-	71.4	154.8	289.5	694.4	1 390.9	1 717.5	1 939.0
- general arable	-	-	393.1	1 079.5	2 004.1	3 076.6	3 977.0	4 496.9	4 749.5
Total	-	-	591.7	2 324.2	5 343.0	9 828.1	13 947.0	16 193.5	16 866.9

Source: Consultants' estimates - see text.

CHAPTER 9

ECONOMIC ANALYSIS

9.1 Economic Costs

Table 9.1 shows the project year-by-year economic costs, in US dollars. These are based on the financial costs given in Chapter 7, with the following adjustments:

(a) All capital and recurrent costs are net of duties and taxes.

(b) Foreign exchange costs have been converted from financial to economic values by means of the 1.5 conversion factor, which reflects the difference between the shadow and official exchange rates (SoSh 135/US$ and SoSh 90/US$ respectively). The resultant conversion factors are as follows:

- Capital costs:	
Civil works	1.39
Furniture and equipment	1.37
- Operating costs:	
Utilities, maintenance of civil works and miscellaneous costs	1.10

(c) Capital costs of vehicles are included in the form of annual depreciation and interest charges in the recurrent costs rather than as capital sums.

(d) Capital costs of construction plant are allowed for in the civil works costs, so are not included as a separate item in Table 9.1.

(e) Capital costs of agricultural machinery are taken into account in the crop budgets, in the form of depreciation and interest charges, and are therefore omitted from Table 9.1.

(f) Operating costs of vehicles and plant and for land levelling have been adjusted to allow for the difference between the economic and financial prices of fuel.

(g) To avoid double counting of costs the credit fund has been excluded from the economic analysis. The items of crop production expenditure for which the credit would be used are already included in the crop budgets.

(h) Local staff costs are net of personal taxes, as shown in Tables 7.6 and 7.8. It has been assumed that expatriate staff are not subject to personal taxation in Somalia. The foreign exchange costs of such staff have been shadow priced.

(i) Physical contingencies, at 10% are included but financial contingencies are excluded.

TABLE 9.1

Project Capital and Recurrent Costs at Economic Prices
('000 US$ per annum)

	Project year 1	2	3	4	5	6	7 onwards
Capital Costs							
Civil works	13 055	13 101	9 191	9 155	10 235	6 323	-
Furniture and equipment	-	584	263	126	90	53	-
Total	13 055	13 685	9 454	9 281	10 325	6 376	-
Operating Costs							
Staff	-	390	557	593	621	558	176
Vehicle and plant operating and land levelling	-	154	368	755	936	1 251	1 349
Utilities	-	-	11	55	73	73	73
Maintenance	-	69	108	131	156	175	179
Other	-	19	26	26	32	32	32
Total	-	632	1 070	1 560	1 818	2 089	1 809
Total base costs	13 055	14 317	10 524	10 841	12 143	8 465	1 809
Contingencies (10%)	1 306	1 432	1 052	1 084	1 214	847	181
TOTAL COSTS	14 361	15 749	11 576	11 925	13 357	9 312	1 990

9.2 Economic Analysis

9.2.1 The Main Analysis

Table 9.2 shows the project costs and benefits. The assumed project life is 30 years, with a residual value of plant and machinery of 25% of replacement costs in the first year. No residual value has been assumed for the civil works, which include buildings and banana packing shed equipment. Based on the figures in Table 9.2, the results of the economic analysis are as follows:

	High Prices	Low Prices
Internal rate of return (IRR)	18.8%	14.7%
Present values at 10% at Year 0 (US$ '000):		
- Costs	66 442	66 442
- Benefits	121 345	93 768
- Net present value (benefits minus costs)	54 903	27 326
- Benefit - cost ratio	1.83 : 1	1.41 : 1

At both price levels, therefore, the Homboy Irrigation Project would be economically viable. In the Interim Report of December 1986 the provisional IRR was much below the IRRs quoted above. Subsequently, a thorough review of both costs and benefits was undertaken, the most significant changes from the Interim Report being as follows:

(a) The cost of civil works was reduced by over 35%, due to:

- the introduction of continuous irrigation without night storage;
- removal of the gravel surfaced roads;
- the number of village centres has been reduced by half from 10 to 5, and the level of infrastructure for each has been kept to a minimum;
- farmers' housing costs have been reduced significantly from the original proposals. Instead of building houses for settlers each family will be expected to construct their own from materials supplied by the project authority.

(b) The cost of agricultural and other machinery and plant in the Interim Report, was based on the high complement of equipment proposed in the original study of 1980. These have been reduced, in keeping with the proposal that individual families will have farming backgrounds and provide as much physical labour as possible for farm operations. This reduces the machinery needs for planting, weeding, harvesting and transport for all crops except rice, where there is a particular labour constraint during planting and harvesting. These reductions affect both capital and operating costs.

TABLE 9.2

Project Economic Costs and Benefits at High and Low Prices
(US$ '000)

Year	Low price assumption			High price assumption		
	Costs	Incremental benefits	Net cash flow	Costs	Incremental benefits	Net cash flow
1	14 361	-	(14 361)	14 361	-	(14 361)
2	15 749	-	(15 749)	15 749	-	(15 749)
3	11 576	592	(10 984)	11 576	923	(10 653)
4	11 925	2 324	(9 601)	11 925	3 355	(8 570)
5	13 357	5 343	(8 014)	13 357	7 368	(5 989)
6	9 312	9 828	516	9 312	13 153	3 841
7	1 990	13 947	11 957	1 990	18 293	16 303
8	1 990	16 194	14 204	1 990	20 816	18 826
9	1 990	16 867	14 877	1 990	21 602	19 612
10	1 990	16 867	14 877	1 990	21 602	19 612
11	1 990	16 867	14 877	1 990	21 602	19 612
12	1 990	16 867	14 877	1 990	21 602	19 612
13	1 990	16 867	14 877	1 990	21 602	19 612
14	1 990	16 867	14 877	1 990	21 602	19 612
15	1 990	16 867	14 877	1 990	21 602	19 612
16	1 990	16 867	14 877	1 990	21 602	19 612
17	1 990	16 867	14 877	1 990	21 602	19 612
18	1 990	16 867	14 877	1 990	21 602	19 612
19	1 990	16 867	14 877	1 990	21 602	19 612
20	1 990	16 867	14 877	1 990	21 602	19 612
21	1 990	16 867	14 877	1 990	21 602	19 612
22	1 990	16 867	14 877	1 990	21 602	19 612
23	1 990	16 867	14 877	1 990	21 602	19 612
24	1 990	16 867	14 877	1 990	21 602	19 612
25	1 990	16 867	14 877	1 990	21 602	19 612
26	1 990	16 867	14 877	1 990	21 602	19 612
27	1 990	16 867	14 877	1 990	21 602	19 612
28	1 990	16 867	14 877	1 990	21 602	19 612
29	1 990	16 867	14 877	1 990	21 602	19 612
30	1 990	18 543	16 553	1 990	23 278	21 288

(c) Staffing levels have been reduced from the original study levels assumed in the Interim Report, through modification of the extension system proposals and emphasis on increased individual farmer responsibility in respect of water distribution and irrigation system maintenance, etc. Lower staff levels have therefore resulted in a smaller building programme (offices and houses) as well as lower annual operating costs.

(d) Crop benefits were also reconsidered and foreign exchange crop costs and returns were shadow priced at SoSh 135 rather than the SoSh 90/US$ official exchange rate used in the provisional calculations. The net effect was to give higher economic returns to the selected crops. Some smaller increases in benefits also resulted from assuming the port of entry and exit to be Kismayo rather than Mogadishu.

A major increase in benefits has accrued as a result of assuming that the 3 000 ha suitable for banana production is planted to bananas as soon as it is developed. In the Interim Report this was not to be done until after the results of the proposed 500 ha banana 'pilot' settlement project had been observed in project year 5. As shown in the sensitivity analyses, the inclusion of bananas is a major factor in the project's viability. Returns to rice were also improved as a result of the higher yields assumed, (4 000 kg/ha compared with 3 500 kg/ha in the Interim Report). The increase arose from further data on actual production achieved on other projects in Somalia, as discussed in Section B - Agriculture.

9.2.2 Sensitivity Analyses

The results of the sensitivity analyses carried out are shown in Table 9.3. At High Prices the IRRs range from 11.6% if no bananas are grown to 16.1% if benefits are delayed by one year but there are no changes in costs. The comparable figures at Low Prices are 8.4% and 12.7% respectively.

The project would be rather more sensitive to a fall in crop prices than to increases in capital and operating costs. In the former case, the IRRs would fall to 16.2% (High) and 12.4% (Low) compared with 16.6% (High) and 12.7% (Low) for an equivalent 15% rise in costs. Similar reductions in the IRR would occur if benefits were delayed by one year. These changes are, however, small compared with the reductions that would occur if no bananas were to be grown. If the banana holdings were planted to general arable crops, including cotton as the primary cash crop, the project would be marginally viable with the High economic prices and not viable with Low Prices. The respective IRRs would be 11.6% and 8.4%.

TABLE 9.3

Sensitivity Analyses
(US$ '000)

Assumptions	Present values at 10% at Year 0				
	Costs	Benefits	Net present value	Benefit-cost ratio	IRR (%)
Base Case:					
High Prices	66 442	121 345	54 903	1.83 : 1	18.8
Low Prices	66 442	93 768	27 326	1.41 : 1	14.7
Costs +15%; Benefits Unchanged					
High Prices	76 410	121 345	44 935	1.59 : 1	16.6
Low Prices	76 410	93 768	17 358	1.23 : 1	12.7
Benefits -15%; Costs Unchanged					
High Prices	66 442	103 161	36 719	1.55 : 1	16.2
Low Prices	66 442	79 719	13 277	1.20 : 1	12.4
Costs +15%; Benefits -15%					
High Prices	76 410	103 161	26 751	1.35 : 1	14.1
Low Prices	76 410	79 719	3 309	1.04 : 1	10.6
Benefits Delayed 1 Year; Costs Unchanged					
High Prices	66 442	108 056	41 614	1.63 : 1	16.1
Low Prices	66 442	83 465	17 023	1.26 : 1	12.7
Benefits Delayed 1 Year; Costs +15%					
High Prices	76 410	108 056	31 646	1.41 : 1	14.3
Low Prices	76 410	83 465	7 055	1.09 : 1	11.0
General arable farms replace banana farms; Costs Unchanged(1)					
High Prices	65 389	73 710	8 321	1.13 : 1	11.6
Low Prices	65 389	58 008	(7 381)	0.89 : 1	8.4

Note: (1) Costs adjusted for reduced expenditure relevant to non-banana crops.

Source: Consultant's estimates.